Opportunities for the Ocean Tracking Network in the Arctic

In December of 2012, the Ocean Tracking Network (OTN) developed a Strategic Plan to guide its infrastructure and scientific development. A key focus of OTN activity, both geographically and scientifically, is in the Arctic. While the challenges of successfully operating in this region are immense, OTN science can make a major contribution to maintain the health of Arctic ecosystems and in assuring the sustainable development of aquatic biological resources in the area. The purpose of this document is to lay out proposed OTN actions in the Arctic to realize the goal of the OTN Strategic Plan.

The Arctic is of immense strategic and socio-economic importance to Canada. Canada's North encompasses a land mass of about 3.9 million km^2 (about 39% of Canada's territory), and a sparse population of about 101,000 that is in large part dependent on local biological resources to meet subsistence needs. Federal, provincial and territorial governments responsible for the north are increasingly turning towards development of the presently lightly-exploited fish populations to provide jobs and food for their constituents. These governments are in need of basic research and effective monitoring programs to guide fisheries management so that harvesting occurs sustainably.

The arctic marine environment faces increasing anthropogenic pressure that has already altered the structure and function of its ecosystems and influenced the aboriginal people dependent on it. The important stressors impacting the arctic marine environment include:

a) climate change, including extensions of temperate species (e.g., harp seals, capelin, Atlantic salmon) into arctic waters.
b) growing exploitation of marine and anadromous species,
c) exploration and extraction of other natural resources,
d) increasing ship traffic

Unfortunately, the Arctic marine environment is one of the least studied and understood ecosystems on the planet. As well, the highly dynamic nature of this system (e.g., seasons of low and high solar radiation, temperature, productivity, etc.) makes comparisons, models and conservation and management plans developed for temperate and tropical systems ineffective. To guide the future developments that will occur, there is a pressing need for research that examines basic biological, ecological and oceanographic of arctic marine ecosystems, in addition to studies that quantify the impact of the multiple stressors on this system.

Present status of Canadian Arctic Research and Monitoring

There has been a history of independent research efforts in the Canadian Arctic, and these efforts continue. To facilitate communication and coordination among them, an umbrella group called the Canadian Network of Northern Research Operators has been formed. However, the complexities and increasing cost of conducting Arctic research has generated a rethink of Canadian Arctic Strategies. As a member of the Arctic Council, Canada is looking to coordinate, collaborate, and share research activities with other circum-Arctic nations, and to do so as well within the existing Canadian efforts. Canada's ArcticNet

research initiative, funded by the Network of Centres of Excellence of Canada and associated research partners drawn from government, and the public and private sectors, has developed a highly-successful and extraordinarily diverse series of collaborative research programs using shared infrastructures. These programs deal with both terrestrial and aquatic environments. ArcticNet researchers are active throughout the Canadian Arctic, working in the natural and social science areas, and their work involves many international collaborations. The Canadian government is also now proceeding with the development of the Canadian High Arctic Research Station (CHARS) in Cambridge Bay. CHARS will have a core research program of its own (currently being defined), but also envisions itself as a coordinating body for existing independent research programs which are currently underway in the Arctic (a hub and spoke model, with CHARS at the hub). Defense Research and Development Canada (DRDC) has developed world-leading capabilities for the operation of autonomous vehicles under the Arctic's ice, and in association with the Geological Survey of Canada in the mapping of the under-ice sea bottom. A number of environmental non-governmental organizations (ENGO's), including the WorldWide Fund for Nature (WWF), Oceans North, and Tides Canada have an active interest in Arctic issues, and in some instances have initiated independent or collaborative research programs with various partners.

OTN and the Arctic

From the OTN's conception the Arctic has been a key geographic focus. The initial OTN funding request to the Canada Foundation for Innovation called for the installation of acoustic telemetry capability in the Canadian Arctic, Alaska, and also in Greenland, as well as subarctic partnerships in Labrador. Subsequent to the finalization of the OTN award, anticipated funding for our Greenland partners failed to materialize and Greenland deployments have not proceeded. However, the Arctic, Alaska and sub-arctic deployments are in operation. The Natural Sciences and Engineering Research Council of Canada in funding its OTN Canada Network Grant placed a major emphasis on Arctic research. This research was initially centered at the University of Manitoba, the University of Windsor, and the University of Victoria, and DFO, but following staff retirements Manitoba has withdrawn. The work involves an extensive network of collaborators from within and without the OTN.

Geographically, OTN assets are primarily deployed in the central and eastern Arctic. They include acoustic receiver lines and/or oceanographic equipment near Resolute, Cambridge Bay, and off of Baffin Island (Pangnirtung and Scott Inlet). Additional equipment has been deployed in Prince William Sound, Alaska in association with the Prince William Sound Science Centre. OTN and its partners also have sub-Arctic telemetry equipment positioned along the coast of Labrador. OTN work in the Arctic is focused on its core mission of documenting the movements and survival of marine animals, and investigating how environmental variables impact them. This mission is unique to the OTN, and similar work is not being supported or conducted by any other research infrastructure or group in the Arctic. The results from the work can make important contributions to the sustainable development of the Arctic.

Progress on NSERC Funded OTN Arctic Research

Autonomous telemetry and oceanographic instruments are a necessity for full seasonal and long-term comprehensive research projects/programs in the Arctic. In phase I of NSERC sponsored OTN research, a key goal was to establish the viability (i.e., performance, reliability, durability) of these instruments in this harsh environment. In addition to this goal, the researchers strove to establish the infrastructure and generate data on oceanography in key ecosystems and movement and trophic interactions of key species.

The highlights of the Arctic Arena of OTN Phase I include:

a) Oceanographic and acoustic telemetry instruments worked very well in the arctic marine environment providing continuous data sets that could span a full calendar year. This research pushed acoustic telemetry receivers and tags to new depths (> 1000m), opening up opportunities to study deep-water species, many of which are important commercial fisheries globally. As well, extensive range testing of a suite of acoustic telemetry tags, including 69 and 180 kHz, was performed.

b) Extensive oceanography data was collected in Cumberland Sound that has established that much of the surface water in this eastern arctic ecosystem has a Pacific origin.

c) The first deep-water (>1,000 m) deployment of acoustic receivers provided the first data on the movement of deep-water fish species (Greenland halibut, arctic skate and Greenland sharks - commercial and by-catch species), which led directly to plans to move a management line to protect Greenland halibut stocks in Cumberland Sound.

d) Documentation of fine scale movement and behavior of arctic cod (an abundant and key species critically important for transferring energy from zooplankton to seabirds/marine mammals) and sculpin in the high arctic, which are currently being related to oceanographic and ice conditions.

e) Long term movement studies of ringed seals, Greenland halibut, arctic skate and Greenland sharks were initiated using archival satellite tags. These data have provided insights on the influence of environmental variables on the movement of these species, and include collaborations with researchers in Greenland and Denmark.

With increasing interest to develop northern fishing stocks, increasing ship traffic, changes to climate and ice conditions and natural resource exploitation there is a pressing need to quantify animal movements and relate this to oceanographic conditions in the Arctic. OTN, and associated equipment and expertise, can play a pivotal role in generating these data. A key element of this will be to partner, or continue partnerships, with government (e.g., Nunavut and DFO), environmental non-governmental organizations (e.g. WWF-Canada) and arctic programs (e.g., CHARs, Arctic Net) to maximize efforts and logistics in the Canadian Arctic. This research will need to address key issues related to conservation of arctic biodiversity and development of marine resources. Key issues in the Arctic can be addressed using autonomous acoustic and oceanographic technology, and the associated OTN expertise and technology, over the next five years. OTN investigations underway or being initiated at this time as part of Phase II of the NSERC sponsored research include:

Impact of temperate species on arctic ecosystems and biodiversity. As waters warm and ship traffic brings organisms from the south, the movement of temperate species to the Arctic waters has accelerated and expanded. There is a need to quantify the ecology of native species and also to examine how this has changed with the presence of new species. Phase II of OTN will expand the species being studied to include the Arctic charr, an anadromous fish of great importance for subsistence fisheries and which is being eyed for development of commercial fisheries. The work will document the movements and genetic structure of the native Arctic charr but will also be examining the potential impact of Atlantic salmon on arctic charr ecology and biology. The Atlantic salmon is believed to be expanding its range northward due to climate change. Other new species that need to be assessed include capelin, harp seals and killer whales, and likely unforeseen species. Arctic cod are a key native species that will continue to be studied as part of OTN in the high arctic at Resolute Bay, but this work needs to expand to new regions of the Arctic.

Current PIs working on this issue: Tallman, Power, Fleming, Fisk, Heath, Vagle
Collaborating Gov't agencies: DFO, Government of Nunavut
Collaboration ENGO – WWF-Canada
Collaborating Arctic Research Groups: Arctic Net (L Fortier – Arctic cod)

Progress in Alaska

The OTN deployment in Alaska is very recent, having occurred in March of 2013. It is intended to pick up the movements of salmonids that migrate along the coast heading from southern locations toward feeding areas in the Bering Sea, and will also contribute to research on marine species including herring which have been acoustically tagged in this region.

Gaps

OTN assets are concentrated in the Central and Eastern Arctic. There is no OTN infrastructure in the Beaufort Sea, where large-scale offshore oil and gas developments are occurring. Our resources are also too limited to provide detailed acoustic receiver coverage of an area as vast as the Arctic. While we are successfully monitoring the movements and survival of species occupying limited ranges, we are not able to document regional-to-circum-Arctic movements. We also require funding to tag more Arctic animals to provide credible sample sizes for the research work underway. OTN as a relative newcomer to the Arctic is not well known in the Arctic research community.

Opportunities

Costs for deploying and maintaining things in the Arctic and limited transportation options are significant limiting factors for development of the OTN infrastructure in this region. However, there is potential for OTN to partner with the existing research initiatives already underway in the region to establish additional receiver coverage and possibly

oceanographic monitoring capability, significantly reducing costs. OTN research teams in turn can assist these other groups by deploying and maintaining their equipment in regions where our logistics are well established. A significantly enhanced infrastructure can be leveraged to attract the additional funding necessary to increase the number of tagged animals active in the Arctic.

Action items:

Getting OTN's presence in the Arctic recognized

- OTN will formalize linkages to ArcticNet by participating in ArcticNet annual meetings to make its Arctic activities and capabilities known to the ArcticNet community.
- OTN will seek membership in the Canadian Network of Northern Research Operators.
- OTN will liase with CHARS, to insure its inclusion as one of the "spokes" in the CHARS hub and spoke model.
- OTN will link its activities to the webpages of research partners such as WWF-Canada

Building Arctic infrastructure capability and partnerships

- OTN researchers will continue to execute their Arctic research programs in collaboration with the Government of Nunavut and DFO, and seek collaborations with the national and international research community in these programs.
- OTN will partner with Ocean Networks Canada (ONC) to add OTN receivers to the ONC cabled observatory that is being installed in Cambridge Bay, site of the future CHARS research station.
- OTN will seek opportunities to realize additional low-cost equipment deployments to strategically expand the scale and scope of its infrastructure deployment in the Arctic. This could include finding opportunities to place equipment on offshore oil and gas infrastructure in the Beaufort Sea, placing it on existing Arctic monitoring buoys, or by piggybacking on projects that have established logistics to inexpensively deploy equipment.
- OTN will offer logistical assistance to investigators who need access to Arctic sites where OTN has an established logistical chain.
- OTN will link its database on fish movements to the existing databases created by ArcticNet and other Arctic researchers, to make its data available to the community at large. This will also make available to OTN researchers potentially valuable data from other programs which they may not be aware of at this time.
- OTN will approach potential funders with an interest in Arctic research to inform them of the OTN capabilities and activities, with an eye to leverage funding opportunities and to serve as a match-maker between these groups and researchers who might be able to address their information needs.

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