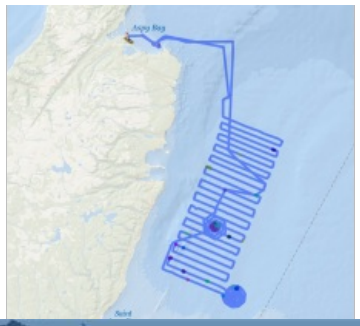
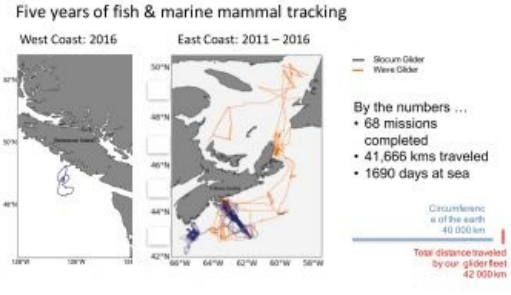
NEW TECHNOLOGY BRINGING SCIENCE AND INDUSTRY TOGETHER

Snow crab tracking using wave gliders





Coastal communities around the globe are seeking better ways to understand and manage regional ecosystems. They depend on the ocean to sustain economic opportunities, ensure food security and safeguard fragile environments and species. For harvesters, scientists and government organizations in Nova Scotia, Canada, timely, accurate and comprehensive data on movements of valued species such as crab is essential for designing effective fishery management regimes.

Ocean Tracking Network (OTN), the Canadian government and local harvesters have been tagging and monitoring aquatic animals for years. But not all tracking methods are practical or cost-effective for highly mobile, yet slow moving animals like snow crab and lobster. Electronic tagging systems and traditional bottom-moored acoustic receivers have limitations on detection range, and have to be periodically retrieved or interrogated via acoustic modems to get the data stored on them. The challenge for scientists is to seek new ways of developing 'mobile receivers' that can patrol an area and generate the same data that an extensive moored array would deliver.

To tackle this challenge, a powerful collaboration was formed under the leadership of OTN, working with local fishermen, Canada's Department of Fisheries and Oceans (DFO) and Emera Inc. scientists. These stakeholders have joined forces to explore new technologies and new ways to monitor snow crab migration in eastern Nova Scotia.

Figure 1: Canadian snow crab.

Ocean Tracking Network: a research initiative grows

Since 2008, OTN (oceantrackingnetwork.org), headquartered at Dalhousie University in Halifax, Nova Scotia, has been deploying acoustic receivers and oceanographic monitoring equipment in key ocean locations and inland waters around the world. In numerous projects they document the movements and survival of aquatic animals carrying a variety of electronic tags (acoustic, satellite, radio, data archival), with a special focus on acoustic technologies.

Maritime Link power line initiative

OTN's expertise in tracking marine animals was called upon to assist in evaluating potential environmental impacts on crabs and lobsters from the proposed undersea Maritime Link power line that would span the Cabot Strait exit of the Gulf of St. Lawrence. Multiple stakeholder groups needed a better understanding of crab migration patterns, to determine whether the project would impact the animals, and if yes how to mitigate any issues.

OTN joined forces with stakeholders to monitor snow crab migration in eastern Nova Scotia. The joint effort involved OTN, local fishermen, Canada's Department of Fisheries and Oceans (DFO) and Emera scientists (the project's proponents).

Each group has its own information needs about the crabs' movements, behaviour and population abundance.

- Emera focused on meeting the impact assessment directives for monitoring and documenting the habits and behaviour of snow crab before and after cable installation.
- OTN sought the best possible data for the scientific community to provide a foundation for sustainable oceans management.
- Commercial harvesters were working with government agencies to adjust fishing quotas so that they more accurately tracked the spatial distribution of the resource.
- DFO required further data to support its conservation and sustainable fisheries mandates.


Figure 2: Emera Maritime Link (left bottom box)â€“ Area with snow crab monitoring. (Image courtesy: Emera)

Fishermen gain visibility, strengthen dialogue

Commercial harvesters in Nova Scotia depend on a healthy ecosystem for their livelihood. Snow crab fishing is a major industry in the community, with annual revenues of more than CAD111 million (2014). Harvesters need to balance production as well as sustainability, bringing in the largest possible harvest without impacting the long-term health of the crab population.

Fishing quotas are a critical mechanism for balancing the long-term environmental and commercial needs of the fishery. With so much at stake, local harvesters are doing all they can to ensure that quotas will maintain sustainable fisheries.

Fishing in the Canadian waters of the North Atlantic is regulated by zones, and each zone is assigned a specific quota every year by the DFO. The agency sets these quotas based on data from an annual biomass survey, and statistical modelling which factors in things like environmental variables.

Quotas can vary dramatically between adjacent zones. One zone might allow an annual harvest of 8,000lbs., while its neighbour might permit 160,000lbs. It is not surprising that local harvesters whose activities are limited to specified zones, are not always in full agreement with their assigned quota – especially if it differs with their perception of the potential catch. An annual snapshot of a specific population cannot always reflect migration and other behaviour that is difficult to model.

Local fisherman note that scientists at the DFO have been going out year after year to perform biomass estimates, and if they cannot find crab in their annual surveys, the quota remains low. This is despite the fishermen's observations of phenomenal catches. Their theory is the crabs were moving from one zone to another which was missed in the annual survey (the survey also includes data collected from boats that report catching a tagged crab).


Figure 3: OTN Mission #46 (DL) to track tagged crab. (Image courtesy: OTN)

Emera maritime link and snow crabs monitoring mission

To monitor and accurately track the movement of the Snow Crabs, VEMCO Positioning System (VPS) arrays were deployed for fine scale movements (shown as red lines). The wave glider surveys (blue) provided valuable data on medium and long-range movements of snow crabs. Findings showed:

- At least 15 of 48 animals were detected in 2015
- Snow crab movement is extensive with documented travel as far as 600km+

A new partnership yields results

To help strengthen their case and verify their own informal observations, these fishing groups took the initiative to develop an acoustic tracking programme to see if the crabs were moving among zones. The harvesters built partnerships with government and OTN, paid to tag approximately 100 snow crab at their own expense, and provided their vessels and time to deploy undersea receivers along the fishing zone boundary line.

Dr. Whoriskey of OTN suggested using the wave glider to better monitor the movement of the snow crabs. The fishermen thought this was a great idea as they believed the wave gliders would provide more accurate monitoring of the mobile snow crabs. The fishermen questioned both stationary receivers used by OTN, as snow crabs may not always pass near the lines, and the annual stock surveys performed by DFO. By using the wave glider they could travel directly into where fishing is concentrated, and move back and forth across the area. This data could indicate if a crab had moved into an area. By combining both mobile (the wave glider) and stationary receiver lines, OTN got a more continuous survey of snow crab migration instead of a point in time snapshot.


Figure 4: OTN employee applying a tag to a crab before returning it to water. (Image courtesy: OTN)

OTN's experience with mobile autonomous platforms

OTN has been using wave gliders (of Liquid Robotics) for years in support of national and international research programmes. The wave glider is an autonomous, long-duration ocean robot powered by waves and sun. It can be instructed to patrol specific target areas continuously, 24x7, and deliver data on movements of marine life within these areas. It carries a broad array of scientific sensors and can communicate data in real-time from the seabed to space.

OTN has realized excellent results:

- Offloaded 500+ stations to date
- 97% success rate
- Saved ship days previously used to manually harvest data from receiver lines

The wave glider has proved its worth for supporting the operations and maintenance of acoustic telemetry arrays. Previously, researchers had to spend up to a week at sea retrieving data from fixed receivers. The wave glider initiative reduced the average cost of these voyages by 66%. Funds once used to harvest data could be redirected to more undersea receivers, expanding research, or other programmes. The development of the wave glider as a mobile receiver flowed naturally from this initial use.

This successful initiative not only provides new information about the behaviour of the crabs, it also sets the stage for continued dialogue and partnerships with all the stakeholders. Plans are already underway to tag additional crab in 2017, and DFO, as well as the OTN and harvesters, are committed to teaming up on the next phase of the project, which will involve how the crabs respond to a new marine protected area in the study region.


Figure 5: Liquid Robotics â€“ subsea view of the Wave Glider, a long-duration, unmanned ocean robot. (Image courtesy: Liquid Robotics)

Data for better science and resource management

Canada's DFO plays the central science role in the snow crab tracking project. This government agency strives for sustainable fishery management based on robust science. Since its ultimate mandate is sustainability of the fisheries, the organization must be conservation-oriented. When evaluating new data and methodologies, the DFO is cautious, but also open to new information and approaches.

When the DFO and harvesters came together to work on the wave glider tracking project, the DFO saw the project as an opportunity to add an important new set of data to its understanding of the local ecosystems. They were interested in using the acoustic tags to understand previously inaccessible segments of population, where there was very little information. Dr Jae Choi, DFO Science Maritimes, finds the use of the wave glider very fascinating as they are able to observe a segment of the snow crab population for which previously they had almost no movement (data).

Revealing the big picture with more data

With wave glider data provided by OTN, DFO can access new sources of data about species that had been unavailable using previous methods. The wave glider can also provide near continuous data upload and mobile tracking over longer periods of time – a capability that simply was not possible with boat catches or fixed undersea receivers. The wave gliders can cost-effectively patrol an area for weeks or months to provide an extended view into the behaviour and migration patterns of these mobile animals. DFO can also tag other species such as crab predators that are associated with the crab ecosystem, to gain a better understanding about the relationships between different species in the area.


Figure 6: Five years of fish and marine mammal tracking 2011-2016. (Image courtesy: OTN)

A springboard for collaboration and future opportunities

The community-driven research programme is an important partnership model for helping Canada's coastal communities sustain economic opportunities, ensure food security and safeguard ecosystems. Local fishermen are gaining access to data that could potentially impact their industry through a mobile platform that can share data on tagged animals instantly. Scientists and academics at DFO and OTN are expanding their studies and tapping into data that can help them do their jobs better and more cost-effectively.

But among the most exciting developments is the close collaboration between all parties, which culminates in a yearly Snow Crab Summit. The project has brought together a diverse set of groups, all working toward a common goal: gaining the best available science on the health and behaviour of a species that is vital to the region.

Nova Scotia's fishermen, government agencies, scientists, and other stakeholders are looking forward to continued collaboration to enhance their knowledge in the years to come.

Manufacturer	Model	Measurements
Airmar	200WX	Lat/lon, air temperature, barometric pressure, wind speed, wind direction
Datawell	MOSE-G	Wave height and direction
SeaBird	GPCTD + DO	Conductivity, temperature, dissolved oxygen concentration
Turner	C3	Chlorophyll a fluorescence, CDOM fluorescence,

		turbidity @ 850nm
Vemco	VR2C	Acoustic receiver @ 69kHz

Table 1: Wave glider with the following instrumentation.