PHOTO Nick Hawkins Photography



TRACKING NETWORK

2019+ ANNUAL REPORT



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OCEAN TRACKING NETWORK 2019+

Message from the directors

Since 2008, the Ocean Tracking Network (OTN) has been creating a unique global research, conservation and infrastructure platform that tightly integrates biological, oceanographic and social sciences, promotes technological innovation, and fosters collaborative partnerships across sectors and around the world.

In 2019, we continued investing in this winning formula by forming new collaborations and expanding our world-class infrastructure.



We offered expertise and facilitated training for students, early career researchers and the science community in field operations, data management and the deployment and maintenance of infrastructure and other technologies.

The recent months have posed some unique challenges. Similar to many other organizations, our headquarters staff have shifted to a remote work environment, adapting to new realities brought about by the global pandemic. We are enormously proud of the way OTN staff have continued to support our collaborators around the world, have kept our infrastructure fully functional, and have grown OTN's reach despite the difficulties and limitations of working in a COVID-19 environment. We hope this review of our 2019+ activities finds our readers well, and we look forward to updating you on OTN's 2020 projects in the coming year.

Sara lurson

SARA IVERSON. Scientific Director

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FRED WHORISKEY, Executive Director

INTRODUCTION

About OTN

OTN is a global aquatic research, data management and partnership platform headquartered at Dalhousie University in Halifax, Nova Scotia, Canada.

OTN's mission is to inform the stewardship and sustainable management of aquatic animals by providing knowledge on their movements, habitats and survival in the face of changing global environments.

Since 2008, OTN has been deploying acoustic and satellite tagging systems, oceanographic monitoring equipment and marine autonomous vehicles (gliders) in key ocean locations and inland waters around the world. OTN's technical capabilities continue to expand with the addition of remotely operated vehicles (ROVs) and side scan sonar systems.

OTN is changing the way oceans and freshwater systems, and the life that moves within them, are understood. New technologies are providing a window into the underwater world; at the same time, the way this information is stored, managed, shared and visualized is creating and sustaining networks around the world.

Together, the Network and its collaborators are tracking animals, connecting people and transforming global oceans management.

Highlighted Projects



More than 20,000 mutually compatible acoustic receivers are deployed across the globe at any given time. OTN positions its equipment to link to and leverage this existing receiver capacity, creating a worldwide network and providing truly global tracking coverage.



238 SPECIES TRACKED



AS OF APRIL 2020

576 PROJECTS 843 CONTRIBUTORS

202 INSTITUTIONS

Knowledge generated through OTN collaborations is used provincially, federally and internationally to help guide the management of valued aquatic species and the sustainable use of ocean and freshwater systems.

For a complete list of OTN-supported projects, visit: MEMBERS.OCEANTRACK.ORG

1652 ACTIVE RECEIVERS

CANADIAN HIGHLIGHTS



INVESTIGATING IMPACTS ON JUVENILE **ATLANTIC SALMON MIGRATION**

Atlantic salmon are highly valued in Canada for cultural and recreational reasons. However, the species is currently listed as endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Researchers from Dalhousie University, Fisheries and Oceans Canada (DFO) and the Atlantic Salmon Federation (ASF) are using acoustic telemetry and genome techniques to study juvenile salmon as they move from rivers to the sea to better understand whether aquaculture and/or hatcheries or the natural environment are hindering the recovery of salmon stocks.

MEASURING IMPACTS OF VESSEL TRAFFIC ON PACIFIC KILLER WHALES AND CHINOOK SALMON

Until now, little was known about the impacts of shipping along North America's Pacific coast on killer whales and their primary prey-Chinook salmon. Researchers are using acoustically tagged Chinook salmon in the Strait of Georgia and a passive array of 10 hydrophones in Cowichan Bay, British Columbia, to collect data on encounters based on shipping noise and whale vocalizations. This is an important step toward understanding impacts and filling knowledge gaps on how salmon respond to shipping traffic and avoid predation.

MONITORING IN THE MUSQUASH ESTUARY MARINE PROTECTED AREA

The Musquash Estuary Marine Protected Area (MPA) is located 20km south of Saint John, New Brunswick, and encompasses the Musquash Estuary. OTN acoustic receivers are assisting DFO in ongoing monitoring of the estuary's ecosystem to determine how migratory species are using the area, and to ensure the conservation objectives of the MPA are being met. The project demonstrates the potential for using monitoring technology in the establishment and management of MPAs.

TRACKING NORTHERN COD IN NEWFOUNDLAND

Following a two-decade fishery moratorium, Canada's Atlantic northern cod stock is showing tentative signs of recovery. However, significant knowledge gaps on the seasonal distributions and migration pathways for this species remain. Researchers engaged in the Northern Cod Acoustic Tracking Project (NCAT) are tagging cod and working with OTN to place new acoustic receiver arrays in the Northwest Atlantic Ocean to better understand the movements, stock structure and habitat use of cod. Launched in the fall of 2019, the six-year study aims to help researchers, fishermen and decision-makers better predict the distribution of cod and provide information on the status of cod stocks-a critical step towards sustainable management of a re-developed Atlantic cod fishery.



GLIDING ALONG THE LABRADOR SHELF

In partnership with the Coastal Environmental Observation Technology and Research (CEOTR) group, the Nunatsiavut Government, Dalhousie University, Oceans North, the Ocean Frontier Institute (OFI), and DFO, a Slocum glider was launched off the coast of Nunatsiavut (Northern Labrador) to collect oceanographic data along the Labrador Shelf. This mission is the first of this new partnership that focuses on the North, and preliminary results will help determine future glider paths in the region.

INTERNATIONAL HIGHLIGHTS

TRACKING SHARKS IN THE EASTERN PACIFIC

Through a partnership with the MigraMar Network in the Eastern Pacific, OTN's acoustic receivers are monitoring poorly understood juvenile hammerhead sharks off the coast of Peru. MigraMar is also tracking more than 20 key species in the region, including sea turtles, sharks and rays. Information gathered from these tracking studies are used to inform conservation and management policy.

A SEASONAL WHALE CORRIDOR IN MADAGASCAR

In the Southwest Indian Ocean, along a 1,300km stretch of the Madagascar coast, passive acoustic monitoring is tracking the movements of blue whales, fin whales, and minke whales to investigate seasonal use of the region as a migratory corridor and breeding habitat.



SHARK INTERACTION IN PROTECTED AREAS IN THE CARIBBEAN

Off the coast of Florida and the Bahamas, OTN receivers are detecting the movements of Caribbean reef, tiger, bull, great hammerhead and nurse sharks. The Caribbean is one of the most understudied regions for shark conservation in the world. Information gathered from this collaborative research project aims to inform regional and international management policies by broadening understanding of how sharks live in, and travel among, protected areas in the Caribbean.

areas. These findings highlight the importance of multi-state cooperative management strategies, and researchers are now working to provide a comprehensive picture of their range. This long term (2015-2022) acoustic telemetry project is conducted by Bonefish and Tarpon Trust, together with Carleton University, the University of Massachusetts Amherst, and the Florida Fish and Wildlife Conservation Commission and in collaboration with both the Florida Acoustic Telemetry Network (FACT) and the Integrated Tracking of Animals in the Gulf of Mexico (iTAG).

A MULTI-STATE APPROACH TO MANAGE ATLANTIC TARPON AND PERMIT

In the Caribbean Sea, Atlantic Ocean and the Gulf of Mexico, permit and Atlantic tarpon play important roles in the ecosystem and support valuable recreational fisheries. An array of 75 acoustic receivers in the Florida Keys is gathering information on distribution and habitat use of these species to support regional conservation and management planning. Tracking has revealed mature tarpon moving over 1,000km along the east coast of the United States, and permit moving to spawning areas outside of current protected

IMPACTS OF COASTAL URBANIZATION ON SHARKS OFF THE COAST OF MIAMI

At the University of Miami in Florida, an OTNsupported array is helping researchers assess the impacts of coastal development and urban sprawl on shark health and behaviour. Researchers are using hydrophones and detection software to measure boat activity (noise) in relation to the residency patterns of tagged sharks. While the analyses so far have revealed no clear evidence of the effects of boat traffic on shark habitat use, the data offer insight on the potential impacts of urbanization on coastal sharks.

PROJECT SPOTLIGHT

Apognmatulti'k

species in Atlantic Canada

Bringing together Mi'kmaw, local, and western knowledge systems to better understand aquatic



THE PROJECT WAS LAUNCHED IN 2018, AND KEY MILESTONES TO DATE INCLUDE:

BAY OF FUNDY







TOMCOD TAGGED

BRAS D'OR LAKE



EEL TAGGED





Apognmatulti'k (Mi'kmaw for "we help each other") is a threeyear collaborative study that aims to increase understanding of the movements and seasonal habitat use of key species of interest to Mi'kmaw and coastal communities: American eel (katew), American lobster (jakej), and Atlantic tomcod (punamu) in the Bay of Fundy and Bras d'Or Lake ecosystems.

Research questions and experimental design are co-developed to reflect the values of all partners and facilitate knowledge sharing and learning across cultures. Data collected will be shared with communities, managers, and decision-makers to support the stewardship of aquatic resources.

The project has engaged four masters' students, one postdoctoral research fellow, six undergraduate students, and one research assistant. Additionally, a community liaison staff member is based in each study area to coordinate outreach and engagement activities. Several workshops have been hosted under the project, focused on data programming, field and metadata training, and surgical training.

The project is funded by a NSERC Strategic Partnership Grant, and is co-led by OTN, the Unama'ki Institute of Natural Resources (UINR), the Mi'kmaw Conservation Group (CMM), the Marine Institute of Natural & Academic Science (MINAS), DFO, Acadia University and Dalhousie University.

apognmatultik.ca



2019+ GLIDER HIGHLIGHTS

Gliders

With funding from OTN, OFI, the Marine Environmental Observation Prediction and Response (MEOPAR) Network and contributions from DFO, the CEOTR group operates Canada's largest operational fleet of gliders (six Teledyne Webb Slocum gliders and two Liquid Robotics Wave Gliders). The gliders have completed more than 100 missions, travelling more than 72,000km, and collecting 200 million data points along the way in support of oceanographic monitoring and animal tracking in Atlantic Canada and beyond.

WAVE GLIDERS

In 2019, CEOTR led three extended-duration missions, traversing 4,790km over 125 days. The gliders successfully offloaded tagged animal detections from the Cabot Strait Line, the Sable Island Array, and the Halifax Line long-established OTN receiver lines located off the coast of Atlantic Canada. The gliders also collected data on water temperature, salinity and currents, and recorded other oceanographic features in support of research and industry initiatives. As part of an ongoing partnership with Emera NL and DFO, a Wave Glider was deployed to track snow crab movements in Cape Breton—a highly valuable species for commercial fisheries in the region. The glider travelled 2,800km over 67 days and detected 111 tagged snow crab. Information will be used to understand the potential impacts of the Maritime Fixed Link power transmission line on crab movements.

PHOTO Riley Smith Photo, courtesy of MEOPAR

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SLOCUM GLIDERS

In 2019, Slocum gliders covered more than 4,400km in the Northwest Atlantic Ocean, sampling environmental conditions, tracking acoustically tagged animals, and listening for whales.

In support of MEOPAR's Whale Habitat and Listening Experiment (WHaLE), gliders equipped with hydrophones and sensors were deployed in the Gulf of St. Lawrence and Roseway Basin to listen for the calls of baleen whales. During the monitoring, 161 North Atlantic right whale, 119 fin whale, five blue whale, 143 sei whale and 79 humpback whale calls were detected.

PHOTO Nick Hawkins Photography

WHaLE researchers are seeking to understand the changing distribution of right whale food sources and how the whales are changing their movements in response. Results from glider missions also aim to reduce the number of right whale-ship collisions and are assisting with the protection of critical right whale habitats such as the Roseway Basin off southeastern Nova Scotia.

Understanding the migration routes, and habitat use of right whales helps reduce the risk of accidental ship strikes and fishing-gear entanglements-the main causes of death for these critically endangered mammals.



Results from glider monitoring are providing researchers with the scientific basis to establish policy and protected habitats for baleen whales including the critically endangered North Atlantic right whale.

PHOTO Nick Hawkins Photography

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TOTAL DETECTIONS BY TYPE



OTN has a total of 624.674.045 detections divided up into the following:

ANIMAL These detections are confirmed as belonging to a tagged animal deployed by an OTNaffiliated researcher or data partner.

TRANSMITTER These detections are from tags that were deployed in fixed locations (i.e. sentinel tags), or tag codes used by transceiver units, i.e. for inter-receiver synchronization.

MYSTERY TAG These detections are not yet associated with any deployed tag.

TEST These detections are of tags that have been identified by manufacturers as reserved for testing purposes only, but for which we have no associated information (i.e in the case of shipboard testing or sentinel transmitters).

INTERNATIONAL UNION FOR CONSERVATION OF NATURE SPECIES LISTED IN THE OTN DATABASE



HEADQUARTER HIGHLIGHTS

The OTN Data Centre (OTNDC) connects a global community of researchers, teaches open source data analysis tools, and contributes to the development of global data standards. OTN nodes across the globe are managing acoustic and other telemetry data using software and data systems developed and maintained by the OTNDC.

Over the past year, the OTNDC strengthened its connection with the Great Lakes Acoustic Telemetry Observation System (GLATOS), teaching workshops at the GLATOS annual meeting, and hosting a data managers workshop in Halifax for the OTNDC and GLATOS staff. This collaboration resulted in the implementation of new project, tag, and station metadata pathways from the core GLATOS data system to the global OTN data node network, facilitated through a GLATOS-controlled OTN Database node.

There was a great deal of expansion across the network of inter-compatible OTN data nodes in 2019. The OTNDC finalized integration with a fully inter-compatible data node managed by the FACT Network in the southeastern US and integrated the OTN node managed by the Atlantic Cooperative Telemetry/Mid-Atlantic Telemetry Observing System (ACT-MATOS) into the OTN network. The OTNDC also deployed a database node for MigraMar, a marine research and conservation network uniting the telemetry research community of the southeastern Pacific, operating from Chile to California.

The OTN Data Centre

WORKSHOPS

- In partnership with Dalhousie's SURGE Innovation sandbox, OTN hosted the Discover Coding workshop series, which introduced graduate students and researchers to data manipulation with Python. All workshop content is available on the OTN YouTube channel and GitHub.
- OTN staff facilitated Ocean Biodiversity Information System (OBIS) training for data managers from the St. Lawrence Global Observatory. Participants learned data analysis, formatting, and mapping of biological data and metadata held by this CIOOS regional node into OBIS' EML format.
- The OTN data team completed Carpentries training, a formally recognized certification for teaching programming and data analysis.

For a complete list of OTN database nodes and partners, visit: MEMBERS.OCEANTRACK.ORG



Events & activities

OTN SYMPOSIUM Arendal, Norway

The 8th annual OTN Symposium: Track, Connect, Transform, highlighted more than a decade of NSERC and CFI-supported research. Researchers and highly qualified personnel (HQP) from OTN's national and international arenas gathered in Arendal, Norway (in conjunction with the biennial International Conference on Fish Telemetry) to discuss next generation problem solving and integration across global networks. Participants also discussed data and field best practices, risk assessment and management opportunities, and the development and integration of key research themes across networks. Key themes included partnerships with industry, local harvesters, and Indigenous peoples, as well as bringing together different types of knowledge and data into collaborative projects. The 2019 symposium was made possible thanks to sponsorship from InnovaSea, the Centre for Ocean Ventures and Entrepreneurship (COVE), the Dalhousie Faculty of Science and especially a legacy sponsorship from our 2010-2017 NSERC network.

INTERNATIONAL YEAR OF THE SALMON

OTN marked the International Year of the Salmon (IYS) with a series of salmon-focused talks cohosted with Big Spruce Brewing. OTN's IYS talks toured Nova Scotia, with stops at NSERC's

Science Rendezvous at the Halifax Seaport Market, the Salmon Run in Ingonish, the Harrison Lewis Coastal Discovery Centre in Port Joli, and at a special Oceans Week Halifax screening of Artifishal. IYS is an initiative formed by the North Atlantic Salmon Conservation Organization and the North Pacific Anadromous Fish Commission to help address issues facing wild salmon populations and aid in the development of recovery strategies.

TAG! YOU'RE IT!

It was a record year for Tag! You're It! (TYI), OTN's 'conservation in a can' India pale ale crafted by Big Spruce Brewing. Thanks to its first-time inclusion in NSLC stores across Nova Scotia, the colla'beer'ation raised \$29.000 for local marine conservation organizations.



In recognition of IYS, funds were awarded to six organizations undertaking salmon habitat restoration and recovery efforts in their respective communities: the Cheticamp River Salmon Association, the Clean Annapolis River Project, the St. Mary's River Association, the Unama'ki Institute of Natural Resources, the Medway River Salmon Association, and the LaHave River Salmon Association.

Since its inception in 2017, 50 cents from every can of TYI have been allocated to organizations that focus on marine research, education, and conservation. As of April 2020, the partnership had raised more than \$55,000 (and counting)!



ABOVE ideasOTN co-chairs, Kim Whoriskey and Robert Lennox.

IDEASOTN TELEMETRY WORKSHOP

Students, postdocs, and early-career professionals learned about the latest in technology, statistics and network collaboration at the ideasOTN Telemetry Workshop—part of OTN's continued commitment to train the next generation of scientists. The workshop provided opportunities to improve the synthesis of collaborative research outputs and generate new ideas to push the field of telemetry studies forward. The workshop was organized by a committee of OTN students and early career researchers, and was sponsored by OTN, Innovasea, Lotek, and Star-Oddi. All content from the workshop is available on the **OTN** YouTube channel.



ABOVE Dr. Iverson stands next to Mattel's marine polar biologist Barbie, for which she served as the role model.

MATTEL AND NATIONAL **GEOGRAPHIC'S POLAR MARINE BIOLOGIST BARBIE**

OTN's Scientific Director, Dr. Sara Iverson, was recognized as an influential Canadian scientist and role model for Barbie's 60th anniversary campaign. In early 2019, Mattel Inc. and National Geographic launched a line of five career dolls and playsets with a focus on research, science and explorationfields where women have historically been underrepresented—to send the message that You Can Be Anything. To celebrate the launch, 11-yearold aspiring shark biologist, Shayla Lindsay won a personal experience with Dr. Iverson. Shayla spent a day at Dalhousie University, meeting other young female scientists in Dr. Iverson's lab and even joining a blue shark tagging trip in the Northwest Atlantic.

"I'm really pleased to help girls get excited about marine biology and the importance of understanding the ocean, and to play a role in giving them a chance to make their dreams a reality."

DR. SARA IVERSON





FUNDING AND SUPPORT GENEROUSLY PROVIDED BY:

