Acoustic tracking of marine species in Nova Scotia waters from receivers positioned near N.S. offshore oil and gas platforms: report on the first field season

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OCEAN TRACKING NETWORK

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Fig. 1. Using the shark table to surgically implant an acoustic tag in a blue shark.

Executive summary

With Deep Panuke E&T and R&D Fund support, Ocean Tracking Network personnel successfully fitted 20 female juvenile blue sharks off of Eastern Passage, Nova Scotia, with Vemco V16 (16mm) acoustic tags to track their movements in the Northwest Atlantic Ocean.

Tagging was conducted as part of a summer course (*Biology and Conservation of Sharks, Skates and Rays*) for senior undergraduates at Dalhousie University, which trained 23 students in shark capture and tagging, and telemetry techniques.

Six VR2W acoustic receivers were deployed around Sable Island in late summer 2013 to support blue shark tracking. Additional acoustic receivers were placed on offshore oil and gas infrastructure belonging to Encana, ExxonMobil, and Statoil. A receiver was also placed on an ROV (remotely operated underwater vehicle), which inspected the Deep Panuke pipeline.

At present, a total of 4212 detections of the tagged sharks have been retrieved, mostly from the inshore portions of the OTN Halifax Line. We anticipate additional detections on the outer portion of this line once data offload/servicing of these receivers is completed in early 2014. Additional detections were made on autonomous marine vehicles belonging to OTN, and on the newly-deployed Sable Island receivers. While none of the tagged sharks were detected on the receivers deployed by industry partners on buoys in proximity to their offshore platforms, these receivers did register an acoustically tagged grey seal. This animal was originally tagged on Sable Island on 30 June 2013. Subsequently it was detected on the Wave Rider buoy associated with Encana's Deep Panuke field (coordinates- 43.81200, -60.66500). The animal was first detected on 6 July 2013, and again on 10 Aug 2013.

All project milestones are on track or exceeded. We expect this and next year's work on the project to make a valuable contribution to our understanding of how the North Atlantic's top predators' use migratory pathways and hotspots in our oceans.

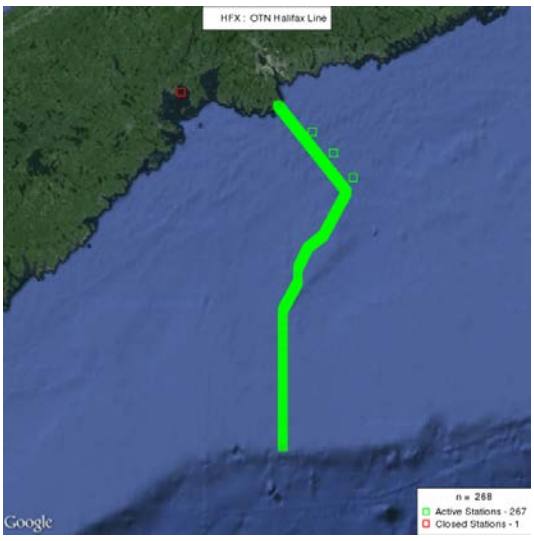


Fig. 2*. The Halifax Line acoustic telemetry line, comprised of 256 active stations over 200km from Chebucto Head, Halifax, to the Scotian Shelf. This line captures north-south movements of acoustically tagged animals including* Atlantic bluefin tuna, Atlantic cod, Atlantic salmon, Atlantic sturgeon, grey seal, spiny dogfish, blue shark and white shark.

Introduction

In 2013, the Deep Panuke E&T and R&D Fund supported Dalhousie University's Ocean Tracking Network proposal to conduct acoustic telemetry work in the Deep Panuke offshore oil and gas development region of Canada's East Coast.

The purpose of the study was to:

- Document the movements and marine habitats used by valued marine species in the Northwest Atlantic Ocean, particularly around Nova Scotia,
- Acoustically tag a currently understudied top predator (blue sharks, *Prionace glauca*) to provide fundamental information about the species' distribution and survival in Nova Scotia waters,
- Expand the capacity of North American east coast acoustic telemetry networks by augmenting acoustic receiver coverage in the region by deployments of new receivers on infrastructure associated with the offshore oil and gas industry, and through training of new professionals.

Key objectives included:

- Conduct a pilot project to deploy and maintain acoustic receiver units on appropriate offshore oil and gas infrastructure in Nova Scotia to complement existing receiver coverage,
- Quality Assurance/Quality Control the data from detections of tagged animals at these sites and store it in the OTN data warehouse,
- Capture, tag, and release 20 blue sharks per year for two years (2013 and 2014),
- Transmit recorded detection information from the data warehouse to the national and international investigators who have tagged the fish,
- Document movements, habitat use, and survival of acoustically-tagged marine animals, many of which are highly migratory (e.g., we are recording the movements of Bluefin tuna through NS waters from the Gulf of Mexico into the Gulf of St. Lawrence),
- Make the information freely available to end-users, including industry, government, and the public,
- Train 18 students per year in the use of the marine tracking technology and animal tagging,
- Expand the project to other offshore oil and gas platforms globally if this pilot project is successful.

This report gives initial results from the first field season of the project. All milestones for 2013 were met on time.

Methods

The surgical team was trained by the university veterinarian on the surgical implantation of acoustic tags into sharks prior to the 2013 field season. The Dalhousie University Animal Care Committee pre-approved all animal-handling procedures. All students were given a classroom demonstration on how to handle, tag, release, and track pelagic sharks based on current best practices of catch-and-release shark fishing. In addition, they were trained in the collection of scientific data and the application of veterinary techniques for shark surgery and post-surgery care.

In the field, 100lb rod-and-reel fishing lines and barbless J-hooks were used to catch sharks. Sharks were attracted to the fishing lines by a chum-slick. During fishing, two rods were set; one at the surface (< 4 m depth), and the second at a depth of > 30 m. Hooked sharks were brought to the boat as quickly as possible and hoisted into a specially constructed 'surgical table', which positioned the animal for surgery with its ventral side up and provided a gap on the bottom to accommodate the dorsal fin (Fig. 1). Individuals of this species enter into a state of tonic immobility when they are placed on their backs.

Fig. 3: Placement of the OTN acoustic receivers in the project area. The red squares mark the Halifax line stations with blue shark detections. The white and green tracks to the right of the Halifax line give the glider mission tracks for OTN gliders fitted with acoustic receivers. The red square close inshore to the left of the Halifax gives a blue shark detection by a glider. The orange square at the end of the Deep Panuke Pipeline gives the approximate positions of the receivers hosted by Encana and ExxonMobil on their infrastructure. A remotely operated vehicle (ROV) with an acoustic receiver on board also did a transect along the pipeline path during the annual inspection/maintenance of the Deep Panuke pipeline for Encana. Orange squares near the Flemish cap show the locations of the receivers placed in association with StatOil. These have yet to be retrieved so we have no data from them yet. The OTN Cabot Strait line is also shown.

Once on the shark table, the animal's gills were irrigated to provide oxygen. Prior to surgery, the shark length and girth were measured (cm). Weight (kg) was calculated from the formula weight in kg = (length * $(girth)^2$)/800, where length and girth are in inches. Sex was identified and recorded.

After sterilizing the surgery area (midway ventral side up between the pectoral and anal fins), a 3-4 cm incision was made in the abdomen, and the tag was inserted into the peritoneal cavity. Silk sutures were used to close the incision. The entire surgical procedure took less than seven minutes. Sharks were released as quickly as possible to reduce handling time and stress.

The acoustic telemetry infrastructure in the region includes the OTN Halifax Line and the OTN Cabot Strait Line (Figs. 2,3). In addition to these fixed lines, the OTN Wave Glider and Slocum electric gliders carried modified receivers to detect tagged animals during missions (Fig. 4).

Encana (one receiver at the Deep Panuke site), ExxonMobil (one receiver at the ExxonMobil Sable Offshore Energy Project site) and StatOil (three receivers at Flemish Cap sites) authorized the trial deployment of acoustic receivers on oceanographic buoys associated with their respective offshore oil platforms. Encana also permitted the attachment of a receiver to an ROV, which annually inspects the pipeline from the Deep Panuke site to the Nova Scotia coastline. A hand-held VR100 receiver was deployed from the blue shark charter vessel during the five tagging missions.

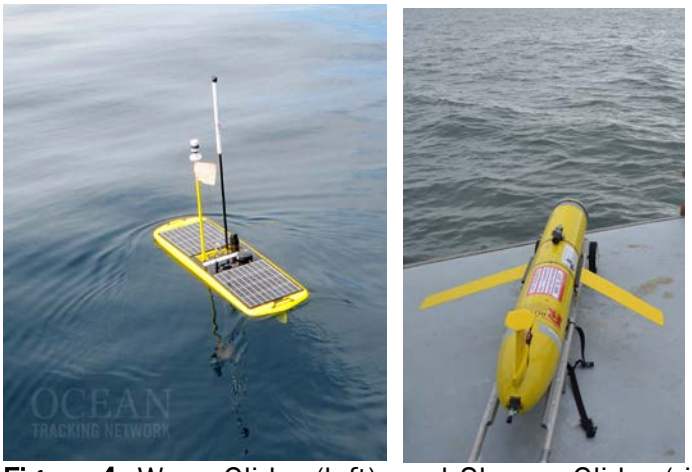


Figure 4. Wave Glider (left), and Slocum Glider (right). Both types of autonomous vehicles were fitted with acoustic receivers and deployed during the study.

Results and discussion

Over three missions between 31 July and 2 August 2013, 20 blue sharks were successfully caught, named, tagged, and released (Table 1). During this period, 23 students were trained in the capture, handling, tagging and tracking of acoustically tracked sharks as part of the Dalhousie University undergraduate course *Biology and Conservation of Sharks, Skates and Rays.* Sharks frequently show distribution patterns in the ocean in which individuals of similar sizes and ages group together; all sharks captured and tagged were juvenile females indicating the Eastern Shore area of Nova Scotia was favored by juvenile female blue sharks in 2013. This species is known to segregate by size and age. Young males and large females are uncommon in Nova Scotia waters, for unknown reasons. The six year lifespan of the tags that we have placed in our study's blue sharks will help us understand the movements of the species and hopefully permit us to identify some of the factors that contribute to the observed segregation in the species.

Using acoustic tags with a six-year battery life, and assuming that a significant portion of the tagged sharks survive for this duration, we should be able to document shifts in behavior as they grow and mature. This will provide valuable long-term information on the species where relatively little information currently exists. All 20 tagged sharks were subsequently detected on acoustic receivers lines in the region following receiver data offload. Thus, all animals successfully recovered from initial stress associated with capture and tagging. At this time, data analysis is preliminary and incomplete, as we have offload information from about 45% of the receivers on the OTN Halifax Line as of January 2014. We expect this download to be completed during the January—February 2014 period.

From the date the experimental animals were released through 1 December 2013, a total of 4,212 blue shark detections were recorded by the inner portion of the Halifax Line, Sable Island receivers, and the OTN autonomous vehicles. The majority of these detections come from the inner Halifax Line (n=4197). There were five additional detections from the gliders; two from Brianna on 7 October 2013 and three from Wryley, 2 days later, 9 October 2013. All ten detections from Sable Island were from Percy on 27 September 2013. No detections of the tagged blue sharks were obtained from receivers placed either on Encana or ExxonMobil offshore infrastructure, or on the Encana ROV. At this time, the receivers placed at the StatOil sites have not yet been retrieved. Two individuals were detected by the OTN Slocum glider during its mission covering the Halifax Line; one on 7 October and another on 9 October.

ANIMAL_ID (floy tag ID, pit tag code, etc.)	TAG ID CODE	CAPTURE LATITUDE	CAPTURE LONGITUDE	LENGTH (cm)	WEIGHT (kg)	SEX
Eva	26651	44.209163	63.27934	160	33	F
Percy	26652	44.20216	63.24593	138	20	F
Riley	26653	44.21458	63.23736	158	30	F
Meeko	26654	44.20345	63.25824	130	17	F
Sophie	26655	44.21245	63.227145	153	25	F
Brandy	26656	44.20226	63.24866	140	23	F
Lucy	26657	44.17844	63.23646	162	28	F
Xena	26658	44.20221	63.23848	164	41	F
Leia	26659	44.18082	63.22768	137	21	F
Hayley	26660	44.18111	63.22008	151	25	F
Blueberry	26661	44.17669	63.23979	152	25	F
Finnigan	26662	44.18141	63.22412	143	22	F
Wryley	26663	44.17254	63.23924	116	8	F
Brianna	26664	44.21387	63.24617	141	22	F
Tika	26665	44.20386	63.24852	152	25	F
Janina	26666	44.22348	63.24687	149	25	F
Lola	26667	44.201745	63.219623	139	18	F
Alyssa	26668	44.21659	63.23805	156	28	F
Ophelia	26669	44.20432	63.26720	129	11	F
Skylar	26670	44.21658	63.23802	162	31	F

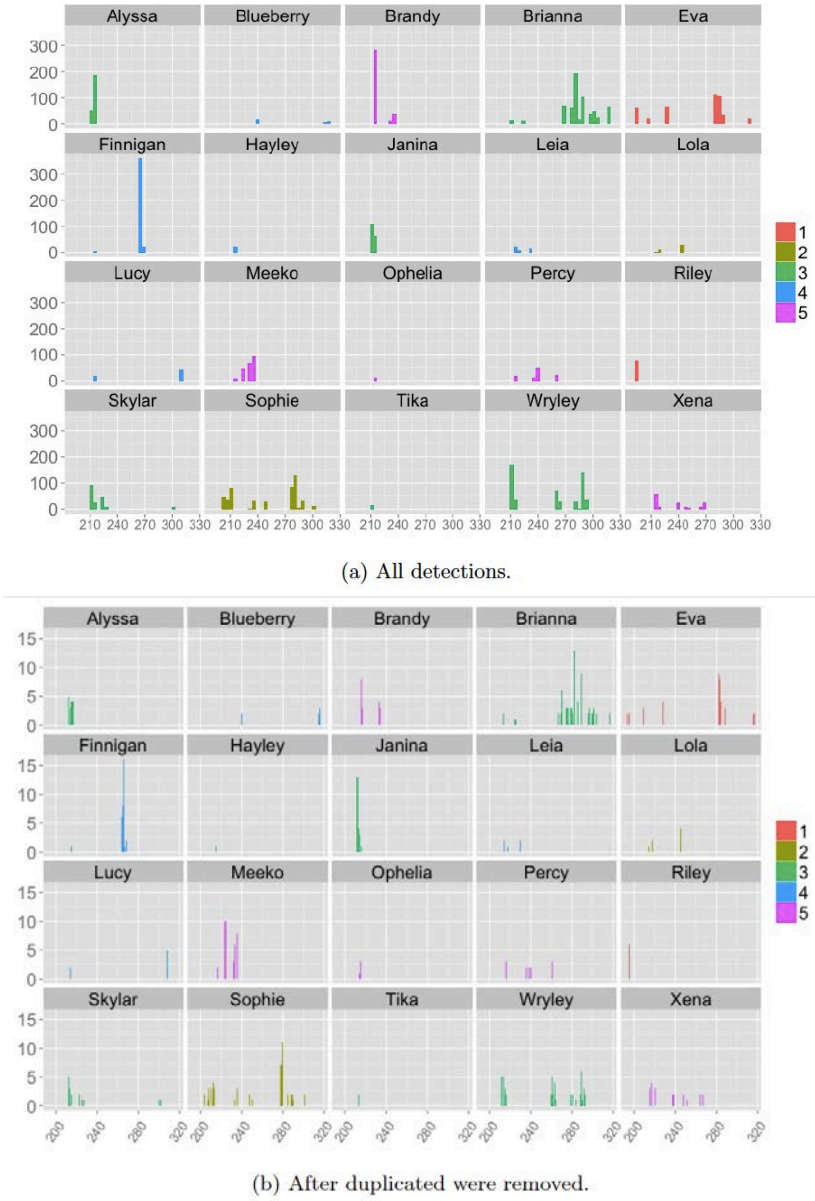
Table 1: Animal name (Animal_ID), tag ID code; latitude/longitude of catch and release location, length, calculated weight (to nearest kg), and sex of the 20 tagged sharks.

A summary of all detections of all sharks, by day of the year, is given in Fig. 5.

To simplify the analysis, multiple detections by the same individual on the same day at the same station were treated as a single confirmation-of-presence at a given station on a given day. This resulted in a new dataset containing 419 detections. Detections at a given station for individual sharks were fewer than 15 per day (Fig. 5b). Fig. 6 gives the number of detections on different days of the year per individual shark for the Halifax line.

Preliminary information suggests that these juvenile sharks generally remained in the area around Halifax through the summer and autumn. Detections dropped off on the inshore portion of the Halifax Line towards the end of September, with our last detections occurring in mid-November. If these animals subsequently moved offshore to avoid winter conditions we should see additional detections on the yet-to-be downloaded offshore portions of the Halifax Line. If they moved to the south, we may receive data on these movements from our

collaborators who maintain acoustic receiver lines in U.S. waters. These lines cover coastal areas from Maine to Florida.



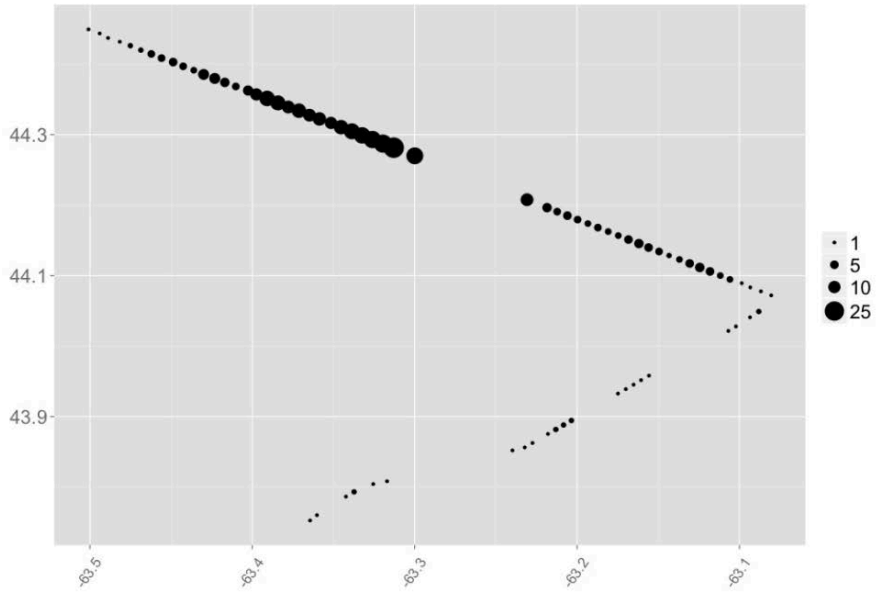
(a) All detections.

(b) After duplicated were removed.

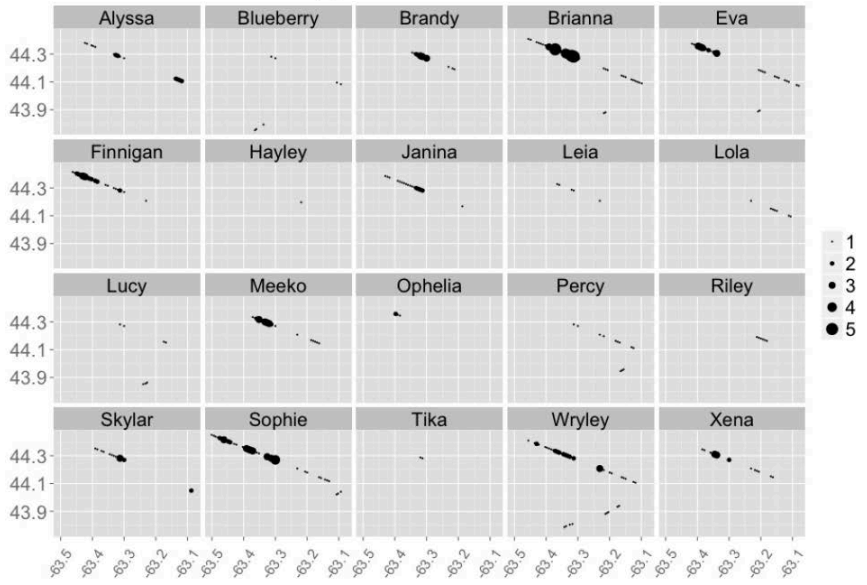
Figure 5. (a) Number of detections (Y axis) on the day of the year (X axis; Jan 1 = 1, Dec 31 = day 365) per individual shark for the HFX Line. (b) Number of Halifax Line stations (Y axis) on which individual sharks were detected, by day of the year (X axis). Information on individual sharks is given in Table 1. Animals plotted in the same color were tagged on the same day.

Most of the detections of tagged sharks occurred on the inner portions of the Halifax Line (Fig. 6a). We interpret this information with caution because of the incomplete nature of our information from the Halifax Line. However, the pattern may indicate that the majority of the animals remained in the inshore region for most of the study period, close to the point

where they were tagged. This suggests that the majority of animals of this size and age showed some degree of site fidelity, although this pattern did not apply to all of the experimental animals. One tagged shark (Percy) was detected on multiple receivers of the Halifax line, and subsequently at Sable Island (Fig. 7). Hence some individuals were wanderers.



(a) Overall distribution.



(b) Distribution per shark.

Figure 6: Plots of number of detections at each station by individual sharks between release and 1 Dec 2013. Stations are plotted in decimal degrees according to their latitude (Y axis) and longitudes (X axis). The size of the circle indicates the scale of detection frequency at each station. Panel (a) shows pooled data from all sharks. Panel (b) breaks down detections by individual sharks. The portion of the Halifax line covered by these data has a V shape, which was required to avoid mooring receivers in areas of high fishing intensity.

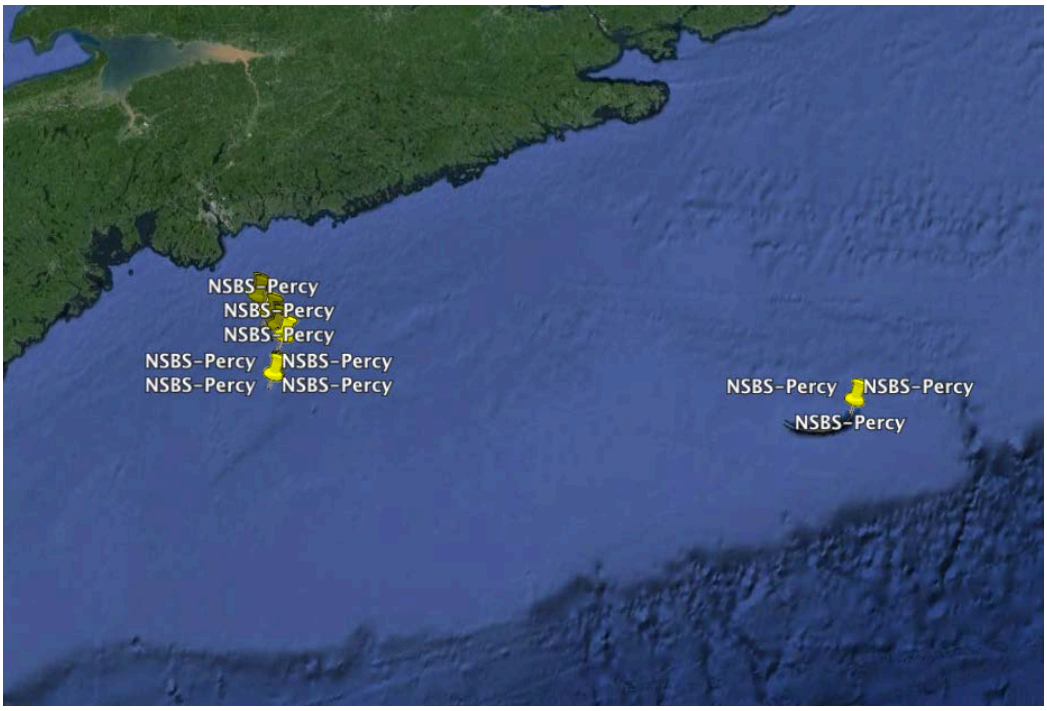


Figure 7. Detections of shark "Percy" on receivers on the Halifax line (left side of the figure), and at Sable Island (right side of the figure).

Concluding Remarks

The 2013 field season was highly successful. Considerable data has been obtained on tagged blue sharks, and we anticipate more will become available as the rest of the Halifax Line receivers are offloaded.

As noted earlier, none of the tagged sharks were detected at the offshore oil infrastructure sites. We suspect that this is explained by some degree of site fidelity to the area where sharks were initially tagged and released. As these animals grow larger, they may range farther afield. We also did not have detections from the Encana ROV which patrolled the continental shelf from the Deep Panuke site to the Nova Scotia mainland; however, two individual sharks were detected by the OTN Slocum glider. Lack of detections by the Encana ROV may indicate that there were no tagged animals in this area. Alternatively, it is possible that the noise from the operation of the vehicle impaired our ability to detect the coded tags of our animals. With permission of the company, we will reattempt this mission in 2014, but include a broad-spectrum sound sensor that will let us determine if interference affects receiver detection ability.

Student training

The study has given undergraduate students valuable practical experience, and their comments on the experience were universally positive. A selection of their comments includes:

"This was one of the most interesting courses I have taken. I left many days in deep thought or inspired by the content, and any course that is able to do this is clearly on the right track.'

"Great class. Loved every minute of it. Learned a lot!'

"One thing I really loved about this course was going out to see sharks in the wild."

"This was the coolest class ever!"

Of the 23 students, 22 responded that their favorite thing about the course was 'shark tagging'.

Media coverage

The project generated considerable positive interest in the media. Several local TV news crews filmed the capture and tagging of the experimental animals, and the field activities were also covered by radio, newspapers and web information services. Dalhousie University's new president, Dr. Richard Florizone, joined the students for a day of tagging and also captured one of the sharks used in the study.

Media coverage included:

Blue sharks tagged and tracked off Nova Scotia (CBC)
http://www.cbc.ca/news/canada/nova-scotia/blue-sharks-tagged-and-tracked-off-nova-scotia-1.1309567

New study aims to track blue sharks off Nova Scotia coast (CTV)
http://www.ctvnews.ca/sci-tech/new-study-aims-to-track-blue-sharks-off-nova-scotia-coast-1.1393059#ixzz2qOemJdDf

New Dal president joins marine mission to tag blue sharks (Chronicle Herald)
http://thechronicleherald.ca/metro/1145300-new-dal-president-joins-marine-mission-to-tag-blue-sharks

Dalhousie students set out to tag, track sharks off the coast of N.S. (CTV)
http://atlantic.ctvnews.ca/dalhousie-students-set-out-to-tag-track-sharks-off-the-coast-of-n-s-1.1392688

New funding for shark research in Nova Scotian waters
http://sharkyear.com/2013/new-funding-for-shark-research-in-nova-scotian-waters.html

Acknowledgements

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