Fish Tracking Study
Progress Report to FORCE – February 2011

Acoustic Tracking of Fish in the Minas Passage and at the NSPI (OpenHydro) turbine site

(extension of an OEER/OETR funded project)

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Summary

To examine the potential risk of fish – turbine interactions, we focused on the movements of three fish species in the Minas Passage area and near the NSPI/OpenHydro turbine in the FORCE demonstration area. Underwater acoustic telemetry receivers were deployed in the Minas Passage and in nearshore areas of the Minas Basin during July-Nov 2010 to track the movements of striped bass, Atlantic sturgeon, and American eel.

This project is an extension of the fish tracking project funded largely by the OEER. Funding from FORCE has allowed the tracking of an additional 50 fish implanted with VEMCO acoustic transmitters (Total tagged = 120 fish). All of the 50 acoustic tags funded by FORCE were implanted in striped bass, for a total of 80 striped bass tagged in May (N=43) and August (N=37). Most of the 30 tagged Atlantic sturgeon were captured, tagged and released in Minas Basin during August. Only 10 eels were captured in the Stewiacke River in early October 2010 and all of these were tagged and released.

Data from all acoustic receivers were downloaded in November. Data analysis is underway, with preliminary results for striped bass indicating very high post-surgery survival (>98%), and significant detections by receivers in the NSPI turbine berth area (31% of tagged bass) and by the OTN line of receivers stretching across the Minas Passage (66% of tagged bass).

Of the 10 eels tagged in October, three were detected as they migrated out of the Minas Basin and one of these was detected near the NSPI/OH turbine. All but 2 of the 30 tagged Atlantic sturgeon were detected, with 21 and 8 sturgeon detected by the OTN line and turbine receiver array, respectively.

Main Objectives (of the overall study, funded by both OEER and FORCE)

1) Define movement patterns (path, velocity, depth, seasonality, and number of passes) of tagged fishes passing through the NSPI (OpenHydro) turbine test area;
2) Detect dispersion and avoidance behaviour of tagged fishes moving in close proximity (< 500 m) of the NSPI (OpenHydro) turbine;
3) Assess movements of tagged fishes passing through the Minas Passage receiver line ("listening gate");
4) Collect *in situ* data to ground truth and refine the hydrodynamic models. These models can then be utilized to predict how objects moving through the water column might interact with the test turbines and, potentially, large scale commercial turbine arrays.

Tagging and Receiver Deployment

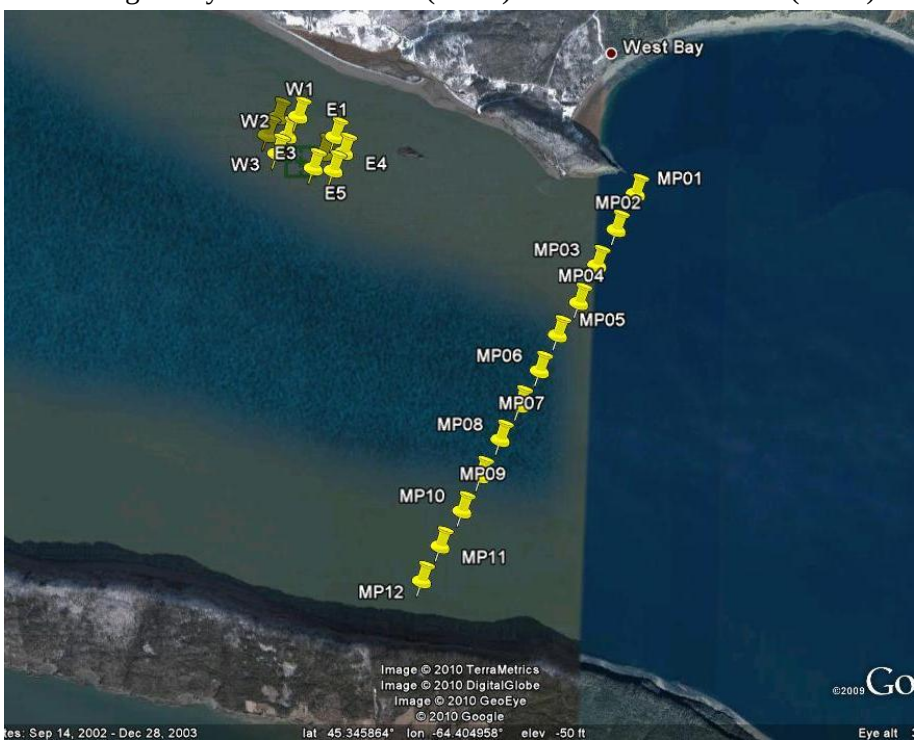
To date, 80 striped bass, 30 Atlantic sturgeon and 10 American eel have been implanted with VEMCO transmitters. Striped bass were captured through angling and tagged in two batches. The first group of large spawners (n=43, 22 males, 21 females, Mean TL: 71.1 cm) were tagged in the Stewiacke River during early May. The second group of schoolie-sized stripers (n= 37, Mean TL: 43.2cm) were tagged near the Gaspereau River mouth (Guzzle) in early August.

Atlantic sturgeon were tagged during August from shallow Minas Basin waters (Delhaven/ Cornwallis mouth area and Walton area) using a bottom trawler chartered from Delhaven. Eels were captured using fyke nets set in the Shubenacadie River near Enfield in early October.

During the summer and fall 2010, we monitored tagged fish movements using 30 receiver stations located throughout the Minas Basin and Minas Passage (see attached figures for locations and mooring units). An array of 10 acoustic receiver moorings was positioned around the turbine site on June 22, 2010. In addition, a 12 unit "listening gate" array of receivers was placed across Minas Passage on July 14 – this is a joint project between the Ocean Tracking Network and Acadia. All moored receivers within the Minas Passage were deployed using a chartered lobster fishing vessel from Parrsboro. An additional 8 receiver units were placed in intertidal sites of the Minas Basin and are part of an ongoing sturgeon tracking project at Acadia (Dadswell and Stokesbury).

One of the turbine array receiver units (deployed in June) was retrieved in August to examine wear on the unit. It was found that the unit was in excellent condition – and, after downloading of data, was redeployed. It appears that the new "compact" mooring design, which incorporates the VR2w receiver and acoustic release mechanism within the buoy bulkhead, is performing much better than the previous design. We also expect this design to improve the detection efficiency of the acoustic receiver as it will tend to tilt less.

a) Minas Passage array near OH turbine (N=10) and OTN receiver line (N=12) in 2010.



b) Minas Passage and Minas Basin receiver mooring locations in 2010.

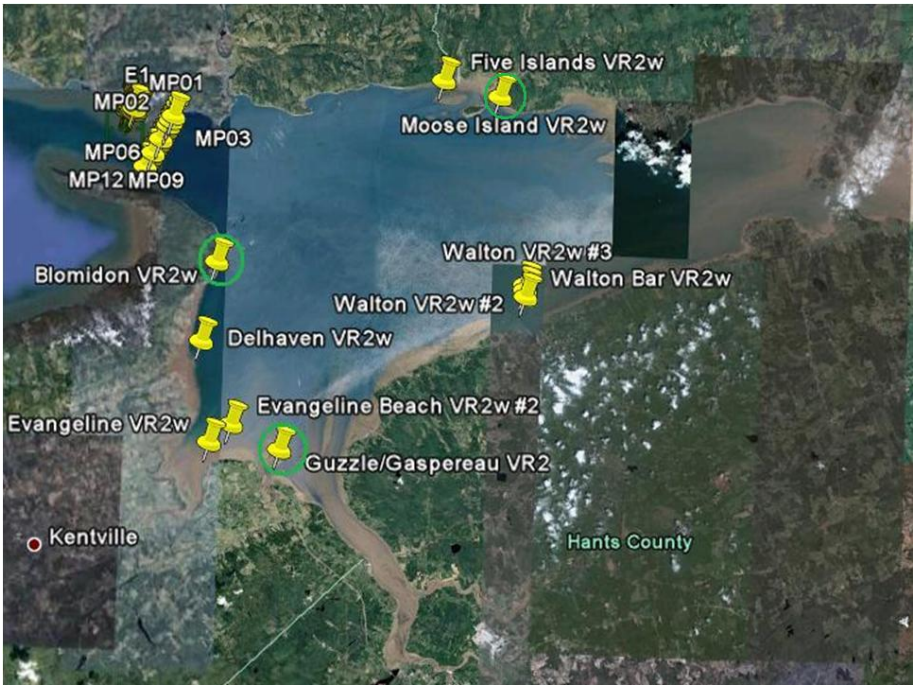


Figure 1. VEMCO receiver mooring arrays in the a) Minas Passage and b) Minas Basin.

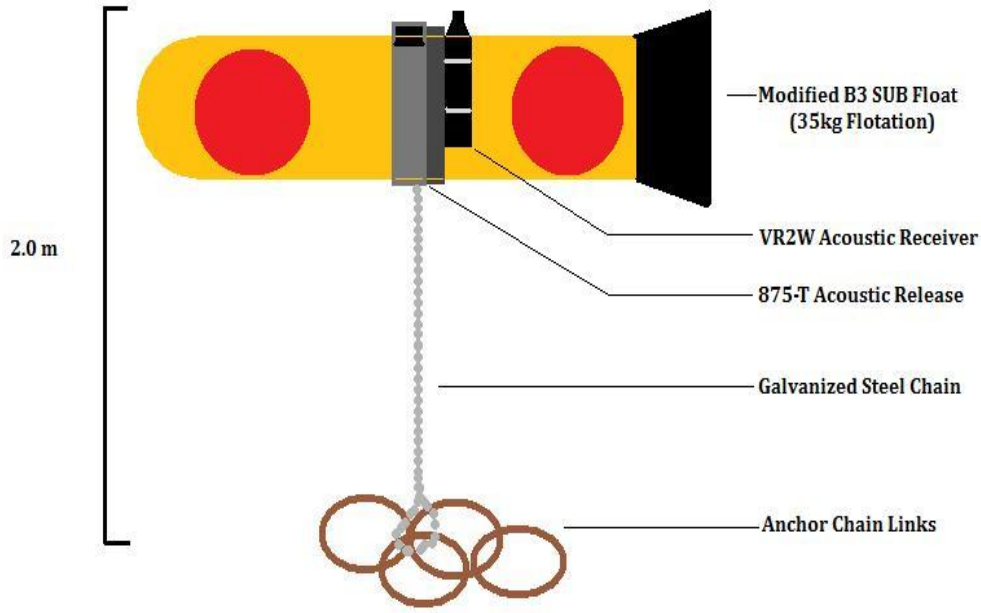


Figure 2. Mooring unit design deployed at the NSPI turbine site in June 2010 (n=10) and across the Minas Passage in July 2010 (n=12).

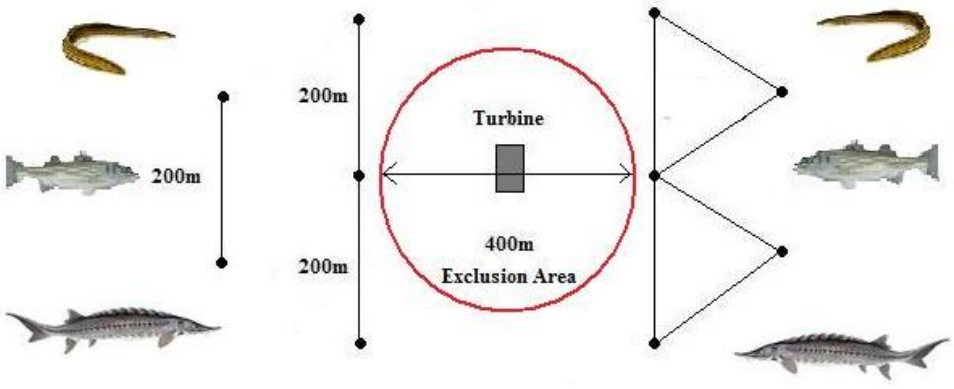


Figure 3. Diagram indicating relative position of acoustic receiver mooring units (black dots) within the array surrounding the Open Hydro turbine and 200m radius exclusion zone (red circle).

a)

Surgical implantation of VEMCO acoustic transmitters

b)

Figure 4. Photos showing a) implantation of a VEMCO acoustic transmitter in a striped bass and b) subsurface buoys with installed VEMCO receivers and acoustic releases.

Results to date

Acoustic tag detections, by species and by general location (see Figure 1), are summarized in Table 1. Ninety-two percent of all fish tagged in 2010 were detected by receivers deployed in Minas Basin and Passage (turbine receiver array and OTN receiver line). Of these, 28% were detected within 500 m of the NSPI (OpenHydro) turbine.

Table 1. Summary of fish tagged and those detected by Vemco receivers in different locations.

Species	Month tagged	# Fish tagged	Total # detected	Minas Basin # detected	OTN line # detected	NSPI/OH turbine # detected
Striped bass	May	43 adult	42 (98%)	33 (77%)	40 (93%)	21 (49%)
	Aug	37 juv.	37 (100%)	37 (100%)	12 (32%)	4 (11%)
Atlantic sturgeon	June	1	1 (100%)	1 (100%)	0	0
	Aug-Sept	29	27 (93%)	24 (83%)	21 (72%)	8 (27%)
American eel	Oct	10	3	1 (10%)	3 (30%)	1 (10%)
Total		**120**	**110 (92%)**	**96 (80%)**	**76 (63%)**	**34 (28%)**

Striped bass:
Of the 80 striped bass tagged, 79 were detected by receivers deployed in the Minas Passage (OTN line and turbine array) and Minas Basin. Post-surgery survival was excellent (at least 98%). The single undetected adult striper was tagged in May and may have been caught by one of the many recreational fishers in the Shubenacadie-Stewiacke River area.

The OTN receiver line detected 93% of all tagged adult stripers; 49% were detected by the turbine receiver array. All of the 37 tagged juvenile stripers were detected on receivers located in nearshore areas of the Minas Basin, with 32% also detected by OTN line receivers and 11% by the receiver array near the NSPI/OH turbine. Striped bass swimming depths were highly variable – near surface to > 95m within Minas Passage. Adult striped bass were detected more commonly in Minas Passage and at greater depth than juveniles, which tended to be located in the top 10 m.

Atlantic sturgeon:
Twenty-eight of the 30 sturgeons tagged were detected, with most detections occurring in the nearshore areas of the Minas Basin and while passing through the OTN receiver line. Eight sturgeon were detected by the turbine receiver array.

Ten of the 11 retrieved receivers of the OTN line detected sturgeon, with most of the detections (2/3) on those receivers located in the southern area of the Passage. Depth of detection indicates that sturgeon were moving in waters 25-35 m deep on the north side, 25-40 m deep in the central area and 30-50 m deep in the southern region of the Passage (Figure 5).

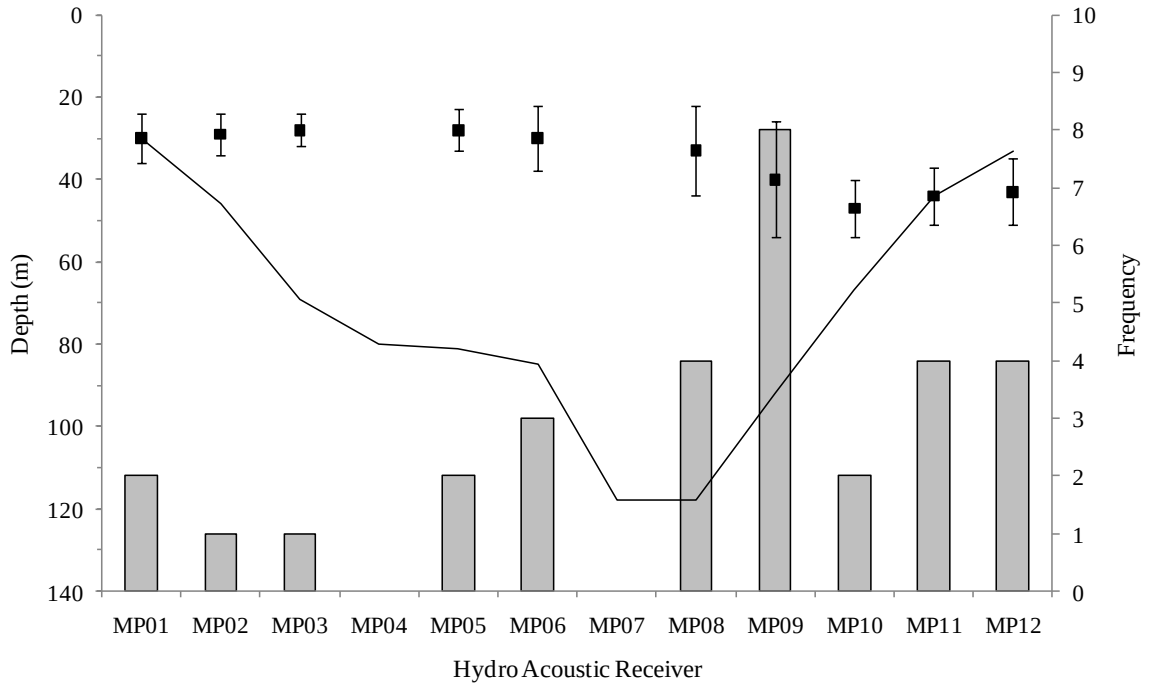


Figure 5. Bottom depth at mean water level (line; primary y-axis), depth (solid square = mean; whiskers = SD; primary y-axis), and frequency (grey bars; secondary y-axis) of Atlantic sturgeon, electronically tagged in the Minas Basin in summer 2010 moving through the Minas Passage in Autumn 2010 per hydro acoustic receivers placed approximately every 400 m spanning the Passage (MP01 = Northern most receiver; MP12 = Southernmost Receiver). Receiver MP04 was not retrieved, and receiver MP07 contained no detection information. Detections at MP12 are from sturgeon traveling closer to MP11 (From Stokesbury et al. in preparation).

American eel:

Of the 10 American eels tagged, 3 (30%) were detected in the Minas Passage 17-20 days after being tagged in the Shubenacadie River. The receivers detected eels in both shallow (< 20 m) and deep (60-100m) waters in the Minas Passage. The eels appeared to exhibit staging behavior near the bottom with travel out of the Basin occurring at lesser depths (3-20 m), a pattern similar to that documented for out-migrating American eels in Passamaquoddy Bay, NB. (Bradford et al. 2009 – AFS Symposium Proceedings).

Safety and Environment

All necessary permits were obtained and all field work was carried out as planned, without incident.

Deliverables / Reporting

Project progress and outcomes:

1. Enhancement of the OEER funded project with the tagging (VEMCO acoustic transmitters) of 50 additional fish (completed);
2. Detection of tagged fish via receivers located in arrays near the NSPI turbine, and in the Minas Passage receiver line (completed);
3. Assessment of spatial and temporal patterns in movement of tagged fish near the turbine (location, depth, speed, etc) (underway);
4. Assessment of the dispersion and avoidance behavior of tagged fish moving in close proximity to the NSPI turbine (underway);
5. Assessment of movement of tagged fish in relation to the Minas Passage receiver line. This will provide much needed information on the general movements of the three migratory species highlighted in this project (underway);

Note: The final report to the OEER is due 1 Nov 2011. As the overall project work is co-funded, the content of the final OEER and FORCE reports will be similar.

Recommendations for 2011 / 2012 (as submitted in report to OEER)

1. We recommend that fish detection and tracking in the Minas Basin and Passage be continued for the 2011 field season (Apr-Nov), especially given that all 120 fish implanted with acoustic tags in 2010 are still transmitting (sending out pings), with 79 acoustic tags remaining viable for only another 9-10 months (up to Nov 2011) before the batteries in their transmitters fully drain. The majority of the needed infrastructure for detection of tagged fish has been procured and can be re-deployed in the Passage in April with reduced cost (e.g. refitting of sub-buoy units and mooring weights) and with reduced effort, given that the project team have now gained considerable expertise with deployments in the Minas Passage. An additional year of funding would allow the best use of existing field equipment, fish already tagged (and transmitting signals) and research expertise of the team. It would also allow much needed tracking of fish movements during the spring and early summer period as the 2010 data covers July-Nov only. The coming field season (starting in April when many fish move back through the Passage into the Minas Basin) provides an opportunity to assess how tagged fish naturally use the area so that a suitable baseline, covering a full season, can be established.

2. Due to the harsh nature of the Minas Passage, instrumentation housed in moorings like those in the current study should be retrieved after about 4-5 months of deployment, checked for wear and tear, data downloaded and batteries replaced. After equipment maintenance and refitting, as needed, we recommend redeployment for another 4-5 months, preferably not during winter.

3. Our data on how tagged demersal and pelagic fish use the Minas Passage includes depth preferences, movements through the Passage, seasonality and tidal effects on movement. When analysis is complete, this information will be of much interest to the science and regulatory branches of DFO and will be of value to FORCE's Environmental Monitoring Advisory Committee. We recommend that device and project developers consider our results in future deployments and designs for "fish friendly" in-stream turbine infrastructure.

4. There is much public concern over the risk of fish-turbine interactions. This project will provide scientifically defensible data to help address some aspects of these sensitive issues. Unfortunately, our project can not address the behavior of fish relative to the operation of a turbine as it is now clear that the Open Hydro turbine became nonfunctional (blades broken off) prior to the deployment of our receivers. However, our study does provide much needed baseline information on "natural" patterns of fish movement in the Minas Passage.