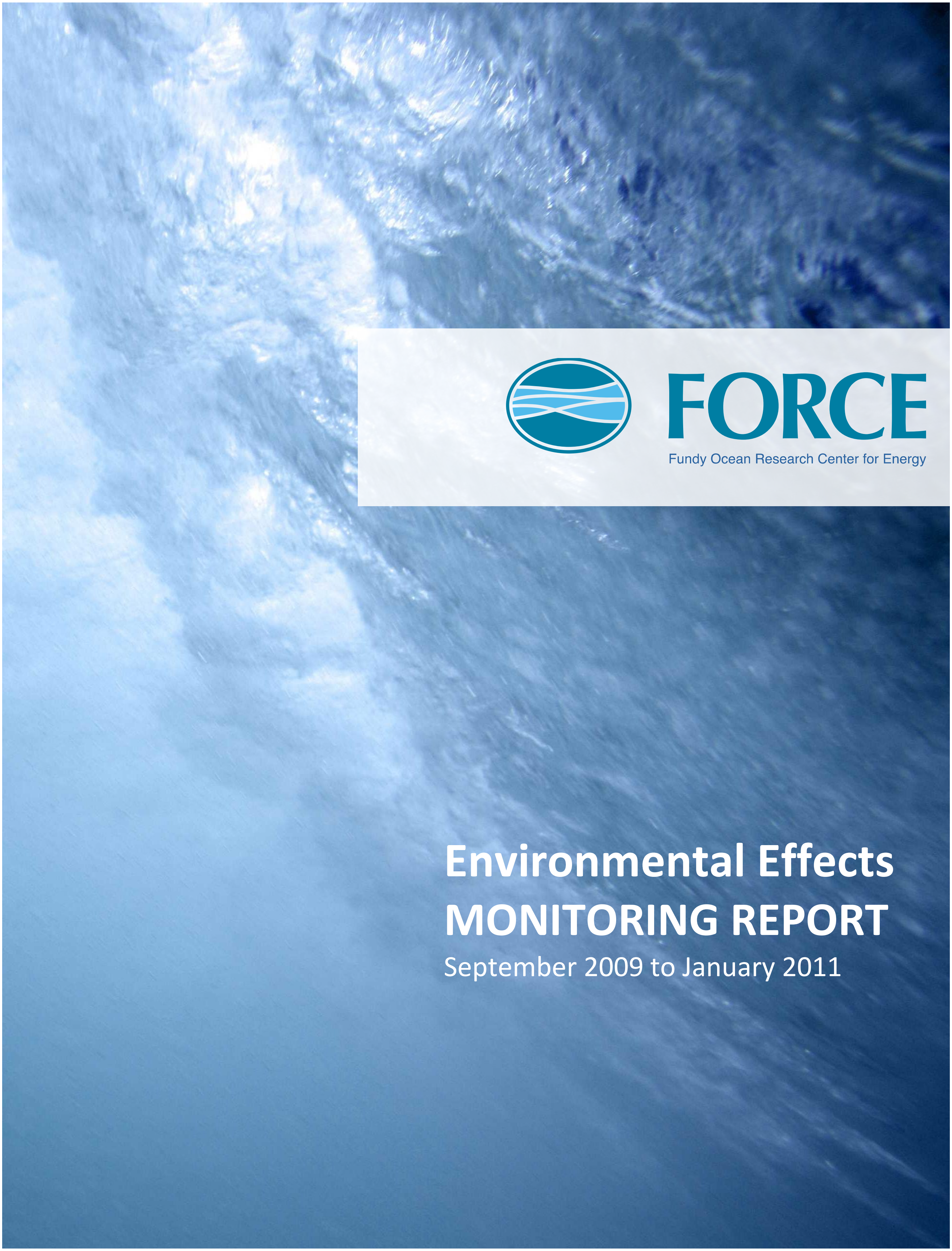


FORCE

Fundy Ocean Research Center for Energy

Environmental Effects MONITORING REPORT

September 2009 to January 2011

Table of Contents

List of Tables & Figures

List of Appendices

ACKNOWLEDGEMENTS

FORCE would like to thank and acknowledge the important contribution of Envirosphere Consultants Limited in providing the critical third party technical review of FORCE's first Environmental Effects Monitoring report. We would also like to acknowledge the scientific and engineering consultants who conducted important work on behalf of FORCE, including: Acadia University, Atlantic Marine Geological Consulting Limited, BioIdentification Associates, CEF Consultants Ltd., Envirosphere, Seaforth Geosurveys Inc., and Sea Mammal Research Unit Limited. As well, we are grateful for the technical input and review provided by Nova Scotia Power Incorporated in the preparation of this report. This report was completed October 2011.

EXECUTIVE SUMMARY

This report fulfills reporting requirements for environmental monitoring at the FORCE Minas Passage Tidal Demonstration Site, under the Fisheries Act Authorization (Fisheries and Oceans Canada (DFO)) and Condition 3.1 of the provincial Environmental Assessment (EA) Approval for the project, by summarizing the key results of the Environmental Effects Monitoring Program (EEMP) from the commencement of the program in late September 2009 to January 2011. The EEMP has covered the early development of the project including the deployment of the first tidal turbine installed at the site by Nova Scotia Power Inc. (NSPI)/OpenHydro (OH) from November 12, 2009 until December 14, 2010.

The Environmental Effects Monitoring Program focuses on monitoring the effects of the marine environment of installation, operation, and removal of turbines and cables—environmental monitoring of onshore components of the project are dealt with under separate approval processes. The objective of an EEMP is to test the environmental impact predictions identified in the EA study. Components of the EEMP were proposed in the Project's Environmental Management Plan (EMP), and approved in principle by DFO and the Nova Scotia Department of the Environment (NSE). The final EEMP was modified based on advice from an independent Environmental Monitoring Advisory Committee (EMAC), established as a requirement of the provincial EA Approval and Fisheries Act Authorization. All reports documenting field studies and background information collection for the EEMP and covered in this report are provided in the Appendices.

An "adaptive management" approach has been used in implementing the EEMP, that is, one that reviews activities and outcomes continuously and modifies them periodically to reflect new information as well as the results of assessments of outcomes relative to objectives. Regulators, and EMAC, recognized the novel and exploratory nature of many of the monitoring activities—Minas Passage is a unique environment which presents challenges for monitoring due to its high currents and tidal range. Most of the monitoring approaches used for the EEMP, although often derived from conventional protocols, were applied for the first time in the challenging environment of Minas Passage.

Environmental monitoring at the tidal demonstration site began shortly after approvals for the project were received, and in advance of the installation of the NSPI/OpenHydro turbine on November 12, 2009. The turbine was installed successfully with no environmental impacts observed for the process. In place, the turbine and instrumentation initially operated successfully, but communication with the turbine through an acoustic link failed soon after deployment. Monitoring equipment mounted on the turbine recorded engineering parameters for the turbine, and made physical oceanographic measurements, including currents, for about three weeks before the devices eventually failed on December 4, 2009. Subsequently the turbine remained in place for over one year, during which turbine blades and some instrument

modules were lost. Presence of the structure at the site for over a year, as well as the subsequent recovery operation, provided an opportunity for several of the monitoring studies to look for environmental impacts—no adverse environmental impacts were observed. The findings represent an important step in understanding interactions between tidal turbines and the environment.

In summary, the EEMP has collected useful information, both focused on determining possible impacts of the tidal turbine, as well as on obtaining background environmental data for the Minas Passage; and has provided the opportunity to investigate the application of a variety of monitoring approaches and technologies in the challenging Minas Passage environment. Some of the main findings of the EEMP studies are as follows:

Seabirds and Waterfowl: Low to moderate in densities of seabirds relative to other coastal areas of Nova Scotia were observed at the site, but a high diversity of species use the area throughout the year. No preference for, or avoidance by, seabirds and waterfowl of the turbine installation site were noted.

Marine Mammals: Harbour Porpoise is the predominant marine mammal identified in the Minas Passage area based on observational surveys from shore and vessels as well as passive acoustic monitoring of porpoise and dolphin calls in the vicinity of the turbine and in a reference area. Use of passive acoustic monitoring in the project demonstrated that this technology is a useful tool for future real-time and long-term monitoring at the site.

Fish: Echo-sounder and mid-water trawl surveys demonstrated the presence, relative abundance, and seasonal movements of a wide range of fish species—both those expected to occur and highlighted in a literature review conducted as part of the EEMP—which use Minas Passage through the summer and fall. Species occurring at the site included: Atlantic herring, dollar fish (*Peprilus triacanthus*), Atlantic mackerel, gaspereau, smelt, lumpfish, sea raven, summer flounder, winter skate, tomcod, silver hake, red hake, walleye pollock, striped bass, dogfish and Threespine stickleback. Atlantic herring, dollar fish, mackerel, gaspereau, smelt and lumpfish were most consistently caught. Movements of fish species of interest in the Inner Bay of Fundy including striped bass, Atlantic sturgeon, and American eel, were demonstrated through the successful use of acoustic tags as part of a monitoring program which FORCE in part supported to include the Minas Passage. Acoustic tagging will likely be used as a monitoring technique in future, before and after the turbines are deployed.

Lobster: Studies of lobster catch were undertaken prior to, and after turbine deployment, as well as before and during lobster fishing season, in a survey designed to detect changes in catch reflecting turbine installation and other environmental parameters. The survey provided baseline information on lobster abundance over a broad area and variations in the vicinity of the installed turbine. Overall, lobster catch did not reflect differences which could be attributed to the tidal turbine installation although one of the comparisons showed a lower catch within a 200-m radius of the turbine. This result is preliminary in that other factors could have been involved in the result but it has provided an effects hypothesis which can be tested in future monitoring at the site.

Public and Citizens' Monitoring: No observations of unusual sightings of, or damage to, fish, seabirds or marine mammals attributable to the project, were made by the public or other users of the Minas Passage (e.g. fishers) during the study period.

Deployment and Recovery of NSPI/OpenHydro Turbine: The turbine was successfully deployed and recovered without environmental consequences, and no bio-fouling or damage to the turbine structure resulting from the deployment occurred. A side-scan sonar and towed video survey completed after turbine recovery, indicated no changes in bottom characteristics at the turbine and reference sites, with the exception of 1-m diameter pits in the bedrock surface caused by two legs of the turbine support structure, and some unidentified debris on the seabed thought to be part of the damaged turbine.

Real-Time Fish Monitoring: Although one of the objectives of the EEMP was to accomplish real-time monitoring for fish and marine mammal behavior and/or avoidance near operating turbines, limited suitable technology or methodology is available, and consequently, effective real-time monitoring has not been done to date. An exception is the passive acoustic monitoring of porpoise and dolphin vocalizations, which has the potential to determine effects of project activities on behaviour of these animals. Finding or developing suitable technology is an ongoing objective for this Project, and other Tidal In-stream Energy Conversion (TISEC) projects around the world.

The knowledge gained from the studies conducted to date will be employed in projects undertaken in future as part of the EEMP for the Tidal Demonstration Project.

1. INTRODUCTION

This report was prepared by the Fundy Ocean Research Center for Energy (FORCE), with input from Nova Scotia Power Inc. (NSPI), based on the Environmental Effects Monitoring Program (EEMP) initiated in late September 2009 and continuing through January 2011. Components of the EEMP were proposed in the Project's Environmental Management Plan (EMP) dated October 16, 2009, and approved in principle by DFO and the Nova Scotia Department of the Environment (NSE). The monitoring activities described in this report extend from late 2009 to January 2011, including pre-deployment and deployment monitoring of the first Tidal In-stream Energy Conversion (TISEC) unit by NSPI/OpenHydro, which was installed from November 12, 2009 until December 14, 2010.

Prior to the commencement of the EEMP, the Project had been assessed under a joint federal–provincial Environmental Assessment (EA) review process and was subject to regulatory approval in accordance with respective legislation. The project received provincial EA approval on September 15, 2009, and FORCE was required to meet Terms and Conditions provided by

Nova Scotia Environment (NSE) as part of the approval for the project. In February 2010, the federal responsible authorities for the environmental assessment determined that the project would not likely result in adverse environmental effects, thereby allowing them to take a course of action in relation to the project. In 2010, an addendum to the EA was prepared to account for additional funding that was provided by Natural Resources Canada through the Clean Energy Fund and changes to the onshore portion of the project.

The purposes of this Report are three-fold:

- To summarize the results of the FORCE EEMP as per the Terms and Conditions of the provincial Environmental Assessment Approval for the project dated September 15, 2009;
- To fulfill the requirement of an “as built” report under Fisheries Act Authorization #08-HMAR-MA7-00223035 issued by DFO on October 7, 2009 to NSPI for the deployment, operation and recovery of the turbine; and
- To provide a public record of the environmental effects monitoring program completed by FORCE during the deployment of the NSPI/OH turbine.

Background environmental information and Environmental Assessment Predictions for the project are available in the EA Registration Document, while Terms and Conditions for the provincial EA Approval for the project are available by viewing either the NSDOE EA website at http://www.gov.ns.ca/nse/ea or the FORCE website at www.fundyforce.ca. Additional information collected after the receipt of the provincial EA Approval is available in the EA Addendum Report, which is also available at the FORCE website. A summary of the EA Impact Predictions noted above are provided in Appendix A of the present report.

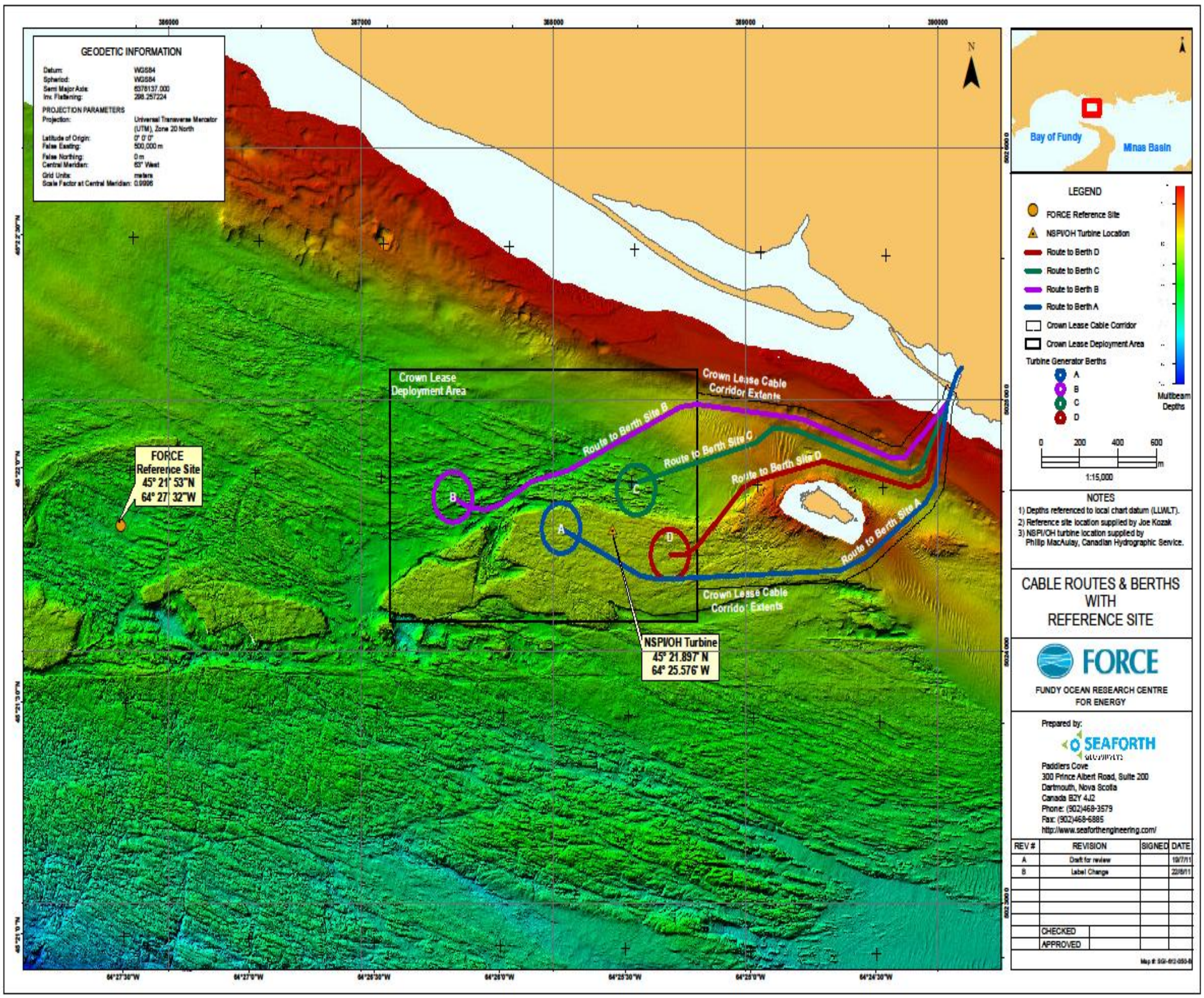
2. PROJECT DESCRIPTION

The Fundy Tidal Energy Demonstration project is managed by the Fundy Ocean Research Center for Energy (FORCE). Presently, the Project consists of four undersea berths for TISEC subsea turbine generators, four subsea cables (to be installed) connecting the turbines to land-based infrastructure, an onshore transformer substation, and power lines connecting to the local power distribution system. The marine portion of the project is located in a Crown Lease Area, 1.6 km by 1 km in area, in Minas Passage near Black Rock, and the onshore facilities are on leased lands on the West Bay Road approximately 10 km West of Parrsboro. A detailed description of the Project is available in the above-noted EA Registration Document and the EA Addendum document on the FORCE website. The initial project description did not include a fourth sub-sea grid-connected berth site within the approved Crown Lease area (Berth D, Figure 1), which FORCE developed at the request of the Nova Scotia Department of Energy subsequent to the EA Approval.

After the Project was approved, monitoring at the site began, which bracketed the deployment of the first TISEC turbine on November 12, 2009 by NSPI/OpenHydro; construction of land-based facilities began in February 2010. The marine cables are presently scheduled to be installed at the site in the spring of 2012, with two to three turbines to be deployed in the latter part of 2012.

Figure 1 shows the Fundy Tidal Energy Demonstration Facility in the Minas Passage, including the marine demonstration area and berth sites, cable routes, onshore facilities, the location of the EEM Reference site, and the location at which the NSPI/OH turbine unit was installed, which will be referred to in the following sections.

Figure 1 – Project Location – Berth Sites, Cable Routes and EEM Reference Site



3. ENVIRONMENTAL EFFECTS MONITORING PROGRAM (EEMP)

An Environmental Effects Monitoring Program (EEMP) measures specific parameters in the environment during the course of the project, to test assumptions or predictions of the effects of the project on the environment. At its most basic, EEM seeks to establish or disprove a cause-effect relationship between a specific project activity and a specific environmental effect.

FORCE's EEMP was required as part of the EA Terms and Conditions for EA Approval. The EEMP was carried out in cooperation with NSPI, as many of the monitoring activities applied to the broader project area and the NSPI turbine site. NSPI was also required to meet monitoring and reporting requirements under a Fisheries Act Authorization from DFO.

In consideration of the challenging environment of the Minas Passage, as well as the limited commercially available and reliable monitoring methodologies for such an environment, it was recognized by regulators and Environmental Monitoring Advisory Committee (EMAC), that the EEMP for the Demonstration Project should use an adaptive management approach. Adaptive management is a decision process that promotes flexible decision-making that can be adjusted as outcomes from management actions and other events become better understood. The adaptive management approach recognizes the unique and severe physical environment of the Minas Passage and the need to coordinate research data collection and reporting between researchers. It is not a 'trial and error' process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Simply stated, adaptive management is an iterative process of planning and implementing an action, monitoring, evaluation, and making adjustments as needed.

Biophysical and environmental parameters selected for monitoring were based on a proposed EEMP identified in the Project's Environmental Management Plan (EMP), and approved in principle by DFO and NSDOE. The final EEMP implemented during the NSPI/OpenHydro deployment period was modified based on advice from the Environmental Monitoring Advisory Committee (EMAC) for the project, established as one of the conditions of the provincial EA Approval in order to provide impartial scientific advice to FORCE. The EMAC consists of independent science experts and stakeholders, including fishers and First Nations representatives, as well as provincial and federal regulators who participate as observers. The full set of EMAC's recommendations on the EEMP, and FORCE's responses are available at the FORCE website at: www.fundyforce.ca.

The EEMP was implemented by a number of consultants working on behalf of FORCE. As well, to maximize funding and to optimize delivery, several of the EEMP surveys funded by FORCE were expansions to monitoring research projects already underway and supported by the Offshore Energy and Environmental Research Association (OEER). The final EEMP for the project is summarized in Table 1, which shows the various field components of the Plan for the period of September 2009 to January 2011.

Table 1 - Summary of the Environmental Effects Monitoring Program – September 2009 to January 2011

EEM PARAMETER	LOCATION	METHOD	TIMING
Seabirds	Minas Passage & Demo Area	From shore & vessel observations – CWS Standard protocol	7 surveys from shore – May-Nov 2010; 2 surveys from vessels – July/Aug 2010
Marine Mammals	Minas Passage & Demo Area	From shore and vessel observations – Standard protocol	Same as above
	Demo Area & vicinity of NSPI/OpenHydro turbine	Passive acoustic monitoring – 3 deployed C-POD hydrophones	Aug– Nov 2010
Lobster Fishery	Demo Area & control sites	Catch & release –catch rate comparison between test & control areas	3 Surveys -Sept/Oct 2009; Nov 2009; May/June 2010
Fish Movements	Minas Passage	Echo-sounder/mid-water trawl netting from vessel	2 surveys -Apr/May, 2010 (no netting) 13 surveys/101 net tows – June to Nov, 2010
	Demo Area & vicinity of NSPI/OpenHydro turbine	Acoustic tagging / tracking –Acoustic telemetry receiver lines & VEMCO transmitter fish tags	July-Nov 2010
Acoustic Environment (Noise)	Vicinity of NSPI/OpenHydro turbine site	Suspended recording hydrophone (vessel/drifting)	Dec 2009 & May 2010
Benthic and Scour	Reference Site & NSPI/OpenHydro Turbine site	Side-scan sonar/video	After recovery of turbine – completed Jan 2011
CTD and SPM	Minas Passage	Standard Sampling protocols - from vessels	Samples collected Jul/Aug/Oct 2010 & Jan 2010

During the monitoring program, FORCE and Offshore Energy Environmental Research (OEER) Association co-sponsored a Workshop in Wolfville, Nova Scotia in October 2010 to review research and monitoring needs for tidal energy development. The workshop included invited experts, and the outcomes confirmed the validity of key topics for monitoring as previously identified in other reviews (for the workshop report, go to www.offshoreenergyresearch.ca). An important priority and challenge identified by the workshop was the need for real-time monitoring of fish and marine mammal behaviour and movement in the vicinity of turbines, as well as interactions with them; a topic which is the subject of ongoing research around the world. Thus, although it remains a goal of the FORCE EEMP to apply real-time monitoring of turbine interactions of fish and marine mammals, reliable and effective methodologies remain in the developmental stages. Under the 2010 EEMP, this type of monitoring was limited to passive acoustic monitoring of porpoise and dolphin vocalizations. In addition, research on the application of 2D/3D sonar devices by DFO to monitor fish movements near turbines, funded by

the OEER and partially funded by NSPI, was initiated in 2009 and is still underway. Project descriptions of the tidal research underway can be found at:
http://www.offshoreenergyresearch.ca/Home/TidalEnergyResearch/tabid/386/Default.aspx

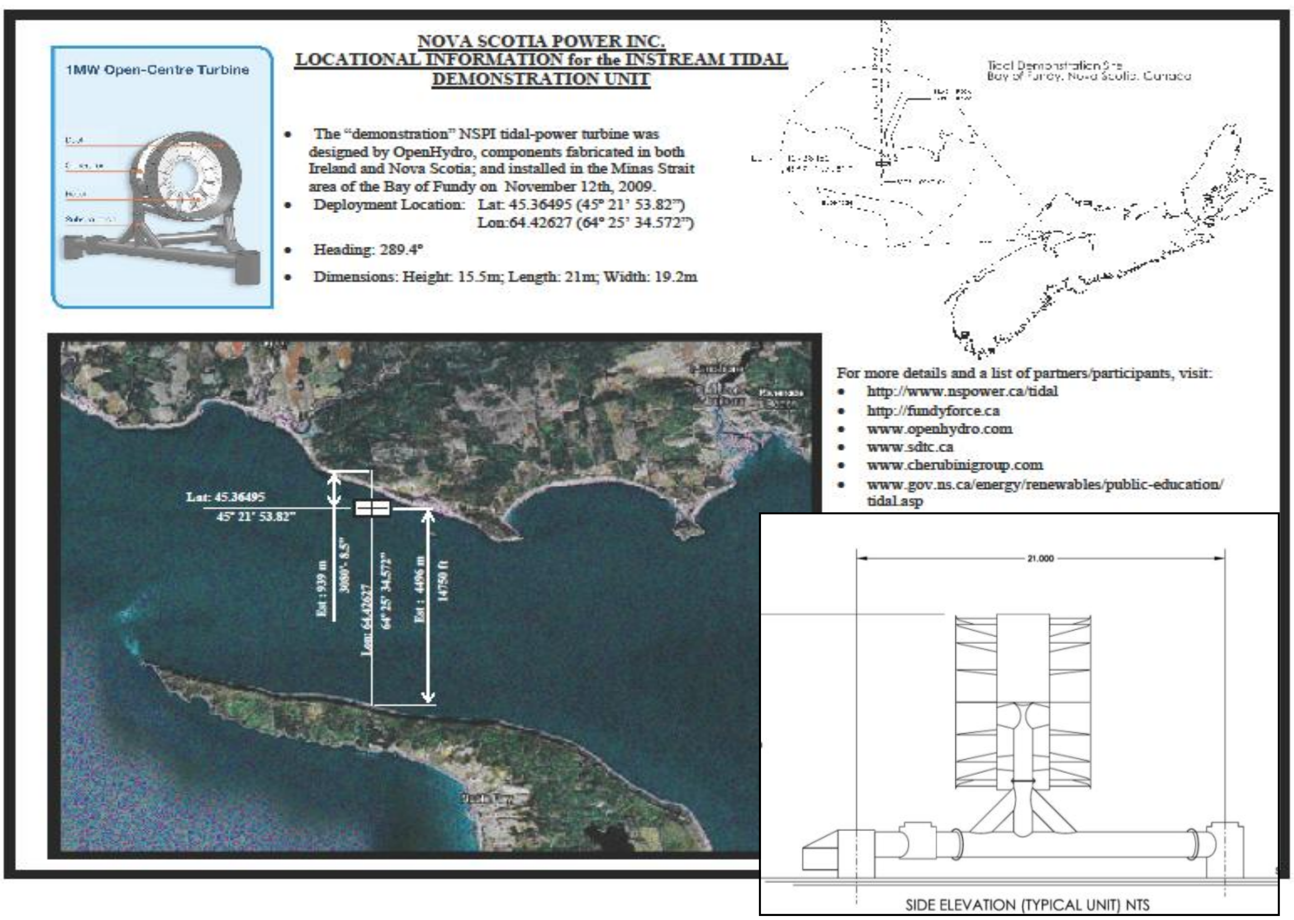
4. DEPLOYMENT AND RECOVERY OF THE NSPI/OH TURBINE

This section provides information on the NSPI /OpenHydro turbine deployment and recovery operations, including FORCE's observations, to provide context for the environmental effects monitoring efforts for the period of September 2009 to January 2011.

A report prepared by NSPI on the Deployment and Recovery of the NSPI/OpenHydro turbine is provided in Appendix B. The NSPI document describes activities, and also provides a discussion on "lessons learned" from the perspective of deployment and recovery, and instrument communications issues.

The NSPI/OpenHydro turbine is a 1 MW shrouded, open-centre, horizontal axis design with 12 blades, each 2 metres in length with a 5 metre open centre. The open centre and shrouded blade design is expected to minimize impacts on marine mammals, fish and seabirds, and also avoids the use of lubricating oils and thus reduces potential for chemical pollution. Figure 2 provides additional specifications of the NSPI/OpenHydro turbine and deployment.

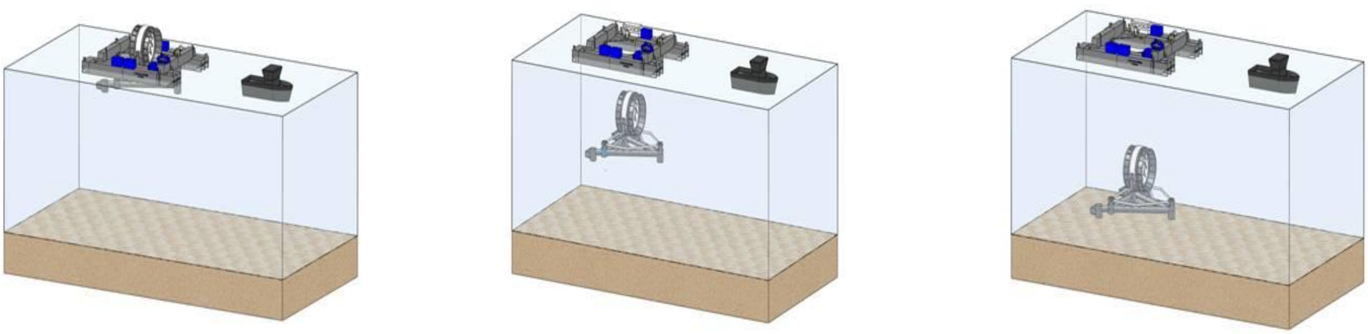
Figure 2 – Location and Specifications for NSPI/OpenHydro TISEC Unit



The NSPI/OpenHydro turbine was mounted on a steel subsea base, referred to as the Gravity Based Structure (GBS) or Subsea Base (SSB), which was built at Cherubini Metal Works in Dartmouth, Nova Scotia. The GBS weighed 400 metric tons and the turbine 50 metric tons, for a total assembly weight of 450 metric tons. The turbine on the structure was equipped with a load bank for dissipating generated electricity as heat (a subsea cable was not available to remove generated electricity—subsea cables will not be installed until 2012), along with battery packs to operate the monitoring and data logging equipment, and monitoring devices including data loggers, three Acoustic Doppler Current Profilers (ADCP), strain gauges, and an acoustic modem to allow transmission of collected data for regular downloading and analysis.

The turbine assembly was deployed using the specially-designed OpenHydro Installer barge (see Figure 3), which was pre-tested in the Bedford Basin, prior to moving the turbine assembly and barge to the Minas Passage location.

Figure 3 - Description of Turbine Installer Barge and Deployment Process



Notes for Figure 3:

The OpenHydro Installer barge is a special-purpose vessel built by OpenHydro for the sole purpose of deploying, recovering and transporting the OpenHydro Tidal Turbine Generator Unit in a marine environment known for extreme tidal forces. As such, this barge has features and specialized interfaces with the Unit that are not on a standard sea-faring barge.

Successful maneuvering of the Unit is contingent on the use of these unique features, as is the safety of the equipment and personnel involved. Any proposed alternative to this OpenHydro Installer barge must be able to demonstrate the following capabilities:

1. The barge is 32.8 meters long by 23.3 metres wide and capable of supporting the Tidal Turbine Generator Unit.
2. The Open-Centre "moon pool" design allows the 10 m diameter Unit to be raised out of the water, and allow personnel a stable access work platform in which to assess and service the Unit and associated sensory equipment.
3. The "moon pool" features a flood lighting system to permit work and visual contact with the Unit 24 hours per day to ensure the efficiency and safety of activities.
4. The barge is equipped with ball-and-taper lifting mechanisms manufactured by First Subsea (http://www.ballgrab.co.uk) to mate with the three engineered 20 inch diameter lifting attachment points on the Unit's Gravity Subsea Base.
5. The barge features a lifting frame assembly to guide and mate the ball-and-taper lifting mechanisms to each of the lifting attachments points on the Subsea Base simultaneously.
6. Cable drum winches on the barge have a minimum cable length per winch of 105 m, and a working lifting capacity of 120 tonnes. In addition, each winch is equipped with its own controls, weight-on-line load cell technology and line payout monitoring equipment.
7. The barge features line handling and retrieval equipment hydraulic and video lines required between the barge and the lifting frame.
8. The barge is equipped with bolted sea-fastening attachment point system which mates to the Unit's Gravity Subsea Base as required by the Insurers for approval of towing activities.

9. Land surveying class GPS geographic locating equipment and satellite communication with antenna is used to position the Unity within a 1 degree variance within the predominate tidal flow directions.
10. The barge is equipped with Gemini underwater sonar imaging manufactured by Tritech International (http://www.tritech.co.uk/index.htm) for accurate positioning of the Unit.
11. The barge features a VHF marine radio base station.
12. An underwater video camera, with wide screen display equipment on deck, allows personnel to visually monitor the Unit for some distance under water during deployment and recovery activities.

4.1 Deployment

The NSPI/OpenHydro turbine was installed at Berth C (refer to Figure 1), allocated for the deployment through mutual discussions with FORCE and participating parties tidal device providers. Based on an evaluation of bathymetry and geological considerations at the site, the project team identified a location which was acceptable for deployment. The turbine assembly was deployed on November 12th, 2009, and placed within 0.6 metres of the engineered location. The deployment location as shown in Figure 1 was located on a bedrock plateau at 28.8 metres below mean low water (42.3 metres below mean high water), at Lat: 45° 21.897’ N Long: 64° 25.576’ W. Turbine and instrumentation were functional immediately after deployment, but communication was never re-established although attempts were made on several occasions. NSPI/OpenHydro also made several attempts to observe the turbine assembly, and in March 2010, using 2-D and scanning 3-D sonar, a first indication of damage—the possible loss of turbine blades—was detected. Based on this information, and the ongoing inability to communicate with the unit, NSPI/OpenHydro decided to recover the turbine assembly in the fall of 2010, approximately one year earlier than planned. Future deployments when cables are in place will utilize data capabilities through the cables and will not require acoustic communication.

One of the goals in deployment and subsequent recovery of the turbine was to avoid disruption of the lobster fishery at the site. The complex logistics of the project resulted; however, in this objective not being met—both the deployment and recovery of the turbine unit occurred during the fall lobster season. As they would normally do in any circumstance involving marine activities in areas with an active lobster fishery, the NSPI/OpenHydro team worked with local lobster fishers to ensure minimum disruption to the fisheries activities during the deployment and recovery operations, and engaged local fishers in designing and executing the deployment and recovery operations. Local fishers’ vessels were also employed as standby and safety vessels—their input and assistance during the process was instrumental throughout.

4.2 Recovery

The NSPI/OpenHydro turbine unit was successfully retrieved on December 16, 2010. The recovery utilized the same OpenHydro Installer Barge used for deployment. Upon retrieval, the turbine blades and center ring, as well as the acoustic modem were no longer attached, but otherwise the remaining structure did not show signs of damage. Further detailed evaluation is required, but the initial assessment indicated that the turbine was not strong enough to withstand the tidal forces experienced in the Minas Passage. NSPI/OpenHydro later indicated that the current regime measured by the Acoustic Doppler Current Profiler on the device, was stronger than the baseline measurements provided in advance, and that the turbine had been under designed for the tidal forces involved.

After recovery, the barge and turbine assembly were moved to Saint John, New Brunswick and stored over the winter, until favourable weather conditions allowed transport to Dartmouth. The barge and turbine assembly were moved to Cherubini Metal Works in Dartmouth in May, 2011. Downloading of the data from the unit was completed, and a detailed analysis is still underway. Initial analysis of collected data indicates that the turbine was operational for approximately 3 weeks, until December 4, 2009.

4.3 Environmental Monitoring Activities During Turbine Deployment, Operation, and Recovery

Environmental monitoring during the turbine deployment was a cooperative effort between FORCE and NSPI. Both organizations have specific monitoring requirements; FORCE has an EEM Plan approved by regulators for the demonstration site as a whole, while NSPI has requirements specific to the berth location where the turbine was installed. The monitoring undertaken is complementary, but in some cases additional monitoring was undertaken by NSPI specific to the site of the deployed turbine. Results were presented in the relevant study reports.

As a condition under the Fisheries Act Authorization issued to NSPI for the turbine deployment, NSPI was required to submit environmental monitoring reports to Fisheries and Oceans Canada (DFO) on a regular basis. NSPI submitted reports to DFO on: March 17, May 21, June 22, July 23, August 16, September 28 and October 27, 2010, and the Deployment and Recovery Report on June 23, 2011.

A FORCE representative observed turbine deployment and recovery operations, and inspected the turbine unit onshore on June 3, 2011 at the Cherubini facility. The inspection covered only the turbine mount, since the GBS portion of the assembly was below the water level. During recovery and after subsequent inspection, the unit did not show evidence of bio-fouling or algae growth, strike marks or scrapes, or any entangled fishing gear or debris. Subsequent discussions with NSPI and OpenHydro representatives confirmed that there was no significant bio-fouling on the GBS at the time of recovery.

Due to the high currents, water depths, and turbidity, the use of video or photography for monitoring proved difficult. NSPI attempted to use video to determine the condition of the turbine, with limited results. Video mounts on the turbine unit during the deployment were not possible; video cameras were attached to the lifting frame and OpenHydro Installer Barge; however, during the recovery operation, and provided useful information.

No real-time monitoring for fish or mammal movements around the turbine was attempted during the installation period, although passive acoustic monitoring of marine mammals (porpoises and dolphins) using porpoise click detector moorings, tested during the monitoring program in the vicinity of the turbine and in a reference area (see Section 5 and report in Appendix D) collected relevant information, and may be a useful tool in future. No fish or marine mammals were seen during the various operations related to the turbine deployment. Real time monitoring of fish and marine mammals in turbulent areas with high currents such as the Minas Passage is an ongoing challenge, not only for the FORCE project, but for other TISEC projects around world.

5. SUMMARY OF MONITORING STUDIES

Various EEM studies were undertaken during the period covered by this report—from September 2009 until January 2011. This section provides an overview of the studies, and the study reports are presented in the Appendices.

As they were completed, interim and final reports were provided to the EMAC for ongoing review and advice, and to assist in making recommendations for the 2010 and 2011 EEMPs. Interim monitoring reports were also provided to DFO by NSPI as required under the Fisheries Act Authorization, as noted in Section 4.3. All complete reports for field studies and background information carried out under the *aegis* of the EEMP are presented in the Appendices, and are available to the public, as is this full report, on the FORCE website.

Environmental monitoring continues to be a challenge at the site because of the lack of instruments and methods capable of dealing with the turbulent, high current tidal environment of the Minas Passage. In addition, many of the studies were hampered by the limited availability of vessels to deploy and retrieve instrumentation or run survey routes.

5.1 Seabirds and Waterfowl

To gather information on seabirds and waterfowl in the vicinity of the tidal demonstration site, FORCE carried out baseline and first-year monitoring studies in 2008 and 2009 respectively. As part of the EEMP, a series of one-day shore-based observational surveys for seabirds at the Fundy Tidal Power Demonstration Site were carried out from May to November 2010. As well, two vessel-based surveys reaching from the outer Minas Basin to Cape Spencer were undertaken to provide additional baseline data and environmental monitoring information to assess potential impacts of the project. The shore-based surveys took place in May (1, 13 and 27) and on June 12, October 23, and November 13 and 22, 2010, and vessel-based surveys took place on July 19 and August 18, 2010 (see report Appendix C).

Thirty-two species of water-associated birds were observed from shore in the vicinity of the demonstration facility, with Herring Gull, Great Black-Backed Gull, Common Eider and Red-Throated Loon the most common and abundant species. The greatest number of species occurred during fall migration in late October and early November (October 23 and November 13 surveys), but no migration peak was observed in May, and the expected peak spring movement of birds through the area may have occurred earlier.

Ten species were observed in vessel surveys which included parts of Minas Basin, Minas Passage and Minas Channel, including Herring Gull, Great Black-Backed Gull, Ring-Billed Gull, Double-Crested and Great Cormorant, Common Eider, Black Guillemot, Northern Gannet, Wilson's Storm Petrel and Common Loon.

No pattern was observed in the local distribution of birds in several sub-areas of the installation site (between Black Rock and shore; in Minas Passage outside Black Rock; and in the turbine installation ("Crown Lease") area. Greatest concentrations of birds were observed in late-May to early-June in the inshore area extending between Black Rock and shore (Great Black-Backed & Herring Gulls dominant); in the turbine installation area in mid-November (Red-Throated Loons dominant); and in Minas Passage during October 23 and November 22 surveys (Common Eider, Herring Gulls and Red-Throated Loons dominant).

The shore-based component of the survey showed a fall peak in migrants but a spring peak, which was expected to occur, was not demonstrated, suggesting either that it occurred earlier in the year than the period covered by the survey or that it is not as pronounced at the site as in other areas. Loons were the principal family of water-associated birds targeted by spring and fall observations in the study, since they are known to migrate through the area and they feed by diving and consequently may potentially interact with turbines. Because of their likely occurrence in the area in winter, their winter occurrence in the area is a potential data gap. Surveys extending earlier in the spring to capture the spring migrants, as well as in mid-March and December, may be sufficient to document the winter occurrences of alkyd species.

Generally, seabird densities in the study area measured in 2009 and 2010 are slightly lower than or comparable to densities for other Nova Scotia waters. Densities were lower than typical seabird densities in coastal and shelf areas in Nova Scotia waters although peak densities can be comparable to those from adjacent areas of the Bay of Fundy. The 2010 observations, combined with those of earlier baseline and monitoring studies carried out by FORCE, continue to suggest that the tidal demonstration site is not exceptionally important in terms of seabird and waterfowl abundance in the Inner Bay of Fundy.

5.2 Marine Mammals

Marine mammals, which include whales, dolphins, porpoises and seals, occur in the Inner Bay of Fundy and could potentially be impacted by turbine operations, either directly by contacting tidal devices or through impacts on food species. Monitoring during the tidal demonstration project has consisted primarily of on-shore and ship-board observational studies, done in conjunction with the seabird surveys. As well in 2010, an acoustic monitoring program, using porpoise 'click detectors' moored at the FORCE Tidal demonstration site, was used to study porpoise and test the feasibility of using the technology for future monitoring. Both study approaches identified the importance of Harbour Porpoise as the dominant marine mammal species at the site; only occasional white-sided dolphins, and seals have been seen at the site, and no confirmed whale sightings have been made during the surveys. The lack of sightings of whales reflects the low overall abundance and frequency of occurrence of these species in the area.

5.2.1 Vessel and Shore-Based Observations

Shore-based surveys undertaken at the Minas Passage shore installation provided information on the occurrence of Harbour Porpoise (*Phocoena phocoena)* in the study area in spring and fall—showing that the species occurred on most days and usually several times per day—as well as providing some insight into movement and activity patterns (see report Appendix C). Most observations were made on ebbing tides between high tide and low water and all individuals were swimming with the tide and at the surface. No particular association of Harbour Porpoise was noted with the proposed location of tidal turbines.

Harbour porpoise were only observed incidentally as part of the shore-based seabird surveys and the surveys represent only a snapshot of daily activities through the tidal cycle. In addition, the lack of summer to early-Fall observations at the study site, as well as observations in the late-March to early-May period, is a gap in assessing the overall pattern of abundance of Harbour Porpoise at the site. The daily movements of Harbour Porpoise are part of a larger pattern involving adjacent areas of Minas Basin and Minas Channel and also likely interactions with fish movements in the area, little of which can be determined from point observations at the study site. The observations have provided information on local behaviour and distribution which may be valuable in assessing project impacts. Harbour Porpoise may therefore be an important indicator species at the site meriting additional observational effort in future.

Vessel surveys in Minas Passage and Channel conducted in July and August 2010 were less effective at detecting Harbour Porpoise. Five Harbour Porpoise and no other species were observed in the two surveys combined, but similar surveys the previous year were more successful, in particular identifying various species of marine mammal including an unconfirmed sighting of a whale and sightings of White-Sided Dolphins in the area.

5.2.2. Mammal – Passive Acoustic Monitoring

The Passive Acoustic Monitoring (PAM) study, which was an expansion to an existing OEER-funded project, involved a continuous, approximately 3 month passive acoustic monitoring study for dolphins and porpoises (10 August to 23 November 2010) during the NSPI/OpenHydro tidal turbine device deployment in Minas Passage (see report Appendix D). This acoustic monitoring approach records the sounds of porpoises and dolphins (clicking sounds produced for echolocation of prey and communication) and later analyzes them to provide information on the identity of the species, their abundance, timing, daily patterns, and characteristics, providing information on use of the area and the animals' behaviour.

Comparisons can be made of behaviour (as monitored by the sounds produced by the species) in the vicinity of a turbine compared with 'control' sites at some distance from it, thereby showing potential impacts of turbine operation. Three C-PODs (autonomous, cetacean echolocation click detecting hydrophones) mounted on "SUB B3" streamlined instrument buoy moorings were included in the deployment, positioned in close proximity (150 metres east and west) of the turbine, while a third 'control' device was positioned 700 metres west of the turbine site. One of the devices near the turbine failed early in the deployment, while the two remaining C-PODs (east of the turbine and the control site) recorded click data continuously until the batteries expired (89 and 92 days post-deployment). The failed C-POD collected one day of data before stopping and its mounting SUB-buoy was recovered damaged, although the recording failure was determined to be due to an internal instrument fault.

The study confirmed the ability to collect long-term (3-month), high quality, cetacean click and temperature data from moored C-PODs in the Minas Passage, proving the ability of the instrumentation to provide useful baseline monitoring data on Harbour Porpoise behaviour including daily and seasonal patterns, and differences between turbine and control sites. The study answered questions over interferences with other acoustic instrumentation, showing no interference either by concurrent use of Vemco acoustic transmitters and receivers (fish tracking study), or from depth sounders of fishing vessels, which were discriminated by the C-POD analysis. Harbour porpoises were the only members of the groups of cetaceans (dolphins and porpoises) the C-PODs are designed to detect – no dolphin species were detected. Harbour Porpoise was commonly present (93% of days) but the relative abundance indicated by click detections was relatively low, and varied significantly with time of day (highest at night), and with month (highest in September) but showing no variation with location (i.e. between the turbine and control sites). Some click patterns were; however, different between the turbine and control sites. A power spectrum analysis suggested that Harbour Porpoise occurrences followed the tidal cycle but without clear association with either the falling or rising tide. The species was detected regularly through the late summer, but did not appear to spend significant time there (suggesting mainly transit through Minas Passage) but areal coverage of the instruments was not particularly large to detect other activities such as foraging which may occur in the area.

In summary, C-PODs were found to be effective in monitoring cetacean presence. Harbour Porpoises were detected regularly through late summer and autumn but did not (with a few exceptions during neap tides in September and October) appear to spend significant time periods around either the turbine or the control site (suggesting transit through Minas Passage or local foraging in areas out of detectable range). Presence was higher at night at both sites. No statistical evidence of the presence of the turbine attracting or repelling porpoise was found, but when porpoises were present, behavior (based on click train parameters) appeared to differ between the two sites.

5.3 Distribution and Abundance of Lobster

Commercial fishing for lobster is important in Minas Channel, and is one of the few commercial fisheries in the FORCE Tidal Demonstration area. The objective of this study was to provide baseline information on lobster abundance expressed as catch rates and to determine if changes resulted from the tidal energy program. The study, referred to as a catch or catchability study, consisted of setting commercial lobster traps within test and control areas in the vicinity of the tidal demonstration site. Three surveys, two in the fall of 2009, before and bracketing installation of the NSPI turbine, and one in the spring of 2010 while the turbine was in place, have been conducted to date. The study report in Appendix E summarizes the key results from the surveys.

The surveys focused on the FORCE Tidal demonstration site and 'control' areas located to the east and west, which were selected to represent areas unaffected by turbine installation. Locations were randomly selected within the areas and standard lobster traps modified with additional weight to resist tidal currents were used. At the request of NSPI/OpenHydro, the study also included stations located in the vicinity of the NSPI/OpenHydro turbine, at roughly 200 and 500 m distance, to determine differences in catch rates which might reflect turbine effects. The overall study determined patterns of catch and composition in the three areas (demonstration site and East and West Controls) and assessed differences among areas, seasons, depths, and levels of fishing activity (the timing of the baseline surveys spanned the pre-season of the lobster fishery (first survey) and during the fishery (2^{nd} and 3^{rd} surveys)). The findings and all results were analyzed statistically to determine patterns and trends, and an independent statistical review of results was carried out to assess the validity of the statistical approach and findings, as well as to provide recommendations for design improvements. In its execution, the study was adaptive and the approach was modified to respond to the tidal environment to optimize the effort and ensure efficient deployment and recovery of traps. Activities included efforts to maintain standard soak times (the length of time the traps were in the water), experimentation with the use of paired traps, repositioning of traps moved by the tide, adjustments for loss of traps, and efforts to manage efficient recovery and deployment. Sources of variability included survey timing, water depth, habitat type, number and types of sampling site locations, trap movement and soak time.

Some broad general conclusions were reached by the study, which has provided a useful baseline for future monitoring at the site, including providing a statistical basis for refining the designs of monitoring programs. In general, the study found that catch was comparable between the Eastern Control, Tidal Demonstration site, and West Control area. Catch rates in the spring (2010 following turbine deployment) were markedly lower than the two fall surveys, and catch rates were higher nearer to shore and consequently in shallower water. Size composition of the catch in three size classes, favoured small lobster in shallower water and thus near shore; large lobster were widely distributed with no correlation with depth. In addition, the distribution of lobster by sex and reproductive state (whether females were berried or not) did not appear to vary spatially. Catch rates were greater the longer traps were in the water. In the only correlation with project activities found in the catchability study, lobster catch was found to be lower 200 m from the turbine than at 500 m distance. This outcome could not be linked to specific turbine effects, as the study was not designed to account for other factors such as variation in the substrate or position in relation to subsea features, but provides guidance for design of further studies at the site.

The independent statistical review concluded overall that the project results and design were valid statistically, but suggested improvements to increase the ability of the design to measure catch parameters and monitor changes.

5.4 Fish Surveys – Distribution, Abundance and Movements

The Inner Bay of Fundy is an important feeding and nursery area for marine and estuarine fish and Minas Passage is migratory pathway for most species. However the high tides and currents, as well as availability of research funding have hindered work on determining the utilization of the Passage. Consequently, patterns of behaviour, distribution and movement of fish in the study area are imperfectly known, but essential for assessing impacts of tidal turbines. Therefore EMAC placed a high priority on studies of fish in Minas Passage. Efforts supported in whole or in part by FORCE have been highly successful. Work included a background literature, which updated information on the occurrence and migration of fishes in the Minas Passage (see Appendix F). NSPI/OpenHydro conducted a short-term hydroacoustic survey without a trawl component in April and May 2010. FORCE also undertook an extensive hydroacoustic and mid-water trawl survey of Minas Passage (Appendix H) in 2010 which determined species composition, abundance, timing and distribution of fish. FORCE also funded an expansion of OEER-supported acoustic tagging studies to monitor the movements of key species including Striped Bass, Atlantic Sturgeon, and American Eel tagged in coastal areas of Minas Basin and rivers entering it. Finally, FORCE supported a project, focused on the use of drift nets as a monitoring tool, which resulted in a July 2010 drift net deployment in the Blomidon-Minas Passage area (Appendix G). Summaries of the fish surveys are presented below.

5.4.1 Fish Distribution and Abundance in Minas Passage – Hydroacoustic and Mid-Water Trawl Surveys

A hydroacoustic (echo-sounder) fish survey was conducted from a small (18.6 m) commercial stern trawler approximately bi-weekly from June to October of 2010 in Minas Passage, spanning the FORCE Tidal Demonstration Site (Appendix H). Hydroacoustic surveys use sound or backscatter reflected from the swim bladders of fish in the water column to estimate the abundance, biomass and distribution (depth and location) of fish under the vessel. Receiving equipment is calibrated to enable accurate measurements of the intensity of backscatter to be converted to an estimate of fish density or acoustic biomass. An echo sounder cannot determine the identity of the species present without independent verification, typically done by using trawls or nets to catch the fish. In the present study, a mid-water trawl was used to capture fish identified in the hydroacoustic record. The present survey was highly successful, providing a detailed background data set for assessing potential for tidal impacts.

The hydroacoustic fish survey was intended to identify seasonal changes in fish distribution both spatially and vertically in the water column. Initial survey trials to develop protocols were carried out in June 2010 with approximately bi-weekly surveys conforming to a consistent methodology conducted from July to October. The NSPI/OpenHydro turbine was in place within the tidal power lease area during these surveys.

Species occurring at the site, determined from mid-water trawls included: Atlantic herring, dollar fish (butterfish, *Peprilus triacanthus*), Atlantic mackerel, gaspereau, smelt, lumpfish, sea raven, summer flounder, winter skate, tomcod, silver hake, red hake, walleye pollock, striped bass, dogfish and Threespine stickleback; and occasional krill (a planktonic shrimp-like crustacean) were also sampled. Atlantic herring, dollar fish, mackerel, gaspereau, smelt and lumpfish were most consistently caught. At times, predominately bottom species, such as sea raven, summer flounder, and winter skate were caught well above the bottom. Gadoid (cod-like) fishes, including tomcod, silver hake, red hake, and pollock, were caught in low numbers, inconsistently, and were generally small (<10 cm fork length). A large striped bass and large dogfish were caught on September 17 and October 26 respectively, and a dogfish was also caught in the initial June survey. No species listed under the Species at Risk Act were caught during any survey work in 2010.

The relative abundance of different species of fish changed seasonally. Herring by far outnumbered all other species caught in the spring, dominating the catch especially in June and early July. In October, when most herring are thought to leave Minas Basin, herring still made up the largest single component in most tows, but were much less abundant than earlier in the year (about 7% of the June average).

The quality of the data generated by the hydroacoustic survey system was considered good and there was reasonable consistency between catch data and the acoustic record, with samples of fish captured and species identified in the areas of fish abundance identified by acoustics. The correlation between acoustic biomass and the catch in the mid-water trawl was only moderate, however, in part because of the patchiness and dominance of herring during some of the surveys, but also thought to be because of the varying currents and turbulence in the Minas Passage, preventing good alignment of the mid-water trawl and the vessel hydroacoustic echo sounder.

Some key findings from the study were:

- Surveys found that fish were relatively evenly distributed throughout Minas Channel between July and October.
- Both acoustic and tow data indicated a relatively even distribution of biomass throughout Minas Passage, with little spatial differences or concentration by species. The tidal power lease area had fish biomass similar to other parts of the cross section of Minas Passage and therefore does not appear to be a specific migration or passage route for any species.

- Major differences between tow and acoustic estimates of biomass were most probably a result of differences in abundance and patchiness of herring as well as reflecting the difficulty in adequately positioning trawls to sample fish seen on the hydroacoustic system.
- The major component of finfish biomass in Minas Passage is adult herring moving into the area in June, followed by young herring in later July and August, gaspereau in September, and a broader mix of species leaving the upper Bay of Fundy in October.
- Tidal conditions were not a significant predictor of biomass, but the strong tidally-induced currents may have increased the variation and range in spatial and vertical fish distributions.
- Fish were acoustically observed moving upwards in the water column at night, but catches were higher during the day, suggesting visual cues, such as the fish seeing trawl doors, leading to escape behaviour into the net, increasing catch efficiency.

5.4.2 Fish Movement - Acoustic Tagging/Tracking

An important new technology for monitoring the activities of fish in the ocean—use of acoustic tags—has been applied to the problem of determining fish movements in the vicinity of the FORCE Tidal Demonstration Site. FORCE contributed to a project funded largely by the OEER which implanted acoustic transmitters in Striped Bass, Atlantic Sturgeon, and American Eel in Minas Basin and rivers feeding into it (Appendix I). Underwater acoustic telemetry receivers (hydrophones to listen for distinctive acoustic signals of the tags) deployed across the Minas Passage at Cape Sharp, and in near-shore areas of the Minas Basin during July to November 2010, recorded the unique acoustic signals transmitted by tagged fish near the receivers, to track the movements of these species.

Funding from FORCE allowed the implanting of VEMCO acoustic transmitters in an additional 50 Striped Bass (120 fish were tagged in total—80 Striped Bass, 30 Atlantic sturgeon, and 10 eels). Striped Bass were captured by angling and tagged in the Stewiacke River in early May, 2010, or near the Gaspereau River mouth in early August; while Atlantic sturgeon were tagged after capture 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. Preliminary results have shown a high success rate for the project, with high post-surgery survival for all species, and significant detections by receivers in Minas Passage Sixty-six per cent of tagged bass crossed through the line of receivers at Cape Sharp, and 31% were detected in the NSPI/OpenHydro turbine berth area. Of the 10 eels tagged in October, three were detected as they migrated out of Minas Basin and one of these was detected near the NSPI/OpenHydro turbine site. All but two of the 30 tagged Atlantic sturgeon were detected, with 21 and 8 sturgeon detected by the line at Cape Sharp, and the turbine receiver array, respectively.

This application of the technology was successful and will continue to be employed and expanded in 2011 to gather further information on fish movements in the FORCE Tidal Demonstration area.

5.5 Ambient Marine Noise

Noise monitoring, both ambient baseline and during operation of tidal turbines, has been identified as an important objective of environmental monitoring at the FORCE demonstration site.

In addition to measuring noise levels, which may potentially influence marine mammals, operators have been interested in determining noise signatures near an operating turbine. Both FORCE and NSPI/OpenHydro have attempted to obtain underwater noise levels at the site. Early in the project, on September 24, 2008, FORCE deployed a suspended hydrophone from a drifting vessel with motors off in Minas Passage for a baseline survey in the FORCE lease area; and conducted a post-deployment survey in the vicinity of the NSPI/OH turbine berth site on December 2, 2009 with the vessel under power. NSPI/OpenHydro subsequently conducted a survey at the turbine berth site conducted using "drifting" suspended hydrophones on May 11, 2010.

Sound level data from both sets of surveys were later determined by an independent consultant engaged to be unreliable, indicating that sea state and turbulence interferences were a problem in the generated data. Overall, the noise level data collected on the three surveys was considered inconclusive; and therefore, no further analysis has been undertaken. In consultation with DFO, FORCE agreed to undertake a more detailed baseline noise survey after the removal of the NSPI/OpenHydro turbine and prior to the deployment of any other turbines at the site. This work is scheduled to be completed in 2011.

5.6 Seabed Environment and Scour Survey

In January 2011, a side-scan sonar and towed video camera survey was conducted at the Reference Site and at the location of the NSPI/OpenHydro test deployment site, to determine conditions on the bottom after the recovery of the turbine assembly (see report - Appendix J). Sonograms and side-scan sonar mosaics were interpreted, compared and contrasted with previously collected multi-beam bathymetry and derived backscatter and slope imagery, to determine both natural change and possible effects of the turbine placement, operation, and removal over a one year time frame. The analysis showed no detectable seabed change at the Reference Site since the original data was collected over 5 years ago. The seabed consists predominantly of exposed sedimentary bedrock ridges projecting from intervening flat regions of gravel with boulders.

No change in the seabed at the turbine site was observed in the survey, with the exception of a several metre long linear piece of seabed debris, possibly remains of the turbine blades or center-ring, as well as small imprints believed to have been left by two of the feet of the GBS. The turbine was placed on a broad, resistant, exposed volcanic basalt platform, and two of the feet of the gravity platform appear to have created 1-m diameter depressions in this bedrock surface. No other changes in the morphology or gravel distributions of the seabed were detected and no fine-grained sediments occur both in the near-field and far-field that could have been disturbed by the turbine.

5.7 Physical Oceanography

Oceanographic measurements (See Appendix K) were made on vessels of opportunity in Minas Passage in July, August, and October 2010 and January 2011, to obtain information on water transparency, suspended sediment, and water temperature. A standard Secchi disk deployment was used to measure transparency; surface water samples were taken by bucket for laboratory measurement of suspended sediments; and surface temperature was measured to an accuracy of 0.1 º C using a thermometer calibrated to a U.S. National Institute of Standards (NIST) standard. Several of the observations coincided with overpasses of an ocean remote-sensing satellite and the information was provided to the Bedford Institute of Oceanography to contribute to the data set used to calibrate the satellite sensors.

Observations were consistent with the seasonal pattern based on earlier observations for the site, which includes high transparency and low suspended sediment levels in summer, reaching low transparency and higher suspended sediment levels in winter.

Sea surface temperature showed a late-summer peak, ranging from 16.3 -17.4ºC. in August to a low of 3.5 - 4.1º C. in January; and suspended sediment levels ranged from 3.3 to 6.2 mg/L in July - August to levels of 9.4 to 12.5 mg/L in January. Secchi Depth, a measure of water transparency, ranged from 2.75 to 3.5 m in July and August respectively to a low of 1.5 m in January 2011. These findings are consistent with previous studies and no further monitoring is anticipated for these parameters.

6. ADDITIONAL OBSERVATIONS

FORCE established a 1-888 number in October 2009 both as an inquiry line, but also to report any usual environmental occurrences in the study area and to identify concerns, complaints and any other issues raised by the public and others in the area communities. The organization also established the Community Liaison Committee (CLC) as another mechanism for the local community to provide feedback, identify questions and concerns on the project. As well, the CLC is a mechanism to provide ongoing updates on the project to the local community.

It was anticipated that if any usual incidents did occur, such as fish kills, mammal and any unusual seabird activity, etc. in the marine demonstration area, these would be reported to FORCE via the 1-888 number and/or the CLC, to the federal and provincial regulatory agencies.

FORCE consultants working on vessels or from shore for the EEM studies were available to note any unusual events or occurrences; but no unusual incidents or occurrences were observed during the deployment period.

The Marine Animal Response Society (MARS) was also contacted on a regular basis to determine if there were any reported mammal strandings or mortalities in the Minas Passage area during the deployment of the NSPI/OpenHydro turbine. One fin whale mortality was reported in the Minas Basin - Minas Channel area while the turbine was in place, but MARS determined that the mortality was not related to the presence of the turbine. No other occurrences were reported to MARS in the Minas Channel area during the turbine deployment period.

7. CONCLUSIONS

The planned field studies proposed under FORCE's EEMP, were successfully implemented and reports completed. However, in many cases the monitoring methods and instruments for measuring environmental effects in the Minas Passage are still a work-in–progress, and require additional research.

The turbine was only operational for a short period of its deployment. However, the 450 metric ton turbine assembly was in the water for over one year, and, the EEM program did not detect any adverse impacts. The EEMP did gather additional environmental background data and information for the Minas Passage area, and enabled the testing of a variety of monitoring technologies and methods.

Based on the adaptive management approach, the lessons learned were valuable and will be incorporated in the design of future EEM studies. As there will be no turbines deployed in 2011, the 2011 EEMP will be focused on gathering additional background information and the ongoing testing of monitoring methodologies. EMAC has provided FORCE with recommendations for the 2011 EEMP, which along with FORCE's response, is available on the FORCE website. As well, FORCE will continue to work with others, such as the OEER, to identify and implement research on monitoring approaches in the Minas Passage.