COBSCOOK BAY TIDAL ENERGY PROJECT

2012 ENVIRONMENTAL MONITORING REPORT FINAL DRAFT

FERC PROJECT NO. P-12711-005

MARCH 26, 2013

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March 26, 2013

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

Subject: Cobscook Bay Tidal Energy Project (P-12711-005)
2012 Environmental Monitoring Report

Dear Ms. Bose:

ORPC Maine, LLC (ORPC) is pleased to submit the attached 2012 Environmental Monitoring Report for the Cobscook Bay Tidal Energy Project. This report represents a significant milestone for the project and the project's Adaptive Management Plan, and we believe it demonstrates improved knowledge of our TidGen™ Power System's installation, operation and interaction with the marine environment.

This Report is being submitted following a 30-day agency review period and an Adaptive Management Team meeting. The meeting, held on March 12, 2013, was an opportunity for ORPC to present monitoring results and make recommendations for potential modifications to monitoring frequencies and methods in a collaborative setting with regulators and technical advisors. Following the agency review period and the Adaptive Management Team meeting, ORPC addressed not only the comments from agencies but also feedback from the Adaptive Management Team and revised this Final Report to address these comments.

If you have any questions regarding this submission, please contact me by telephone at 207/221-6254 or by email, njohnson@orpc.co.

Sincerely,

Nathan E. Johnson
Director of Environmental Affairs

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EXECUTIVE SUMMARY

Introduction

ORPC Maine, LLC, a wholly-owned subsidiary of Ocean Renewable Power Company, LLC (collectively ORPC), submits this 2012 Environmental Monitoring Report for Phase I of the Cobscook Bay Tidal Energy Project (Project), in compliance with the Federal Energy Regulatory Commission (FERC) pilot project license P-12711-005. This report represents a significant achievement for the Project and its Adaptive Management Plan and demonstrates improved knowledge of our TidGen™ Power System's installation, operation and interaction with the marine environment.

The purpose of FERC's pilot license process is to advance new marine hydrokinetic technology while minimizing the potential for environmental impacts. The process allows developers to test and evaluate new hydrokinetic technologies and determine environmental effects of the technologies, while maintaining FERC oversight and agency input. Pilot projects must be temporary, limited in size, removable, and able to shut down on short notice, and license terms ensure environmental monitoring and safeguards during the short project term.

ORPC is using this licensed pilot project to advance, demonstrate, and accelerate deployment of its tidal-current based marine hydrokinetic energy conversion technology, associated power electronics, interconnection equipment, and environmental monitoring program within a replicable full-scale, interconnected array of devices capable of reliably delivering electricity to the domestic power grid. The Project consists of designing, building, installing and monitoring a commercial-scale array of multiple grid-connected TidGen™ devices on the sea floor in Cobscook Bay off Eastport and Lubec, Maine in two phases.

Project Installation and Operation

ORPC received its pilot project license on February 12, 2012. The Project was installed during the period March 20, 2012 – August 14, 2012 following approval of its installation plans by FERC's Division of Dam Safety and Inspection. Electricity generated by the Project was delivered by an underwater power cable to an On-shore Station in Lubec, Maine, where it was power-conditioned and connected to the Bangor Hydro Electric Company power grid on September 13, 2012. Bangor Hydro issued a Permission to Operate: Certificate of Completion on September 25, 2012. The Project is the first federally licensed, grid connected tidal energy project (excluding a dam) in the Americas.

The Project operated through October 7, 2012 at which time ORPC addressed initial start-up issues related to the TidGen™ device's core technology, the turbine generator unit (TGU). ORPC extended a planned maintenance phase to ensure that corrective measures resolved the following issues: electromagnetic noise that compromised the integrity of data streams; a misalignment of a subsea connector that affected water speed sensors; loose bolts at the intermediate connections that required replacement and alternative methods of preventing vibration loosening in the future; and a failed resistor in the opto-electric circuit controlling the brake (effectively locking out the TGU). During this extended maintenance period the TGU was retrieved on October 24, 2012 and reinstalled on December 7, 2012.

Environmental Monitoring Challenges

The implementation of the environmental monitoring plans was affected by two overriding challenges: the realities of working regularly in the marine environment (i.e., limited visibility, high velocity, deep water conditions with changeable weather at the surface); and the start-up, conditioning, and maintenance issues associated with the new marine hydrokinetic technology and environmental monitoring instrumentation, especially the components that represented first of their kind applications.

To overcome these challenges ORPC took the following approach to ensure consistency with the Project's license:

- Data was collected in accordance with the approved environmental monitoring plans and Adaptive Management Plan and in conjunction with the installed infrastructure and operational status of the TGU.

- Where deficiencies in equipment and methodologies were identified, ORPC engaged technical advisors, consulting scientists, manufacturer representatives, and qualified in-house personnel to troubleshoot issues and develop improvement plans, as necessary.

Adaptive Management Plan for Environmental Monitoring

ORPC developed an Adaptive Management Plan as required by the FERC pilot project license.. The Adaptive Management Plan is an integral part of ORPC's implementation of the Project and provides a strategy for evaluating monitoring data and making informed, science-based decisions to modify monitoring as necessary. The Adaptive Management Plan, therefore, was designed to be modified within the Project time line and acknowledges that elements such as key environmental uncertainties, applied studies and institutional structure may evolve over time. The plan has worked well for the agencies, stakeholders, and ORPC as the Project evolved from a concept to the first pilot installation and operation.

Environmental Monitoring Results

The following environmental monitoring plans were adopted as license articles in our Federal Energy Regulatory license issued on February 27, 2012. Results to date indicate significant achievements that contribute to our overall understanding of device interactions in Cobscook Bay:

Article 405. Acoustic Monitoring Plan

ORPC's acoustic consultant Scientific Solutions Inc. (SSI) developed a NOAA sanctioned methodology using a drifting spar buoy for the difficult task of pre-deployment acoustic monitoring at the high velocity deployment site. The same method was utilized to monitor generated noise at ORPC's "beta-unit". Our Acoustic Monitoring Plan includes post deployment monitoring to validate the predicted devise noise levels in our Final Pilot License Application to FERC.

Scientific Solutions, Inc. (SSI) conducted acoustic monitoring using the same methodology and equipment envisioned for the TidGen™ during Phase I pile driving in March and April 2012. Results confirmed that pile driving source levels were within acceptable ranges provided that sound absorption devices were used and best practices were implemented for pile and follower assembly. ORPC will implement these best practices if pile driving is used during Phase II installation, which will occur at the same project area, environment and geology as Phase I.

Phase I acoustic monitoring was originally scheduled for December 2012 around the installed TidGen™ device, but needed to rescheduled due to maintenance on the TGU. The revised monitoring date will occur following TGU redeployment in early April 2013.

Article 406. Benthic and Biofouling Plan

MER Associates' review of the benthic survey of the cable route conducted on November 9, 2012 concluded that the exposed sections of the cable are causing minimal disturbance to the seabed and are not adversely impacting the surrounding habitat or benthic epifauna. In addition, the buried portion of the cable is stationary and is not expected to cause any disturbance impacts. Unburied sections of the cable are pinned in position and have not been observed to move. ORPC is continuing to improve methods and quality of data collected for the benthic survey. Review of dive video and inspection of the device following retrieval indicate minimal biofouling of the TidGen™ device. Marine growth, most likely hydroids, was concentrated on the generator, flat surfaces, and sacrificial zinc anodes.

Article 407. Fisheries and Marine Life Interaction Plan

The University of Maine's (UMaine) School of Marine Sciences continued fisheries surveys in 2012 using a vessel mounted down-looking sonar to determine total water column fish biomass at both the installation and control site for each month. Results indicate March had the lowest biomass and May had the highest.

ORPC installed a seabed mounted side-looking sonar on an environmental monitoring tower to monitor marine life interaction with the TidGen™ device. UMaine analyzed an acoustic data subset from the system and detected a total of 13,643 fish tracks; 3,191 of these were detected during flood tides and 10,452 detected during ebb tides. The following summarizes results of the analysis.

Target Strength

The distribution is slightly bimodal, with peaks at -57 dB and -50 dB and most detections lying near these values.

Fish Density

Density appeared to be greater beside and above the TGU than in the turbine zone, though no tests for statistical significance have been carried out due to the low sample size.

Direction of Fish Movement
The compass heading distribution for fish in each sampling zone was bimodal with peaks at the predominant current directions, indicating fish moving primarily with or against the prevailing current. Due to the small sample size, statistical significance was not tested. Against-current tracks were nearly as prevalent as with-current tracks in the region beside the TGU. Above the TGU, fish moved with the prevailing current almost exclusively. In the turbine zone during the flood tide, a greater proportion of fish were tracked moving against the current than with it. Overall, variance in direction of tracks above the TGU and in the turbine zone appeared greater during flood tides than during ebb tides. However, without current direction data, variation in fish track directions cannot be attributed to fish behavior alone. ORPC has made modifications to resolve this issue and it is anticipated that current direction will be collected concurrently with the operational data.

The vertical direction distribution for fish beside the TGU peaked at 0°, indicating that most fish in this zone moved horizontally. There were no clear peaks in the distribution for fish in the turbine zone or above it, with vertical movement spread across all directions. Variance in vertical direction appeared greater during the flood tides than the ebb tides.

Article 409. Hydraulic Monitoring Plan
Sandia National Laboratories utilized their SNL-EFDC model to simulate flow in Cobscook Bay which reproduces available data sets for three water-level locations and an Acoustic Doppler Current Profiler (ADCP) measurement. The results of the modeling demonstrate that there are no significant changes in tidal range, flow rate, or velocity upon operation of five ORPC TGUs, with changes of less than 10 millimeters of tidal height being predicted in some local areas. These results may be within the numerical accuracy of the model and hence may or may not be significant. Sandia National Laboratories concluded that the operation of five TGUs in Cobscook Bay will have little to no effect on regional aquatic habitat as regional processes are unchanged, as our original model predictions noted in the FERC final pilot license application..

Scour monitoring to date indicates no significant change in seabed elevation around the foundation piles, except at pile 6 where the bottom support frame skirt was embedded upon deployment. It is now at grade at this location.

Article 410. Marine Mammal Monitoring Plan
ORPC collaborated with Dr. Moira Brown, senior scientist at the New England Aquarium to design and implement a plan to minimize marine mammal exposure to loud noise-generating activities during Phase I pile driving. The Plan included emphasized details on skills, an observer training program, observer equipment needed, observation methods, data collection and management protocols and associated data sheets, and an incident reporting form. ORPC staff and qualified candidates from the local community were trained by Dr. Brown in Eastport on February 16-17, 2012 and subsequent performed observation during pile driving, as well as subsequent deployment and retrieval activities and incidental sightings.

Marine mammal observations made by trained personnel in 2012, including during periods of construction, operation, and maintenance, did not indicate changes in marine mammal presence or behavior. There is no evidence of marine mammal strike with system components during deployment and retrieval or with TGU foils during operation.

Article 412. Bird Monitoring Plan

The Center for Ecological Research (CER) conducted monthly surveys at the TidGen™ deployment site in North Lubec, Maine between November 2011 - May 2012 to monitor wintering seabirds and waterfowl. Preliminary results from November and December 2012, following Phase I installation, show the same general number of seabirds as was observed in the previous two winters.

In addition, CER conducted surveys during Phase I pile driving. The responses of seabirds to the vibratory hammer noises were generally minimal or of short duration. No obvious seabird response was observed to the louder diesel impact hammer.

Recommended License Modifications

The initial operation of the Project in 2012 has provided an opportunity to collect and analyze environmental monitoring data throughout construction and during operation. Additionally, the project has provided insight and clarity regarding the logistical needs and challenges related to construction activities, operation and maintenance. This experience has increased understanding regarding the appropriate level of environmental monitoring required. ORPC is recommending the following modifications to environmental monitoring based on the knowledge and experience our team has gained.

Table ES-1 summarizes ORPC's proposed FERC license modifications. ORPC provided a draft report to the Adaptive Management Team for a 30-day review and comment period as required by our FERC license. ORPC held an Adaptive Management Team meeting during the later part of this review period on March 12, 2013 to formally present the results of our 2012 monitoring and proposed modifications. The meeting was an opportunity for regulatory agencies to understand the recommended modifications in a workshop setting and collaborate to finalize modifications appropriately.

Table ES-1. *Recommended License Modifications.*

License Article	Environmental Monitoring Plan	Recommended Modifications
404	Adaptive Management Team	1. Move Herb Scribner from AMT to advisor role. 2. Move Nathan Johnson from advisor to AMT. 3. Replace Laury Zicari, U.S. Fish & Wildlife, with Steve Shepard. 4. Replace Ron Beck, USCG, with Lt. Megan Drewniak, USCG.

License Article	Environmental Monitoring Plan	Recommended Modifications
405	Acoustic	Schedule Change: 1. Phase I schedule. Due to TGU operational status and weather constraints ORPC was unable to conduct measurements "within 6 months of deployment." ORPC recommends the license article be revised to indicate measurements to be conducted "within 6 months of TGU operation." 2. Phase II schedule. The license article states that "One year later (after Phase I acoustic measurements), acoustic monitoring will be performed around the five-device TidGen™ Power System." We recommend that this be revised to "Acoustic monitoring will be conducted within 6 months of the completed project array operation."
406	Benthic & Biofouling	Despite challenges with data collection in the fall of 2012, initial results indicate minimal to no impact to the benthic community from the power and data cables. ORPC conducted an inspection on February 2, 2013 using improved techniques and enhanced equipment, the results of which confirm the low impact from the cable. We are therefore recommending the frequency of the benthic and biofouling inspections be reduced. We propose to modify the license article as follows: "Section 8.0 Schedule …It is anticipated that inspection will occur **quarterly** during Phase I of the project."
407	Fisheries and Marine Life Interaction	Schedule Change: ORPC recommends revising *Table 2. Proposed Monitoring Schedule of the Fisheries Monitoring Plan for Cobscook Bay*, based on Phase I operation and proposed Phase II installation schedule. The revised Table 2 has been added to Appendix E of this Report.
409	Hydraulic	ORPC recommends that measurements for scour occur on a quarterly basis during scheduled dive inspections.
410	Marine Mammal	*Section 6.2. Monitoring by Dedicated Marine Mammal Observers.* Recorded sightings as well as knowledge of the low risks associated deployment, maintenance and retrieval of various project components have contributed to ORPC

License Article	Environmental Monitoring Plan	Recommended Modifications
		recommending trained staff perform incidental sightings during these activities rather than two dedicated observers. To support ORPC's recommendation to perform incidental observations during deployment and retrieval activities, we recommend that trained staff perform visual scans of the area 30 minutes before, 10 minutes before, and immediately prior and following these activities and document sightings accordingly.
412	Bird	Pre-deployment and Phase I surveys have indicated significant sea and shorebird concentrations only during winter migrating periods (November to through April). ORPC is therefore recommending that *Section 7.0 Reporting*, of the Plan be modified to remove surveys during fall migration and spring and summer seabirds.

Agency Comments and ORPC Response
In addition to technical comments, ORPC was pleased to receive positive feedback on the Report and the value and benefit of the adaptive management process. ORPC has revised this report to address comments received where necessary.

In accordance with ORPC's Adaptive Management Plan, the 2012 Environmental Monitoring Report will be made available to the public. ORPC received feedback from the Adaptive Management Team during the March 12, 2013 meeting regarding preferred options for the public dissemination of the Report. In addition to the Report being available on FERC's website, it will also be posted to ORPC's website (www.orpc.co). Hard copies of the full report will be provided to the municipal offices of the City of Eastport and the Town of Lubec, and ORPC will coordinate additional dissemination with community organizations.

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1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

ORPC Maine, LLC, a wholly-owned subsidiary of Ocean Renewable Power Company, LLC, (collectively, ORPC), is a Maine-based developer of hydrokinetic power systems and projects that harness the power of oceans and rivers to generate clean, predictable renewable energy. In partnership with coastal and river communities, ORPC works to create and sustain local jobs while promoting energy independence and protecting the environment.

ORPC received a pilot project license for the Cobscook Bay Tidal Energy Project (Project) from the Federal Energy Regulatory Commission (FERC) on February 27, 2012 (FERC Project No. P-12711-005). The purpose of the Project is to evaluate the potential for a new source of clean, renewable energy generation using tidal energy resources in Cobscook Bay, Maine. ORPC obtained an initial preliminary permit for the Project area in Cobscook Bay from FERC on July 23, 2007; FERC issued a successive preliminary permit on January 13, 2011. Feasibility studies, including environmental surveys, and pre-filing consultation were conducted, resulting in ORPC's filing of a draft pilot license application with FERC on July 24, 2009 and subsequently the final pilot license application in September 2011. The FERC pilot project license boundary for the Project encompasses the proposed development area (Figure 1).

In March 2012, ORPC began construction of the Project off the coast of Eastport and Lubec, Maine (Figure 1). Following installation of the initial phase of the Project during the spring and summer of 2012, the Cobscook Bay Tidal Energy Project began delivering electricity to the Bangor Hydro Electric Company grid in September 2012. This is the first grid-connected installation of ORPC's TidGen™ Power System. The Project installation will be completed in 2014.

<u>TidGen™ Power System</u>
ORPC has designed the TidGen™ Power System to operate in water depths of 60 to 150 ft. The core component of the TidGen™ Power System is ORPC's proprietary turbine generator unit (TGU). The TGU utilizes four advanced design cross flow (ADCF) turbines to drive a permanent magnet generator mounted between the turbines on a common driveshaft. The ADCF turbines rotate in the same direction regardless of tidal flow direction; rotational speed of the turbines is directly related to water flow speed. The TGU is 98 feet in length, 17 feet high and 17 feet wide. It is attached to a bottom support frame, which holds the TGU in place approximately 15 feet above the sea floor. The bottom support frame is 98 feet long by 50 feet wide by 15 feet high. The bottom support frame is constructed of steel and the TGU is constructed of steel and composite material. The coupled TGU and bottom support frame comprise the TidGen™ device (Figure 2). The TidGen™ device is connected to an underwater power consolidation module, which is then connected to an on-shore station through a single underwater power and data cable. The on-shore station is interconnected to the local power grid. The TidGen™ Device and the related cabling and on-shore station comprise a complete TidGen™ Power System.

Figure 1. Cobscook Bay Tidal Energy Project location map.

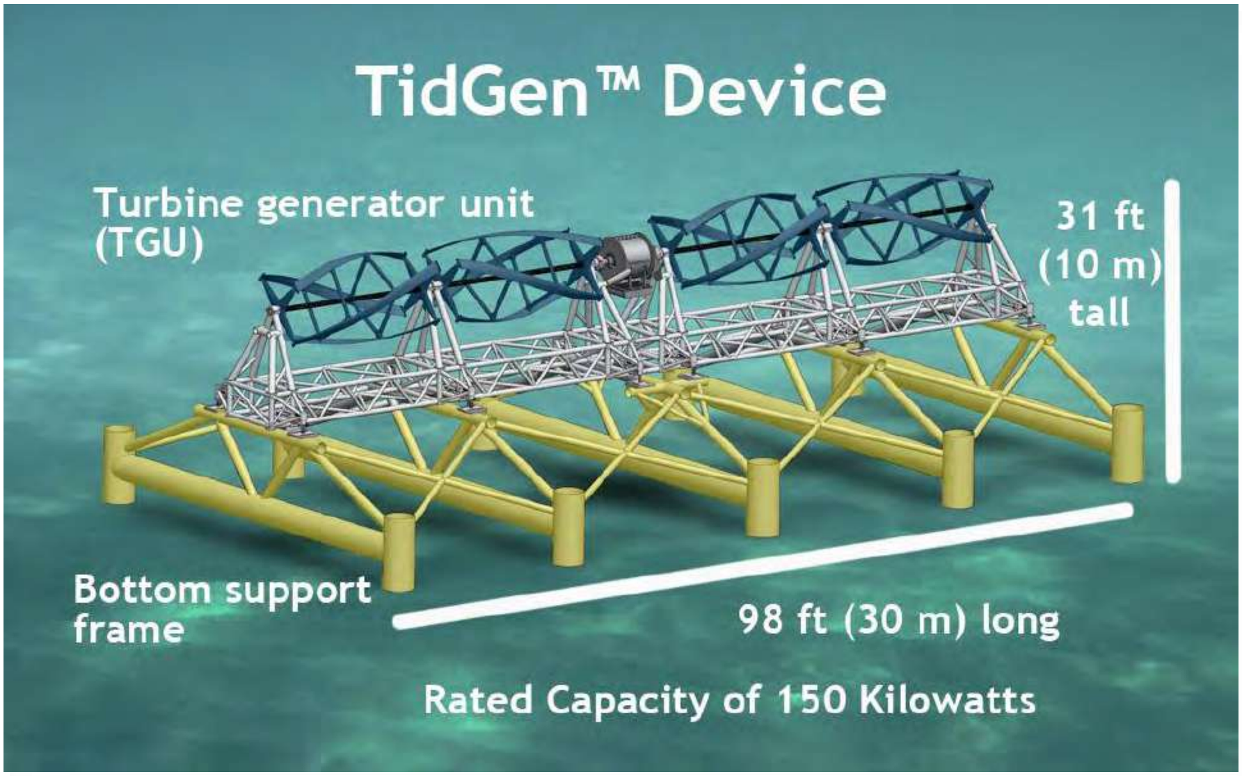


Figure 2. TidGen™ device illustrating turbine generator unit and bottom support frame.

1.2 Bottom Support Frame Installation

The foundation design for the TidGen™ device at the Project site consists of a pile bent arrangement consisting of ten steel piles, each with a 30-in. diameter and 0.5-in. wall thickness. The piles were designed to vary in length due to bottom sediment depth with each driven to the top of the bedrock and protruding 15+ ft above the seafloor.

The bottom support frame for the first TidGen™ device was deployed on the seabed on March 20, 2012 (Figure 3). The deployed bottom support frame acted as a template for the driving of piles to secure the foundation in place.

ORPC obtained an Incidental Harassment Authorization (IHA) from the National Oceanic and Atmospheric Administration – National Marine Fisheries Service (NOAA NMFS), Office of Protected Resources, on March 8, 2012. The IHA process was required due to the potential for the associated noise levels generated during pile installation to exceed NOAA's guidelines for instantaneous and continuous impact noise.. In addition, the FERC license for the project established a restricted period for pile driving between April 10 and November 7 of any year (Article 402). During pile installation, ORPC collected environmental monitoring data, implemented mitigation measures, and developed best management practices to maintain pile driving source levels below established regulatory thresholds.

ORPC's Final IHA Report for Phase I Pile Driving presented monitoring results for Phase I and also established best management practices and recommendations for Phase II installation (Appendix A). The Report also described how ORPC's FERC license was modified through the adaptive management process to remove the restrictive period for Phase I pile driving.

Figure 3. Bottom support frame deployment, March 20, 2012.

1.3 CABLE INSTALLATION

The power cable delivers electrical power from the TidGen™ devices to the On-shore Station in Lubec, Maine. In Phase I, the power cable was connected to a single TidGen™ device and delivers a nominal 800 volts (V) of DC at a maximum current of 200 amps to shore.

The underwater power and data (P&D) cable route was chosen after survey results indicated the fewest obstacles to cable laying, such that little or no pre-deployment clearing of obstacles was required. Based on consideration of environmental and safety concerns, ORPC buried the underwater P&D cable at all feasible locations along the cross-current portion of the cable route to a depth of approximately two ft. ORPC initially proposed burying the underwater portion of the cable using jet-plow technology. However, the installation was completed using a modified shear plow to further reduce environmental disturbance (Figure 4).

ORPC conducted multiple practice runs of the cable laying operation prior to installation. This included a test event conducted on June 29, 2012 to assess the capabilities of the shear plow to properly install the power and data cables.

Subsea cable installation occurred on July 13, 2012. Installation began with the barge moored at the offshore cable terminus where the shore cable termination anchor was deployed. The deployment barge was then moved along the cable transects, dispensing cable from the deployment reel as it advanced. Once the cable was laid along the seabed, the barge was stopped and the shore-side cable end was transferred to shore for completion of the on-shore cable run.

Figure 4. Shear plow on deck of deployment barge.

Following the laying of the outboard cable transect, the cable was secured by divers with anchors embedded into the cobble substrate. In locations where penetration did not occur due to hard substrate, the cables were stabilized by the installation of 4 ft long iron U-shaped staples at intervals of approximately 25 ft. The staples will be removed at the completion of the Project (Figures 5 and 6).

Figure 5. Staple used to secure unburied cable.

Figure 6. Installed staple.

The underwater P&D cable burial in the intertidal zone was performed at low tide using an excavator with a narrow width bucket to minimize disturbance (Figure 7). The cable was buried up the beach at a depth of 3 ft and re-covered with beach material. Trenching continued directly inland to the On-shore Station, located approximately 400 ft from the mean high water line. A 30 ft-wide utility easement has been leased from International Aqua Foods USA, Inc. for the duration of the pilot project license.

Figure 7. Intertidal trench with narrow width bucket.

1.4 TGU DEPLOYMENT

The TidGen™ TGU 001was placed on a floating platform, moved to the deployment location and lowered to the bottom support frame using a heavy lift crane on August 14, 2012 (Figures 8). Guide cables were used to orientate and direct the TGU to the bottom support frame. These operations were conducted at slack neap tides. A series of locking connections were actuated by divers, equipped with a torque tool to connect the TGU to the bottom support frame. Final connection, calibration, and positioning were completed after the TGU was attached to the bottom support frame.

Figure 8. Installation of the first TidGen™ TGU in Cobscook Bay, Maine, August 14, 2012.

1.5 TGU Operation

Electricity generated by the Project was delivered by an underwater power cable to an On-shore Station in Lubec, Maine, where it was power-conditioned and connected to the Bangor Hydro Electric Company power grid on September 13, 2012. Bangor Hydro issued a Permission to Operate: Certificate of Completion on September 25, 2012.

The TidGen™ Power System is monitored from the On-shore Station, which has the capability to start, stop, and monitor the TidGen™ Power System. Data, video, and instrumentation readings are transmitted by data cable bundled with the power transmission line. All major system components are instrumented and monitored for operational characteristics and environmental/ecological study, with data collected to document and validate Project performance. The environmental monitoring tower, equipped with Simrad instrumentation to monitor marine life interaction with the TGU, was deployed on August 20, 2012. The Simrad system was subsequently tested and calibrated the following week.

Initial operation of the boosted generator mode showed that significant amounts of electromagnetic noise was added to the data channels which compromised the integrity of the data streams. The instrumentation bottle was retrieved by SCUBA divers, and changes were made to the internal wiring. Upon redeployment and reconnection of the instrumentation bottle much of the electromagnetic interference was removed from the instrument data lines. However, it appears that the SIMRAD fisheries monitoring equipment is especially sensitive to disturbance on its power feed. Data from the SIMRAD shows signs of electromagnetic noise when the generator is operating in boost mode. ORPC added more line filters to other elements of the system, but this has not eliminated the issue.

In addition to the issues described above, there were issues with the water speed sensors deployed with the TGU. A Nortek Aquadopp unit was not functional, and a Valeport flow sensor with the TGU was providing confused data. After retrieval of the TidGen™ device, we discovered that a SubCon connector had been inadvertently rotated during installation, resulting in connection to the incorrect terminals. This was rectified, and upon redeployment the water speed sensors are now providing consistent flow data.

Video inspection of the TGU on October 7, 2012 showed what appeared to be loose bolts on one of the TGUs. A more detailed inspection showed that multiple intermediate joint attachments had loose bolts present. A decision was made to retrieve the TGU as soon as practical, and this was accomplished on October 24. The TGU was retrieved and brought to shore and all TGU joints inspected. At the intermediate TGU connections, many of the bolts had vibrated loose. These bolts were replaced and methods of preventing vibration loosening of the bolts were implemented. These methods included using a higher torque preload and drilling through the nut and bolt assemble and placing a pin to prevent rotation.

Upon redeployment of the TGU on December 7, the system was put online and power generated. However, after operating in boost mode for a short period of time, the electronic brake circuit self-activated, and the TGU stalled. After this event, the brake circuit could not be enabled so the brake would not release. An analysis of the issue points to failure of a resistor in the opto-electric circuit controlling the brake. Since the brake is normally closed, this means that the TGU is locked out. The unit has since been retrieved on January 22, the circuit issue has been addressed and redeployment is scheduled for late February 2013.

2.0 ADAPTIVE MANAGEMENT (License Article 404)

2.1 ADAPTIVE MANAGEMENT PLAN

ORPC developed an Adaptive Management Plan (AMP) as required by the FERC pilot project license (P-12711-005, Article 404) for the Project. The AMP is an integral part of ORPC's implementation of the Project and provides a strategy for evaluating monitoring data and making informed, science-based decisions to modify monitoring as necessary. As required by Article 404, the AMP was drafted in consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Coast Guard, Maine Department of Environmental Protection, and Maine Department of Marine Resources. ORPC also consulted with technical advisors, who have been involved with the development of each of the elements of this Project. The AMP reflects the collaborative approach that has been an integral part of the Project since its beginning.

The collaborative approach that was adopted for the AMP was first utilized for the 2009 memorandum of understanding (MOU) between the State of Maine and FERC, that included a working structure to develop and permit Maine's first hydrokinetic power project. An important component of the MOU was to develop appropriate and cost effective environmental studies and monitoring plans. It was clear from the onset that knowledge of the eco-system and its many facets potentially affected by this new hydrokinetic power project would require new methods of inquiry to collect, monitor and evaluate environmental data. Many of the new scientific methods that have been developed for the Project have become a new basis for learning, and the scientific community has begun modifying approaches to environmental studies using these new methodologies in other programs. This learning has helped to bring the agencies and industry to a point where they have more tools to confidently address the needs of permitting of a commercial development. ORPC's AMP was designed to utilize not only the environmental studies at the Project site, but also environmental studies from other hydrokinetic projects and related studies from around the world.

ORPC's AMP recognizes that many scientific uncertainties exist and that environmental conditions constantly change. The AMP, therefore, was designed to be modified within the Project time line and acknowledges that elements such as key environmental uncertainties, applied studies and institutional structure may evolve over time. The plan has worked well for the agencies, stakeholders, and ORPC as the Project evolved from a concept to the first pilot installation and operation.

This Environmental Monitoring Report will be provided to the Project's adaptive management team for review and comment prior to submittal to FERC. In addition, ORPC anticipates holding an adaptive management team meeting in early March 2013 to discuss the results of the 2012 monitoring and make recommendations for any modifications appropriate. The March meeting will build on the July 2012 meeting held in Eastport, Maine that brought the team together to discuss the adaptive management process. The AMP is included as Appendix B to this report.

2.2 Adaptive Management Team Workshop, July 2012

ORPC held an Adaptive Management Team workshop on July 24, 2012 in Eastport, Maine. The workshop was on opportunity for the team to meet for the first time to discuss the adaptive management process for the project and make recommendations to further enhance the plan, including evaluation tools, public dissemination of information, and the FERC license modification protocols.

The workshop objective was to discuss how adaptive management works in a regulatory setting and the roles that members, advisors and other stakeholders play in that process. The Adaptive Management Team, advisors and outside resources established the framework to advance the evaluation and decision making process for environmental monitoring from tidal energy pilot projects towards commercialization.

In addition to the Adaptive Management Team, the workshop was attended by representatives from FERC, DOE, and international academia. Attendees are listed below in Table 1. Workshop minutes are included as Appendix B.

Table 1. *ORPC Adaptive Management Team Workshop Attendee List.*

NAME	ORGANIZATION	ROLE	RESPONSIBILITY	JULY 24th ATTENDANCE
Herbert Scribner	ORPC	Project Developer	Communication	✓
Steve Shepard	U.S. Fish & Wildlife Service	Government Regulator	Compliance with established regulations	✓
Sean McDermott	National Marine Fisheries Service	Government Regulator	Compliance with established regulations	✓
Dan Tierney or Jeff Murphy	National Marine Fisheries Service	Government Regulator	Compliance with established regulations	Unable to attend
Linda Mercer	Maine Department of Marine Resources	Government Regulator	Compliance with established regulations	Unable to attend
Ron Beck	U.S. Coast Guard	Government Regulator	Compliance with established regulations	Unable to attend
Jim Beyer	Maine Department of Environmental Protection	Government Regulator	Compliance with established regulations	✓
Michelle Magliocca	NOAA Office of Protected Resources	Government Regulator	Marine Mammals	✓

ADVISORY				
Nathan Johnson	ORPC	Project Developer	Advisory	✓
Gayle Zydlewski	University of Maine	Technical Advisor	Fisheries Monitoring	✓
Moira Brown	New England Aquarium	Technical Advisor	Marine Mammal Monitoring	✓
Jay Clement	U.S. Army Corps of Engineers	Government Regulator	Advisory	Unable to attend

OTHER RESOURCES				
Ann Miles	FERC			✓
Emily Carter	FERC			✓
Rachel Price	FERC			✓
Ryan Sun Chee Fore	DOE			✓
Whitney Blanchard	DOE			✓
Graham Daborn	Acadia University			✓
Glen Marquis	ORPC	Project Developer	Workshop Facilitator	✓

2.3 Adaptive Management's Role in Environmental Monitoring and Reporting

ORPC's FERC pilot project license requires regulatory review of annual monitoring reports prior to FERC submittal. Therefore, ORPC has prepared this Environmental Monitoring Report with the intent of providing it for comment to the Adaptive Management Team, which includes the regulators recommended by FERC. This Report presents results and makes recommendations for improvements and/or modifications to the Project's environmental monitoring program. ORPC intends to provide this Report to the Adaptive Management Team and follow-up with a meeting in early March 2013. The February meeting will be an opportunity for ORPC to summarize the early results of the monitoring program and solicit feedback from the Team, including any recommendations for program modifications.

The AMP summarizes the minor and major license modification process required to make changes to environmental monitoring. ORPC strongly supports the involvement and concurrence of the Adaptive Management Team in applicable license modification requests and the AMP process establishes a path forward to proceed in this manner.

3.0 ACOUSTIC MONITORING (License Article 405)

The primary goals of the Acoustic Monitoring Plan are to identify and characterize the noise radiated by the TidGen™ Power System in the high-velocity environment of the Project site by gathering acoustic data under various environmental and mechanical conditions both prior to and during Project deployment. This is being accomplished by the following:

1. Ambient noise measurements at the deployment area were conducted in 2011 prior to the deployment of a single-device TidGen™ Power System.

2. Noise measurements were conducted in 2011 during ORPC's Beta TidGen™ Project to gather preliminary data and gain experience with the equipment and methodologies.

3. Noise measurements will be conducted on the single-device TidGen™ Power System after its Phase I deployment.

4. Noise measurements will be conducted on the multi-device TidGen™ Power System after its Phase II deployment.

The equipment and methodologies used will gather noise data and help determine the origins of the noise. The Acoustic Monitoring Plan will use this data to characterize the TidGen™ Power System's acoustic footprint, in accordance with the requirements of the FERC pilot license.

Additional information on potential marine life interaction with the TGU will be monitored as outlined in the University of Maine Fisheries and Marine Life Interaction Monitoring Plan. The presence of marine mammal species in the vicinity of the Project is addressed in the Marine Mammal Observation Plan. Separate from these study plans, ORPC, in conjunction with Scientific Solutions Inc. (SSI), is developing monitoring technology and methods to deploy an active acoustic monitoring system. The ultimate goal of this system under development is to monitor marine life automatically and in real time.

3.1 Methodologies

ORPC has developed a drifting noise measurement system (DNMS) that has been used for pre-deployment acoustic surveys and will be used to measure the noise created by the TidGen™ Power System. The DNMS has been fabricated and assembled for ORPC by SSI under the guidance of Dr. Peter Stein (Figure 9). A recent upgrade to the system switched to Reson hydrophones Model TC4013 and a 394A40 pistonphone calibrator for more accurate and traceable measurements prior to Phase I acoustic testing.

Figure 9. SSI conducting noise measurements, 2011.

3.2 Results

3.2.1 Pre-deployment Measurements

ORPC's Final Pilot License Application submitted to the FERC in September 2011 incorrectly included a report titled AAM System Testing as Attachment E to the Acoustic Monitoring Plan. It was intended to include preliminary ambient noise measurements as Attachment E. The correct report, *"Underwater noise measurements of a proposed tidal generator site in Cobscook Bay using a drifting noise measurement buoy, including ambient noise and estimates of tidal generator noise impact, July 2011"* is attached as Appendix C to this Report. This study was conducted around ORPC's Beta TGU that was afixed to our research barge.

Results of the 2011 acoustic surveys for ambient and Beta TGU generated noise are summarized as follows:

> ***Ambient Noise***
> Figure 10 shows the ambient spectral levels measured during one of the lowest current periods along with spectral levels measured close to the operating Beta TGU during one of the highest current (and Beta TGU rotational) periods. Ambient noise levels are equivalent to a sea state 1 condition and were measured a large distance from the barge when the Beta TGU is effectively not rotating (0.2 RPM or less). This is essentially the slack tide condition and represents some of the lowest ambient levels measured. The peak increase in noise when as close as 68 m from the Beta TGU is approximately 35 dB (at 105Hz), although the difference across the spectrum is generally less than 20 dB.

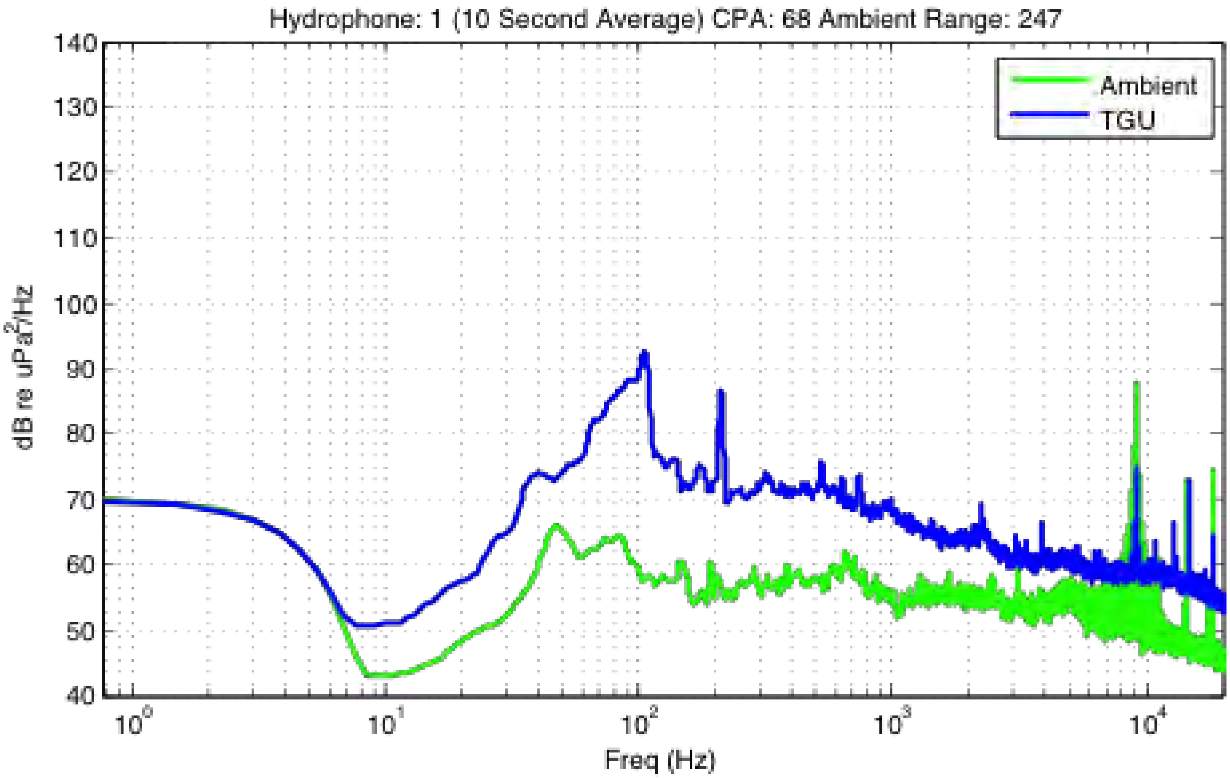


Figure 10. Ambient noise levels vs. Beta TGU noise levels at 22.4 RPM. Ambient noise levels are measured approximately 250m from the location of the barge/Beta TGU while the Beta TGU is nearly stationary (0.2RPM), and the tides are essentially slack. Beta TGU noise levels are measured 68 m from the barge. Some of the broadband noise increase is likely due to the increase in ambient noise with current speed. The tonals above 8 kHz are measurement system related. The tonals below 8 kHz are the Beta TGU and can be heard in a playback of the data recording.

Beta TGU Radiated Noise
At the closest points of approach during the drifts, which are as low as 10 m from the barge, measured radiated noise levels are less than 100 dB re $\mu Pa^2/Hz$ with most of the energy in a 50 Hz band around 200 Hz. Approximate RMS levels are less than 112 dB re μPa^2 at 68m from the Beta TGU. By roughly 200-500 m from the barge, the noise from the Beta TGU is undetectable above the ambient levels.

Table 2 presents the Beta TGU noise levels 68m from the barge, as well as ambient levels across a variety of current conditions, as third-octave band levels. From this data it is clear that broadband ambient noise levels can change significantly with current conditions. Under similar current conditions (e.g., 2.9 knots), the difference in noise levels between ambient conditions and the Beta TGU radiated noise is generally less than 15 dB at 68 m.

The planned TidGen™ device deployment consisted of five devices, each with a generator powered by four ADCF turbines. Therefore, each TGU will be twice the size (four ADCF turbines versus four) as the beta TGU. Thus one can conservatively assume there will be 10 times the number of TGUs as in the beta TGU contributing to the noise. If we assume the measured noise results for 1 TGU and wish to extrapolate to a proposed TidGen™ installation that is the equivalent of 10 of the beta units, one can assume that the combined noise would sum incoherently, or increase by 10log10 dB, or 10 dB. This gives a maximum predicted RMS noise level of 122 dB re μPa^2 at ranges up to about 68 m from the installation. These levels are only measured very close to the TGU (ranges less than 100 m) and are essentially at or well below the threshold for a level B harassment. Thus an incidental harassment authorization is not deemed necessary.

A single accelerometer located on the barge showed a similar spectral pattern as the radiated noise data. It is clear that longer-term monitoring can be accomplished with accelerometers attached to the TidGen™ unit. Once installed, taking a baseline measurement with the DNMS buoy and then monitoring with the accelerometers to measure any increases will be adequate to determine that the noise has not increased, along with alerting the operators as to any mechanical faults.

Table 2. *Ambient noise measurements in varying current conditions versus typical TGU measurement. These results show that at most the TGU increases the noise levels by 15 dB and only very close to the TGU (ranges under 100 m).*

		dB re μPa^2/Hz						
		Ambient						TGU
	Current (Knots)	1.5	2.2	2.9	3.3	3.0	1.1	2.9
Third Octave Band (Hz)	80	54.8	58.3	64.6	76.9	66.7	65.3	65.5
	100	59.5	64.7	69.7	81.5	72.0	67.7	71.7
	125	64.7	69.2	77.4	82.9	75.4	76.7	78.7
	160	70.4	81.2	80.6	85.2	78.3	86.0	85.2
	200	70.0	76.8	80.4	87.8	80.7	89.6	85.3
	250	72.2	81.5	80.9	87.1	85.7	94.3	95.0
	315	70.8	85.4	90.1	96.2	85.9	94.3	102.5
	400	70.1	85.6	91.0	91.8	87.2	98.7	104.8
	500	71.4	83.2	90.9	91.6	91.5	101.8	94.6
	630	72.7	84.8	98.6	97.8	88.5	95.4	92.6
	800	77.1	83.8	89.1	95.3	88.7	95.9	98.0
	1000	76.1	85.0	91.3	96.5	80.6	98.9	93.1
	1250	76.8	87.6	89.2	92.4	81.6	104.9	92.8

3.2.2 Measurements during Phase I Pile Driving

The DNMS was also utilized in the spring of 2012 to monitor acoustic source levels and isopleths ranges during pile driving for the bottom support frame installation. Results of the acoustic monitoring conducted during pile driving are included in the Final IHA Report for Phase I Pile Driving, included as Appendix A.

Hydroacoustic monitoring results confirmed that pile driving source levels were within acceptable ranges provided that sound absorption devices were used and best practices were implemented for pile and follower assembly. ORPC will implement these best practices if pile driving is used during Phase II installation, which will occur at the same location/environment and geology as Phase I.

3.2.3 Phase I TidGen™ Measurements

ORPC's Acoustic Monitoring Plan states that acoustic monitoring will be performed around the single-device TidGen™ Power System within six months of deployment. Acoustic monitoring was scheduled for December 2012 however, due to the operational status of the turbine, this work was delayed. ORPC has scheduled the Phase I acoustic monitoring to be conducted following TGU redeployment in early April 2013.

4.0 BENTHIC AND BIOFOULING MONITORING (License Article 406)

The primary goals of the Benthic and Biofouling Monitoring Plan are to evaluate the benthic community during the Project and to study whether the structures introduced into the marine system have the potential to allow biofouling accumulation that may alter the habitat within the Deployment Area. These goals will be accomplished by: 1) characterizing the existing benthic community (pre-deployment) (Figure 11); 2) examining the recovery of the benthic resources disturbed during the installation of the subsea cable; 3) examining the benthic community near the deployed TidGen™ devices; and 4) examining the presence and relative extent of coverage of biofouling organisms on the deployed TidGen™ devices. The Benthic and Biofouling Monitoring Plan will use the data gathered to evaluate the potential Project effects on the benthic community in accordance with the requirements of the FERC pilot license process.

Figure 11. Lower intertidal sampling in the cable crossing area. Photo: MER Assessment Corporation.

Installation of the power and data cables occurred in July 2012 by means of a shear plow, as described in Section 1.3. This installation technique resulted in minimal disturbance to the benthos. Additional information regarding the monitoring of the hydraulic flow fields and sediment transport in the Deployment Area is included in the Hydraulic Monitoring Plan.

A benthic survey was not performed in July 2012, as described in the Acoustic Monitoring Plan, due to a shift in deployment schedule from that anticipated in the FPLA. The goal is to conduct this survey "following the first growing season after the single-device TidGen™ Power System is deployed." ORPC anticipates completing the survey in the summer of 2013.

4.1 Methodologies

4.1.1 Benthic

Divers under the direction of ORPC visually inspected the cable route as part of the Inspection and Maintenance Plan. Divers inspected the cable to monitor that buried sections remained covered. They also inspected for any signs of cable movement that might have occurred to exposed sections, warranting extra protection measures such as additional burial, covering or anchoring. During these inspections divers also looked for recovery to the benthic community at locations where the cable was buried. Video recordings made during the inspections were analyzed by MER Assessment Corporation (MER) to compare benthic habitat to the pre-deployment survey of the cable route performed in July 2011.

The results of a November 9, 2012 cable inspection were provided to MER for analysis to assess the condition of the benthic habitat and associated epibenthic fauna. Their Benthic Cable Survey Report summarized observations made during the review and provided comments on the video recording methods and recommendations for improvements (Appendix D).

4.1.2 Biofouling

Divers under the direction of ORPC staff visually inspected structures, including any exposed cable and the TidGen™ devices. Monitoring for biofouling accumulation occurred during regular inspection and maintenance intervals and will continue for the duration of the Project. It is anticipated that inspection will occur monthly during Phase I of the Project. Biofouling on the TidGen™ devices and cable will be photo documented to determine the rate and extent of growth. The TGU will be brought to the surface quarterly for maintenance and inspection. Although ORPC does not anticipate marine debris to be extensive at the depth and location of the Project, marine debris can be adequately removed from the TGU at the three-month inspection intervals. If marine debris is causing an immediate problem to power system operation, ORPC will determine the appropriate course of action for removing the debris.

4.2 Results

4.2.1 Benthic Survey of Cable Route

ORPC conducted an inspection of the power and data cable route on October 5, 2012, following initial system operation. The divers made video recordings; the quality, however, was poor due to low lighting and visibility. A factor likely contributing to the restricted visibility was suspended sediments resulting from the opening of the local sea urchin dragging season on October 1.

A dive inspection of the cable route was performed on November 9, 2012. The inspection covered sections of the cable route running from the TGU deployment area to the shoreline landing in Gove Cove on Seward Neck in Lubec, Maine. The inspection was completed in three separate dives, recorded as Go Pro videos “11 9 12A, B, and C.” Videos of the November 9, 2012 dive were provided to MER for analysis.

Again, the video quality of the November 9, 2012 dive was a concern for MER (their full report is included as Appendix D):

> The quality of the Go Pro video image on the surface is remarkably good. However, definition seems to be lost once at depth under artificial lighting conditions. This lack of definition is particularly problematic when reviewing the video and attempting to identify organisms along the bottom; identification was therefore only possible based on observable shape and, in some cases, color, although this, too, was not always clear. Additionally, the narrow-beam lighting provided by the spot light(s) used during recording only allows a narrow field-of-view, making determination of abundance difficult other than in cases where substantial numbers of a particular organism are seen. The generally erratic motion of the camera further complicates review of the videos due to the blurring of the image, particularly when the video is paused during review.

In addition, MER’s assessment was complicated by the fact that the final “as-built” cable route did not coincide exactly with the area covered by the July 2011 baseline survey, as shown in Figure 12. The change in route was required by ORPC for three reasons: 1) a shift in the TGU deployment location to avoid shallow bedrock and allow proper penetration of the piling supports for the TGU and 2) to avoid shallow to bedrock areas along the cable route that would have prevented cable penetration, and 3) deviation from the planned route due to local site conditions including high current speeds acting on the deployment assets during installation.

The offset between the baseline survey cable route and the “as-built” cable route clearly made direct comparisons between the two impractical. Furthermore, although the location of the start of the dive and video recordings is *generally* known, it is unclear *exactly* where the starting point is with exception of video segment 11 9 12B, which starts at the shore cable termination anchor (SCTA), an image of which is included on the recording. Without visible markers along the path and the uncertainty of the points at which the dive and recordings end, it is unclear where along the recording the diver is at any given time. Similarly, it is difficult to determine proximity to the cable route other than when the cable is visible. The difficulty of visually tracking a mostly buried cable in a high flow tidal environment has become apparent.

Figure 12. 2011 Baseline survey video locations and 2012 as-built cable route.

Despite the difficulties encountered with the video review and the inability to directly compare the November 9, 2012 videos to those of the July 2011 baseline, certain general statements were made. The bottom sediments seen in videos 11 9 12A and 11 9 12B, recorded along the deeper portion of the cable route between the TGU and the dogleg toward shore, appear to be generally consistent with the sediment description for Transect 2 of the baseline survey conducted in July 2011 that covered the deeper areas of the cable route (refer to Table 1). The first portion of video 11 9 12A, reported as starting at the "dogleg" and heading southeast toward the TGU, covers an area that was not covered during the baseline survey due to the cable route shift. Sediments shown on the later portion of the video are consistent with those observed at the northeast end of the July 2011 Transect 2 video, specifically rocks, coarse sand and relic mussel shell. This is also similar to the sediment description of Station 9 of the July 2011 baseline survey (the sampling station at the end of Transect 2) where the sediments are described as cobble, relic mussel shells and shell hash. Sediments observed along the path of video 11 9 12B begin as cobble with a fine layer of silt, gravel, occasional rocks, small boulders and relic shell and transition to gravel and rocks at the end of the recording; these are also generally consistent with the sediment descriptions of the baseline Transect 2 video which begins over cobble, stones and relic shell, and transitions to rocks, coarse sand, shell hash, clay and relic mussel shell. The epifauna seen on videos 11 9 12A and 11 9 12B are also consistent with those previously observed, specifically a predominance of sea potatoes and green sea urchin and sea cucumbers, northern red anemones and scallops occasionally or rarely seen.

The sediment and epifauna composition seen on video 11 9 12C appear generally consistent with those previously seen along Transect 1 of the July 2011 baseline. Specifically, the sediment transitions from predominantly relic mussel shell in the deeper area at the northeast end to cobble, gravel and clay in the shallower area at the southwest. Epifauna was dominated by urchins throughout much of the recording with sea potatoes observed in the deeper area; northern red anemones became more numerous attached to hard substrate in the shallower area where sea peaches began to appear. Several scallops were seen but their broader abundance is difficult to determine. Nevertheless, their abundance appears to be reduced compared to Transect 1 of the July 2011 baseline survey when they were commonly seen. It should be noted however that both sea urchin and sea scallop dragging seasons occurred between the 2011 baseline survey and the November 9, 2012 cable inspection.

The laying and burial of the cable was completed in July 2012 using a vessel-towed sled and plow. Most of the video recordings taken on November 9, 2012 focus on a narrow area immediately surrounding the exposed or buried cable, but some panning of the broader surrounding area occurred. During these pans, no obvious evidence of the passage of the sled, such as furrowing or mounding of the bottom, were observed.

The cable is buried for some portions of all three videos and therefore is not visible. Where the cable is not visible, the divers appear to have difficulty determining its exact route, although they are able to locate exposed sections further along the route. Given the uncertainty of the video recordings' proximity to the buried cable, it is difficult to assess whether any disturbance effect exists. Where exposed, the cable is stapled into the bottom with steel "U"-shaped bar set at relatively frequent intervals. These exposed, stapled sections of the cable show little sign of movement and little, if any, evidence of scouring of the bottom. In certain areas, urchins, northern red anemones and waved whelks were frequently seen attached to the cable; in others sea potatoes, sea cucumbers and scallops were seen occurring immediately adjacent to the cable.

4.2.2 Biofouling

Growth of marine grass occurred primarily on the TGU's flat surfaces, sacrificial zinc anodes and generator after slightly more than two months of submergence (August 14 to October 25, 2012). Little to no accumulation was observer on any of the rotating components. Video inspection of the bottom support frame, submerged for approximately 5 months, revealed similar growth of marine life.

Following its retrieval on October 25, 2012, the TGU was pressure washed on shore to remove any observed marine growth. Figure 13 shows the condition of the TGU prior to pressure washing. ORPC will continue to monitor biofouling during both routine dive inspection and TGU retrievals.

Figure 13. The TGU generator prior to pressure washing, October 26, 2012.

4.3 Conclusions and Recommendations

Based on the results of the November 9, 2012 cable inspection, MER's benthic survey of the cable route concluded that the exposed sections of the cable are causing minimal disturbance to the seabed and are not adversely impacting the surrounding habitat or benthic epifauna. In addition, the buried portion of the cable is stationary and is not expected to cause any disturbance impacts. Unburied sections of the cable are pinned in position and have not been observed to move.

MER recommended that the quality of the video recordings be improved in order to make it a useful tool in a continuing effort to assess benthic impacts. MER met with ORPC and its dive consultant on December 14, 2012 to discuss improved data collection methods during cable surveys. Steps to be taken include improvement of the field of view through additional lighting, correction of the "hot spot" effect through the use of a light diffuser over the spot light lens, and reduction or elimination of the erratic motion of the recording. More precise location information needs to be provided, including, at a minimum, geographic coordinates for the start and end of each recording. Additional comments on the video quality and recommendations for improving the quality are included in Attachment D. Steps are being taken to implement the recommendations.

5.0 FISHERIES AND MARINE LIFE INTERACTION MONITORING (License Article 407)

The goal of the Fisheries and Marine Life Interaction Monitoring Plan is to collect pre-deployment and post-deployment information to provide an initial description of fish distribution and relative abundance within Cobscook Bay to supplement existing information for the general Passamaquoddy Bay area. Specific objectives include:

- Characterize fish presence and vertical distribution in Cobscook Bay with acoustic technologies
- Conduct stratified sampling to evaluate tidal cycle, diel, and seasonal trends
- Characterize fish distribution, species, and relative abundance and summer seasonal occurrence with multiple netting efforts in open-water pelagic and benthic areas, near-shore sub-tidal areas, and intertidal areas of outer, middle, and inner bays within Cobscook Bay
- Use data gathered to develop a preliminary assessment of the potential effects of the Project on fish populations in the Deployment Area and to the extent possible in Cobscook Bay
- Monitor indirect fish interactions with the TidGen™ devices(s) to evaluate potential Project effects
- Evaluate potential cumulative effects of the Project based on this comprehensive data set and the direct interaction monitoring data collected

The University of Maine (UMaine) prepared the Fisheries and Marine Life Interaction Monitoring Plans Annual Report, March 2013, included as Appendix E to this report. Phase I of the Project requires monitoring to assess potential effects of the TidGen™ Power System on the marine environment. ORPC's monitoring plan regarding marine life has two parts: 1) Fisheries Monitoring Plan and 2) Marine Life Interaction Monitoring Plan.

Fisheries Monitoring Plan
The Fisheries Monitoring Plan is a continuation of research started by UMaine's School of Marine Science researchers in 2009. The study was designed to capture tidal, seasonal and spatial variability in the presence of fish in the area of interest (near the TidGen™ deployment site). The design involves down-looking hydroacoustic surveys during several months of the year, and examines the vertical distribution and relative abundance of fish at the project and control site (for relative comparison). Pre-deployment data were collected in 2010, 2011, and early 2012, and will be compared to post-deployment data to quantify changes in fish presence, biomass, and vertical distribution associated with the installation of the TidGen™ power system. Surveys are planned through the year 2017.

Marine Life Interaction Monitoring Plan
The Marine Life Interaction Monitoring Plan uses side-looking hydroacoustics collected by ORPC at the TidGen™ project site to assess the interaction of marine life (fish, mammals and diving birds) with the TidGen™ device. This monitoring focuses on the behavior of marine life (primarily fish) as they approach or depart from the region of the TGU and attempts to quantify

changes in behavior in response to the TidGen™ unit. The approximate location of the side-looking hydroacoustic device is shown on Figure 14.

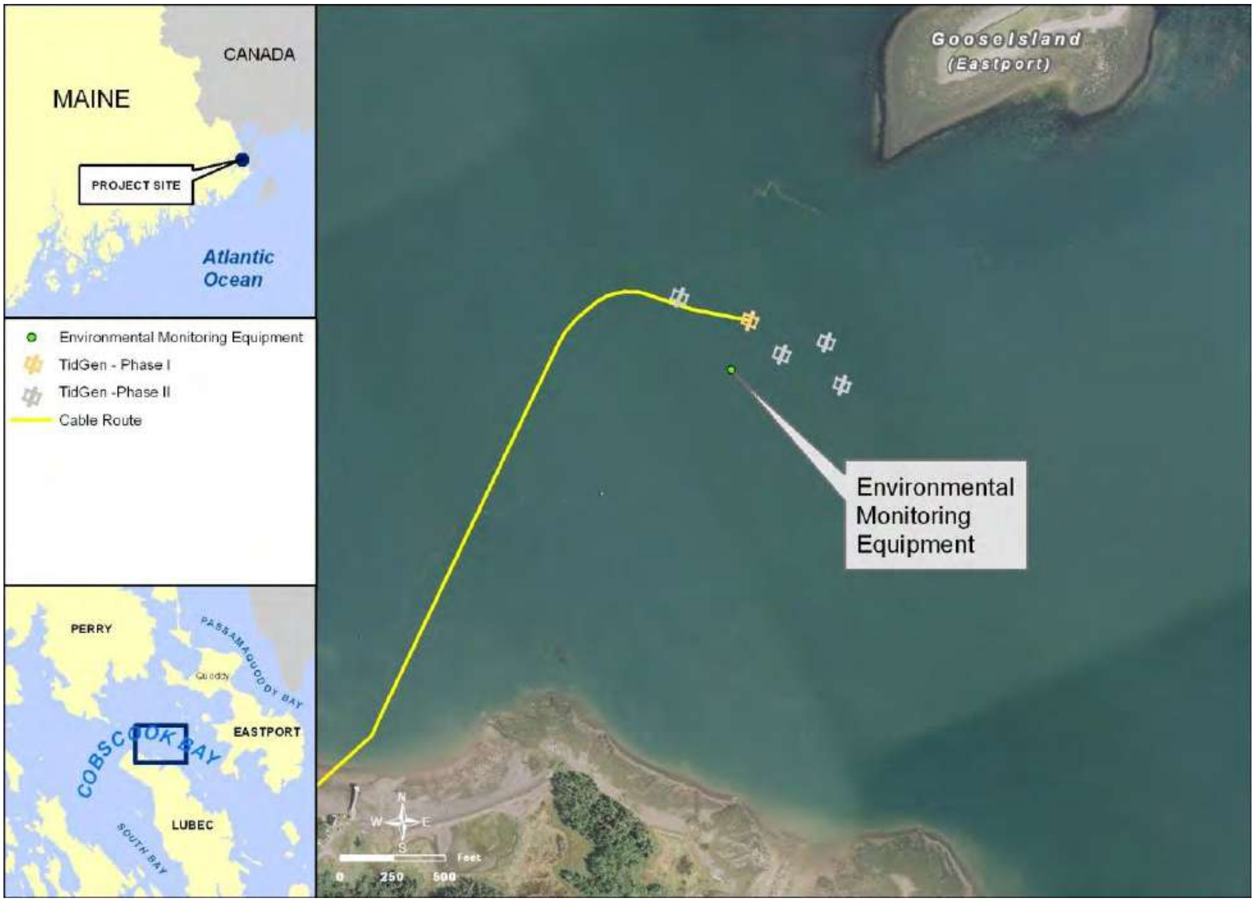


Figure 14. Location of TidGen™ 001 and environmental monitoring equipment.

5.1 Methodologies

5.1.1 Fisheries Monitoring Plan (Down-looking Hydroacoustic Surveys)

Fisheries Study Design

To compare the relative abundance and vertical distribution of fish at the project site and a control site nearby, both before and after TGU deployment, down-looking hydroacoustic surveys are conducted from a research vessel for one a 24-hour period several times per year at each site (Table 3). Locations during pre-deployment sampling include one site at the project location (CB1) and one control site (CB2), approximately 1.6 km seaward of the project site (Figure 15). During post-deployment, three sites were sampled: two at the project location (CB1a, beside the TGU, and CB1b, in line with the TGU) and one at the same control site (CB2) (Figure 15). Sampling locations at the project sites in 2012 varied geographically because of construction activity and related safety concerns around the TidGen™ device. January and March were pre-deployment surveys, so only CB1b and CB2 were sampled. CB1b in March was only sampled for 12 hours due to extreme weather. There was no November sample because the TGU was removed for maintenance.

The down-looking surveys are carried out using a single-beam Simrad ES60 commercial fisheries echosounder, with a wide-angle (31° half-power beam angle), dual-frequency (38 and 200 kHz) circular transducer. In May 2012, a Simrad EK60 200 kHz split beam echosounder was added to the previous sampling protocol. The transducers are mounted over the side of the research vessel 1.8 meters below the surface, and they ensonify (alternately, every 0.5 seconds) an approximately conical volume of water extending to the sea floor. A 600 kHz Workhorse Sentinel Acoustic Doppler Current Profiler (ADCP) is set to record mean current speed in 1 meter bins to the sea floor every 30 minutes during the survey. ADCP data are used to determine slack tide periods during sampling.

Table 3. *Months sampled for Fisheries Monitoring Plan (down-looking hydroacoustics). 1 and 2 indicate sampling at CB1 and CB2, respectively; 1a, 1b, and 2 indicate sampling at CB1a, CB1b, and CB2, respectively. Light gray indicates presence of TidGen™ bottom support frame only; dark gray indicates presence of complete TidGen™ device.*

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2010					1, 2			1, 2	1, 2	1, 2	1, 2	
2011			1, 2		1, 2	1,2		1, 2	1, 2		1, 2	
2012	1, 2		1, 2		1a, 1b, 2	2		1a, 1b, 2	1a, 1b, 2			

Figure 15. Fisheries Monitoring Plan study area and down-looking hydroacoustic survey locations for 2012. Each point represents the mooring location for one 24-hour survey. Numbers indicate the month of each survey; a and b indicate CB1a or CB1b, if applicable. Darker points (8b and 9a at CB1) are approximate due to GPS error.

The single-beam transducer, used for relative comparison to baseline data collected in 2010 and 2011, does not provide information on an acoustic target's location within the ensonified beam cross-section. This lack of angular data prevents meaningful target strength (TS) data, and therefore estimates of absolute fish abundance, from being acquired. Instead, a relative hydroacoustic measure of fish biomass is used to examine changes in fish biomass over time. This relative measure is also used to assess vertical distribution of fish biomass in the water column.

Comparisons of fish biomass and vertical distribution are made among the control site and Project site(s) and among different months at each site. Sampling before and after TGU installation at the Project as well as at a control site improves the ability to distinguish changes that may be related to the presence of the TGU from changes due to annual, seasonal, daily, and tidal variation. These methods are consistent with a before-after-control-impact (BACI) statistical design. In the future, split beam data will be used to provide accurate TS on single fish and potentially allow quantitative measures of fish movement.

Fisheries Data Processing
Hydroacoustic data are processed using Echoview® software (5.3, Myriax Pty. Ltd., Hobart, Australia), and statistical analyses are carried out in MATLAB (r2011b, The MathWorks, Inc., Natick, MA, USA). Frequency data of 200 kHz are used in analyses. Processing includes scrutinizing the data and removing areas of noise (e.g., from electrical interference, a passing boat's depth sounder, or high boat motion). Hydroacoustic interference from entrained air is common in the upper 10 m of the water column; analyses are therefore limited to the lowest 15 m of the water column. Unwanted hydroacoustic signals (such as plankton, krill, and fish larvae) are excluded by eliminating backscatter from targets with TS less than -60 dB. Most fish have a TS between -60 dB and -20 dB but TS varies greatly with fish anatomy and orientation (Simmonds and MacLennan 2005). This variability, combined with the TS uncertainty inherent in single beam systems, means that some fish will be excluded from analyses. Fish presence is measured on a relative scale using volume backscatter (S_V), which is a measure of the sound scattered by a unit volume of water and is assumed proportional to biomass (Simmonds and MacLennan 2005). S_V is expressed in the logarithmic domain as decibels, dB re 1 m^{-1}. Area backscatter, s_a, is the summation of volume backscatter over a given depth range, and is also proportional to fish biomass (Simmonds and MacLennan 2005). s_a is expressed in the linear domain ($m^2 \cdot m^{-2}$) and is used for vertical distribution comparisons.

Because flowing tides are the focus of this study, hydroacoustic data during slack tides are not included in these analyses. Slack tides span one hour, centered at the time of low or high water. Mean current speed is obtained for each half hour by averaging ADCP data from surface to seafloor. The recorded time with the lowest water flow value is deemed slack. The half hour before and after this time is then removed from hydroacoustics data processing and analyses.

Inspected hydroacoustic data are divided into 30-minute segments. Echoview is used to calculate the mean S_v of the water column for each 30-min interval. For each interval, s_a is calculated for 1-m layers within the water column. By calculating the proportion of total water column s_a that is contributed by each 1-m layer of water, the vertical distribution of fish is constructed for each 30-min time interval. Layers are measured upward from the sea floor, rather than downward from the surface, as the TGU is installed at a fixed distance above the bottom (top of TGU at 9.6 m above the sea floor). In the future, split beam data will be processed similarly to determine whether it can be used for comparison to previously collected single beam data. At minimum, split beam data will be used to 1) make meaningful comparisons of the vertical distribution of fish using s_a; 2) quantify the number of fish tracks observed in 1 m layers measured up from the sea floor; and 3) provide accurate TS for tracked fish. Analyses comparing S_v between the single and split beam systems are underway.

Statistical comparisons of overall fish biomass and vertical distribution can be conducted among survey dates using t-test and linear regression analyses, as in Viehman 2012. Briefly, mean water column S_v values for each entire 24 h survey can be compared to other 24 h surveys using t-tests (significance level = 0.05). Vertical distributions can be compared by linear regression of one distribution onto the other. Shape similarity is indicated by a significant fit (significance level of 0.05) and a positive slope. Negative slope or insignificant fit indicates dissimilar distributions.

For a full description of single-beam data analyses methods used and results from pre-deployment data collected, see Viehman 2012.

5.1.2 Marine Life Interaction Monitoring Plan (side-looking hydroacoustics)

Marine Life Interaction Study Design

ORPC has mounted a Simrad EK60 split beam echosounder (200 kHz, 7° half-power beam width) to a steel frame (Figure 16) located 44.5 m from the southern edge of the TidGen™ device (Figure 15). This frame holds the transducer 3.4 m above the sea floor, with the transducer angled 9.6° above the horizontal with a heading of 23.3°. The echosounder samples an approximately conical volume of water extending for 100 m, directly seaward of the TidGen™ device (Figure 15). The actual sampled volume used in data analysis is smaller, extending to the far edge of the TGU (78.1 m) rather than beyond. This is because after that point, interference from sound reflection off the water's surface becomes too great to reliably detect fish. The sampled volume is upstream of the device during the flood tide and downstream of the device during the ebb tide. The echosounder is powered and controlled via undersea cables from ORPC's On-shore Station in Lubec, where data files are stored on a server and collected periodically by UMaine.

Figure 16. Environmental monitoring observation tower.

The echosounder records data continuously (though to date, collection has been intermittent; see Sections 3.2.1 and 4.2). Continuous data collection at a fast sample rate (4 to 6 per second) allows each fish or other marine animal that passes through the beam to be detected several times, recording information on the echo strength and 3D location within the beam (Figure 18). These data are used to track fish movement during their approach to the TGU (flood tide) as well as during their departure (ebb tide) on a fine spatio-temporal scale. The sampled volume is divided into three zones: the turbine zone, where fish would be likely to encounter the TGU; above the turbine zone (A, Figure 17a); and beside the turbine zone (B, Figure 17a). Fish numbers and movement in each zone provide indicators of TGU avoidance. The total sampling volume to 78.1 m range (for a 7° cone) is 1,866 m^3, and of this, 607m^3 are within the turbine zone, 345 m^3 are beside the turbine zone, and 914 m^3 are above the turbine zone.

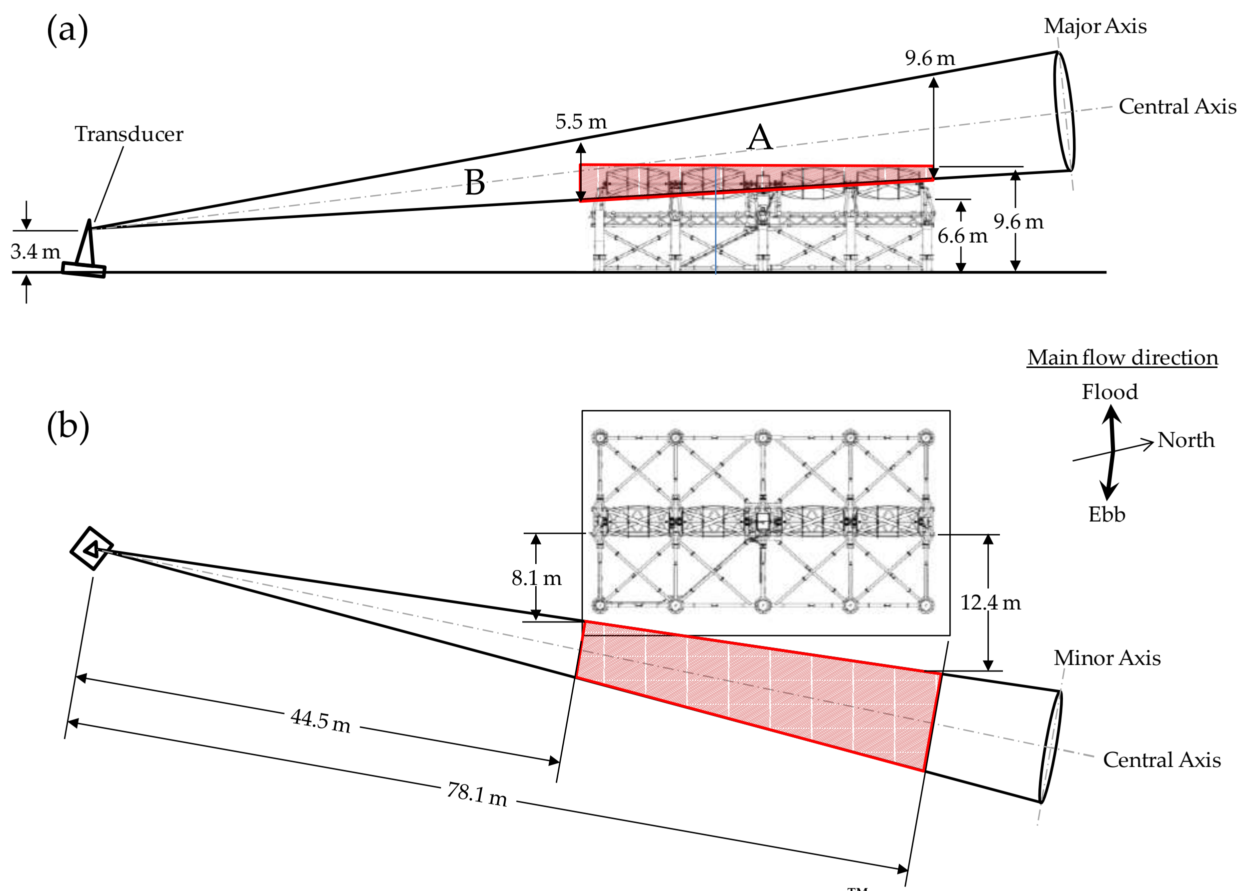
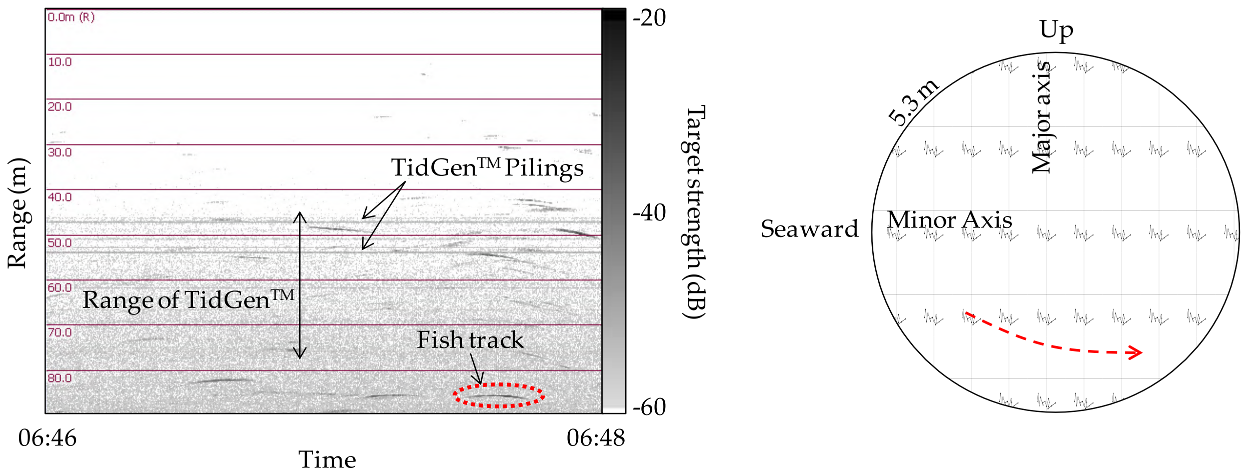


Figure 17. Marine Life Interaction Monitoring Plan setup. TidGen™ device and Simrad EK60 support structure shown from (a) the seaward side and (b) above. Hydroacoustic beam represented as 7° cone (half-power beam width) in solid black lines. Red hatched area indicates sampled volume within the TidGen™ device zone, A indicates the volume sampled above the TidGen™ device, and B indicates the volume sampled beside the TGU. Flow directions shown were provided by ORPC.



(a) (b)

Figure 18. (a) Sample of side-looking hydroacoustic data from 9/30/2012 during the flood tide. (b) Fish in red dashed oval in (a) tracked through beam cross section. Outer circle represents 3.5° off-axis, or 5.3 m at this range. Each dot is a single detection of the fish. Red dashed arrow indicates direction of movement.

Other data collected (provided by ORPC) include current speed and direction, TGU movement in rotations per minute (RPM), and TGU operation state (generating or not). Current speed and direction are collected by a flow meter mounted to the bottom support frame.

Marine Life Interaction Data Processing

Echoview is used to process raw side-looking split beam hydroacoustic data. Processing in Echoview begins with manually inspecting the data to identify and exclude unwanted noise (e.g., interference from depth sounders, entrained air from the surface, reflection from surface waves), and setting a TS threshold of -60 dB (consistent with down-looking approach) to exclude plankton and other small objects from analyses. Echoes from single targets are detected, excluding those more than 3.5° from the central axis of the beam or beyond 78.1 m from the transducer (due to the increase in surface noise interference). Single target detection parameters are summarized in Table 4. Echoview's fish tracking module is then used to trace the paths of individual fish through the sampled volume. Schools of fish are excluded from analyses. Fish track data are then exported from Echoview to be further analyzed using MATLAB. The data for each fish track include time of fish detection, location of the fish within the beam over time (range, depth, major and minor off-axis angles), fish TS, and fish swimming speed and direction. Data can then be grouped by month for further analyses.

Flood and ebb tide data are treated separately for all except overall summary data (e.g., total fish TS distribution and fish numbers). This is because a fish's approach to the TGU is sampled during the flood tide while its departure from the TGU is sampled during the ebb tide, and behaviors during each are assumed to differ (Viehman 2012; Viehman and Zydlewski submitted).

Table 4. *Single target detection settings in Echoview.*

Parameter	Value	Units
Target strength threshold	-60.00	dB
Pulse length determination level	6.00	dB
Minimum normalized pulse length	0.60	Unitless
Maximum normalized pulse length	1.50	Unitless
Beam compensation model	Simrad LOBE	
Maximum beam compensation	6.00	dB
Maximum standard deviation of minor-axis angles	1.000	Degrees
Maximum standard deviation of major-axis angles	1.000	Degrees

Target Strength

Target strength (TS) is a point source measure and is the relative amount of acoustic energy reflected back toward the transducer by an object, represented in decibels (dB; Simmonds and MacLennan 2005). Though TS is dependent on several factors, including fish anatomy (e.g., swim bladder or none) and orientation relative to the transducer, it is generally proportional to fish size (Simmonds and MacLennan 2005). Depending on the species known to be in the area, TS may be used to identify with some probability the species of a detected fish and its size. The TS distribution is therefore extracted for each month of data in order to provide information on the size of fish sampled. The fish community of Cobscook Bay is also being assessed by UMaine (preliminary results from 2012 are attached to UMaine's report in Appendix E), and results from that study will aid in identifying probable species represented by hydroacoustic targets.

Number and Location of Fish Tracks

The total number of fish tracks detected by Echoview for each month of hydroacoustic data provides an index of the abundance of fish in the sampled volume over time.

The location of each fish in the sampled volume is used to place it in one of the three zones (in the turbine zone, beside the turbine zone, or above the turbine zone; Figure 17a). Density of fish in each zone is calculated for each ebb and flood tide by dividing the total number of fish detected in each zone by the volume sampled within the zone over the course of the tide. This volume is calculated by multiplying the area of the zone's vertical cross-section by the approximate linear distance of water to pass through it during the time sampled. The linear distance of water is the mean current speed multiplied by the sampling duration. In this way, fish counts were normalized for varying sample times and volumes, allowing the direct comparison of densities from different tidal stages. Densities obtained from each tidal stage are then grouped by month and can be compared to those from other months using a t-test (significance level = 0.05).

Fish Swimming Speed and Direction of Movement

The speed and direction of movement of each fish is compared to the current speed and direction at the time of fish detection (when data are available). Higher deviation from the current speed or direction within the turbine zone than in other zones may indicate avoidance behavior. For each month, the difference in fish speed and direction from current speed and direction in each zone is calculated for each tidal stage (flood or ebb) and can be compared to corresponding values from other months using t-tests (significance level = 0.05).

If current speed and direction information is not available (see Section 3.2.1), the distributions of fish movement direction and speed and their variance can be used as indicators of avoidance. More variable movement directions are associated with avoidance reactions (e.g., diverting above, below, or to the side of the TGU, or reversing direction; Viehman 2012). Variance in speed and direction within each zone can be compared using one-way ANOVA tests (significance level of 0.05).

5.2 Results

5.2.1 Fisheries monitoring plan (down-looking hydroacoustics)

Down-looking hydroacoustics data for the Fisheries Monitoring Plan have been collected as outlined in Section 2.1. Total water column fish biomass was determined at each site for each month (Figure 19). Vertical distribution of fish biomass by 1 meter depth layers (measured upward from the sea floor) was determined at each site for each month (Figure 6 and Appendices B and C). Pre-deployment data from 2010 and 2011 were analyzed previously and are not included here, but full analyses are available in Viehman 2012. March had the lowest biomass and May had the highest. As the summer months progressed, biomass decreased.

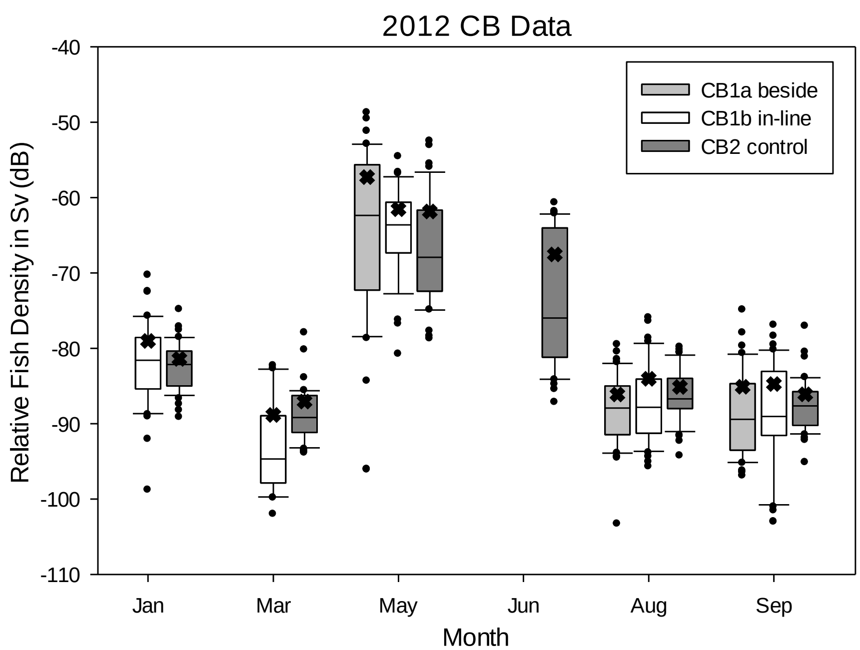


Figure 19. Total water column fish biomass recorded in Cobscook Bay at three sites in 2012. S_v (in dB) is displayed on the y-axis. Each site is represented for each month that data were collected. The box plot shows the 25th, 50th, and 75th percentiles. Each whisker represents the 10th and 90th percentile. The "x" on each is the overall mean. Dots outside the whiskers are outliers and display the variability in fish biomass over a 24 hour period.

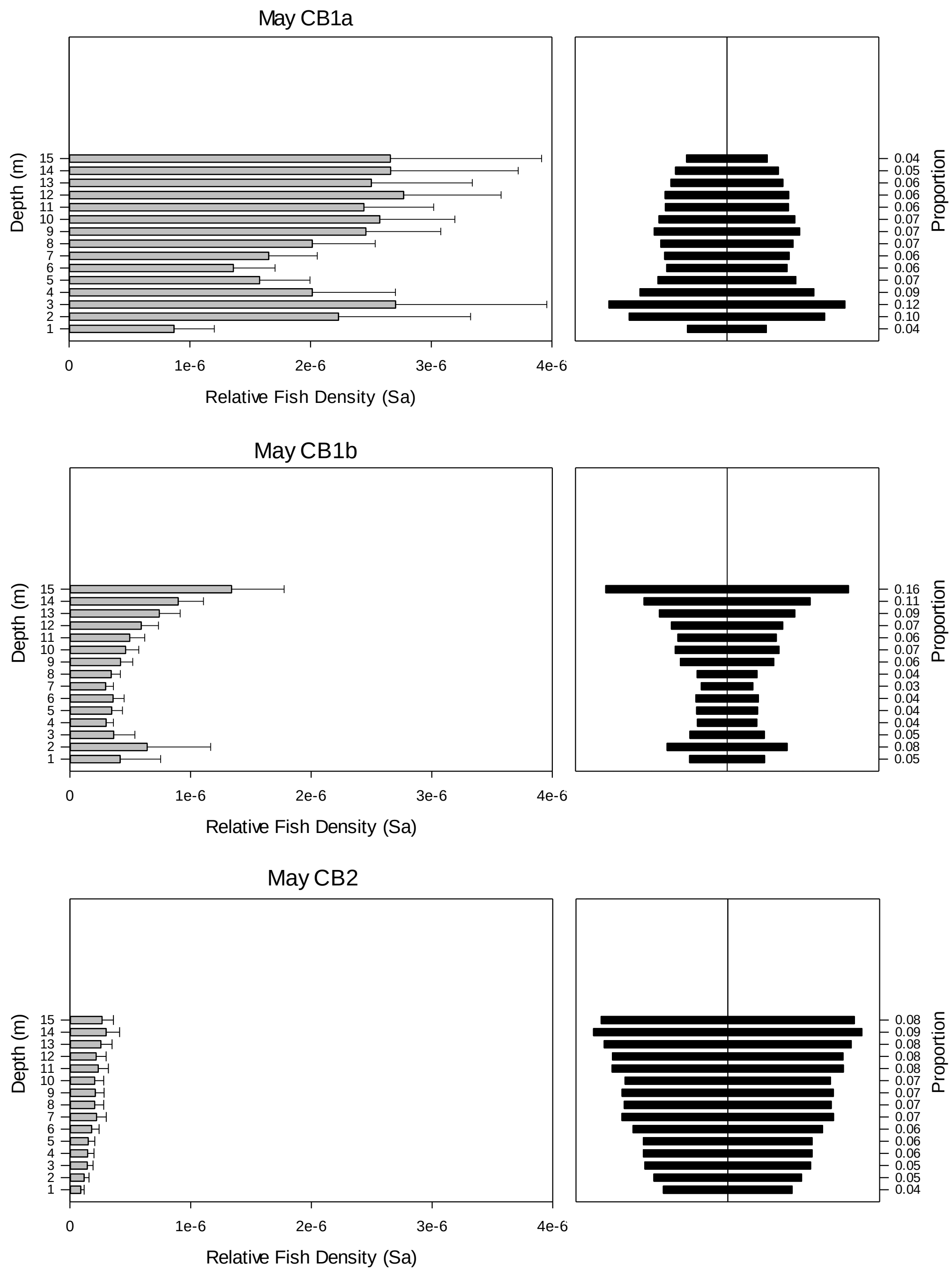


Figure 20. Relative fish densities (+ 1 standard error) for Cobscook Bay in May 2012. S_a is an area-relative measure of biomass. Depth strata start at the ocean floor. Note the upper depth strata were not included due to changing tidal levels and entrained air in the upper water column close to the surface (<10 m). Graphs on right are for visual display of how fish are proportionally distributed in the water column. Depth strata are on the left y-axis and proportions of fish density are shown on the right y-axis. Data for January, March, June, August, and September are included in the appendices of Appendix E.

5.2.2 Marine life interaction monitoring plan (side-looking hydroacoustics)

Data Availability
Data collection for the Marine Life Interaction Monitoring Plan began on August 29, 2012. The echosounder can be remotely accessed, acoustic data collection is automated, and data are stored on an ORPC server that is backed up periodically at UMaine. Due to various operational constraints since the start of data collection, collection has not been continuous (Figure 21). Gaps exist in the side-looking hydroacoustic data whenever the TGU or acoustic system was being repaired or adjusted, during periods of TGU deployment or removal, and whenever divers were present near the echosounder support structure. Additionally, hydroacoustic data have not yet been collected when the TGU was generating power, though collection has been possible while the TGU was free-spinning (moving but not generating power) or still (brake applied). This was because of electrical interference between the data and power transmission cables running together along the seabed to the shore station, and resulted in data gaps 3 to 5 hours in length on days when the TGU was generating. This issue is currently being addressed; however, to date, side-looking hydroacoustic data exist only for times when the TGU was free-spinning or still. As echosounder communication issues are resolved, data collection will become more continuous and reliable.

Collection of water current speed and direction data has also been intermittent. For times when data are available, current direction is not reliable due to the alignment of the flow meter, and therefore was not used in the following analyses. The TGU RPM data were combined with power generation data to determine when the TGU was still, free-spinning, or spinning and generating power. Small gaps exist in all three of these data sets, and the first set of RPM data is not accurate due to a communication error that has since been corrected (Figure 21).

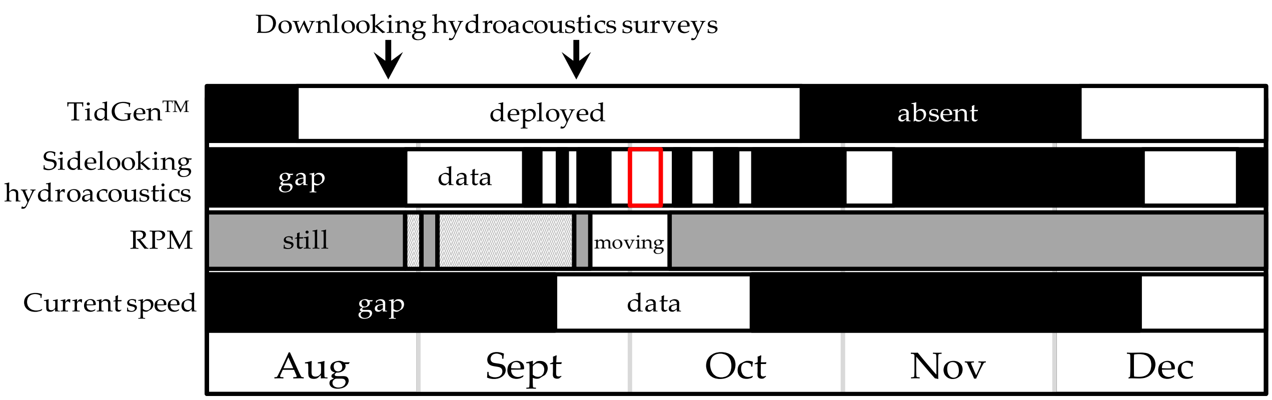


Figure 21. Summary of Marine Life Interaction Monitoring Plan data availability to date. Hatch lines represent revolutions per minute (RPM) data that are not accurate, but indicate that the TGU was free-spinning. Red box highlights data subset analyzed for this report.

Given these gaps in information, a subset of the data collected since August 2012 was analyzed for this report (Figure 22). This subset spans October 1 to October 5, when the TGU was present and fully operating (that is, the brake was not applied, and the TGU would spin when sufficient current speeds were reached, sometimes generating power; Figure 8). Current speed, RPM, and power generation data are available for this time. The TGU was free-spinning for several tidal stages, resulting in approximately 13 hours of ebb tide data and 8 hours of flood tide data to analyze (Table 5).

As full months of data are not yet available, monthly comparisons have not been carried out as described in the methods section. The distribution of fish TS was created, and fish density was calculated for each zone during flood and ebb tide. The direction of fish movement was examined qualitatively. Sample size is low (4 ebb tides and 3 flood tides), so variances were large and statistical analyses were not carried out; however, this provides an example of future results.

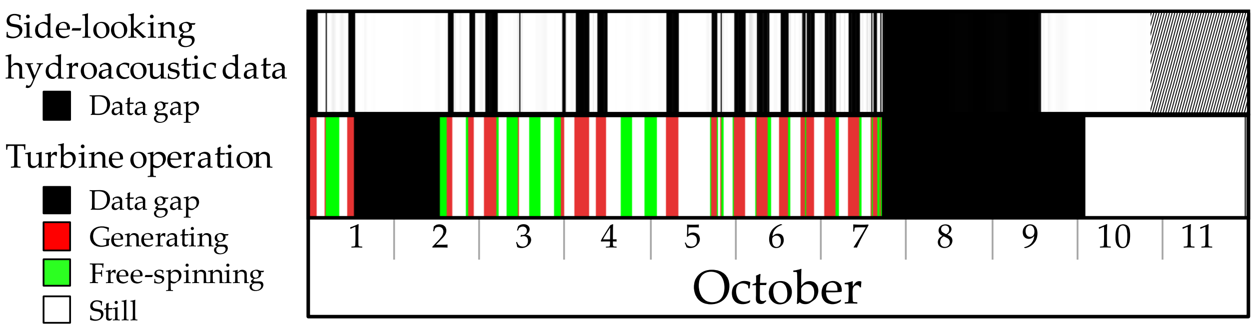


Figure 22. TGU operational state and side-looking hydroacoustic data availability on dates analyzed for this report. Hatch lines represent hydroacoustic data that were available but could not be used due to interference from rough surface conditions. The green (free-spinning) segments in October 1-5 were analyzed for this report.

Table 5. *Summary of data subset analyzed to date.*

Fileset	Date	Start time	End time	Tidal stage	Mean current speed ($m \cdot s^{-1}$)	Duration (hrs)	Total fish tracked
1	10/1/2012	02:06	06:11	Ebb	1.26	4.08	2,538
2	10/2/2012	09:20	11:12	Flood	0.40	1.85	247
3	10/3/2012	03:19	06:27	Ebb	0.06	3.15	3,681
4	10/3/2012	09:47	12:36	Flood	0.31	2.82	1,300
5	10/3/2012	16:20	18:18	Ebb	0.41	1.97	1,873
6	10/4/2012	10:22	13:38	Flood	0.34	3.27	1,644
7	10/4/2012	16:47	20:27	Ebb	0.62	3.67	2,360

5.2.3 Results from subset analyzed

A total of 13,643 fish tracks were detected in the acoustic data subset; 3,191 of these were detected during flood tides and 10,452 detected during ebb tides.

Target Strength
The TS distribution of these fish is shown in Figure 23. The distribution is slightly bimodal, with peaks at -57 dB and -50 dB and most detections lying near these values.

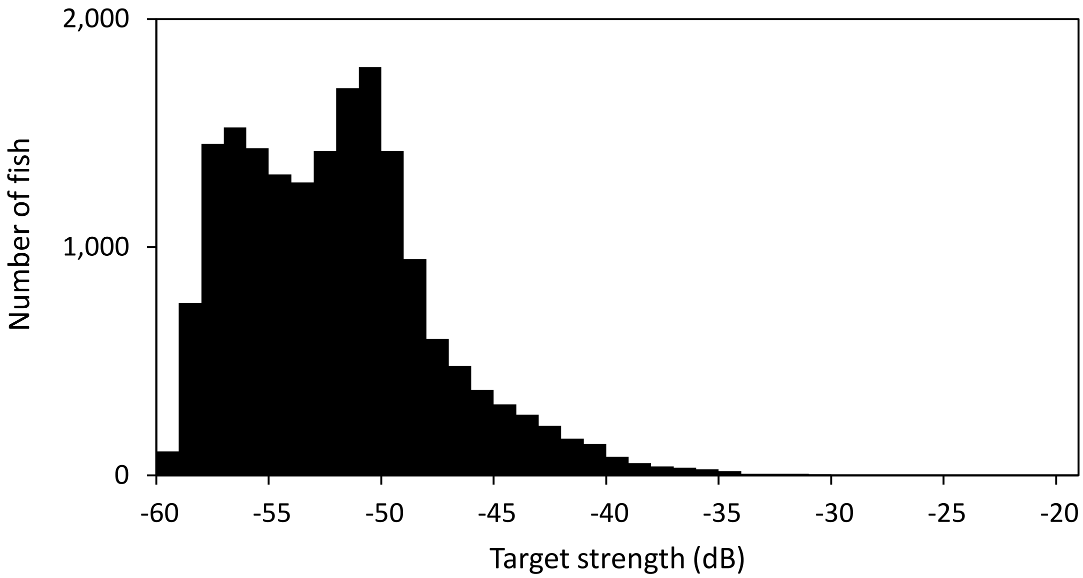


Figure 23. Target strength distribution of all fish detected in data subset.

Fish Density
The mean density of fish in each sampling zone is shown in Figure 24. Density appeared to be greater beside and above the TGU than in the turbine zone, though no tests for statistical significance have been carried out due to the low sample size. At this point, densities in the zone beside the TGU may be disproportionately large compared to the densities above and in the turbine zone, possibly due to noise reducing the number of fish detected.

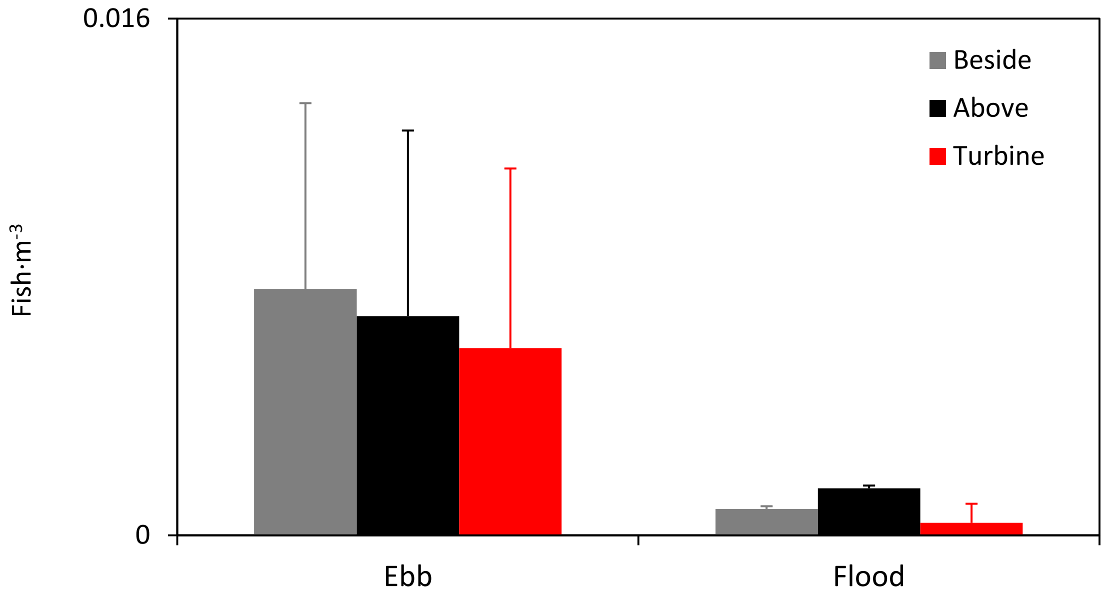
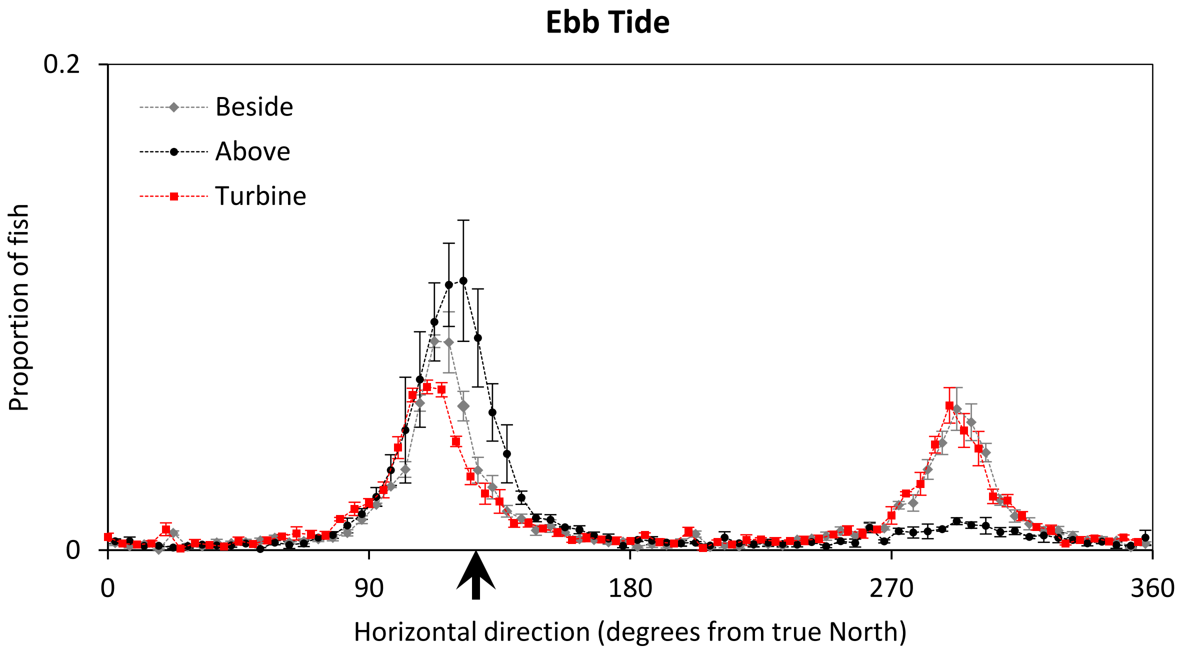


Figure 24. Mean fish density (+1 standard error) in each sampling zone during flood and ebb tide.

Direction of Fish Movement

The compass heading distribution for fish in each sampling zone was bimodal with peaks at the predominant current directions, indicating fish moving primarily with or against the prevailing current (Figure 25). Due to the small sample size, statistical significance was not tested. Against-current tracks were nearly as prevalent as with-current tracks in the region beside the TGU. Above the TGU, fish moved with the prevailing current almost exclusively. In the turbine zone during the flood tide, a greater proportion of fish were tracked moving against the current than with it. Overall, variance in direction of tracks above the TGU and in the turbine zone appeared greater during flood tides than during ebb tides. However, without current direction data, variation in fish track directions cannot be attributed to fish behavior alone.

The vertical direction distribution for fish beside the TGU peaked at 0°, indicating that most fish in this zone moved horizontally (Figure 26). There were no clear peaks in the distribution for fish in the turbine zone or above it, with vertical movement spread across all directions. Variance in vertical direction appeared greater during the flood tides than the ebb tides.



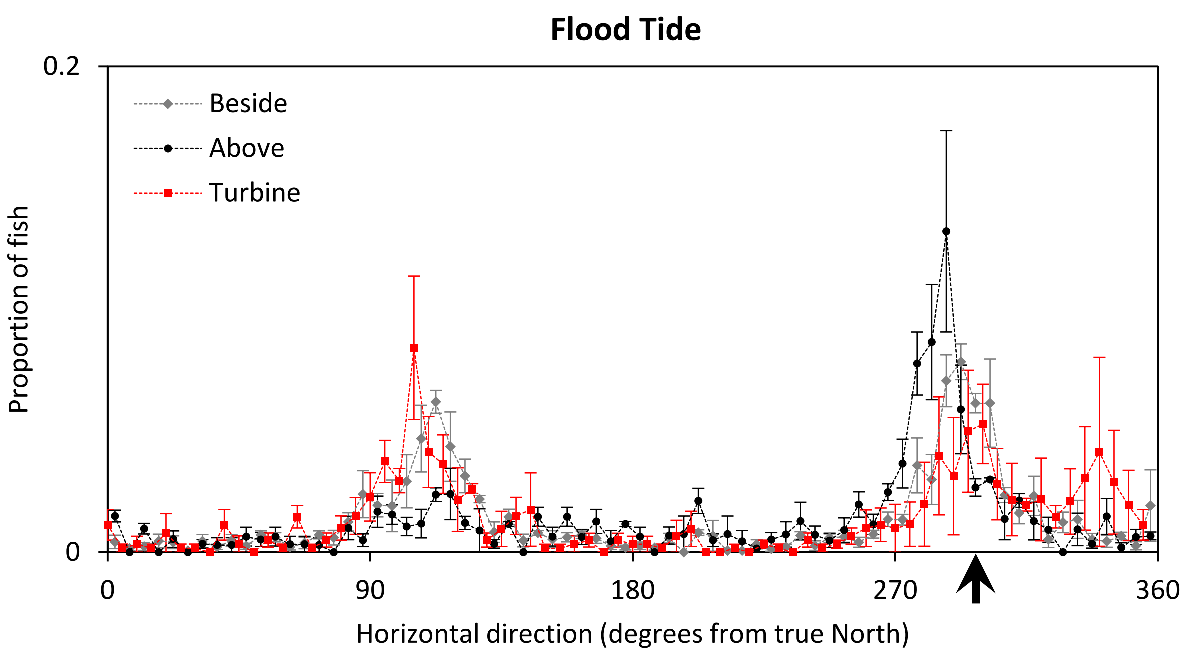


Figure 25. Distribution of horizontal direction of fish movement in each turbine zone for ebb and flood tides. 0°, 90°, 180°, and 270° are North, East, South, and West, respectively. Mean proportion of fish shown on vertical axis. Error bars represent ± 1 standard error. Arrows show predominant direction of tidal flow, obtained by ORPC.

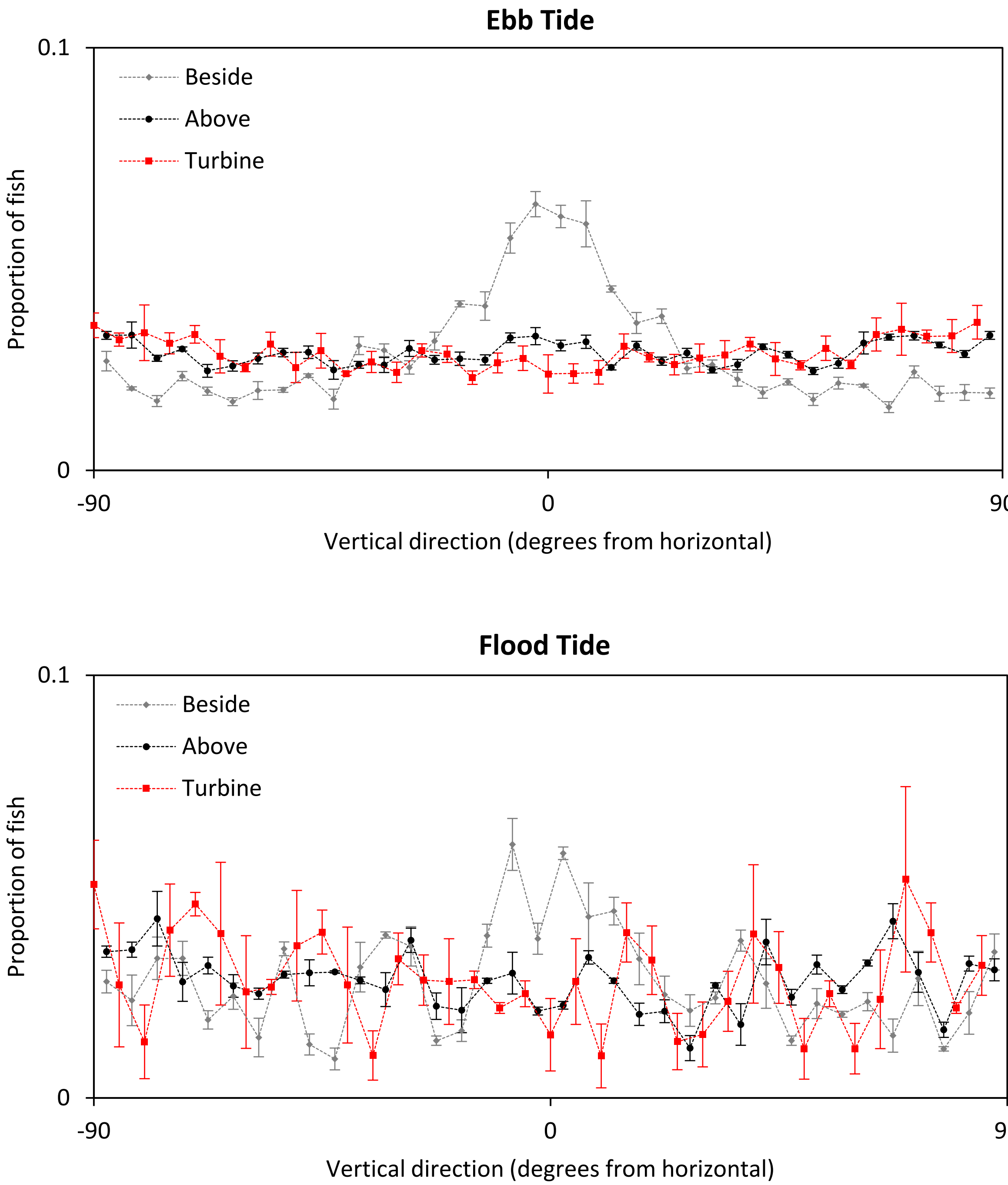


Figure 26. Distribution of vertical direction of fish movement in each turbine zone for ebb and flood tides. -90° degrees is downward, 90° is upward. Mean proportion of fish shown on vertical axis. Error bars represent ± 1 standard error.

5.3 Conclusions and Recommendations

Ideal data collection is difficult under the best circumstances, and the highly dynamic environment of Cobscook Bay combined with construction activities associated with the Project have affected data collection to date. Outlined below are the obstacles encountered within each monitoring plan and a discussion of how these have been or will be addressed as data collection continues.

5.3.1 Fisheries Monitoring Plan (down-looking hydroacoustic surveys)

As shown in Figure 15, sampling locations have so far been highly variable. Ideally, these locations would be consistent over time. This variability has been mainly due to construction activities surrounding the installation, maintenance, and retrieval of the TidGen™ device, and the safety protocols involved (e.g., minimum safe distances for moorings). Additionally, November 2012 down-looking surveys were cancelled due to re-deployment of the TGU, causing sampling dates to deviate from the proposed schedule (Cobscook Bay Tidal Energy Project Fisheries and Marine Life Interaction Plan, 2012). Sampling locations and times will become more consistent with what was initially proposed as activity in the Project area decreases. In addition, there has been a recent deployment of a large mooring block near the TGU that will be a permanent mooring for CB1b, minimizing spatial variation at that site. Site CB1a spatial variation will be decreased with the use of a more precise GPS unit.

5.3.2 Marine Life Interaction Monitoring Plan (side-looking hydroacoustics)

The goal of this plan is to collect and assess continuous data on the behavior of fish and other marine life in the vicinity of the TGU while it is operating. However, the operation of the side-looking echosounder at the TidGen™ device site is largely dependent on work carried out on the TGU. As discussed in Section 3.2.1, gaps exist in the hydroacoustic data collected to date which limit possible analyses. The largest gaps correspond to TGU operations (e.g., work on the undersea cables, retrieval or redeployment of the TGU). Smaller gaps occur when communication with the echosounder from shore is interrupted. These interruptions occur when the TGU is generating power, as the electric current in the undersea cables interferes with the neighboring data transmission cable of the echosounder. ORPC has taken several steps to remedy this issue and continues to work towards continuous data transfer. As construction activity in the area decreases and communication issues are resolved, the dataset will become more continuous and will be processed as described in this report.

Sound reflection off of the TGU support structures and the surface may affect fish detection within the turbine zone, and the extent of this effect must be examined. Interference with the returned acoustic signal not only makes it difficult for Echoview to track fish, but also affects the calculation of fish track parameters such as TS and direction of movement. Additionally, clear gaps exist in the detected fish tracks at the range of each piling and even at the intervening crossbars of the TGU support frame (visible as faint horizontal lines in Figure 4a). It is likely that the detection of fish echoes at these ranges is confounded by the sound reflected by the TGU support structure. To help determine the extent of this effect, the number of fish tracks obtained

by Echoview must be compared with the number of fish tracks obtained by manually counting. Fish tracks may be obvious to the eye even when surrounded by interference that limits their detectability in Echoview. Comparing a manual count of fish tracks to the Echoview-generated count will determine if this is indeed an issue that must be addressed.
If so, there are several options available to explore:

1. Re-aim the transducer until reflection of sound from the TGU support frame no longer interferes with fish tracking. The disadvantage to this is that the beam would be even farther from the TGU face, and will therefore limit the usefulness of behavioral analyses. This method also does not help to reduce the effect of surface noise on the data at greater ranges.

2. Increase the threshold to -50 dB to eliminate most noise from the echogram altogether. This method will also result in the exclusion of fish with weaker acoustic signatures, such as mackerel or small herring. However, small fish are those that tend to interact with TGU foils (Viehman 2012), and most of the fish tracked so far have target strength less than -50 dB (Figure 22). Also, this option is not immune to the effects of surface noise and does not address the effect of very strong targets (such as the pilings) confounding Echoview's fish detection process.

3. Alter the method of fish detection. Image processing techniques may be useful when tracking fish in data with a low signal to noise ratio (as in, e.g., Balk and Lindem 2000).

These options will be assessed as data collection and data quality continue to improve.
Current speed and direction are being collected by ORPC using a flow meter on the TGU bottom support frame. While current speed data collected thus far have been accurate, direction data cannot be used due to the alignment of the flow meter. Once this is corrected, future data analyses will be carried out using both current speed and direction.

5.3.3 UMaine Remarks

Since the implementation of the Fisheries and Marine Life Interaction Monitoring Plans, great progress has been made in the setup and collection of data. New sampling locations and survey equipment have been integrated into the continuing down-looking acoustic surveys, and the side-looking Simrad echosounder has been successfully installed at the Project site and can be remotely operated from shore. Several obstacles remain to be addressed. For the Fisheries Monitoring Plan, these include achieving constant survey locations and further automation of data processing. Issues facing the Marine Life Interaction Plan include continuous data collection, noise reduction, processing automation, and full analyses of data collected to date. All of these concerns are currently being addressed, or will be, in the near future. Results presented here are preliminary analyses of a subset of data collected to date, and analyses in future reports will follow a similar approach. As data collection becomes more continuous and quality improves, we will continue to adapt and refine our analysis techniques and modify the Monitoring Plan accordingly through the adaptive management process and FERC licensing modification as appropriate.

6.0 HYDRAULIC MONITORING (License Article 409)

The primary goal of the Hydraulic Monitoring Plan is to characterize the hydrological zone of influence, area for the Project. This will be accomplished by: 1) conducting measurements of the pre- and post-deployment flow fields in the deployment area; 2) providing experimental inputs into a large-scale computational circulation model for the estimation of far field impacts; and 3) monitoring for scouring, or sediment transport processes, within the deployment area. The Hydraulic Monitoring Plan will use the data gathered to characterize the hydrological zone of influence of the Project in Cobscook Bay and the effects (if any) of the TidGen™ device on flow and sediment transport, in accordance with the requirements of the FERC pilot project license process.

Additional information regarding the monitoring of the benthic community in the deployment area is included in the Benthic and Biofouling Monitoring Plan.

6.1 Methodologies

6.1.1 ADCP Measurements and Hydrodynamics

ORPC will provide Phase I ADCP data to UMaine, who will modify the Quoddy Circulation model to account for the local flow disturbance. The far field flow disturbance will be estimated from this model. This work will be completed in year three of the Project.

In addition, ORPC has been working with Sandia National Laboratories and Sea Engineering, Inc. to apply their SNL-EFDC Model to assess hydrodynamics at the Project site. The study focuses on the initial development of a hydrodynamic model of Cobscook Bay. Potential changes to the physical environment imposed by operation of a five-device marine hydrokinetic TGU array were evaluated using the modeling platform SNL-EFDC (James et al., 2011; James et al., 2012; James et al., 2006a; James et al., 2010a; James et al., 2010b; James et al., 2006b). Model results with and without a TGU array were compared to facilitate an understanding of how this small TGU array might alter the Cobscook Bay environment.

6.1.2 Scour Monitoring

The TidGen™ foundation piles were marked prior to installation for the purpose of measuring changes to seabed elevation from scour. All ten piles were painted with 6-inch squares as well as foot markers as shown in Figure 27.

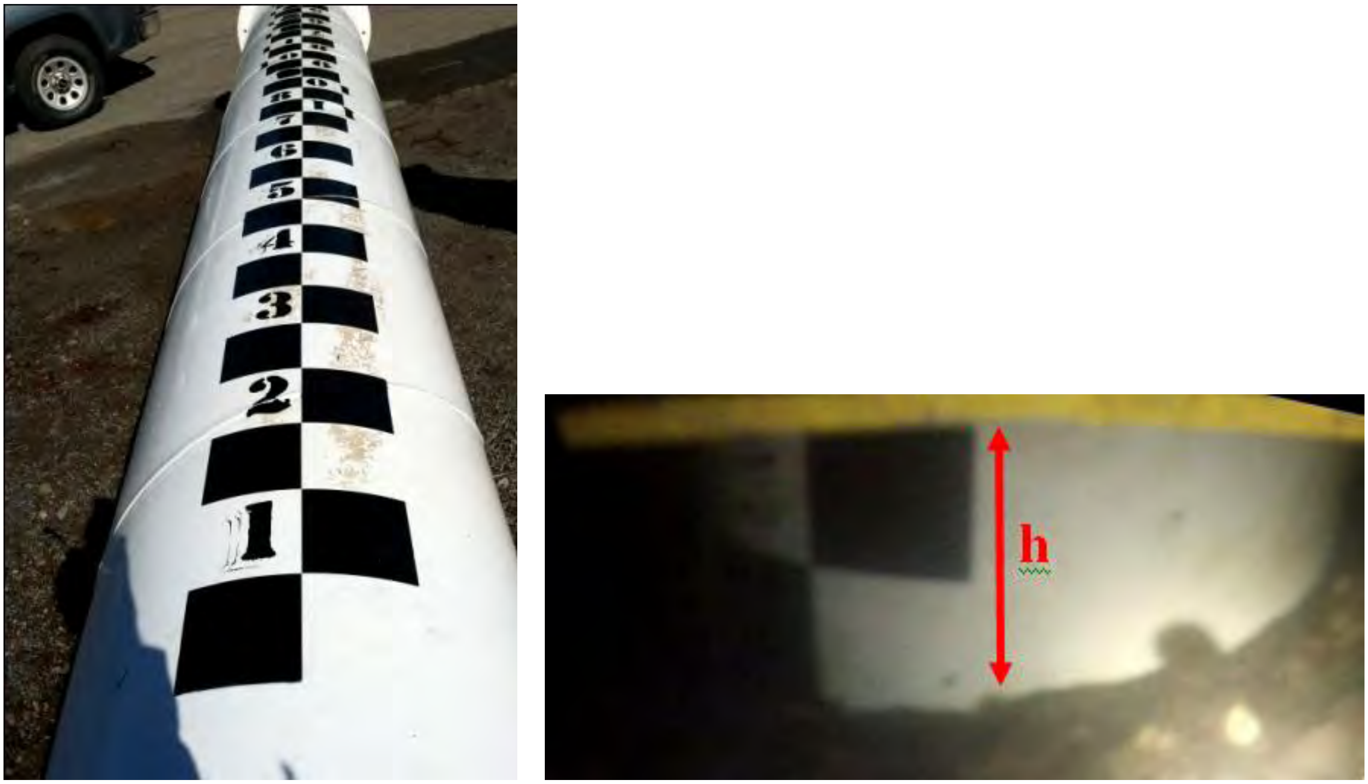


Figure 27. Foundation pile marking scheme for monitoring scour. Foundation pile prior to installation on left. On the right is installed pile #7 indicating the measured reference distance (h) from the bottom support frame skirt to the seabed.

6.2 Results

6.2.1 Hydrodynamic Modeling

The current SNL-EFDC model simulates flow in Cobscook Bay and adequately reproduces available data sets for three water-level locations and an ADCP measurement. Comparison of model predictions with tide station height gauges show agreement to within 5%.

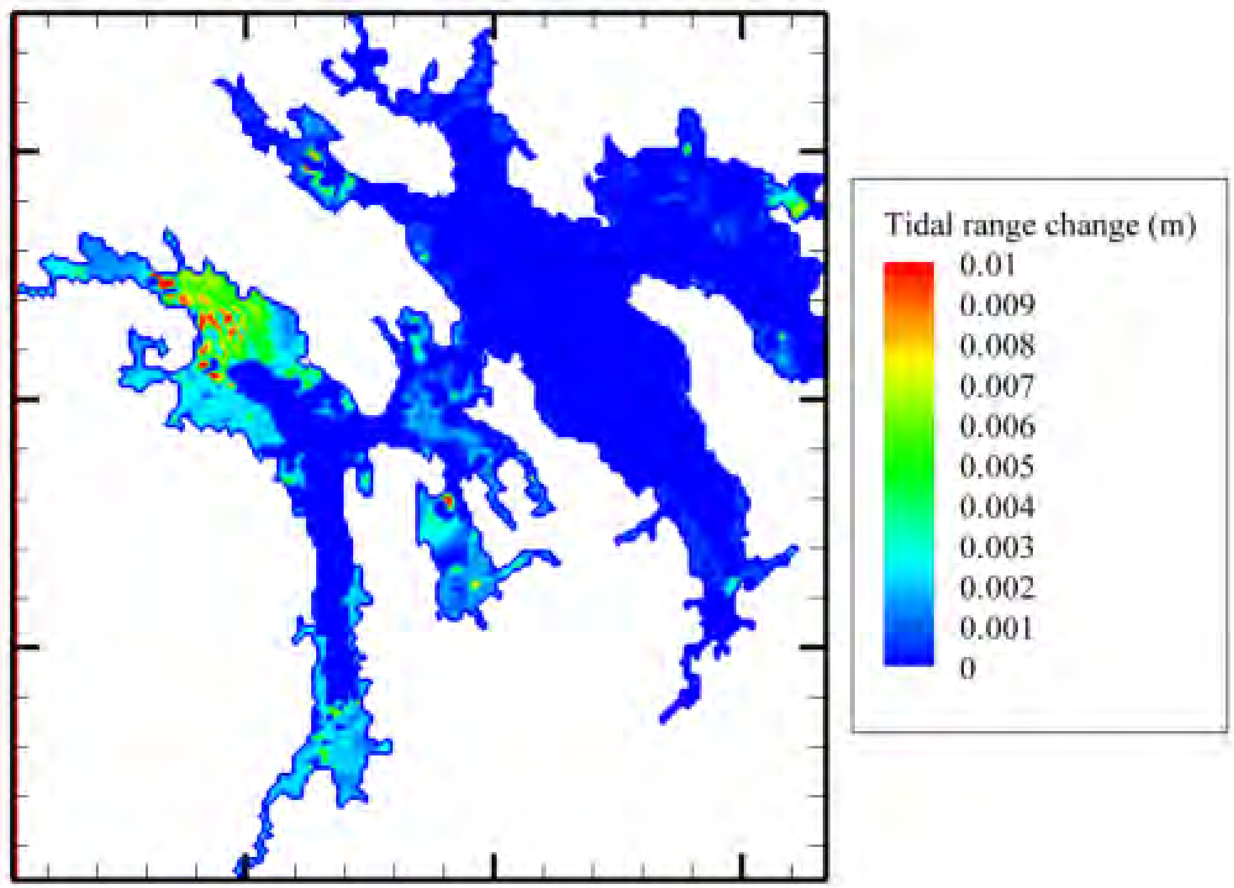


Figure 28. Change in tidal range (with TGUs minus without TGUs) in Cobscook Bay for the 30-day July 2010 simulation.

This work demonstrates that there are no significant changes in tidal range (Figure 28), flow rate, or velocity upon operation of the five ORPC tidal TGUs, with changes of less than 10 millimeters of tidal height being predicted in some local areas. These results may be within the numerical accuracy of the model and hence may or may not be significant. Sandia National Laboratories concluded that the operation of five tidal TGUs in Cobscook Bay will have little to no effect on regional aquatic habitat as regional processes are unchanged. While there are several additional features that could be included in the model (e.g., exchange of groundwater, wind and wave forcing, temperature and salinity transport), this version serves as a good baseline with which to compare system behavior with and without TGU arrays. The full report is included as Appendix F.

6.2.2 Scour Measurements

The bottom support frame for the TidGen™ Power System was set on the seabed on March 20, 2012. Steel piles were driven into the seabed through the sleeves of the bottom support frame between March 24 and April 4, 2012. Piles are numbered as shown in Figure 29. On March 26, 2012 ORPC's dive contractor conducted a dive inspection of the deployed bottom support frame and recorded distances between the bottom of the frame skirt and the seabed (distance *h* in Figure 27).

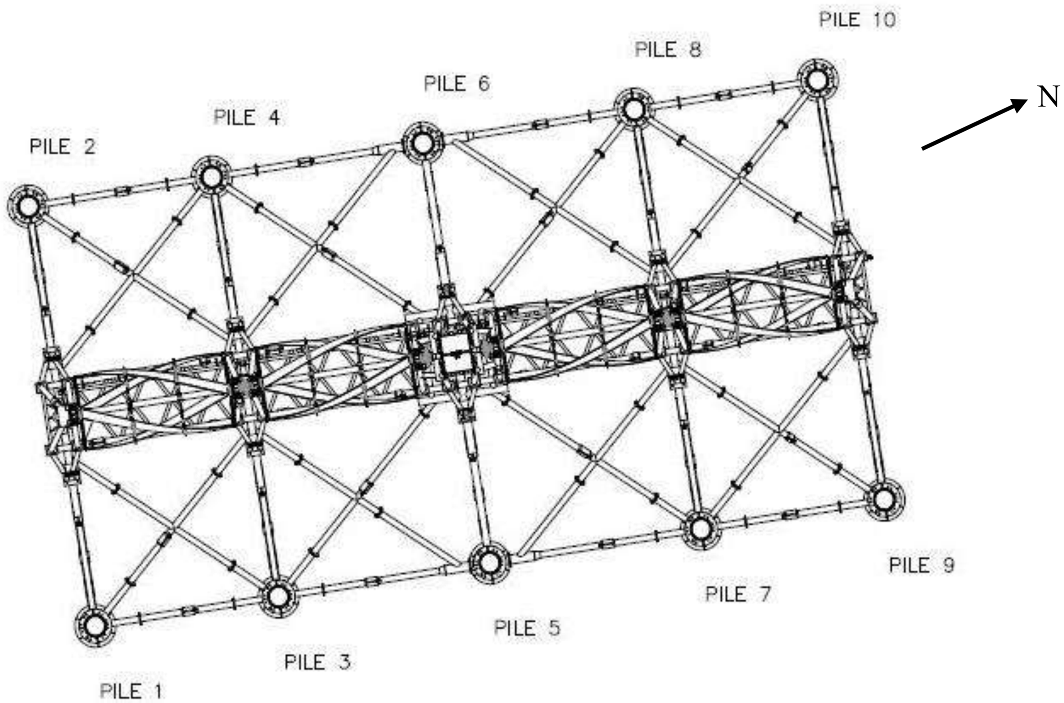


Figure 29. Plan view of TidGen™ Power System showing pile numbers

ORPC's dive team conducted inspections of the TidGen™ Power System between March and the end of 2012. Table 6 summarizes change in seabed elevation at the pile locations between March and October 2012. Measurements were not made at skirt no. 10 due to constraints with limited dive air supply. Due to complexities associated with making measurements underwater, accuracy of measurements is estimated to be no better than 4 in.

Table 6. *Scour Measurements.*

Skirt No.	Distance (inches) of Skirt above Mudline 3/26/2012	Distance (inches) of Skirt above Mudline 10/15/2012	Approximate Change in Mudline Elevation (inches)
1	2 3/4	0 to 4	+ 3/4
2	10	8 to 12	0
3	5 1/2	0 to 4	+3 1/2
4	10	6	+4
5	0	0	0
6	-12	0 to 2	-13
7	12 3/4	12	+ 3/4
8	9 3/4	0 to 6	+6 3/4
9	20 1/4	15	+5 1/4
10	19	-	-

Results of the scour monitoring to date indicate no significant change in seabed elevation around the foundation piles, except at pile 6 where the bottom support frame skirt was embedded upon deployment. It is now at grade at this location.

7.0 MARINE MAMMAL MONITORING (License Article 410)

The primary goal of the Marine Mammal Monitoring Plan is to identify the species, number of animals and their behavior to characterize changes in marine mammal use in and around the deployment area due to the presence of hydrokinetic devices. This goal will be addressed using two observational techniques.

First, incidental observations by trained ORPC personnel and contractors: 1) conducting multi-season marine mammal observations to characterize the species presence, relative frequency of occurrence, and habitat use prior to the deployment of a single-device TidGen™ Power System; 2) conducting multi-season marine mammal observations around the single-device TidGen™ Power System after its Phase I deployment; and 3) conducting multi-season marine mammal observations on the multiple-device TidGen™ Power System after its Phase II deployment.

Secondly, dedicated marine mammal observers, including trained ORPC staff and local skilled mariners, will 4) conduct marine mammal watch prior to and during major deployment, maintenance and retrieval activities (Figure 30). The data gathered will be used to describe marine mammal presence in Cobscook Bay and characterize the effects (if any are detected) of the TidGen™ Power System on marine mammals, in accordance with the requirements of the FERC pilot license process.

The dedicated observer effort is being employed because marine mammals are known to utilize the Cobscook Bay area. This dedicated observer effort will provide ORPC and its contractors with advance notification of the approach, presence and all-clear for marine mammals. ORPC will take all precautions to minimize harassment of and/or contact with marine mammals during these periods of higher risk.

Figure 30. Dedicated observations during pile driving.

Additional information on potential direct interactions between marine mammals and the TidGen™ Power System will be monitored as outlined in the Fisheries and Marine Life Interaction Monitoring Plans. The effect of noise produced by the installation and operation of the TidGen™ Power System on marine mammals is addressed in the Acoustic Monitoring Plan. Separate from these study plans, ORPC is working with SSI under a DOE grant to develop an active acoustic monitoring system, a real-time, automated system capable of tracking the movements of fish and mammals in the vicinity of the TidGen™ Power System.

7.1 Methodologies

7.1.1 Dedicated Observers

ORPC included dedicated observers in the Marine Mammal Monitoring Plan specifically to address monitoring efforts during deployment, maintenance, and retrieval of large, heavy structures using moored vessels. In addition, ORPC further enhanced its marine mammal observation program in response to the mitigation requirements associated with its NOAA NMFS approved IHA for Phase I pile driving in the spring of 2012. These enhancements included detailed training in species identification and recording and the purchase of equipment to assist with detailed observations.

ORPC Marine Mammal Observer and Reporting Plan for Pile Placement (Plan) was designed and implemented to minimize marine mammal exposure to loud noise-generating activities. In collaboration with Dr. Moira Brown from the New England Aquarium (Boston, MA), ORPC developed a Plan that included emphasized details on skills, an observer training program, observer equipment needed, observation methods, data collection and management protocols and associated data sheets, and an incident reporting form. The monitoring protocol called for marine mammal observations to be conducted 30 minutes prior to, during, and 30 minutes after deployment activities. In the event that a marine mammal was observed entering or within a 152 m (500 ft) marine mammal exclusion zone around the installation site during pile deployment activities, a mitigation action plan and curtailment of deployment activity was provided.

ORPC led a workshop on February 16-17, 2012 to train marine mammal observers in the identification and behavior of the marine mammal species known to occur in and around the waters of Cobscook Bay near the Project site (Table 7). In addition, identification and behavioral information was provided for those marine mammal species known to occur in the deeper waters of Head Harbor Passage and the Bay of Fundy offshore from Cobscook Bay.

Table 7. *Marine Mammal Species in Cobscook Bay.*

Common Species in Cobscook Bay	Other Species
Harbor seal	Minke whale
Grey seal	Fin whale
Harbor porpoise	Sei whale
Atlantic white-sided dolphin	Humpback whale
	Right whale

The instructor for the workshop was Dr. Moira Brown, senior scientist at the New England Aquarium. The course curriculum included species identification and behavior, observer skills, data recording, distance estimation; all participants completed a species identification test. A total of 21 individuals, including local residents and ORPC staff were trained and subsequently approved by NOAA NMFS for the purpose of marine mammal monitoring as a result of the IHA for the Project's Phase I pile driving. Figure 31 depicts the plan for vessel observations during pile driving. Observations were also made from land and modifications made during the installation to improve method and safety. Following Phase I pile driving, trained and approved personnel were also employed for dedicated observations during cable installation and TGU deployment and retrieval activities.

Figure 31. Vessel observations during Phase I pile driving.

Additional details on ORPC's marine mammal observation program are included in the Final Report on the Acoustic, Marine Mammal and Bird Monitoring Studies during Phase I Pile Driving Activities, attached as Appendix A to this report.

7.1.2 Incidental Observations

ORPC personnel conducted visual observations of marine mammals in and around the proposed deployment area in Cobscook Bay concurrently with other project-related tasks and developed a comprehensive Marine Mammal Observation Training document for use by ORPC personnel and contractors conducting work in Cobscook Bay (Attachment G). This document provides education and identification instructions on the different marine mammal species that may occur in Cobscook Bay to ensure consistency in recording marine mammal sightings.

Marine mammal species visible from the water's surface were recorded as part of this monitoring effort. Observers used a continuous scanning technique by eye and verified species with binoculars, and distance to the sighting with a laser range finder during periods on the water. These skills were developed through training to identify and observe marine mammals while performing other scheduled activities for the Project. If a marine mammal was observed, the observer documented the location where the observation was made, using latitude and longitude or a place name in order to provide perspective of the marine mammal sighting in relation to the TidGen™ Power System location, species identification and count, observed behavior (e.g., apparent foraging; floating with tide), weather conditions, and estimated distance from observation point (see Appendix A for a sample Marine Mammal Species Observation log sheet).

7.2 Results

7.2.1 Pile Driving

Marine mammal observations were conducted for all pile driving activities in accordance with the IHA and ORPC's Marine Mammal Observation Plan for Pile Driving Activities (including operational amendments). Observations were conducted during 13 separate pile driving events. Marine mammal sightings occurred during 4 of the 13 events; all sightings were harbor seals. Additional details are included in Appendix A.

Notable information and key trends associated with the observations include:

- There were 34 sightings of one species, a harbor seal (most likely 1 individual) that were recorded during 4 pile driving events (3 vibratory hammer and 1 impact hammer).
- No Level A sightings. Shut down or delay procedures were not required.
- No sightings occurred during active pile driving.
- 82% of sightings (28 of 34) occurred within the Level B isopleth (versus outside Level B).

- 100% of the sightings (34) occurred within several hours of high tide (pile driving occurred during high and low slack water periods)
- 88% (30 of 34) of the sightings occurred on the southeast side of the installation.
- ORPC recorded sighting when vessels arrived on site, prior to the 30 minute pre-installation observations required by the IHA. 100% of these sightings (20) occurred on the southeast side of the installation (up current from installation). Tidal velocities during this period are estimated to be approximately 1.5 knots or greater. As the tidal velocity slacked the sightings became more distributed on both sides of the installation.
- 88% of the sightings (30 of 34) occurred prior to pile driving activity.

7.2.2 Dedicated Observations

In accordance with the Marine Mammal Monitoring Plan, ORPC positioned two trained, dedicated observers during deployment and retrieval activities. These activities included the bottom support frame deployment, cable installation, and TGU deployment and retrievals. Table 7 summarizes the observations during these activities:

Table 8. *Marine Mammal Sightings by Dedicated Observers.*

Date	Observation Effort	Activity	Results
March 20, 2012	8 hours (4 observers x 2 hours)	Bottom support frame deployment	No sightings
July 13, 2012	8 hours, 20 minutes (2 observers; 3 hours, 40 minutes and 4 hours, 40 minutes)	Cable deployment	Single harbor seal, between installation activity and Lubec Shore Station, no action required.
August 14, 2012	2 hours (2 observers x 1 hour)	TGU deployment	Single harbor seal, ~1,000 ft southwest of activity, no action required.
October 25, 2012	3 hours (2 observers x 1 hour, 30 minutes)	TGU retrieval	No sightings
December 7, 2012	3 hours, 10 minutes (2 observers x 1 hour, 35 minutes)	TGU re-deployment	No sightings

In addition to dedicated observations, ORPC recorded the velocity of the TGU moving through the water column during deployment and retrievals. This velocity was estimated to be 20 feet per minute, equivalent to approximately 0.20 knots. At this speed the risk of an adverse interaction with a marine mammal and potential injury is extremely low.

7.2.3 Incidental Observations

ORPC operations staff was trained in accordance with the Marine Mammal Monitoring Plan to identify and record sightings during normal on water activities. In addition, operations staff received detailed training on marine mammal species identification and behavior by Dr. Moira Brown from the New England Aquarium as part of the protected species observer program associated with Phase I pile diving.

Incidental marine mammal sightings in 2012 by ORPC staff do not indicate a change or use of the project area as the project transitioned from pre-deployment to operations. Three marine mammal species were identified in the vicinity of the project; harbor seals, harbor porpoises, and a single minke whale over a total of 175.25 hours. Although ORPC had not recorded minke whale sightings in the project area in the past, local feedback indicates they are known to occur in Cobscook Bay.

Table 8 below summarizes incidental sightings, spanning pre-deployment, Phase I installation, and operation in 2012.

Table 9. *Incidental Sightings of Marine Mammals.*

Date	Observation Period (hours)	Harbor Seals	Harbor Porpoises	Minke Whales	Comments and Behavior
1/3/2012	2.50	0	0	0	
1/9/2012	4.50	0	0	0	
1/10/2012	2.50	0	0	0	
1/13/2012	3.00	0	0	0	
1/16/2012	2.50	0	0	0	
2/10/2012	2.00	0	0	0	
2/12/2012	3.00	0	0	0	
2/13/2012	3.00	0	0	0	
3/12/2012	3.00	0	0	0	
3/13/2012	3.00	0	0	0	
3/14/2012	2.00	0	0	0	
3/17/2012	3.00	0	0	0	
3/18/2012	2.00	0	0	0	
3/20/2012	6.50	0	0	0	
3/21/2012	5.00	0	0	0	
3/22/2012	2.50	0	0	0	
3/24/2012	6.00	0	0	0	

Date	Observation Period (hours)	Harbor Seals	Harbor Porpoises	Minke Whales	Comments and Behavior
3/25/2012	12.00	0	0	0	
3/28/2012	12.00	0	0	0	
3/29/2012	12.00	1	0	0	Approaches installation activities and then departs
3/30/2012	12.00	0	0	0	
3/31/2012	12.00	0	0	0	
4/1/2012	11.00	0	0	0	
4/2/2012	10.50	0	0	0	
4/4/2012	3.00	0	0	0	
4/20/2012	2.50	1	0	0	
5/24/2012	1.25	0	5	0	Swimming in pod
6/20/2012	6.00	0	0	0	
6/23/2012	4.50	0	0	0	
6/25/2012	6.00	0	0	0	
6/26/2012	6.50	0	0	0	
9/4/2012	1.50	0	0	1	Feeding
11/1/2012	2.50	1	0	0	Feeding
11/29/2012	4.00	1	0	0	Feeding
Total	175.25	4	5	1	

7.3 Conclusions and Recommendations

Marine mammal observations made by trained personnel in 2012, including during periods of construction, operation, and maintenance, did not indicate changes in marine mammal presence or behavior. There is no evidence of marine mammal strike with system components during deployment and retrieval or with TGU foils during operation.

Based on results of dedicated observations in 2012, as well as further details on installation and maintenance practices, ORPC is recommending that incidental observations are more appropriate than dedicated observers during deployment and retrieval activities. This recommendation is supported by the following:

- Incidental observations will be made by ORPC staff trained in marine mammal identification. ORPC will develop protocols during deployment and retrieval activities for incidental observers to follow to further minimize risk.
- No adverse interactions with marine mammals have been recorded during deployment and retrieval activities.

- Risk of negative interaction with the TGU device is extremely low based on the velocity of the device when raised and lowered through the water column and low percent solidity.

In addition, results of environmental monitoring during Phase I pile driving resulted in recommendations to modify mitigation procedures if similar pile driving activities are conducted for Phase II installations. These recommendations are included in the Final IHA Report for Pile Driving Activities (Appendix A).

8.0 SEA AND SHOREBIRD MONITORING (License Article 412)

The primary goal of the Bird Monitoring Plan is to determine the species, number, and time of peak use of sea and shore birds in the Deployment Area, the onshore landing site where the underwater P&D cables of the TidGen™ Power System will come ashore, and the waters immediately off the landing site. Information about the behavior of these birds within these areas will be gathered as well. This will be accomplished by: 1) conducting multi-season bird observations to characterize the species presence, relative frequency of occurrence, and habitat use in these areas prior to the deployment of a single-device TidGen™ Power System (Figure 31); 2) conducting multi-season bird observations in these areas after the Phase I deployment of the single-device TidGen™ Power System; and 3) conducting multi-season bird observations in these areas after the Phase II deployment. The Bird Monitoring Plan will use the data gathered to characterize bird presence in Cobscook Bay and the apparent effects (if any) of the TidGen™ Power System on sea and shore bird behavior, in accordance with the requirements of the FERC pilot license process.

A report on the 2011 – 2012 winter migrating period as well as an interim report for the end of 2012 is attached as Appendix H.

8.1 Methodologies

Post-deployment sea and shore bird monitoring was conducted by trained observers familiar with local bird species and behavior. As shown on Figure 31, bird surveys are conducted from Seward Neck within the white lines off North Lubec, Maine. The surveys are separated into the near shore area (A) just offshore from the Landing Site and (B) the Deployment Area for the TidGen™ Power System.

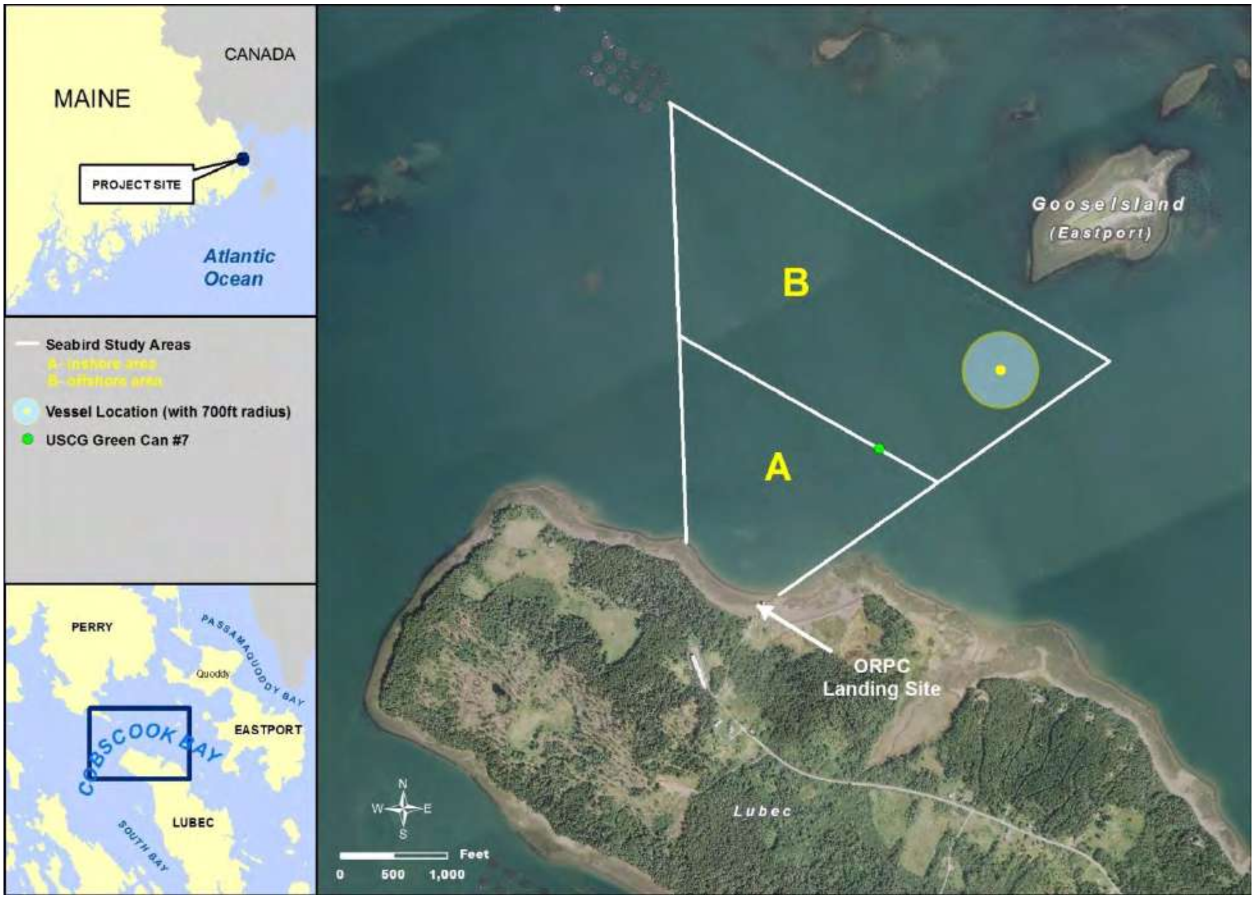


Figure 32. Sea and shore bird study area.

Land-based surveys (Holm and Burger 2002) were conducted from the Landing Site in North Lubec. The land-based survey area is delineated by a line extending from the ORPC Landing Site to the east end of Goose Island. The west side of the survey area is defined by a line extending from the Landing Site to a white building located on the salmon farm directly northwest of the Landing Site. The inshore area (A) is marked by a U.S. Coast Guard navigational channel marker (Green Can #7) to the northeast of the Landing Site. The offshore area (B) is delineated by Green Can #7 and a yellow marker west of Goose Island. Observers use 8x or 10x magnification binoculars and 20x to 60x magnification telescopes for bird identification and a continuous scanning technique across the survey area to identify and count all species present. The highest count for each species is recorded for each 15-minute interval (Martin and Bateson 1986).

Special attention is paid to species known to dive to depths of 65 ft or more; these include Long-tailed Duck (*Clangula hyemalis*), King Eider (*Somateria spectabilis*), White-winged Scoter (*Melanitta fusca*), Common Loon (*Gavia immer*), Black Guillemot (*Cepphus grylle*), Razorbill (*Alca torda*), and other alcids. All surveys were conducted during periods of peak bird activity identified in preliminary surveys and last for a period of three hours. Each survey is divided into

15-minute intervals and the maximum number of each species and their behavior is recorded during each interval. All behaviors of birds on the water's surface are registered. Birds are identified as floating (loafing on the surface), diving (active feeding), or swimming. Birds that fly past the survey area but do not land on the water are also counted.

8.2 Results

The Center for Ecological Research (CER) conducted monthly surveys at the TidGen™ deployment site in North Lubec, Maine between November 2011 - May 2012 to monitor wintering seabirds and waterfowl (Report to ORPC on Bird Studies in Cobscook Bay, August 2012 [Note, because of logistical difficulties no survey was conducted in April 2012 so an additional survey was conducted May 2012]). Previous surveys between August and October 2010 (Final Report to ORPC February 2011) failed to find any substantial numbers of diving birds during the fall migration period. Given the general absence of fall migrants, CER recommended to concentrate survey effort in the winter months (November through April) when a variety of seabirds use the area (Second Interim Report to ORPC, August 2011). Diving seabirds such as Common Eider (*Somateria mollissima*), Red-breasted merganser (*Mergus serrator*), Common Loon (*Gavia immer*), Red-necked Grebe (*Podiceps grisegena*), and Black Guillemot (*Cepphus grylle*) all occur during this period. Because CER has limited its surveys to the winter period, we will provide a single final report in July or August 2013, at the conclusion of the winter season. CER is not reporting at the end of a calendar year because that falls in the middle of the winter season.

8.2.1 2011-2012 Winter Migrating Season

<u>Wintering Waterfowl and Seabirds</u>
Generally, few ducks and seabirds used this section of Cobscook Bay in the winter of 2011-2012. Common Eider was the most common species with >100 individuals seen on three separate occasions. Throughout the winter survey period, Common Loons, Red-necked Grebes, Red-breasted Mergansers, and cormorants were present in small numbers, typically 2-10 individuals. We usually recorded fewer than two Black Guillemots on most winter surveys, which was fewer than during the fall when we had regularly observed 10-20 individuals. Dabbling Duck (American Black Duck, Mallard, Northern Pintail) numbers increased through the winter, reaching a peak of 30 individuals March 5, 2011, but they were less numerous in the winter of 2011-2012. These birds usually fed along the shoreline approximately 100-200 meters east of the Landing Site.

<u>Diving Behavior</u>
Long-tailed Duck, Red-breasted Merganser, Common Goldeneye, Common Loon, Red-necked Grebe, and the two species of cormorants were observed actively diving >80% of the time. Black Guillemots were observed diving 100% of the time and Common Eiders approximately 40% of the time. Common Eiders dive for invertebrate prey such as Blue Mussels (*Mytilus edulis*) and other invertebrates. Although we saw this species regularly in the study area, the limited diving activity in the Deployment Area appears to indicate that this site is not a major feeding ground for this species. Feeding activity was similar in the near shore and mid-channel areas for all

species except Scoter spp., which fed more actively in the near shore. It seems unlikely that there will be substantial interaction between these diving birds and the TidGen™ Power System.

Endangered and Threatened Species

CER surveys did not find any federally or state endangered or threatened species present in the survey area. Bald Eagles, a species that was removed as a threatened species in 2009, were regularly observed (Charles Todd, pers. comm.; Maine Department of Inland Fisheries and Wildlife).

ORPC Spring Construction Activities

In March 2012, ORPC installed the base for the TidGen™ Power System in Cobscook Bay. CER conducted two surveys from the Landing Site at North Lubec on March 31, 2012, to determine if these installation activities might have an effect on seabirds in this study area. This phase of this study documented the number of seabirds that used the general deployment area during both vibratory and diesel impact hammer operations and compared the results to previous survey data from the area. Each survey lasted 2 hours.

The responses of seabirds to the vibratory hammer noises were generally minimal or of short duration. Given the degree of commercial fishing boat activity in the area, CER could only detect brief displacements that were less than 15 minutes long and it was not possible to determine if the seabird response was precipitated by the installation activities. For example, Common Eiders were displaced by a fishing vessel that passed through the deployment area while the vibratory hammer was in use. But after the passage of the fishing boat, the eiders quickly settled in the same area where they had been foraging. This suggests that eiders were not impacted by the noise or action on the barge.

We observed no obvious seabird response to the louder diesel impact hammer. Common Eider numbers declined from 8 to 5 individuals during operation but this was within the normal fluctuation of this species in this area at the time (Vickery 2012). Common Loon numbers declined briefly but it was not clear whether this was in response to the diesel impact hammer noise or it was part of the normal loon movements in this area. Loon numbers returned to previous levels (3 individuals) within 15 minutes.

All seabirds were actively feeding prior to and during installation activities. The fact this behavior did not change when the vibratory or diesel impact hammers were in use seems to indicate that the seabirds present were not adversely affected by the noise.

8.2.2 2012-2013 Winter Migrating Season

Preliminary results from November and December 2012 show the same general number of seabirds as was observed in the previous two winters. On November 27, 2012, we recorded the following numbers of diving birds: Common Eiders (0 individuals), Common Loon (2), Red-necked Grebe (5), Great Cormorant (*Phalacrocorax carbo*: 1), Black Guillemot (1). As expected these numbers increased somewhat in December when we recorded the following numbers on December 20, 2012: Common Eider (85), Black Scoter *(Melanitta americana*: 1), Red-breasted

Merganser (2), Common Loon (2), Red-necked Grebe (2), Great Cormorant (1). A full report will be prepared at the end of the winter season and subsequently provided to appropriate regulatory agencies.

8.3 Conclusions and Recommendations

- Previous studies have indicated most significant concentration of birds occurs during winter migrating season.
- Construction activities did not appear to impact bird presence or behavior.
- 2012-2013 Winter Migration report will be provided later in 2013.

ORPC recommends performing bird surveys only during winter migrating season, and will request a license modification to reflect this change. In addition, based on the results of surveys conducting during Phase I pile driving, ORPC does not anticipate the need to conduct further bird surveys specifically for pile driving activities.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

ORPC made significant accomplishments in 2012 with the installation and operation of the first federally licensed, grid-connected tidal energy project (excluding dams) in all of the Americas. ORPC also received the first long term (20-year) power purchase agreement for a tidal energy project in the U.S. The year also marked the transition of the Project's environmental monitoring program from pre-deployment studies to Phase I operation.

9.1.1 Operational Period

Major construction activities were commenced on March 20, 2012 with the deployment of the bottom support frame. Table 10 summarizes the key installation and operation milestones in 2012.

Table 10. *Installation and Operation Milestones.*

DATE	ACTIVITY
March 20, 2012	Bottom support frame deployment
April 4, 2012	Complete pile installation
July 13, 2013	Cable installation
August 14, 2012	TGU deployment
September 13, 2012	Commence
October 25, 2012	TGU retrieval
December 7, 2012	TGU redeployment

This Environmental Report addresses monitoring that occurred during project activities conducted throughout the year, with notable emphasis on operational periods in the fall of 2012. Detailed monitoring that occurred during foundation installation, including pile driving activities, is included in the Final IHA Report for Pile Driving Activities (Appendix A).

9.1.2 Environmental Monitoring

Environmental data collection is difficult under the best circumstances, and the highly dynamic environment of Cobscook Bay combined with construction activities, and initial operation of the roject has affected data collection to date.

ORPC has taken the following approach to environmental monitoring in 2012 given the transitional status of the Project (pre-deployment through operation), unknowns associated with our innovative technology, and the challenging site conditions:

- Collect data in accordance with environmental monitoring plans, in conjunction with installed infrastructure and operational status of the TGU

- Where deficiencies in environmental monitoring equipment and methodologies have been identified, ORPC has engaged technical advisors, manufacturer representatives, and staff to troubleshoot and develop improvement plans, as necessary.

9.1.3 Phase II Schedule

After successfully completing the installation and initial operation of Phase I, ORPC has a unique opportunity to take advantage of significant lessons learned to dramatically advance the development and competitiveness of our technology. As a result, we have decided to extend the installation schedule for completion of our Project to allow adequate time to incorporate design and process improvements:

- Continuous improvement of ORPC power systems and reduction of installation and operating costs are critical to ORPC's plan to achieve cost parity with any new sources of power by 2020.
- With our historic work last year, ORPC gained significant experience in power system installation, retrieval, operation and maintenance, and incorporating this knowledge into the Project's next phase is of fundamental importance.
- ORPC now plans to install additional devices at its Cobscook Bay site in 2014, with assembly and related activities commencing in early 2014.

9.2 Recommendations – License Modification Requests

The year 2012 has provided not only an opportunity to collect and analyze environmental monitoring data throughout construction and operation, but also to gain insight and clarity on the logistics of construction activities, operation and maintenance, and the appropriate level of monitoring required. Despite limited periods of TGU operation, ORPC is recommending numerous modifications to environmental monitoring based on the knowledge and experience our team has gained.

Table 11 summarizes ORPC's proposed FERC license modifications. ORPC provided an agency review draft report to the Adaptive Management Team for a 30-day review and comment period as required by our FERC license. ORPC held an Adaptive Management Team meeting during the later part of this review period on March 12, 2013 to formally present the results of our 2012 monitoring and proposed modifications. The meeting was an opportunity for regulatory agencies to understand the recommended modifications in a workshop setting and collaborate to finalize modifications appropriately.

Table 11. *Recommended License Modifications.*

License Article	Environmental Monitoring Plan	Recommended Modifications
404	Adaptive Management Team	1. Move Herb Scribner from AMT to advisor role. 2. Move Nathan Johnson from advisor to AMT. 3. Replace Laury Zicari, U.S. Fish & Wildlife, with Steve Shepard. 4. Replace Ron Beck, USCG, with Lt. Megan Drewniak, USCG.
405	Acoustic	Schedule Change: 1. Phase I schedule. Due to TGU operational status and weather constraints ORPC was unable to conduct measurements "within 6 months of deployment." ORPC recommends the license article be revised to indicate measurements to be conducted "within 6 months of TGU operation." 2. Phase II schedule. The license article states that "One year later (after Phase I acoustic measurements), acoustic monitoring will be performed around the five-device TidGen™ Power System." We recommend that this be revised to "Acoustic monitoring will be conducted within 6 months of the completed project array operation."
406	Benthic & Biofouling	Despite challenges with data collection in the fall of 2012, initial results indicate minimal to no impact to the benthic community from the power and data cables. ORPC conducted an inspection on February 2, 2013 using improved techniques and enhanced equipment, the results of which confirm the low impact from the cable. We are therefore recommending the frequency of the benthic and biofouling inspections be reduced. We propose to modify the license article as follows: "Section 8.0 Schedule …It is anticipated that inspection will occur **quarterly** during Phase I of the project."
407	Fisheries and Marine Life Interaction	Schedule Change: ORPC recommends revising *Table 2. Proposed Monitoring Schedule of the Fisheries Monitoring Plan for Cobscook Bay,* based on Phase I operation and proposed Phase II installation schedule. The revised Table 2 has been added to Appendix E of this

		Report.
409	Hydraulic	ORPC recommends that measurements for scour occur on a quarterly basis during scheduled dive inspections.
410	Marine Mammal	*Section 6.2. Monitoring by Dedicated Marine Mammal Observers.* Recorded sightings as well as knowledge of the low risks associated deployment, maintenance and retrieval of various project components have contributed to ORPC recommending trained staff perform incidental sightings during these activities rather than two dedicated observers. To support ORPC's recommendation to perform incidental observations during deployment and retrieval activities, we recommend that trained staff perform visual scans of the area 30 minutes before, 10 minutes before, and immediately prior and following these activities and document sightings accordingly.
412	Bird	Pre-deployment and Phase I surveys have indicated significant sea and shorebird concentrations only during winter migrating periods (November to through April). ORPC is therefore recommending that *Section 7.0 Reporting,* of the Plan be modified to remove surveys during fall migration and spring and summer seabirds.

10.0 AGENCY REVIEW AND RESPONSE

10.1 ADAPTIVE MANAGEMENT TEAM MEETING, MARCH 12, 2013

ORPC held an Adaptive Management Team meeting on March 12, 2013 at the Maine Department of Environmental Protection's Eastern Maine Regional Office in Bangor. The meeting was well attended both in person and those who joined by conference call. As previously discussed in Section 9.2, this meeting was an opportunity for ORPC to present 2012 environmental monitoring results and recommendations for modifications in a collaborative setting with the Team. Specific agenda items included:

- Review of adaptive management's role in the Cobscook Bay Tidal Energy Project
- Summary of 2012 activities and lessons learned
- Explanation of environmental monitoring results
- Discussion of recommended modifications and finalization necessary changes
- A briefing on the overall Maine Tidal Energy Project (Cobscook Bay Phase II and Western Passage Tidal Energy Project)

Minutes from the March 12, 2013 Adaptive Management Team Meeting are included in Appendix B of this Report.

10.2 AGENCY COMMENTS AND ORPC RESPONSE

The 30-day agency review period for the draft report ended on March 15, 2013. However, several agencies requested a minor extension to this deadline, primarily due to a supplemental information document that ORPC submitted to the Adaptive Management Team on March 13, 2013. The supplemental information document was discussed during the Adaptive Management Team meeting and provided additional information in support of ORPC's recommended license modifications.

Table 12 summarizes the agency comments received and ORPC's response and/or action. In addition to technical comments, ORPC was pleased to receive positive feedback on the Report and the value and benefit of the adaptive management process. ORPC has revised this report to address comments received where necessary. In addition, this Final Report incorporates the data included in the supplemental information document submitted to the Adaptive Management Team on March 13, 2013.

Table 12. *Adaptive Management Team Comments on 2012 Environmental Monitoring Report.*

Page No.	Name/Agency	Comment	ORPC Response/Action
13 of 81	Michelle Magliocca, NOAA NMFS	Consideration should be given to the need of an incidental harassment authorization for the use of the active acoustic monitoring (AAM) system. This was discussed during a presentation by Scientific Solutions Inc. (SSI) during a meeting with NMFS in Silver Spring.	SSI received a letter of concurrence (LOC) from NOAA NMFS, Office of Protected Resources, on February 15, 2012 for the proposed AAM testing. NMFS “concurred with SSI and ORPC’s determination that marine mammal take, including Level B harassment, is unlikely to occur; thus an MMPA incidental take authorization is not necessary.”
16 of 81	Michelle Magliocca, NOAA NMFS	Comment on the following sentence: *“This gives a maximum predicted RMS noise level of 122 dB re µPa^2 at ranges up to about 68 m from the installation. These levels are only measured very close to the TGU (ranges less than 100 m) and are essentially at or below the threshold for a level B harassment.”* Is this peak or average RMS sound exposure level? If it’s average, then it exceeds the 120 dB threshold for Level B harassment – in which case an incidental take authorization would potentially be needed.	Values are RMS (or averaged) levels integrated over the entire frequency spectrum. Note that this is a conservative estimate for the 5TGU array and only for ranges less than 100 m from the TGU. Thus the area of exposure that might be over the 120 dB threshold is very small and only very close to the TGU. ORPC’s scheduled acoustic monitoring around the installed TGU in early April 2013 will provide in-situ measurements of noise generated. These results will be provided to NOAA NMFS following completion of the Phase I acoustic report. In addition, the conservative estimates from the 2011 report do not reflect the reduction in total devices from 5 to 3 following Phase II.
17 of 81	Michelle Magliocca,NOAA NMFS	Comment on the following sentence: *“ORPC has scheduled the Phase I acoustic monitoring to be conducted following TGU redeployment in late February or early March*	Jim Beyer, Maine DEP, also noted the proposed schedule for Phase I acoustic monitoring during the Adaptive Management Team meeting on March 12, 2013. Due to scheduling conflicts, this is now proposed for the first week in

Page No.	Name/Agency	Comment	ORPC Response/Action
		2013." Was this conducted?	April 2013. ORPC has revised this sentence in the Final Report to indicate monitoring will occur in "early April 2013."
48 of 81	Michelle Magliocca, NOAA NMFS	Comment on the following paragraph: *"Secondly, dedicated marine mammal observers, including trained ORPC staff and local skilled mariners, will 4) conduct marine mammal watch prior to and during major deployment, maintenance and retrieval activities (Figure 30). The data gathered will be used to describe marine mammal presence in Cobscook Bay and characterize the effects (if any are detected) of the TidGen™ Power System on marine mammals, in accordance with the requirements of the FERC pilot license process."* So monitoring during deployment and retrieval activities is really just for the purpose of noting marine mammal presence correct (since the system wouldn't actually be running and no pile driving would be conducted)? Would system be running during maintenance? What effects of the system on marine mammals would be monitored? Just the presence of the system in the water and surrounding human activity?	Monitoring during deployment and retrieval activities is intended to record marine mammal presence and behavior while the TGU is raised or lowered through the water column. During Phase I, when only one device is present, the system will not be running during maintenance periods.
53	Michelle Magliocca,	Typo: *"indicate do not*	Text in the Final Report revised to

Page No.	Name/Agency	Comment	ORPC Response/Action
of 81	NOAA NMFS	*indicate"*	*"do not indicate"*
55 of 81	Michelle Magliocca, NOAA NMFS	Comment on the following text: "Risk of negative interaction with the TGU device is extremely low based on the velocity of the device when raised and lowered…" Meaning when the TGU device is being deployed and retrieved? What about when the device is stationary?	The "extremely low risk" is associated with the velocity (approximately 0.2 knots) at which the TGU is raised and lowered through the water column.
55 of 81	Michelle Magliocca, NOAA NMFS	Comment on the following text: *"Risk of negative interaction with the TGU device is extremely low based on the velocity of the device when raised and lowered through the water column and low percent solidity."* What does this mean?	ORPC has estimated that the TGU solidity is approximately 18%. This means the vast majority (82%) of the cross-section area of the TGU is open space, which therefore minimizes the risk of marine mammal strike with TGU components.
	Steven Shepard, C.F.P., Maine Hydro Licensing Coordinator, U.S. Fish & Wildlife Service	Email comment and concurrence (March 20, 2013): *The USFWS has reviewed the ORPC Environmental Monitoring Report and Supplemental Information. We find the Report to be comprehensive, informative and responsive to the monitoring requirements.* *1. Concurs with replacing Laury Zicari with Steven Shepard on the Environmental Monitoring Team (Article 404),* *2. Concurs with ORPC's request to change certain monitoring and reporting requirements of Articles 406 and 409 from monthly to quarterly (e.g., benthic monitoring), and*	Comment and concurrences noted.

Page No.	Name/Agency	Comment	ORPC Response/Action
		3. Concurs with the revised Fisheries Monitoring schedule and Plan.	
	Sean McDermott, NOAA NMFS	Email concurrence (March 20, 2013): *NMFS concurs with the comments of the USFWS. The Adaptive Management Team approach has been valuable. In addition: 1. We encourage changes to the benthic monitoring that will address issues identified within the critique/needs. ORPC should continue to consult with the resource agencies as modifications to monitoring are developed. 2. The fisheries and marine life interaction report provides a tremendous amount of data and insight even though the data analysis remains preliminary. The work completed to date says as much about the methodology and technology as the purpose of the work. We encourage the continued dialogue among ORPC, UMaine and the resource agencies as the challenges to monitoring and data analysis are addressed.*	Comments noted.
	Linda P. Mercer, Bureau of Marine Science, Maine Department of Marine Resources	Email comment (March 14, 2013): *I have reviewed the 2012 Environmental Monitoring Report and find it to be a complete*	Comment noted.
	Lt Megan Drewniak, Sector Northern New England, Waterways	Email comment (March 18, 2013): *I have no other comments at*	Comment noted.

Page No.	Name/Agency	Comment	ORPC Response/Action
	Management Division Chief, U.S. Coast Guard	*this time.*	

10.3 Public Dissemination of 2012 Environmental Monitoring Results

In accordance with ORPC's Adaptive Management Plan, the 2012 Environmental Monitoring Report will be made available to the public. ORPC received feedback from the Adaptive Management Team during the March 2013 regarding preferred options for the public dissemination of the Report. In addition to the Report being available on FERC's website, it will also be posted to ORPC's website. Hard copies of the full report will be provided to the municipal offices of the City of Eastport and and the Town of Lubec, and ORPC will coordinate further dissemination with community organizations.

ORPC will also be developing a brief summary of 2012 environmental monitoring results that can be easily distributed to the local communities and the industry as a whole. This summary will be available in April 2013.

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COBSCOOK BAY TIDAL ENERGY PROJECT

FINAL REPORT ON THE ACOUSTIC, MARINE MAMMAL AND BIRD MONITORING STUDIES DURING PHASE I PILE DRIVING ACTIVITIES

PREPARED FOR NOAA

RE: INCIDENTAL HARASSMENT AUTHORIZATION, Dated 3-8-12
For COBSCOOK BAY TIDAL ENERGY PROJECT
FERC PROJECT No. 12711
ORPC MAINE, LLC

June 20, 2012

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EXECUTIVE SUMMARY

ORPC Maine, LLC submits this Final Report on the Acoustic, Marine Mammal and Bird Monitoring Studies during Phase I Pile Driving Activities for the Cobscook Bay Tidal Energy Project (Project) in compliance with the Incidental Harassment Authorization (IHA) issued by NOAA NMFS, Office of Protected Resources.

Pile driving activities for the installation of ORPC's TidGen™ bottom support frame were completed between March 24 and April 4, 2012. This work was accomplished in accordance with regulatory restrictions relating to the presence of endangered Atlantic salmon smolt after April 9th (Federal Energy Regulatory Commission, Pilot Project License, P-12711-005, Article 402). Marine mammal monitoring and mitigation requirements for pile driving were conducted in accordance with the IHA issued by NOAA NMFS, Office of Protected Resources, on March 8, 2012.

The contractor utilized several pile driving hammer techniques during the installation. The primary means was a vibratory hammer which produced continuous noise levels. The secondary means was a diesel impact hammer which produced a more acute, instantaneous noise source.

Environmental monitoring was conducted by leading scientists and experts during pile driving activities and included the following:

- In-air acoustic monitoring on Goose Island and at the Lubec On-shore Station
- Hydroacoustic monitoring in the near field (from the deployment barge) and at various far field ranges (100 m, 1,000 m, and 2,000 m)
- Marine mammal observations located on vessels anchored around the installation site for all pile driving activity and additionally from land stations for three events
- Marine mammal mitigation measures
- Bird survey from the Lubec shore

Results of monitoring during pile driving activities demonstrated minimal impact to the environment. Source levels measured during impact and vibratory pile driving were below the thresholds of concern for Atlantic salmon smolt. Measured Level A and B isopleths ranges were significantly shorter than the conservative calculated ranges included in the IHA. Although there were sightings of birds and harbor seals in the vicinity of the project area both before and after pile driving, their responses to pile driving noise were minimal. This included harbor seals, or possibly a single individual harbor seal, which returned to the project site (outside the Level A exclusion zone) on multiple days of pile driving.

Mitigation measures used during pile driving were successful in maintaining acoustic source levels within acceptable ranges and minimizing impacts to the environment. These measures included wood sound absorption devices installed in the head of the impact hammer and a "soft start" that initiated pile driving at less than 100% energy for both hammer types. In addition, modifications made by the contractor to the physical connection between the pile and the follower alleviated initial acoustic spikes.

Protected Species Observers (PSOs) were successful in recording marine mammal sightings, determining location and the animal's behavior. However, marine mammals were not observed within or approaching the Level A exclusion zone (initially estimated to be 500 feet). Shut down or delay procedures, therefore, were not initiated during pile driving activities.

ORPC presented the initial pile driving acoustic results, including the effectiveness of mitigation measures, to NOAA NFMS on April 2, 2012, as part of the agency consultation required for requesting modification of the restrictive window for pile driving. Meanwhile, ORPC submitted a license modification request of Article 402 Restriction Period for Pile Driving to FERC on March 29, 2012, and supplemented this request with additional information on April 2, 2012. FERC approved the modification on April 4, 2012.

ORPC will utilize this same pile driving process in the future if the installation requires it, thereby making the restrictive window unnecessary. This conclusion is supported by Phase I testing results. Moreover, this conclusion supports the virtues of adaptive management which allows scientifically gathered data to guide the evolution of best management practices for environmental monitoring and mitigation measures.

The following best management practices should be incorporated into future pile driving activities in Cobscook Bay to minimize the level of effort while addressing the areas of greatest risk:

Pile Driving

- The vibratory hammer in combination with wood sound absorption devices used during Phase I pile driving had source levels below regulatory thresholds.
- Modifications to the physical connection between the pile and the follower alleviated initial acoustic spikes.
- The effectiveness of soft start procedures used during Phase I was difficult to quantify. However, no marine mammals were observed within the Level A exclusion zone or at any time during active pile driving.
- ORPC demonstrated that sound exposure levels (SELs) for vibratory hammer activity are limited by provided best practices are used for hammer and pile assembly.
- Information gathered by experts and submitted by ORPC as a modification request related to the restrictive window for pile driving was used to remove the window for the remainder of Phase I operations. This information remains pertinent to Phase II construction and should be evaluated for this purpose.

Hydroacoustic Monitoring

- Hydroacoustic monitoring results confirmed that pile driving source levels were within acceptable ranges provided that sound absorption devices were used and best practices were implemented for pile and follower assembly. ORPC will implement these best practices if pile driving is used during Phase II installation, which will occur at the same location/environment and geology as Phase 1. Additional hydroacoustic monitoring, therefore, should not be required.

Marine Mammal Observations

- Measured isopleths ranges for both the impact and vibratory hammer indicate that conducting observations from the installation barge rather than moored vessels is practical. It is recommended that PSOs monitor to a distance of 500 m, i.e., the greatest extent of Level B isopleths, during any Phase II pile driving.
- No marine mammal sightings occurred at low tide. It is generally accepted that harbor seals haul out on local ledges during low tide – a behavior that is well documented. For Phase II pile driving events, ORPC recommends two PSOs stationed on the installation barge with 180 degree visibility fore and aft. Further consideration should be given to reduced observations during low tide operations and seasons with minimal marine mammal activity.

Sea and Shorebird Observations

- Bird observations were not required by regulatory agencies; however, ORPC conducted surveys to determine any disturbance to a rookery (not active during pile driving) and potential bald eagle nesting areas. Results of bird surveys indicate minimal to no disturbance to birds in the project vicinity during pile driving. The value of future bird surveys during pile driving should be considered prior to Phase II.

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

ORPC Maine, LLC, a wholly owned subsidiary of Ocean Renewable Power Company, LLC (collectively, ORPC), received a pilot project license for the Cobscook Bay Tidal Energy Project (Project) from the Federal Energy Regulatory Commission (FERC) on February 27, 2012 (FERC Project No. P-12711-005). The Project will evaluate the potential for a new source of clean, renewable energy generation using tidal energy resources in Cobscook Bay, Maine. ORPC obtained an initial preliminary permit for the project area in Cobscook Bay from FERC on July 23, 2007; FERC issued a successive preliminary permit on January 13, 2011. Feasibility studies, including environmental surveys, and pre-filing consultation were conducted, resulting in ORPC's filing of a draft pilot license application (DPLA) with FERC for the Eastport Tidal Energy Project on July 24, 2009. Since submitting the DPLA, ORPC has conducted extensive consultation with regulatory and resource agencies as well as other stakeholders, has collected additional environmental data, and has continued to refine its proprietary technology. As a result of these additional studies and consultations, ORPC now plans to deploy a commercial-scale hydrokinetic power system in stages, with the Project, a small pilot project, as the first phase. The FERC preliminary permit Project boundary for the Cobscook Bay Tidal Energy Project (FERC Project No. 12711-005) encompasses the proposed development area. The FERC pilot project license boundary for the Cobscook Bay Tidal Energy Project encompasses the proposed development area (Figure 1).

Figure 1: Cobscook Bay Tidal Energy Project location map.

1.2 FOUNDATION DESIGN AND INSTALLATION

The foundation design for the TidGen™ devices at the project site consists of a pile bent arrangement consisting of ten steel piles, each with a 30-inch diameter and 0.5½-inch wall thickness. The piles were designed to vary in length due to bottom sediment depth with each driven to the top of the bedrock and protruding 15+ ft above the seafloor.

The bottom support frame for the first TidGen™ device was deployed on the seabed on March 20, 2012 (Figure 2). The deployed bottom support frame acted as a template for the driving of piles to secure the foundation in place.

The contractor's deployment plan included the use of a vibratory and diesel impact hammer to drive the piles to refusal. Hammers specifications were included in the Acoustic Monitoring Plan for Pile Driving Activities submitted to NOAA NMFS, Office of Protected Resources on March 1, 2012.

Figure 2. Bottom support frame deployment, March 20, 2012.

1.3 RESTRICTIVE WORK WINDOW FOR ENDANGERED SPECIES

ORPC anticipated the use of driven piles to fix the TidGen™ bottom support frame to the sea floor during the Final Pilot License Application process. In our consultation with NOAA NMFS, Protected Resource Division, it was identified that the potential sound levels of pile driving may emit sound levels that could damage young salmon if the pile driving occurred during smolting season, April 10 – November 7, but not during other times of the year. Below is an excerpt from correspondence from Dan Tierney, NOAA NMFS, to Herb Scribner, ORPC on October 28, 2011:

> *Pile driving that occurs within Cobscook Bay between November 8th and April 9th will not affect listed salmon because they are not anticipated to be present in the action area. The piles driven for Phase 1 of the proposed project (ten of the fifty) will be driven during March 2012; therefore, their installation is not anticipated to adversely affect listed salmon. Although ORPC will endeavor to install the piles for Phase 2 during the preferred work window (November 8th and April 9th), it will likely not be possible to install all forty of the remaining piles during that timeframe. Therefore, ORPC will conduct acoustic monitoring during the driving of the Phase 1 piles to determine if noise levels are below the thresholds of injury to fish as described above. If it is determined that*

> *the noise levels exceed these thresholds, ORPC will work within the recommended November 8th to April 9th work window and/or use a combination of attenuation devices (cushion or bubble curtain) to reduce levels to a point where they will not harm listed fish. So, if during the monitoring of Phase 1 pile driving it is determined that noise levels are significantly below the thresholds for injury, the work window and the attenuation methods will be unnecessary.*

As a condition of a subsequent IHA (See Section 1.5) from NOAA NMFS, Office of Protected Resources, ORPC included a separate Acoustic Monitoring Plan for Pile Driving Activities that included monitoring during initial pile placement by several methods and mitigation measures that covered the range that NMFS had indicated in their correspondence. It was intended by NMFS to require ORPC to drive the initial piles and collect data regarding the monitored sound levels when no salmon were present.

1.4 Incidental Harassment Authorization

ORPC applied for an IHA for pile placement because the pile's vibratory hammer setting and diesel impact hammer could potentially generate noise levels above NOAA's guidelines for continuous and impact noise under the Marine Mammal Protection Act of 1972.

ORPC's IHA application included the estimation of noise source levels and associated isopleths based on calculations performed by Scientific Solutions Inc. (SSI) of Nashua, NH, on in-air hammer specifications and nameplate information provided by the manufacturers.

On a constant radiated energy level it was determined that in-air data can be transferred to in-water data by the addition of 62 dB to account for differences in reference levels and specific acoustic impedance (ratio of particle velocity to pressure). Thus, the 112 dB in-air vibratory source level at the operator (presumed 1 m away) equated to roughly 174 dB re μPa2 @ 1 m in water. The 131 dBA from the plate on the impact hammer equated to 193 dB re μPa2 @ 1 m in water.

Based on Level A harassment above 180 dB for marine mammals for the impact hammer, the Level A harassment isopleths were estimated to be 30 to 100 m from the source. Therefore mitigation measurements were recommended to insure that no marine mammals be within 100 m of the pile driving.

Based on Level B harassment levels for the continuous vibratory source (120 dB), and assumed 15logR propagation loss in shallow waters (cylindrical spreading attenuates at 10logR and spherical spreading attenuates at 20logR), SSI determined the 175 dB source levels for the vibratory hammer do not attenuate to 120 dB until a distance of 4600 m, or roughly 2.5 miles from the source.

NOAA NMFS grants authorization for incidental takings of marine mammals if it finds that the taking will have a negligible impact on the species or stock(s), will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. NMFS has defined "negligible impact" in 50 CFR 216.103 as "...an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Except with respect to certain activities not pertinent here, the Marine Mammal Protection Act defines "harassment" as:

> *any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].*

ORPC consulted with NMFS prior to submittal of an IHA for the Project and subsequently prepared and submitted detailed Acoustic Monitoring and Marine Mammal Observation Plans for the pile driving activity.

ORPC was granted an IHA by NMFS on March 8, 2012 for the take, by Level B harassment only, 72 total grey and harbor seals (Halichoerus grypus and Phoca vitulina), 72 harbor porpoises (Phocoena phocoena), and two Atlantic white-sided dolphins (Lagenorhynchus aculus) incidental to pile driving associated with the tidal turbine project. The IHA included specific monitoring and reporting requirements to determine actual source levels and harassment isopleths ranges (Appendix A).

2.0 PURPOSE AND OBJECTIVES

ORPC conducted pile-driving activities between March 24, 2012 and April 4, 2012. Of concern was the effect of the pile driving noise on endangered species of fish (primarily Atlantic salmon) and marine mammals. Acoustic monitoring was conducted to quantify noise levels generated from various pile driving techniques and to determine the effectiveness of mitigation methods to eliminate the April 10th through November 7th work-window.

The following were the specific objectives of the acoustic monitoring:

- Measure near field noise levels in dB re1µPa peak pressure and SEL to confirm impact hammer levels are maintained at less than 206 dB re1µPa@1m peak and below 187 dB re 1µPa^{2}s SEL at a range of 10 m.
- Vibratory hammer levels were to be maintained at less than 206 dB re1µPa@1m peak.
- Establish the 180 dB re 1µPa@1m rms pressure isopleth for both vibratory and impact hammers (thresholds for Level A harassment are 190 dB for pinnipeds and 180 dB for cetaceans).
- Establish the 160 dB re 1µPa@1m rms pressure isopleth for impact (Level B transient source) using sound attenuation devices.
- Establish the 120 dB@1µPa@1m rms pressure isopleth for vibratory (Level B continuous source).
- Monitor ambient air noise levels with a sound level meter at Goose Island and at the Lubec shore station to identify in air noise levels at a potential bird rookery and seal haul-out areas within this area of Cobscook Bay concurrent with bird surveys. In addition, the acoustic monitoring was to provide data to assist with determining potential impacts on bald eagles. Article 411 of ORPC's FERC license requires ORPC to follow the U.S. Fish and Wildlife's Bald Eagle Management Guidelines for the protection of bald eagles and their habitat during construction and operation of the project

These limits are summarized in Table 1 and

Table **2**. The Acoustic Monitoring Plan for Pile Driving Activities in included in Appendix B.

Table 1. *Acoustic thresholds for injury at 10 m for fish*[1].

Peak Absolute Pressure Limit (Threshold for Injury)	**Sound Exposure Level (SEL) Limit (Threshold for Injury)**
206 dB re 1 μPa	187 dB re 1 $\mu Pa^2 s$

[1] Correspondence between Herb Scribner and Dan Tierney, NOAA NMFS "*The noise produced by driving 3 foot or 6 foot piles with an impact hammer will likely exceed the injury thresholds for noise (206 dB Peak and 187 dB SEL) set by the Fisheries Hydroacoustic Working Group, an interagency (USFWS and NMFS included) work group on the West coast that considers the effects of pile driving on fish,*" October 4, 2011.

Table 2. *NOAA guidelines for root men square (rms) pressure levels for Level A and Level B harassment of marine mammals due to continuous (vibratory hammer) and transient (impact hammer) sources.*

Type	Level A	Level B
Vibratory	180 dB rms	120 dB rms
Impact	180 dB rms	160 dB rms

The objective of marine mammal observations was to reduce risk of marine mammal exposure to Level A noise harassment through identification, localization, mitigation measures as necessary. The Marine Mammal Observation Plan for Pile Driving Activities is included as Appendix C.

The goal of the bird surveys was to identify impacts of pile driving noise on sea and shorebird behavior in the vicinity of the project site. The final bird survey report for pile driving is included as Appendix D.

3.0 SUMMARY OF PILE DRIVING ACTIVITIES

The geographic scope of the study generally includes the Cobscook Bay Deployment Area (

Figure *1*).

The Phase I TidGen™ foundation is comprised of a bottom support frame secured to the seafloor with steel piles. The pile foundation consists of ten 30-inch diameter piles with 0.5-inch wall thickness. Piles were driven open ended with a cast iron driving shoe. The length of each pile was determined by the depth of seafloor surfical materials overlying bedrock.

The bottom support frame was deployed on March 20, 2012. Pile driving commenced on March 24, 2012. Two technologies were used for the pile installation process; a vibratory and a diesel impact hammer (specifications provided in Attachment B). Due to the depth of water, a 100-foot follower was used between the pile and each hammer type. The follower, using a flanged connection, was attached to the pile on deck in a receiver attached to the barge and lowered to the appropriate pile sleeve on the bottom support frame.

Due to limitations of deploying structures in high velocity tidal currents, pile driving operations only occurred during an approximate 1 hour period centered on slack tide. Water depths were approximately 105 feet and 85 feet at high and low slack water respectively.

Once lowered to the seafloor most piles sunk approximately 10 feet into the marine clay under their own weight. Each pile was then driven to refusal using the vibratory hammer. During a subsequent slack water period three piles were driven further into glacial till or to bedrock using the impact hammer. However, operation of the impact hammer provided minimal additional embedment, so its use was discontinued after March 31, 2012. Following the hammer operations each pile was unbolted from the follower and hammer assembly underwater by divers.

Pile driving was completed on April 4, 2012. Figures 3 and 4 show the impact and vibratory hammer assemblies respectively.

Figure 3. Diesel impact hammer operations, March 25, 2012.

Figure 4. Vibratory hammer operations, April 1, 2012.

4.0 MONITORING METHODOLOGIES

4.1 In-Air Noise Measurement System Equipment and Methods

In-air measurements were performed using a sound level meter mounted on an industrial tripod at a fixed location during a particular pile activity. A GPS recording device was attached to the tripod to determine the distance to the pile activity. The sound level meter was a Quest Technologies SoundPro DL-1-1/3 Octave-20 sound level meter that meets Type 1 requirements of the American National Standards Specifications for sound level meters, SI.4-1971.

Each day the sound level meter was deployed on either Goose Island or at the Lubec On-shore Station location. The meter was calibrated before and after each day of recording using the methods and calibrator provided by the meter manufacturer. A PSO remained at a distance to the unit to ensure that the equipment was not engaged by wildlife and to note if boats passed near or between the barge and the measurement location during the driving activity.

4.2 In-Water Noise Measurement Equipment and Methods

In-water measurements consisted of near-source barge based measurements at approximately 10 m from the pile and boat based measurements ranging from 100 m to 2 km. Barge based measurements were conducted with a pair of hydrophones deployed approximately 10 and 20 ft below the surface. Measurements were made as a series 75 second (s) records with approximately 10 s between records using an IOTech WaveBook/516E data acquisition system. Boat based measurements were made using a similar pair of hydrophones at similar depths and data was captured as a series of 60 s records without breaks using a Measurement Computing LGR-5320 data acquisition system. Specification sheets for the equipment can be found in the appendices of the Acoustic Monitoring Plan (Appendix B).

Figure 5. Acoustic monitoring from barge (right) and vessel at 100 m (left), April 2012.

4.2.1 *Barge Data Acquisition Component Summary*

- Hydrophones: 2 X Reson TC4013
- Preamplifiers: 2 X low-noise 1-100 kHz battery operated preamplifier (EPAC)
- Data Acquisition: IOTech Wavebook/516E to laptop computer over Ethernet

4.2.2 *Boat Data Acquisition Component Summary*

- Hydrophones: 2 x Reson TC4013
- Preamplifiers (stage 1): 2 X low-noise 1-100 kHz battery operated preamplifier (EPAC)
- Preamplifiers (stage 2): SSI custom low-noise preamplifier
- Data Acquisition: Measurement Computing LGR-5320 (2-channels @ 100kHz/channel sampling rate)

Prior to every deployment of the barge and boat measurement systems, the hydrophone sensitivity was calibrated through the entire system using a pistonphone recommended by the hydrophone manufacturer. A calibration was also performed at the end of each deployment. This ensured that there was no degradation in the performance of the hydrophones or acquisition system.

4.2.3 In-Water Mitigation Equipment

Figure 6 shows the mitigation equipment used during impact hammer activity. For the first pile Impacted, a single, ¾ in. piece of plywood was used between the hammer and the follower. Subsequent drives used two layers for 1 ½ in. total.

Figure 6. Plywood sound mitigation measures for the diesel impact hammer after pile driving. The first file used ¾ in. thick plywood (right photo). Subsequent impact drives used two layers for 1 ½ in. total (shown on left and center in photo in various stages of assembly).

4.3 MARINE MAMMAL OBSERVATION METHODOLOGIES

ORPC established a Marine Mammal Observer and Reporting Plan for Pile Placement (Plan) to minimize marine mammal exposure to loud noise-generating activities.

ORPC incidental visual monitoring of marine mammals in Cobscook Bay area between 2007 and 2010 indicated that harbor porpoise (*Phocoena phocoena*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), grey seals (*Halichoerus grypus)* and harbor seals (*Phoca vitulina*) may be present in the vicinity. Other species that may occur in the vicinity of the project include North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaengliae*), fin whale (*Balaenoptera physalus*), minke whale (*Balaenoptera acutorostrata*), and sei whale (*Balenoptera borealis*). These latter marine mammal species are generally associated with open ocean habitats and occur locally, but in more offshore locations in the Bay of Fundy. Thus, the four species with the greatest likelihood of occurring in the project area are harbor and grey seals, harbor porpoise and to a lesser extent, Atlantic white-sided dolphins. ORPC does not expect to create noise at levels that harasses marine mammals for prolonged periods of time. There may be some limited peripheral harassment if a marine mammal comes into the work area underwater and is not spotted by our observers.

ORPC's Plan included details on PSO skills, training program, equipment needed, survey methods, data collection and management protocols and associated data sheets, and an incident reporting form. Marine mammal observations were conducted 30 minutes prior to, during, and 30 minutes after deployment activities. In the event that a marine mammal was observed entering or within a 152 m (500 ft) marine mammal exclusion zone around the installation site during pile deployment activities, a mitigation action plan and curtailment of deployment activity was provided.

4.3.1 Marine Mammal Observation Training

ORPC led a workshop on February 16-17, 2012 to train PSOs in the identification of the marine mammal species known to occur in and around the waters of Cobscook Bay near the Project site. The instructor for the workshop was Dr. Moira Brown, senior scientist at the New England Aquarium. A total of 21 individuals, including local residents and ORPC staff, were certified as a result of the training.

The specific goals of the training included the following:

1. *Species Identification*
The instructor presented several images of each one of the species known to occur in the area and identified the specific characteristics unique to each one to aid species identification. Each image shown was obtained from a vessel platform closely approximating what the PSOs will see. Additional information was given on typical seal and whale behaviors and on the legal status of each species.

Table 3. *Common and less common species in Cobscook Bay*

Common Species in Cobscook Bay	**Less Common Species**
Harbor seal	Minke whale
Grey seal	Fin whale
Harbor porpoise	Sei whale
Atlantic white-sided dolphin	Humpback whale
	Right whale

2. *PSO Skills*
The instructor provided the PSOs with specific guidelines on how to set up the PSO team for maximum coverage of the area, how the PSOs should scan the surface of the water, which sighting cues to focus on, and how to distinguish whale species from other marine life (e.g. basking sharks, tuna, ocean sunfish).

3. *Data Recording*
Additional training included how to record data on paper data sheets. PSOs were familiarized with the program and data entry and protocols. Paper data sheets were summarized and digitized into a database for further analysis and reporting.

4. *Distance Estimation*
Distance estimation is difficult, and varies between individuals; the PSOs were introduced to range finder devices and given an opportunity to practice with the device outdoors. PSOs were trained to use a compass to get a bearing to the marine mammal. The range finder distance and compass bearing permit calculation of a sighting to provide for higher resolution data for mapping the sightings collected for the summary report.

4. *Testing*
The PSOs were shown a series of images of marine mammal species expected in the area and be asked to write down their own species identification for each test image. There was a mix of images they had seen before and novel images.

4.3.2 Vessel Observations

ORPC vessel observations were structured as described in the Plan and the IHA. Four PSOs were stationed on two observer boats, one boat anchored at 152 m (500 ft) upstream and one at 500 ft downstream from the installation site (Figure 7). On each boat, two PSOs were positioned so that one PSO surveyed inward toward the installation site (i.e., two PSOs dedicated to scanning continuously only the 152 m, 500 foot exclusion zone) while the second PSO on each boat scanned outward to a distance of 1 nm to conduct behavioral monitoring . Reference marker buoys (Table 4) were anchored at 152 m (500 ft) and 305 m (1,000 ft) were located around the installation site to help the PSOs identify when marine mammals were entering or within the exclusion zone. For behavioral observations from the 152 m (500 ft) marine mammal exclusion zone out to 1 nm, natural land marks can be used (Figure 7). There is water at a distance of 1 nm outward from the installation site on three sides of the installation site, to the southeast, west, and northwest (Table 4).

Table 4. *The location of the 1 nm boundaries A, B and C and the natural landmarks.*

1 nm Boundary	Position	Landmark
Boundary A – southeast of installation site	44 53.985 N x 67 01.640 W	Between Shackford Head and Green can #5
Boundary B – west of installation site	44 54.630 N x 67 04.159 W	Between Grove Point on Seward Neck and Birch Point on mainland
Boundary C – northwest of installation site	44 55.265 N x 67 03.783 W	Between Birch Point on mainland and Nipps Island

All sightings of marine mammals were reported to the recorder who logged an entry on the data sheet for each sighting, including the species, number, and behavior. The location of the marine mammals was estimated using a compass to determine the magnetic bearing to the animal and distance estimation or a range finder to determine the distance from the observation vessel to the animal. The information was entered on the paper data; the actual geo-referenced location was calculated after the observation period has been completed and entered into the computerized record.

The exclusion zone was monitored continuously during all pile driving, including 30 minutes prior to and following operations, to ensure that any marine mammals that enter the area were seen, recorded and if within the exclusion zone, lead to the cessation of pile driving activities until the marine mammal observed was beyond 305 m (1000 ft) or 30 minutes passed with no further sighting. The PSOs continued scanning the marine mammal exclusion zone and outwards to 1 nm until 30 minutes after the pile driving activity had ceased for that event. At the conclusion of the observation period, the team returned to Eastport. The anchoring system remained in place for the duration of the pile installation; however the reference buoys were initially removed daily to prevent entanglement between mooring lines and other vessels.

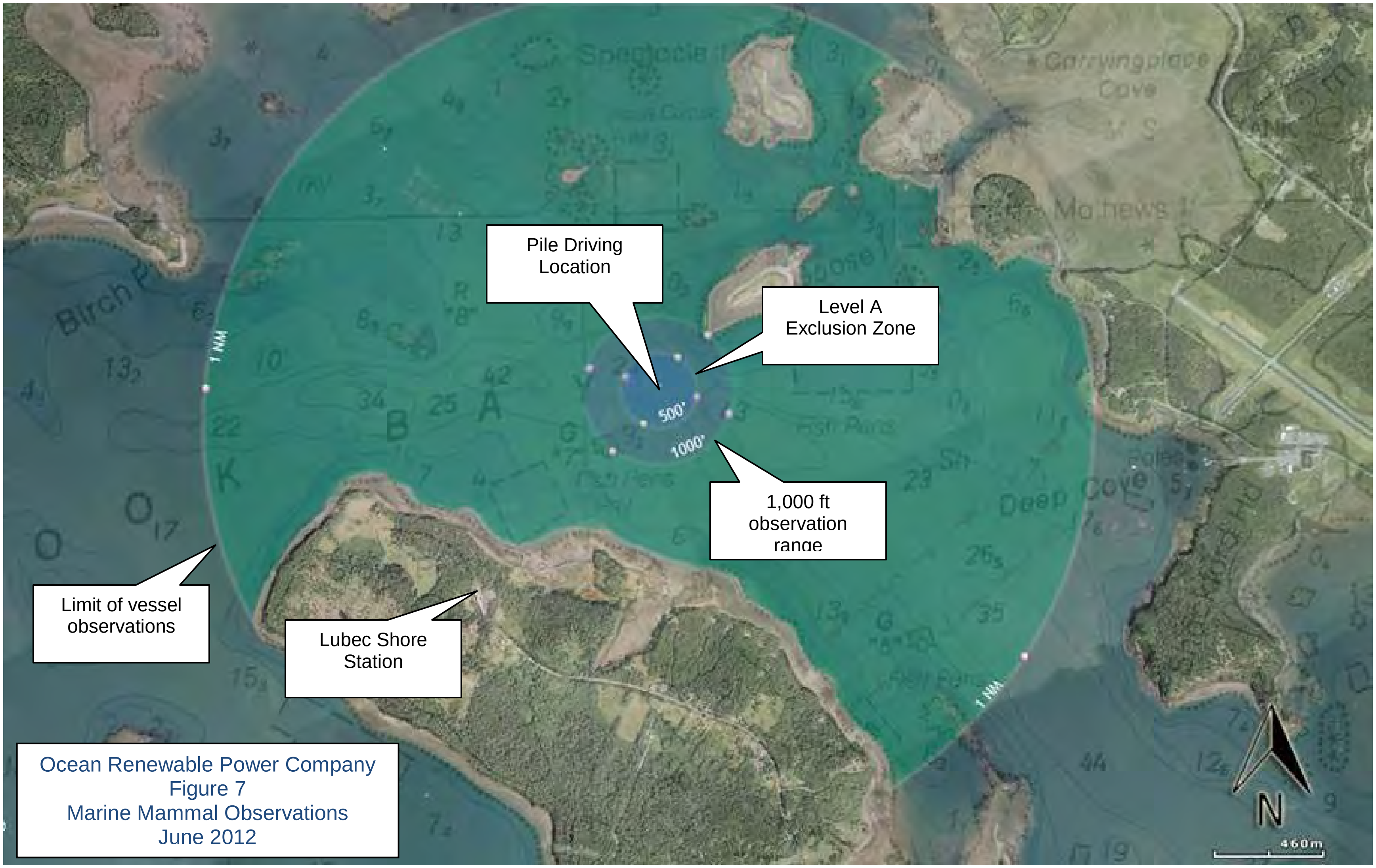

Figure 7. Marine mammal observation ranges.

4.3.3 Land Observations

ORPC's IHA required observations to take place at a 2.5 mile range from the installation site on at least three events during vibratory pile driving to conduct behavioral monitoring and validate take estimates. For these events observers were located at Birch Point in Perry (Figure 8) to look west and southwest and at the Shackford Head Overlook at the Shackford Head State Park (Figure 9) to view to the southwest towards the 2.5 mile ranges.

Land PSOs were provided with the same equipment and recorder sheets as those located on vessels and briefed on communications, access, and safety.

In addition, ORPC prepared plans to add PSOs on land on occasions when low visibility prohibited vessel observations to the 1 nm distance. The plans called for PSOs to be located at the Schooner Overlook to view to the northwest and at Birch Point to look southeast towards the installation site. However, weather conditions encountered during the pile driving installation did not necessitate land PSOs.

Figure 8. Birch Point observations

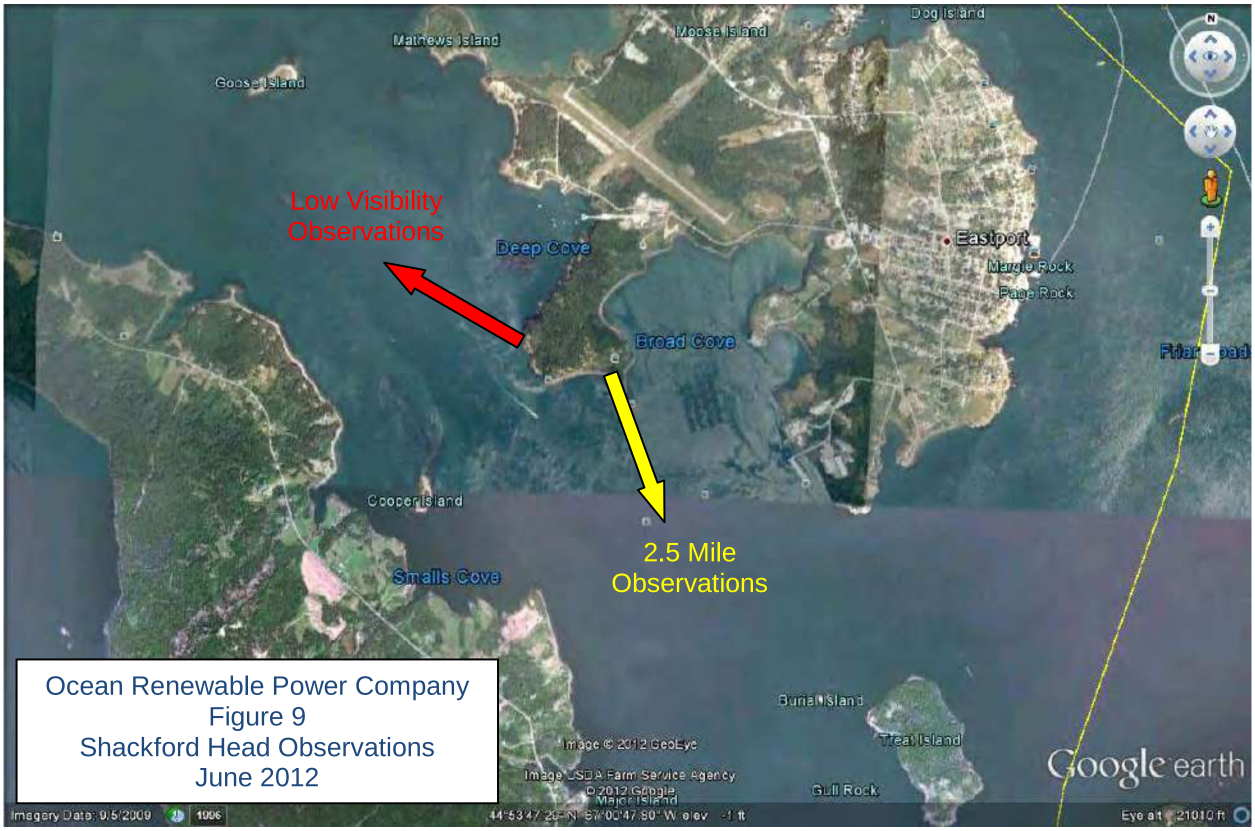

Figure 9. Shackford Head observations

4.3.4 MMO Operational Modifications

During pile driving activities ORPC encountered conditions that necessitated several modifications to marine mammal observations to reduce safety risks and logistical challenges.

<u>PSO Vessel Locations</u>

Due to safety concerns associated with proximity to pile driving, ORPC modified the locations of PSO vessels indicated in our IHA and Marine Mammal Observation Plan for Pile Driving Activities. NOAA NMFS, Office of Protected Resources, was notified of the modification on March 28, 2012. PSO vessels were moored at a distance of 1,000 ft from the installation site (vs. 500 ft proposed). Two dedicated observers on each vessel continued to monitor inwards to the installation site, focusing on the 500 ft exclusion zone. In addition, two dedicated observers on each vessel continued to monitor outwards to a distance of 1 nautical mile.

The barge that the pile driving crane sat on was 150 ft long and was moored at all four corners to large bottom anchors. The mooring lines were approximately 1,000 ft long, making the 500 ft mooring for our observation boats interfere with not only the pile barge but the several other support vessels (diver support, safety, materials barge, and crew boats). The quality of the binoculars and location gear (as described in ORPC's Marine Mammal Observation Plan) assured consistent and full-view coverage of the activity zones.

<u>Removal of 500 ft Range Buoys</u>

Due to inaccuracies in location caused by tidal currents and safety concerns associated with the proximity to pile driving operations, ORPC removed the 500 ft range buoys described in our IHA and Marine Mammal Observation Plan for Pile Driving Activities. NOAA NMFS, Office of Protected Resources, was notified of the modification on March 28, 2012. Strong tidal currents caused the 500 ft range buoys to only surface within approximately 20 to 30 minutes of slack water and their location was greatly compromised by the tidal flow. The buoys also pose a safety hazard to vessels approaching the pile driving barge due to their submergence.

ORPC briefed PSOs on using existing landmarks to identify the 500 ft exclusion zone. In addition, training that occurred by Dr. Moira Brown on February 16-17, 2012, included distance estimation. Each PSO vessel was moored at 1,000 ft from the pile driving barge and equipped with digital range finders (Figure 10). Points of reference for estimating the 500 ft exclusion zone included the following:

- Half the distance between the PSO and the pile driving point
- Half the distance between the southwest tip of Goose Island and the pile driving point
- Half the distance between the green "7" marker buoy and the pile driving point

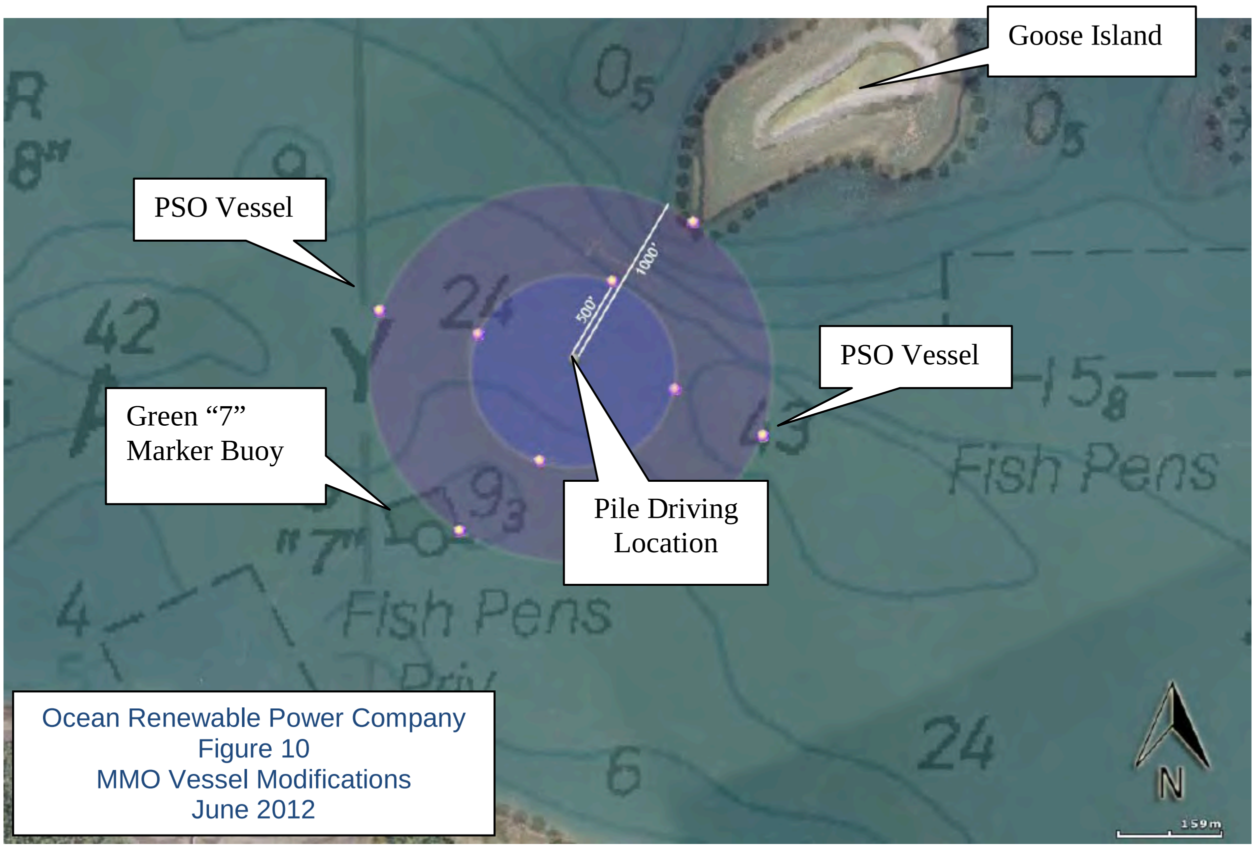

Figure 10. Modifications to PSO vessel locations

4.4 Bird Observation Methods

The Center for Ecological Research (CER) conducted observations on March 31, 2012, to determine if the seabirds that use the proposed deployment area were affected by the installation of the support structure for the TidGen™ device.

The phase of this study documented the number of seabirds that used the general deployment area on March 31, 2012, during both vibratory and diesel impact hammer operations and compared the results to previous survey data from the area.

<u>Wintering Waterfowl and Seabirds</u>
CER conducted two surveys from the landing site at North Lubec on March 31, 2012. Each survey was conducted for a period of two hours. Each survey was divided into 15-minute periods and a maximum of three species and its behavior (see below) were recorded during each period. For reporting purposes,

CER condensed the 15-minute observation periods into 30-minute units by selecting the largest count in each of the two 15-minute periods, e.g., if 7 eiders were counted in the first 15 minute period and 11 eiders were counted in the second period, CER used the higher number, in this case, 11 individuals. CER used a continuous scan method to identify and count all species present (Martin and Bateson 1986). Observers used 8x or 10x binoculars and a 20-60x telescope for the land-based surveys.

Behaviors
CER registered all behaviors of birds on the water's surface. Birds were identified as Loafing (floating on the surface), Diving (active feeding below the surface), or Surface Feeding (active feeding on the surface) (Holm and Burger 2002). In addition, CER noted when construction activities were initiated and recorded bird movements and behaviors during those construction activities.

Figure 11. Bird Surveys from pier on Seward Neck

5.0 Monitoring Results

5.1 In-Air Monitoring Results

In-air measurements at the Lubec On-shore Station location and on Goose Island indicated that the pile driving activity was detectable for both vibratory and impact hammer sources based on the ambient noise level during the pile driving. As the pile driving noise levels and ambient noise levels were variable, the results varied from pile activity being completely masked by ambient noise to levels 5 – 10 dB above ambient. Figures 12 through 15 depict acoustic measurements recorded on Goose Island and at the Lubec On-shore Station for both impact and vibratory hammer operations.

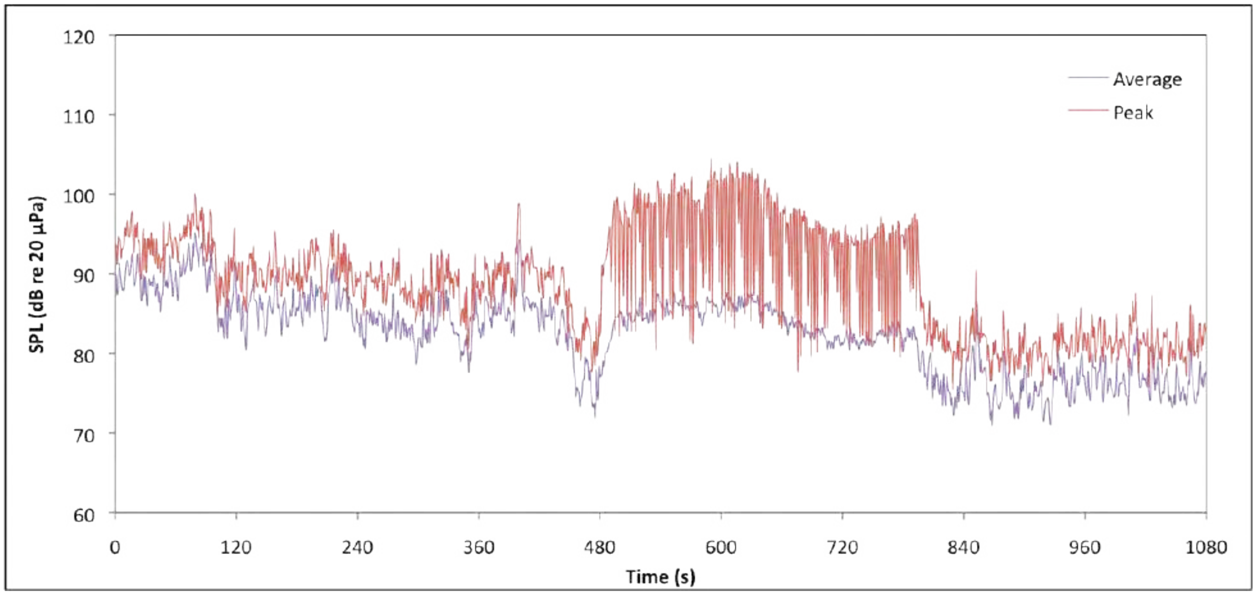

Figure 12. In-air measurements on Goose Island during impact hammer activity, March 25th starting at approximately 2:07 pm.

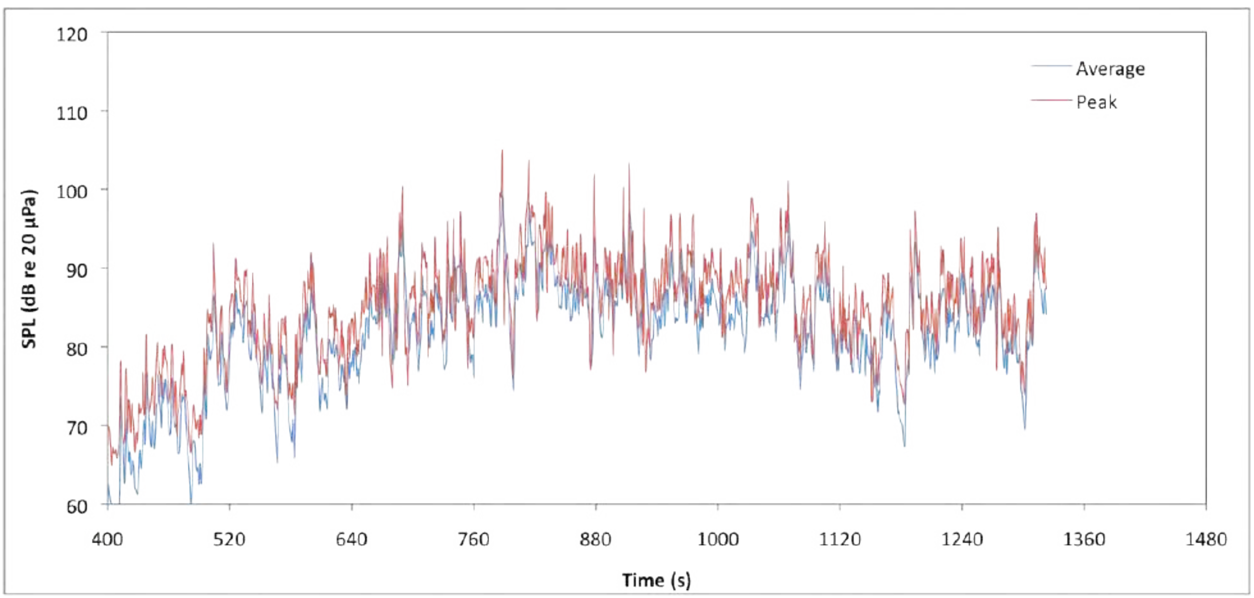

Figure 13. In- air measurements at the Lubec shore station location during impact hammer activity, March 31st starting at approximately 6:00 pm.

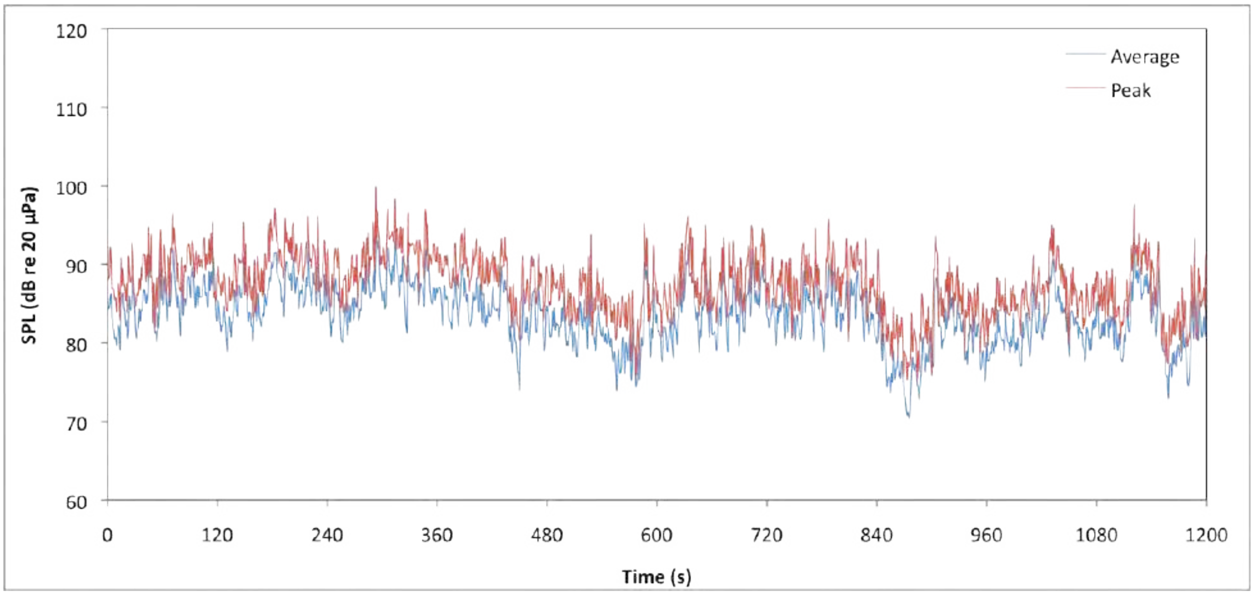

Figure 14. In-air measurements on Goose Island during vibratory hammer activity, March 29th starting at approximately 10:25am.

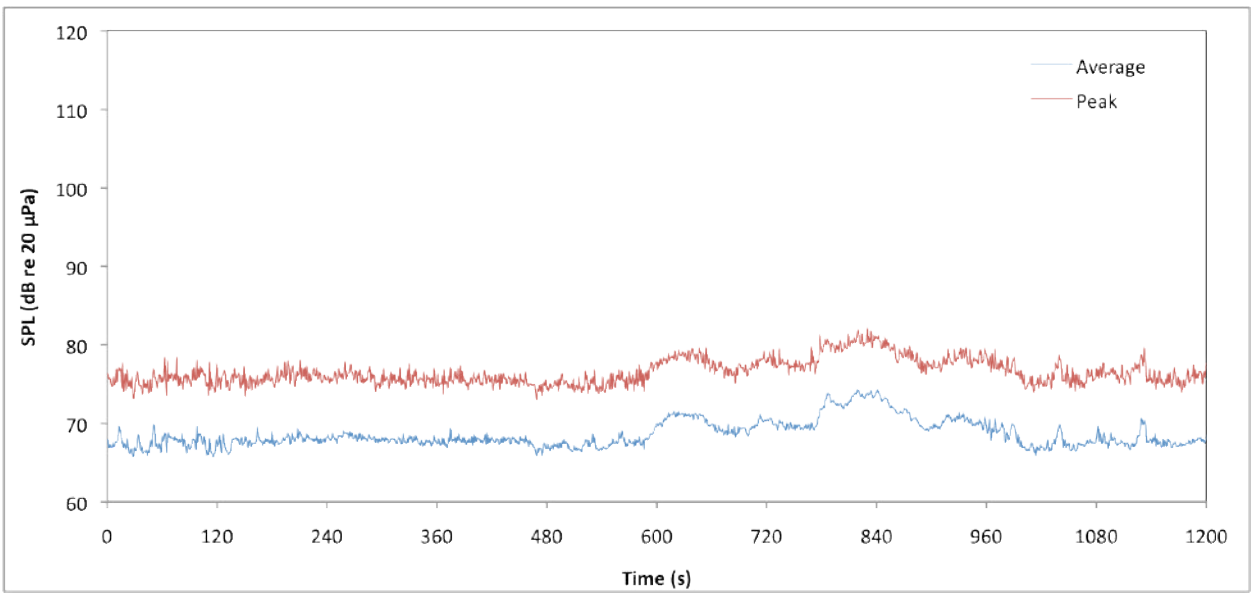

Figure 15. In- air measurements at the Lubec shore station location during vibratory hammer activity, April 1st starting at approximately 6:25am.

5.2 In-Water Acoustic Monitoring Results

5.2.1 Near-Source Summary

In-water acoustic monitoring results indicate that ORPC did not exceed either the SEL or peak noise threshold during the observed impact hammer activity or during the majority of the vibratory hammer activity. Table 4 summarizes the near-source measurements, associated pile activity and relevant noise threshold levels (peak absolute pressure level and sound exposure level). For the two initial vibratory hammer piles that exceeded the SEL limit, the cause is attributable to an improper connection between the vibratory hammer and the pile, which was addressed in later vibratory pile driving events. Upon correction of the connection issue the SEL for vibratory pile driving was within allowable limits. Figures 16 and 17 show recorded peak absolute pressure for impact and vibratory hammer events in the order of pile driving.

Table 4. *Summary of pile driving activity including hammer type, duration, drive depth and near-source receive levels (peak absolute pressure and sound exposure level) at 10 m.*

Pile	**Type**	**Drive Distance (vertical ft)**	**Duration (min)**	**Peak Pressure (206 dB re 1 μPa Threshold for Injury)**	**SEL re 1 μPa^{2}s (187 dB Threshold for Injury)**
8	Vibratory	32	7:30	195	188 (25% over limit)
8	Impact	15	5:17	202	168
5	Vibratory	38	8:09[‡]	184	188 (25% over limit)
3	Vibratory	36	8:30[†]	177	180
3	Impact	0	3:00	200	170
5	Impact	0	1:00	198	169
1	Vibratory	29	7:31[†]	170	171
7	Vibratory	48.5	13:30[†]	171	178

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[‡] Includes soft start period of 2 minutes at 50% energy

[†] Includes soft start period of 4 minutes at 0% (off) and 50% energy

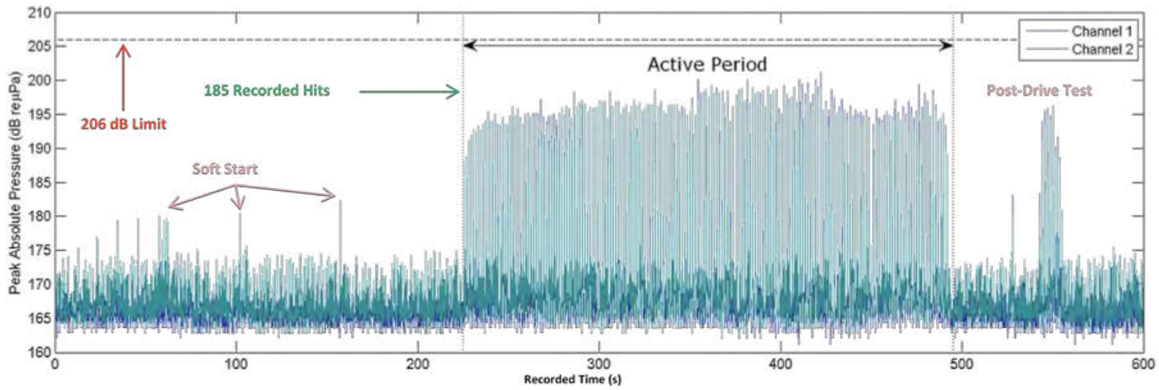

Figure 16. Peak absolute pressure as a function of recorded time for impact hammer activity of pile 8 on March 25th, including soft-start. The peak amplitudes of the impacts never reach or exceed to the 206 dB peak absolute pressure limit.

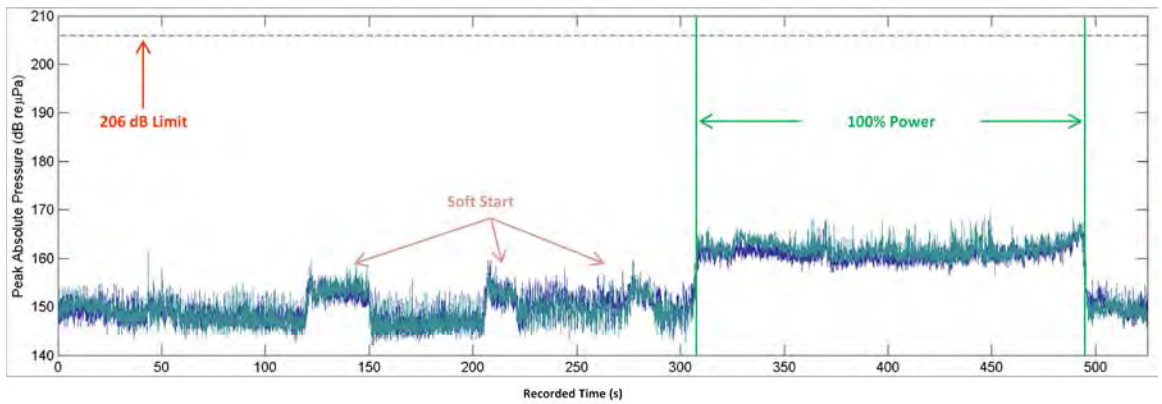

Figure 17. Peak absolute pressure as a function of recorded time for vibratory hammer activity after improving connections between the hammer and follower and the follower and pile. Under normal conditions the vibratory hammer showed fairly consistent output at 100% power. Pile 1, April 1st.

5.2.2 Isopleth Summary

Table 5 summarizes the isopleth ranges for Level A and B harassment using the vibratory hammer (continuous source) and impact hammer (transient source) based on direct measurements and the measured transmission loss. These values show that measured Level A and B ranges were significantly closer to the pile driving operation than the conservative ranges included in the Acoustic and Marine Mammal Observation Plans. The measured Level A (where applicable) and Level B ranges are included in Figures 18 and 19 for vibratory and impacts hammer operations respectively.

Table 5. *Summary of isopleth ranges based on near-source and far-field measurements for Level A and B harassment of vibratory and impact hammer types.*

Type	**Level A range (m)** **(Vibratory 180 dB re 1 µPa rms)** **(Impact 180 dB re 1 µPa rms)**	**Level B range (m)** **(Vibratory 120 dB re 1 µPa rms)** **(Impact 160 dB re 1 µPa rms)**
Vibratory	N/A	500
Impact	10	275

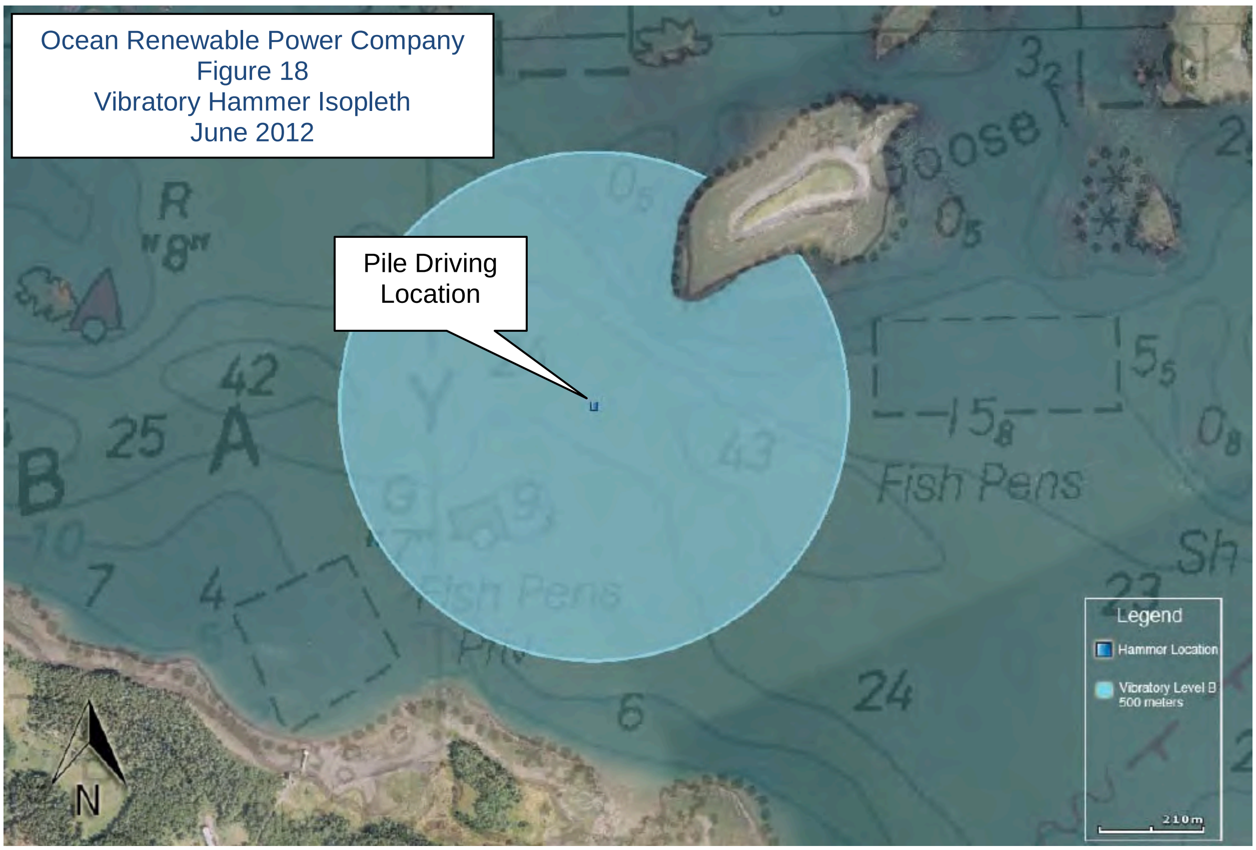

Figure 18. Measured Level B harassment isopleth for vibratory hammer.

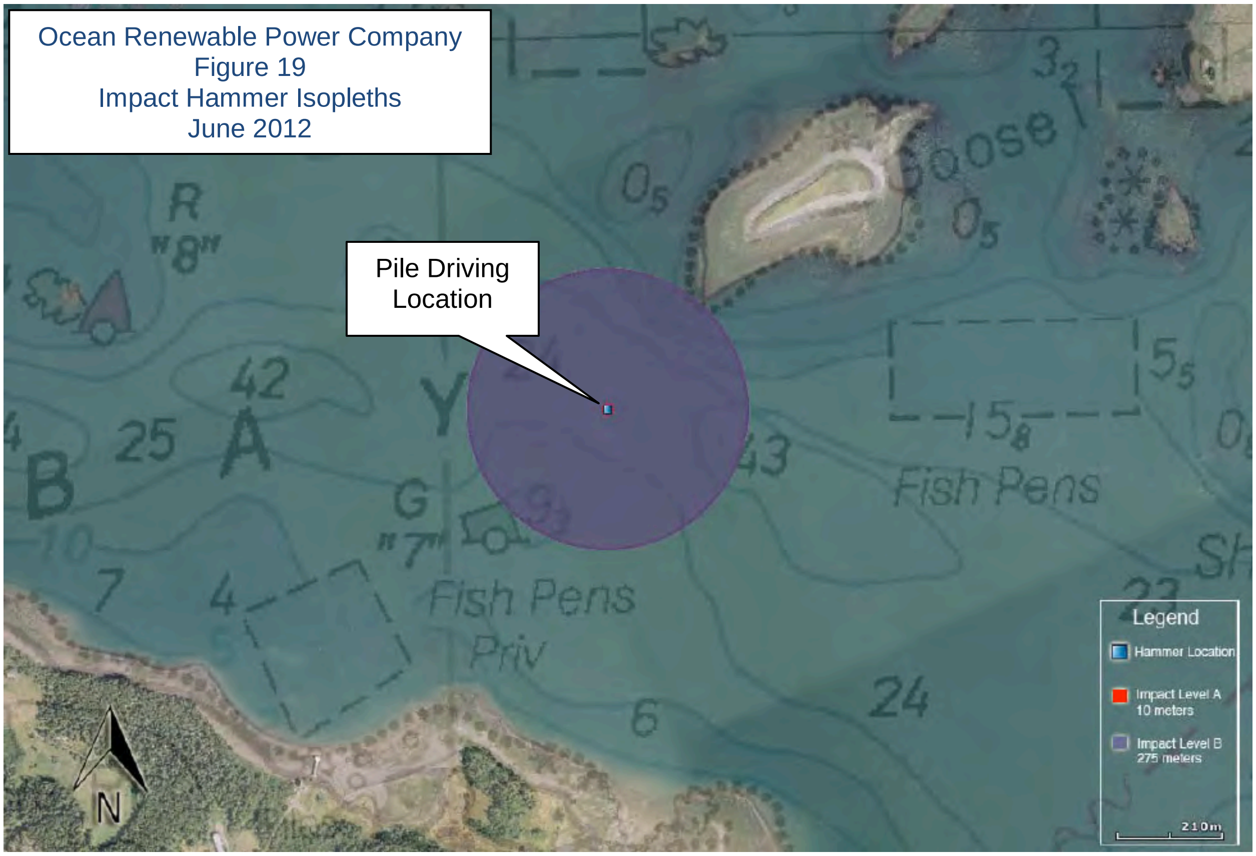

Figure 19. Measured Level A and B harassment isopleths for diesel impact hammer.

5.3 Marine Mammal Observation Results

Marine mammal observations were conducted for all pile driving activities in accordance with the IHA and ORPC's Marine Mammal Observation Plan for Pile Driving Activities (including operational amendments). Observations were conducted during 13 separate pile driving events. Marine mammal sightings occurred during 4 of the 13 events. Recorder sheets for each event are included in Appendix F.

5.3.1 Species

All marine mammal sightings recorded during the Project's Phase I pile driving were Atlantic harbor seals (*Phoca vitulina*). ORPC staff and the PSOs believe with a high level of confidence that all sightings were of an individual harbor seal. There was one the exception of a vibratory hammer event on the morning of April 2, 2012, when due to multiple sightings within a short timeframe on opposite sides of the installation barge there were possibly two harbor seals present during that event.

Information suggesting the harbor seal sightings was an individual animal include:

- *Physical characteristics.* All sightings were of a medium sized harbor seal with no distinguishing features. Figure 20 is a photo of a harbor seal at the Project site prior to pile driving activities.
- *Surfacing times and location.* No sightings recorded multiple seals at the same time. Sightings most frequently occurred between approximate 5 minute dive times. Most sightings were concentrated within a relatively small area.
- *Behavior.* The harbor seal sightings were typically very similar and generally within 500 ft of the southeast observation vessel. Two dominant behaviors were observed; "bottling" (their entire bodies remain submerged with just their heads exposed at the surface) and travelling.

Figure 20. Harbor seal observed swimming prior to pile driving activities.

5.3.2 Behavioral Trends

Table 6 summarizes key environmental monitoring information, including marine mammal sightings, during Phase I pile driving. Figures 21 through 24 indicate sighting locations for the four events during which harbor seals were observed and the associated measured Level A (impact hammer only) and Level B isopleths. Each sighting contains the sequential number of the sighting. Sightings colored yellow occurred during the 30 minute pre or post observation period (no sightings occurred during active pile driving). Sightings colored orange occurred prior to the 30 minute pre-observation period.

Notable information and key trends associated with the observations include:

- Harbor seal (most likely 1 individual) was sighted during 4 pile driving events (3 vibratory hammer and 1 impact hammer).
- No Level A sightings. Shut down or delay procedures were not required.
- No sightings occurred during active pile driving.
- 82% of sightings (28 of 34) occurred within the Level B isopleth (versus outside Level B).
- 100% of the sightings (34) occurred at high tide.
- 88% (30 of 34) of the sightings occurred on the southeast side of the installation.
- 100% of the sightings (20) prior to the 30 minute pre-installation window (when current velocities were relatively high) occurred on the southeast side of the installation (up current from installation). Tidal velocities during this period are estimated to be 1.5 knots or greater. As the tidal velocity slacked the sightings became more distributed.
- 88% of the sightings (30 of 34) occurred prior to pile driving activity. (71% 30 min prior vs. 30 min following [10 of 14]).

5.3.3 Estimation of Takes

As discussed in Section 5.3.1, marine mammal observations sightings and behavior have led to the determination that, with a high degree of confidence, the majority, if not all, of sightings were of a single harbor seal. Therefore, ORPC has estimated a single Level B “take” for each pile driving event where a harbor seal was observed with the exception of the morning pile driving event on April 2, 2012. Due to the location and frequency of sightings during this event ORPC has conservatively estimated two Level B 'takes." Total Level "B" takes of marine mammals during the pile driving period, all harbor seals and most likely a single animal, were five.

Table 6. *Pile Driving Log – Environmental Monitoring*

Pile/Sleeve#	Date	Pile Driving Method	Vertical Drive Length (ft)	Hammer Start	Hammer Stop	Near Field Acoustic Distance (m)	Far Field Acoustic Distance (m)	In-Air Acoustics	Level B "Takes"	Tidal Level	Water Depth (ft)
6/8	3/24/2012	Vibratory	32	13:49	13:37	20	100	Goose Is.	1 Harbor Seal	High Slack	106
6/8	3/25/2012	Impact	15	14:16	14:21	20	100	Goose Is.	1 Harbor Seal	High Slack	103
5	3/29/2012	Vibratory	38	10:32	10:39	15	80	Goose Is.	0	Low Slack	85
3	3/31/2012	Vibratory	36.5	12:04	12:13	10	1000-1100	Shore Station	0	Low Slack	87
3	3/31/2012	Impact	0	18:14	18:17	15	1000	Shore Station	0	High Slack	~99
5	3/31/2012	Impact	0	18:34	18:35	15	1000	Shore Station	0	High Slack	~99
1	4/1/2012	Vibratory	29	6:38	6:45	10	500	Shore Station	0	High Slack	97
7	4/1/2012	Vibratory	48.5	13:02	13:17	10	1000	-	0	Low Slack	84
9	4/2/2012	Vibratory	54.5	7:39	7:50	20	2000	-	2 Harbor Seals	High Slack	100
6	4/2/2012	Vibratory	50	14:03	14:13	-	-	-	0	Low Slack	83.5
4	4/3/2012	Vibratory	44	8:47	8:56	-	-	-	0	High Slack	100.5
2	4/4/2012	Vibratory	38	9:53	10:00	-	-	-	1 Harbor Seal	High Slack	101.4
10	4/4/2012	Vibratory	52.5	16:11	16:17	-	-	-	0	Low Slack	81.5

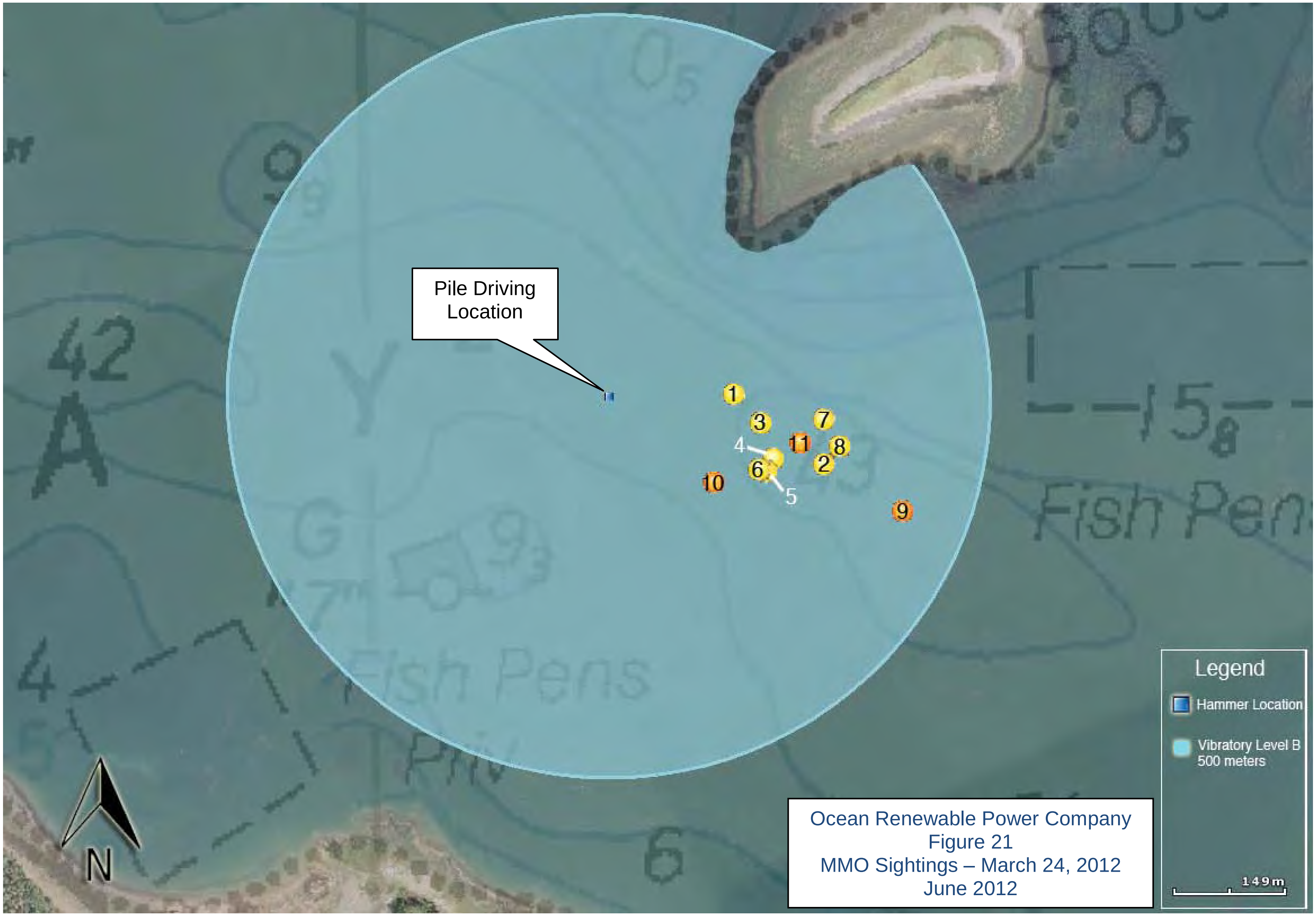

Figure 21. Harbor seal sightings during March 24, 2012 vibratory hammer event. High slack water. Hammer activity 13:49 to 13:57. Sightings that occurred within period 30 minutes prior to or 30 minutes after hammer activity colored orange. Sightings outside this period in yellow.

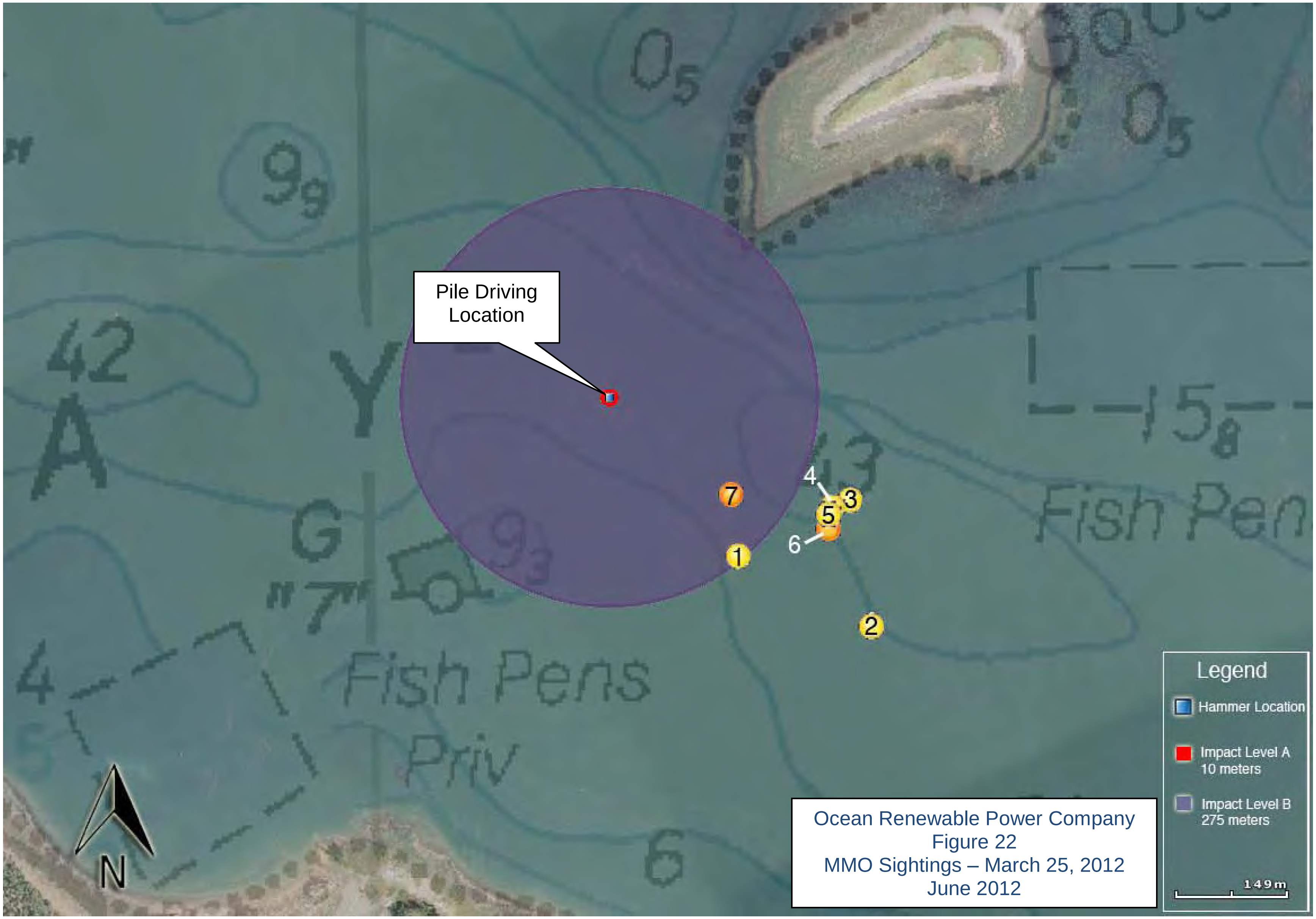

Figure 22. Harbor seal sightings during March 25, 2012 diesel impact hammer event. High slack water. Hammer activity 14:16 to 14:21. Sightings that occurred within period 30 minutes prior to or 30 minutes after hammer activity colored orange. Sightings outside this period in yellow.

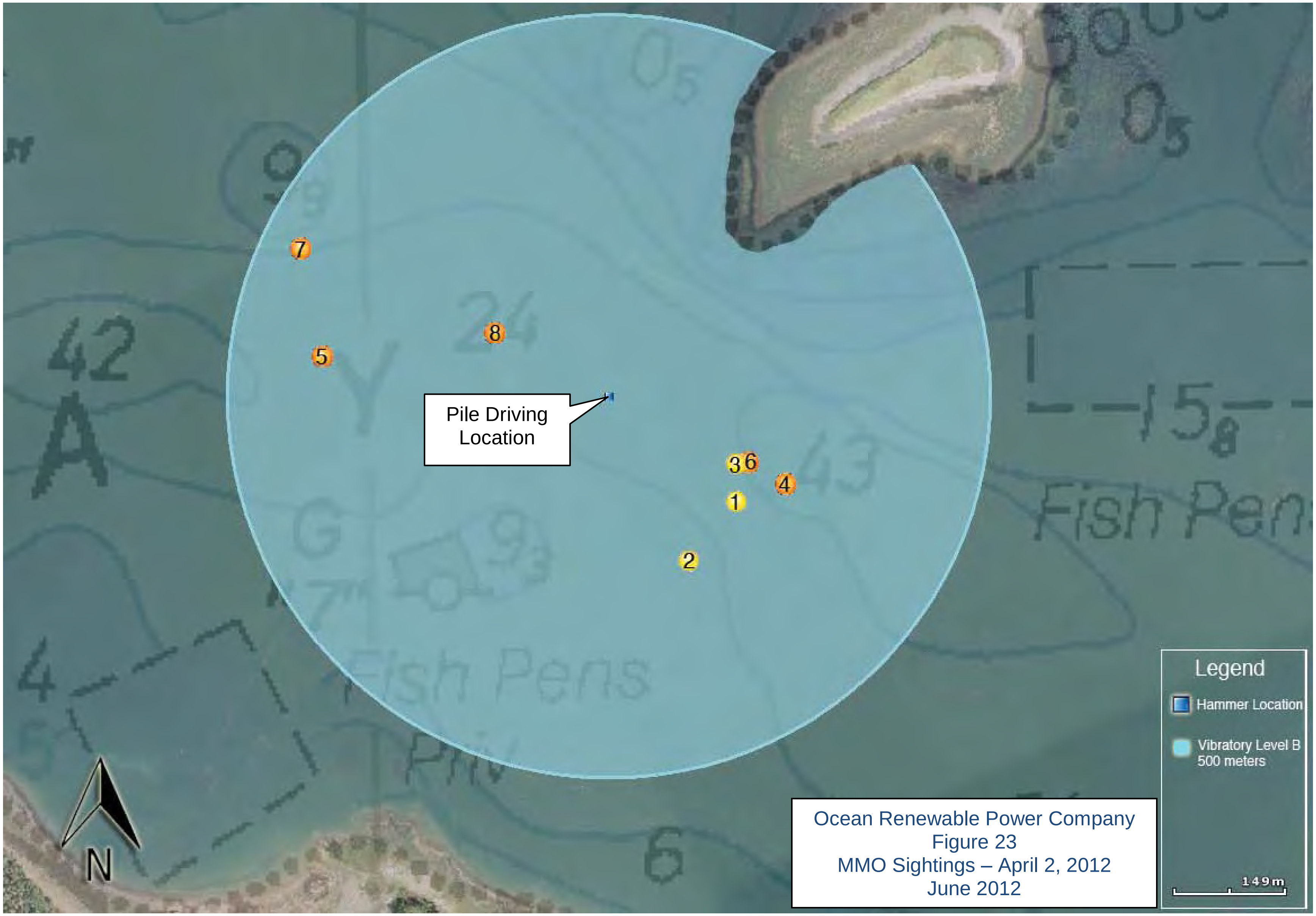

Figure 23. Harbor seal sightings during April 2, 2012 vibratory hammer event. High slack water. Hammer activity 07:39 to 07:50. Sightings that occurred within period 30 minutes prior to or 30 minutes after hammer activity colored orange. Sightings outside this period in yellow.

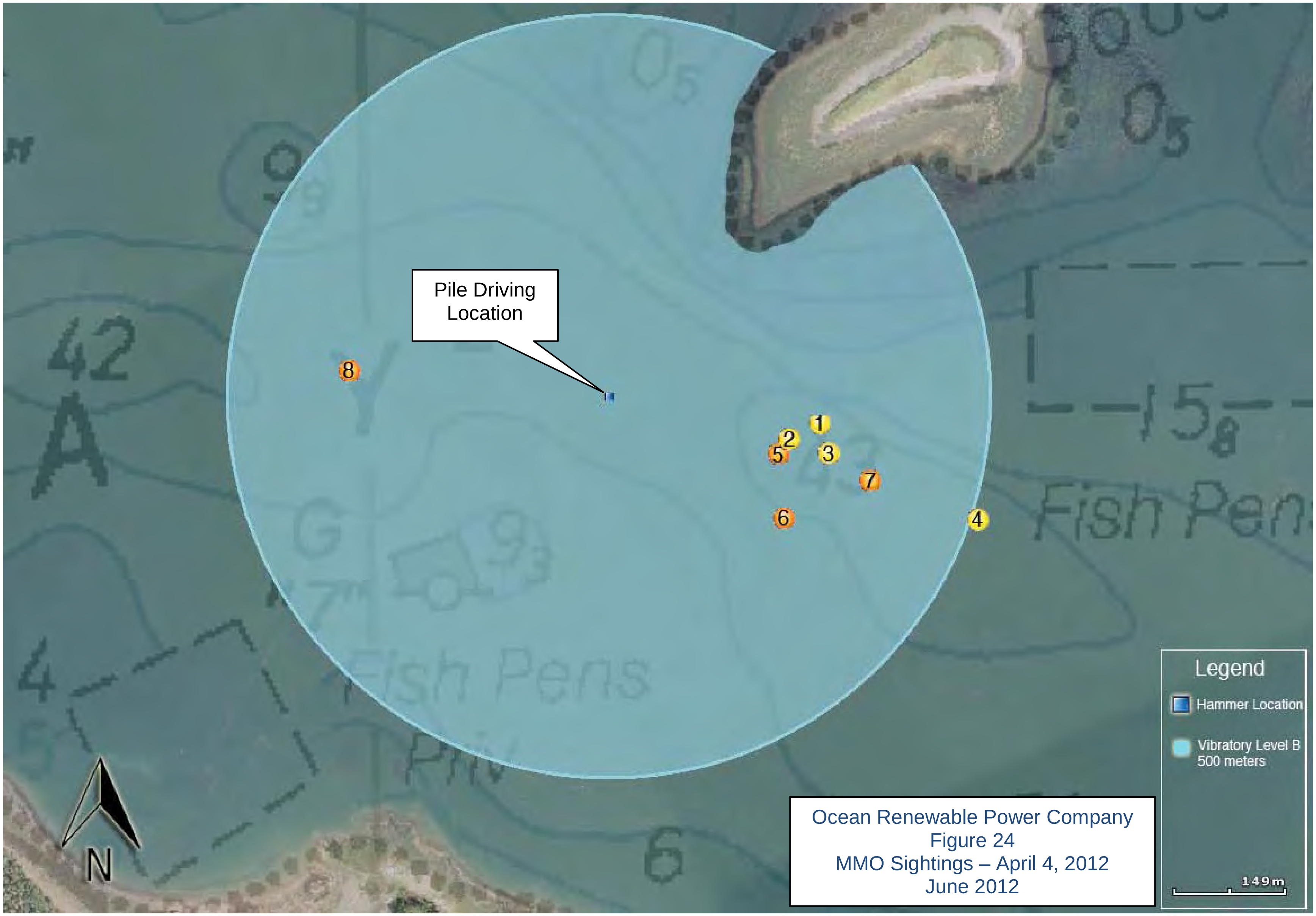

Figure 24. Harbor seal sightings during April 4, 2012 vibratory hammer event. High slack water. Hammer activity 09:53 to 10:00. Sightings that occurred within period 30 minutes prior to or 30 minutes after hammer activity colored orange. Sightings outside this period in yellow.

5.4 Bird Observation Results

There was little response of seabirds to the vibratory hammer noises. Any effects were generally minimal or of short duration. Given the general boat activity in the area, CER could only detect brief displacements that were less than 15 minutes long and it was not possible to determine if the seabird response was precipitated by the installation activities. Three Canada geese near the landing site appeared to be disturbed by the vibratory hammer and departed the area when this equipment started operation. Common eiders were displaced by a fishing vessel that passed through the deployment area while the vibratory hammer was in use but these birds quickly settled in the same area where they had been foraging. This suggests that eiders were not impacted by the noise or action on the barge.

CER observed no obvious seabird response to the louder diesel impact hammer. Common eider numbers declined from 8 to 5 individuals during operation but this was within the normal fluctuation of this species in this area at the time (Figure 3). Common loon numbers declined briefly but it was not clear whether this was in response to the diesel impact hammer noise or it was part of the normal loon movements in this area. Loon numbers returned to previous levels (3 individuals) within 15 minutes.

All seabirds were actively feeding prior to and during installation activities. The fact that this behavior did not change when the vibratory or diesel impact hammers were in use seems to indicate that the seabirds present were not affected by the noise.

Endangered and Threatened Species

CER surveys did not find any federal or state endangered or threatened species on March 31, 2012. Bald eagles are regular in the study area but this species was removed as a threatened species in 2009 (Charles Todd, pers. comm.; MDIF&W). In addition to observations, in-air acoustic results (discussed in Section 5.1) confirm minimal impacts at the shore station site in Lubec from the temporary pile driving noise. Information from the Maine Department of Inland Fish and Wildlife provided on February 17, 2011 indicates no active Eagle nests on Seward Neck in Lubec. The nearest active nest is located approximately 1 mile northeast of the site on Mathews Island within the City of Eastport.

Potential Impact for ORPC Activities in Winter

Given that CER staff observed a general lack of seabird response to these installation activities, it seems unlikely that installation activities will have any adverse affect on non-breeding seabirds at any season. It also seems unlikely that general maintenance activities will disturb seabirds at this site. It does appear that major installation and maintenance activities could affect Canada geese but previous observations confirm that this species is rare in the study area at any season, and Canada geese have not been observed in the deployment area. CER staff did not observe any Canada geese during winter surveys from November 2010 through May 2011, nor from September 2011 through February 2012. The three individuals on March 31, 2012, were the only geese seen on CER surveys.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Pile driving activities were completed between March 24 and April 4, 2012 in accordance with regulatory concerns related to Atlantic salmon occurrence. Environmental monitoring during pile driving activities included:

- In-air acoustic monitoring on Goose Island and at the Lubec On-shore Station
- Hydroacoustic monitoring in the near field (from the deployment barge) and at various far field ranges (100 m, 1,000 m, and 2,000 m)
- Marine mammal observations located on vessels anchored around the installation site for all pile driving activity and additionally from land stations for three events
- Bird survey from the Lubec shore

6.1 Integrated Monitoring Results

Results of the monitoring during pile driving activities demonstrate minimal impact to the environment. Source levels measured during impact and vibratory pile driving were below the thresholds of concern for Atlantic salmon. Measured Level A and B isopleths ranges were significantly smaller than the conservative ranges included in the IHA. In addition, responses to pile driving noise by birds and harbor seals were minimal, with sightings of each occurring in the vicinity of the project area both before and after pile driving. Harbor seals, or more likely a single harbor seal, returned to the project site on multiple days of pile driving.

6.2 Evaluation of Pile Driving Best Management Practices

Mitigation measures used during pile driving were successful in maintaining acoustic source levels within acceptable ranges and minimizing impacts to the environment. These measures included wood sound absorption devices installed in the head of the impact hammer and a “soft start” that initiated pile driving at less than 100% energy.

In addition, modifications made by the contractor to the physical connection between the pile and the follower alleviated initial acoustic spikes. PSOs were successful in recording sighting frequency, location and animal behavior. However, no marine mammal was observed within or approaching the Level A exclusion zone (initially estimated to be 500 feet); therefore, shut down or delay procedures were not initiated.

ORPC presented initial pile driving acoustic results, including the effectiveness of mitigation measures, to NOAA NFMS on April 2, 2012 as agency consultation required to modify the restrictive window for pile driving required by the FERC License. ORPC’s presentation, prepared by SSI, is included as Appendix G. A license modification request to FERC was submitted by ORPC on March 29, 2012, and supplemented with additional information on April 2, 2012. The modification was approved on April 4, 2012.

6.3 Recommendations

ORPC will utilize this same pile driving techniques in the future. Phase I testing results provided information pertinent to future activities with the project and the need for an IHA in particular. This process was also suggested by the NOAA NMFS, Office of Protected Resources.

The following methodologies and modifications should be considered for Phase II installation:

<u>Pile Driving</u>

- Sound absorption devices used during Phase I pile driving were successful in maintaining source levels below regulatory thresholds.
- Modifications to the physical connection between the pile and the follower alleviated initial acoustic spikes.

- The effectiveness of soft start procedures used during Phase I is difficult to quantify. However, no marine mammals were observed within the Level A exclusion zone or at any time during active pile driving.
- ORPC demonstrated that SELs for vibratory hammer activity could be limited provided best practices are used for hammer and pile assembly.
- Information collected by ORPC, and subsequently submitted as a modification request related to the restrictive window for pile driving, was used to remove the window for the remainder of Phase I operations. This information remains pertinent to Phase II construction and should be evaluated for this purpose.

Hydroacoustic Monitoring

Hydroacoustic monitoring results confirmed that pile driving source levels were within acceptable ranges provided sound absorption devices were used and best practices were implemented for pile and follower assembly. ORPC intends to use these best practices if pile driving is used during Phase II installation. Additional hydroacoustic monitoring, therefore, should not be required.

Marine Mammal Observations

Marine mammal sighting and location information collected during Phase I pile driving indicate that certain tidal cycle periods present a greater probability for the presence of harbor seals in the water. In addition, measured isopleths ranges indicate that observations to a distance of 1 nautical mile are not necessary for either the impact or vibratory hammer. Based on these results ORPC suggests the following modifications to marine mammal observations should be considered if pile driving is conducted for Phase II construction:

- Measured isopleths ranges for both the impact and vibratory hammer should facilitate conducting observations from the installation barge rather than moored vessels. It is recommended that observers monitor to a distance of 500 m (the greatest extent of Level B isopleths) during any Phase II pile driving.
- No marine mammal sightings occurred at low tide. It is generally accepted that harbor seals haul out on local ledges during low tide – a behavior that is well documented (Patterson and Acevedo-Gutierrez, *Tidal influence on the haul-out behavior of harbor seals,* 2008). For Phase II pile driving events, ORPC recommends two PSOs stationed on the installation barge with 180 degree visibility fore and aft. Further consideration should be given to reduced observations during low tide operations and seasons with minimal marine mammal activity.

Sea and Shorebird Observations

Bird observations were not required by regulatory agencies; however, ORPC conducted surveys to determine any disturbance to a rookery (not active during pile driving) and potential bald eagle nesting areas. Results of bird surveys indicate minimal to no disturbance to birds in the project vicinity during pile driving. Any disturbance that did occur was temporary; therefore, the value of further bird surveys during pile driving should be considered prior to Phase II.

Appendix A

Final Incidental Harassment Authorization, March 8, 2012

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Silver Spring, MD 20910

DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE

INCIDENTAL HARASSMENT AUTHORIZATION

Ocean Renewable Power Company Maine, LLC (ORPC) (120 Exchange Street, Suite 508, Portland, Maine 04101) is hereby authorized under section 101(a)(5)(D) of the Marine Mammal Protection Act (16 U.S.C. 1371(a)(5)(D)) and 50 CFR 216.107, to harass marine mammals incidental to pile driving in Cobscook Bay, subject to the following:

1. This Authorization is valid from March 12, 2012 through March 11, 2013.

2. This Authorization is valid for pile driving activities in Cobscook Bay, Maine, for installation of an underwater tidal turbine unit, as described in the Incidental Harassment Authorization (IHA) application.

3. ORPC is hereby authorized to take, by Level B harassment only, 72 total grey and harbor seals (*Halichoerus grypus* and *Phoca vitulina*), 72 harbor porpoises (*Phocoena phocoena*), and two Atlantic white-sided dolphins (*Lagenorhynchus acutus*) incidental to pile driving associated with the tidal turbine project.

4. The taking by Level A harassment, serious injury, or mortality of any of the species listed in 3 above or the taking of any kind of any other species of marine mammal is prohibited and may result in the modification, suspension, or revocation of this Authorization.

5. The taking of any marine mammal in a manner prohibited under this Authorization must be reported immediately to NMFS' Northeast Region, 55 Great Republic Drive, Gloucester, Massachusetts 01930-2276; phone 978-281-9328, and NMFS' Office of Protected Resources (NMFS), 1315 East-West Hwy, Silver Spring, MD 20910; phone 301-427-8401; fax 301-713-0376.

6. The holder or designees must notify NMFS' Northeast Region and Headquarters at least 24 hours prior to the seasonal commencement of the specified activity (see contact information in 5 above).

7. Mitigation Requirements

   The holder of this Authorization is required to abide by the following mitigation conditions listed in 7(a)-(d). Failure to comply with these conditions may result in the modification, suspension or revocation of this Authorization.

(a) *Sound Attenuation Device*: When using an impact pile hammer to install piles, wooden sound absorption cushions and/or a bubble curtain will be used to reduce hydroacoustic sound levels and avoid the potential for marine mammal injury.

(b) *Establishment of an Exclusion Zone*: During all in-water impact pile driving, ORPC will establish a preliminary marine mammal exclusion and buffer zone of 152 m (500 ft) around each pile to avoid exposing marine mammals to sounds at or above 180 dB. The exclusion zone will be monitored continuously during all impact pile driving to ensure that no marine mammals enter the 152-m (500-ft) radius. Once underwater sound measurements are taken, the exclusion and buffer zone may be adjusted accordingly so that marine mammals are not exposed to Level A harassment sound pressure levels. An exclusion zone for vibratory pile driving is unnecessary to prevent Level A harassment as source levels will not exceed the Level A harassment threshold.

(c) *Pile Driving Shut Down and Delay Procedures*: If a protected species observer sees a marine mammal within or approaching the exclusion zone prior to the start of impact pile driving, the observer will notify the on-site project lead (or other authorized individual), who will then be required to delay pile driving until the marine mammal has moved 305 m (1,000 ft) from the sound source or if the animal has not been resighted within 30 minutes. If a marine mammal is sighted within or on a path toward the 152-m (500-ft) exclusion and buffer zone during pile driving, pile driving will cease until that animal has moved 305 m (1,000 ft) and is on a path away from the exclusion zone or 30 minutes has lapsed since the last sighting.

(d) *Soft-start Procedures*: A ''soft-start'' technique will be used at the beginning of each pile installation to allow any marine mammal that may be in the immediate area to leave before the pile hammer reaches full energy. For vibratory pile driving, contractors will initiate noise from the vibratory hammer for 15 seconds at 40-60 percent reduced energy, followed by a 1-minute waiting period. The procedure will be repeated two additional times before full energy may be achieved. For impact hammering, contractors will provide an initial set of three strikes from the impact hammer at 40 percent energy, followed by a 1-minute waiting period, then two subsequent three-strike sets. The soft-start procedure will be conducted prior to driving each pile if hammering ceases for more than 30 minutes.

8. Monitoring Requirements

The holder of this Authorization is required to abide by the following monitoring conditions listed in 8(a)-(b). Failure to comply with these conditions may result in the modification, suspension, or revocation of this Authorization.

(a) <u>Visual Monitoring</u>

(i) The holder of this Authorization must designate at least two biologically-trained, on-site individual(s), approved in advance by NMFS, to monitor the exclusion and buffer zone (preliminarily set at 152 m [500 ft]) for marine mammals 30 minutes before, during, and 30 minutes after all impact pile driving activities. The protected species observer(s) shall conduct observations on the number, type(s), location(s), and behavior(s) of marine mammals in the designated exclusion zone (see Reporting section below).

(ii) Protected species observers must call for delay or shut down if any marine mammal is observed within or approaching the designated exclusion zone (preliminarily set at 152 m [500 ft]).

(iii) The holder of this Authorization must designate at least two biologically trained, on-site individuals, approved in advance by NMFS, to conduct behavioral monitoring out to 1 nmi during all impact pile driving. In addition, observers will be stationed at the Level B harassment isopleth (4,600 m [2.5 mi]) during at least three events of vibratory pile driving to conduct behavioral monitoring and validate take estimates.

(iv) Protected species observers will be provided with the equipment necessary to effectively monitor for marine mammals (for example, high-quality binoculars, spotting scopes, compass, range-finder, and digital SLR camera with telephoto lens) in order to determine if animals have entered into the exclusion zone or Level B harassment isopleth and to record species, behaviors, and responses to pile driving.

(v) NMFS must be informed immediately of any changes or deletions to any portions of the monitoring plan, as described in the application.

(b) Hydroacoustic Monitoring

(i) Underwater sound measurements will be taken at the initial installation of each pile driving method to ensure that the harassment isopleths are not extending past the estimated distances. Exclusion zones and harassment isopleths may be adjusted accordingly for marine mammals so that they are not exposed to Level A harassment sound pressure levels (180 dB). ORPC will contact NMFS within 48 hours in order to make the necessary adjustments.

(ii) Persons conducting sound measurements shall coordinate with the pile driver operator and marine mammal observer(s) to determine which activities are occurring at the time measurements are taken and if any marine mammals are in the area.

9. Reporting Requirements

The holder of this Authorization is required to submit a report on all activities and visual and acoustic monitoring results to the Office of Protected Resources, NMFS, and the Northeast Regional Administrator, NMFS, 90 days prior to the expiration of the IHA if a renewal is sought, or within 90 days of completion of pile driving.

a) The visual monitoring report must contain the following information:

(i) number of marine mammals observed and number taken, by species, and, if possible, sex and age class;

(ii) marine mammal behavior patterns observed;

(iii) marine mammal distances to pile driving activities;

(iv) time pile driving begins and ends and if pile driving was occurring during a sighting;

(v) time and locations of all marine mammal sightings;

(vi) environmental conditions, including but not limited to visibility, tide level and state (i.e., slack, ebb, flood), and sea state; and

(vii) other human activity in the area (e.g., vessel operation).

b) The acoustic monitoring report must contain the following:

(i) type of equipment used to collect acoustic data including frequency range;

(ii) estimated water depth of pile being driven and depth at which measurements were taken;

(iii) distances to the source where acoustic data were collected;

(iv) maximum, minimum, and average dB_{RMS} levels received at each measured distance;

(v) the type of pile driving method (i.e., impact or vibratory) associated with each collected measurement;

(vi) estimated rate of attenuation or transmission loss (TL) based on collected measurements; and

(vii) estimated source levels based on TL rate.

c) In the unanticipated event that pile driving activities clearly cause the take of a marine mammal in a manner prohibited by this Authorization, such as an injury (Level A harassment), serious injury, or mortality, ORPC shall immediately cease pile driving activities and report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401 and/or by email to Michael.Payne@noaa.gov and Michelle.Magliocca@noaa.gov and the Northeast Regional Stranding Coordinator (Mendy.Garron@noaa.gov). The report must include the following information:

(i) time, date, and location (latitude/longitude) of the incident;

(ii) the name and type of vessel involved;

(iii) the vessel's speed during and leading up to the incident;

(iv) description of the incident;

(v) status of all sound source use in the 24 hours preceding the incident;

(vi) water depth;

(vii) environmental conditions (e.g. wind speed and direction, Beaufort sea state, cloud cover, and visibility);

(viii) description of marine mammal observations in the 24 hours preceding the incident;

(ix) species identification or description of the animal(s) involved;

(x) the fate of the animal(s); and

(xi) and photographs or video footage of the animal (if equipment is available).

Activities shall not resume until NFMS is able to review the circumstances of the prohibited take. NMFS shall work with ORPC to determine what is necessary to minimize the likelihood of further prohibited take and ensure MMPA compliance. ORPC may not resume their activities until notified by NMFS via letter, email, or telephone.

d) In the event that ORPC discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition as described in the next paragraph), ORPC will immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Michael.Payne@noaa.gov and Michelle.Magliocca@noaa.gov and the Northeast Regional Stranding Coordinator (Mendy.Garron@noaa.gov). The report must include the same information identified in Condition 9(c) above. Activities may continue while NMFS reviews the circumstances of the incident. NMFS will work with ORPC to determine whether modifications in the activities are appropriate.

e) In the event that ORPC discovers an injured or dead marine mammal, and the lead PSO determines that the injury or death is not associated with or related to the activities authorized in Condition 3 of this Authorization (e.g., previously wounded animal, carcass with moderate to advanced decomposition, or scavenger damage), ORPC shall report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources, NMFS, at 301-427-8401, and/or by email to Michael.Payne@noaa.gov and

Michelle.Magliocca@noaa.gov and the Northeast Regional Stranding Coordinator (Mendy.Garron@noaa.gov), within 24 hours of the discovery. ORPC shall provide photographs or video footage (if available) or other documentation of the stranded animal sighting to NMFS and the Marine Mammal Stranding Network. Activities may continue while NMFS reviews the circumstances of the incident.

14. A copy of this Authorization must be in the possession of the lead contractor on site and PSOs operating under the authority of this Incidental Harassment Authorization.

15. This Authorization may be modified, suspended, or withdrawn if the Holder fails to abide by the conditions prescribed herein or if the authorized taking is having more than a negligible impact on the species or stock of affected marine mammals.

James H. Lecky,
Director, Office of Protected Resources,
National Marine Fisheries Service.

3/8/12
Date

Appendix B

Acoustic Monitoring Plan for Pile Driving Activities

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ACOUSTIC MONITORING PLAN FOR PILE DRIVING ACTIVITIES

INCIDENTAL HARASSMENT AUTHORIZATION
COBSCOOK BAY TIDAL ENERGY PROJECT
FERC PROJECT No. 12711
ORPC MAINE, LLC

March 1, 2012

Ocean Renewable Power Company, LLC
120 Exchange Street, Suite 508
Portland, ME 04101
Phone (207) 772-7707
www.orpc.co

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CONTENTS

APPENDICES

LIST OF FIGURES

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1.0 INTRODUCTION

1.1 General Description of the Cobscook Bay Tidal Energy Project

ORPC Maine, LLC, a subsidiary of Ocean Renewable Power Company (collectively, ORPC), has applied to the Federal Energy Regulatory Commission (FERC) for a pilot project license for the Cobscook Bay Tidal Energy Project (Project) on September 1, 2011. The Project will evaluate the potential for a new source of clean, renewable energy generation using tidal energy resources in Cobscook Bay, Maine. ORPC obtained an initial preliminary permit for the project area in Cobscook Bay from FERC on July 23, 2007; FERC issued a successive preliminary permit on January 13, 2011. Feasibility studies, including environmental surveys, and pre-filing consultation were conducted, resulting in ORPC's filing of a draft pilot license application (DPLA) with FERC for the Eastport Tidal Energy Project on July 24, 2009. The DPLA included project areas within Cobscook Bay and Western Passage. Since submitting the DPLA, ORPC has conducted extensive consultation with regulatory and resource agencies as well as other stakeholders, has collected additional environmental data, and has continued to refine its proprietary technology. As a result of these additional studies and consultations, ORPC now plans to deploy a commercial-scale hydrokinetic power system in gradual stages, with the Project, a small pilot project, as the first stage. The FERC preliminary permit Project boundary for the Cobscook Bay Tidal Energy Project (FERC Project No. 12711) encompasses the proposed development area.

The Project will be carried out in two separate phases over an expected eight-year pilot license term. In Phase I, ORPC will deploy, monitor and test a single-device TidGen™ Power System for one year. In Phase II, ORPC will add four additional TidGen™ devices to the power system, for a total of five. During both phases, ORPC will deploy environmental monitoring equipment on the TidGen™ Power System and within the Project boundary (Figure 1). The plan includes monitoring of more intensive activities during the installation phase, such as during pile driving, and monitoring during the operational phase to verify impacts and ensure there is no change during long-term operation.

The core component of the TidGen™ Power System is ORPC's proprietary turbine generator unit (TGU). The TGU utilizes four advanced design cross flow (ADCF) turbines to drive a permanent magnet generator mounted between the turbines on a common driveshaft. The ADCF turbines rotate in the same direction regardless of tidal flow direction; rotational speed of the turbines is directly related to water flow speed. The TGU is 98 feet in length, 17 feet high and 17 feet wide. It is attached to a bottom support frame, which holds the TGU in place approximately 15 feet above the sea floor. The bottom support frame is 98 feet long by 50 feet wide by 15 feet high. The bottom support frame is constructed of steel, and the TGU is constructed of steel and composite material. Together, the coupled TGU and bottom support frame comprise the TidGen™ device (Figure 2 shows the conceptual design for the TidGen™ device). The depth at the proposed Deployment Area is 85 feet at Mean Lower Low Water (MLLW); the TidGen™ devices will thus be placed 49 feet below the surface at MLLW. Each TGU will have a maximum design capacity of 180 kilowatts (kW). During the Project each TGU will operate at a rated capacity of 60 kW. The five-device TidGen™ Power System will have a maximum design capacity of 900 kW and a rated capacity of 300 kW. The power generated will be connected to the grid using a single subsea transmission cable with a line voltage of 13 kilovolts (kV) DC. The total cable length is approximately 4,200 feet (3,700 feet from the TidGen™ Power System to the shore in Lubec, Maine and approximately 500 feet from shore to the on-shore station). ORPC has chosen an underwater cable route that avoids abrupt changes in bottom topography. Based on consideration of environmental concerns, ORPC proposes to bury the cable at all feasible locations along the cable route. The power generated by the TidGen™ Power System will be conditioned at the on-shore station and delivered to the Bangor Hydro Electric Company power grid.

Figure 1. Cobscook Bay Tidal Energy Project location map.

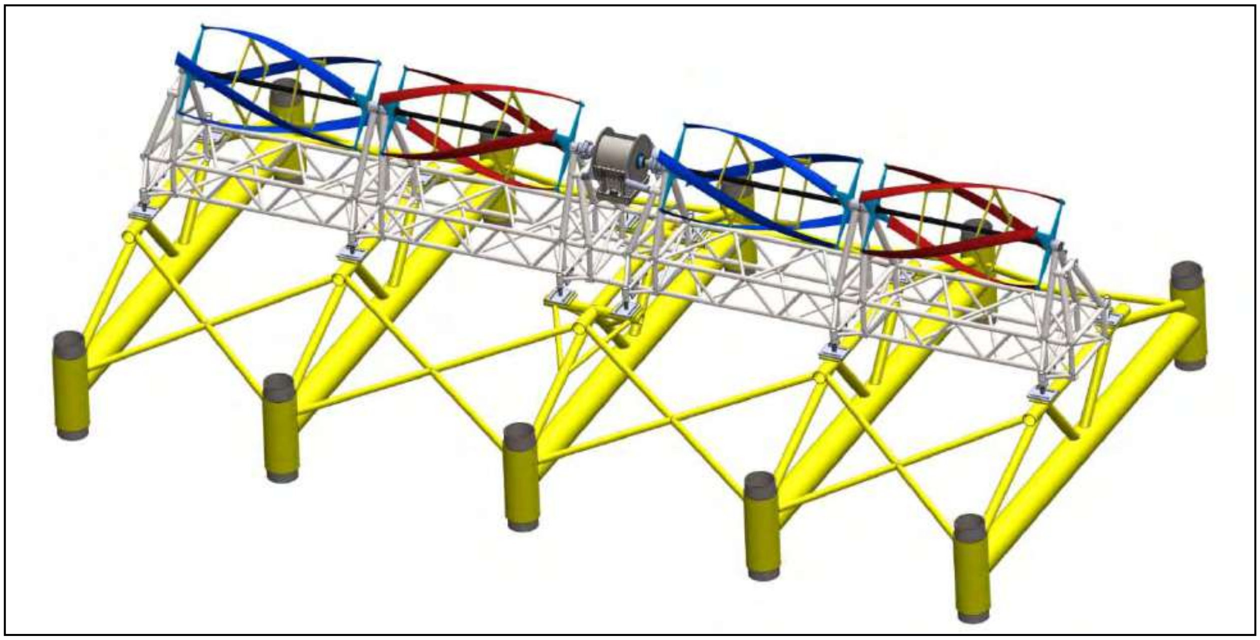

Figure 2. TidGen™ device.

In preparation for the Project, ORPC designed, built, deployed and tested a beta pre-commercial TidGen™ Power System (Beta TidGen™ System) in Cobscook Bay in 2010 (see Figure 3). The Beta TidGen™ System was comprised of a beta pre-commercial TGU (Beta TGU); ORPC's *Energy Tide 2* research, testing and deployment vessel; a mooring system for the *Energy Tide* 2; and data acquisition and environmental monitoring equipment. Rather than being mounted on a bottom support frame, the Beta TGU was deployed top-down from the *Energy Tide 2* and suspended 21 feet below the water surface.

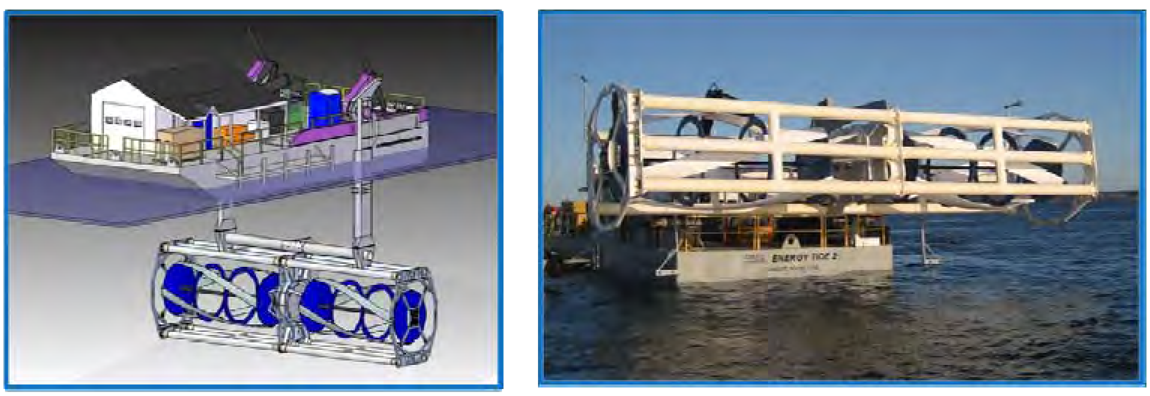

Figure 3. Beta TidGen™ system.

1.2 INCIDENTAL HARASSMENT AUTHORIZATION PROCESS

Authorization for incidental takings will be granted if NMFS finds that the taking will have a negligible impact on the species or stock(s), will not have an unmitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. NMFS has defined "negligible impact" in 50 CFR 216.103 as "...an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Section 101(a)(5)(D) of the MMPA established an expedited process by which U.S. citizens can apply for an authorization to incidentally take small numbers of marine mammals by harassment. Section 101(a)(5)(D) further established a 45-day time limit for NMFS' review of an application, followed by a 30-day public notice and comment period on any proposed authorizations for the incidental harassment of marine mammals. Within 45 days of the close of the comment period, NMFS must either issue or deny the authorization.

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as:
any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].

Summary of Request

On November 2, 2011, NMFS received ORPC's application requesting an Incidental Harassment Authorization (IHA) for the take, by Level B harassment, of small numbers of harbor seal (*Phoca vitulina*), gray seal (*Halichoerus grypus*), harbor porpoise (*Phocoena phocoena*), and Atlantic white-sided dolphin (*Lagenorhynchus acutus*) incidental to pile driving activities in Cobscook Bay, Maine (Appendix A). Upon receipt of additional information and a revised application, NMFS determined the application complete and adequate on January 7, 2012.

2.0 GOALS AND OBJECTIVES

ORPC will be conducting pile driving activities beginning March 1, 2011. Of concern is the effect of the piling driving noise on endangered species of fish (primarily Atlantic salmon) and marine mammals. Acoustic monitoring will be conducted to quantify noise levels generated from various pile driving techniques and determine the necessity for future mitigation measure. The applicability of modifications or elimination of the March 1 through April 9 work window will also be assessed. The following objectives are included in the acoustic monitoring plan:

- Determine near field noise levels in dB//1μPa peak and rms pressure. No impact for endangered fish is expected if levels can be maintained at less than 206 dB//1μPa@1m peak at a range of 10 m. If this can be held then the April 9 deadline for a cessation of pile driving activities can be removed.
- Validate the actual location of the 180 dB //1μPa@1m rms pressure isopleth for both vibratory and impact (level A), with and without sound attenuation devices (thresholds for Level A harassment are 190 dB for pinnipeds and 180 dB for cetaceans).
- Validate the actual location of the 160 dB//1μPa@1m rms pressure isopleth for impact (level B transient source), with and without sound attenuation devices.
- Validate the actual location of the 120 dB//1μPa@1m rms pressure isopleth for vibratory (level B continuous source), with and without sound attenuation devices.
- Integrate the acoustic data with the marine mammal observation data to identify actual number of "takes."
- Monitor ambient air noise levels with a sound level meter at Goose Island and at the Lubec shore station to identify in air noise levels at a potential bird rookery and seal haul-out areas within this area of Cobscook Bay.

3.0 STUDY AREA

The geographic scope of the study will generally include the Cobscook Bay Deployment Area (see Figure 1).

4.0 METHODOLOGY

ORPC and Scientific Solutions Inc. (SSI) have developed a combination of in-water and in-air methods that will be used to measure the noise in the environment where the TidGen™ Power System will be installed. The following sections describe measurement equipment, data collection and processing required to complete the acoustic analysis.

4.1 In-Water Noise Measurement System Equipment

- Measurement system for near-field deployed on the pile driving barge:
  - Hydrophones: 2 X Reson TC4013 (Appendix B)
  - Preamplifiers: 2 X low-noise 1-100 kHz battery operated preamplifier (EPAC)
  - Data Acquisition: IOtech Wavebook/516E to laptop computer over Ethernet (Appendix C)
  - Deployment:
    - ~4" X ~4' spar to be fabricated by SSI

- Drifting Noise Measurement System (DNMS) deployed remotely from monitoring vessel:
  - Hydrophones: 2 X ITC 1042 (see Appendix D)
  - Preamplifiers: SSI custom low-noise preamplifier
  - Data Acquisition: Measurement Computing LGR-5320 (2-channels @ 100kHz/channel sampling rate) (Appendix E)
  - Deployment: 8" spar buoy tethered to small vessel

- Two hydrophones at each location separated by 3 m centered at mid-water column.
- Inside location (approximately or larger than 4' x 6' shack) on barge with 120 V power source.
- Remote and near-field measurement systems manually synchronized to ~1 second accuracy time stamp (GPS time).
- Handheld ruggedized GPS units deployed on each hydrophone buoy for accurate geo-referencing.
- GRAS 42AA piston-phone calibrator with RA0043 coupler for RESON hydrophones.
- Measurements taken from the pile driving barge and those from the DNMS will be coordinated to account for timing, type of pile driving activity and other factors.

4.2 In-Air Noise Measurement System Equipment

- Quest Technologies SoundPro DL-1-1/3 Octave-20 sound level meter which meets Type 1 requirements of the American National Standards Specifications for sound level meters, SI.4-1971 (Appendix F).

- Acoustic calibrator for SLM
- Industrial tripod
- Dinghy will be required to access Goose Island

4.3 DATA COLLECTION

Underwater ambient noise measurements will be made at slack tide while pile driving operations take place. A team of 3 SSI employees will join ORPC in Cobscook Bay prior to the commencement of pile-driving operations to conduct an intensive monitoring and measurement effort in the initial days of pile-driving. Table 1 lists potential measurement periods identified during the first 10 days of March as an example. Actual measurement periods will be modified based on schedule, weather conditions, and other factors.

Table 1. *Initial Measurement Periods*

Date:	Slack Times:	Tide:	30 Min. Window:
3/1/2012	10:49	Low	10:34 - 11:04
3/2/2012	11:46	Low	11:31 - 12:01
3/3/2012	6:18	High	6:03 - 6:33
	12:45	Low	12:30 - 13:00
3/4/2012	7:15	High	7:00 - 7:30
	13:41	Low	13:26 - 13:56
3/5/2012	8:08	High	7:53 - 8:23
	14:33	Low	14:18 - 14:48
3/6/2012	8:58	High	8:43 - 9:13
	15:22	Low	15:07-15:37
3/7/2012	9:45	High	9:30 - 10:00
	16:09	Low	15:54 - 16:24
3/8/2012	10:31	High	10:16 - 10:46
	16:54	Low	16:39 - 17:09
3/9/2012	11:17	High	11:02 - 11:32
3/10/2012	12:04	High	11:49 - 12:19

The near-field measurement system will consist of two Reson TC4013 hydrophones wired to two separate EPAC preamplifiers and recorded on a Wavebook 16 bit digital recording system at 500 kHz per channel (acoustic frequency range of 10 Hz - 100 kHz). The hydrophones will be deployed hanging below a small PVC spar buoy or spherical cable float with DSS-2 cable running from the preamplifiers to data acquisition system on the barge. The EPACs will be secured in a watertight enclosure aboard the hydrophone float. The hydrophone cable will be adjusted to position the two hydrophones at approximately mid water column and separated by approximately 3 m. The data recording equipment will be located at the surface in a small covered location aboard the pile-driving barge. To measure the far field levels around the estimated harassment isopleths the DNMS will be deployed from a small vessel.

Prior to the start of testing the Reson hydrophones and the entire near-field data-acquisition chain will be calibrated with the pistonphone. The DNMS will be calibrated by collocating the two measurement systems and referencing the DNMS measurements to the calibrated Reson measurements.

Measurements of both vibratory hammer and impact hammer operations will be made at ranges of 10, 100, and 1000 m, and further as necessary to determine the 160 dB and 180 dB isopleths. The measurements will be made at each location for a minimum of the duration of the pile driving activity, or 1 minute, whichever is longer, for each configuration of the pile driving activity. For all far-field measurements a corresponding near-field measurement will be made to provide a corollary source level. The data will be analyzed using MATLAB to determine the the root-mean-square (rms) sound pressure levels (SPL). For impact hammer operations, SPL will be calculated by determining rms level over the time window that contains 90% of the energy. A report will be written summarizing all results.

If the measurements exceeds either the 180 dB//µPa rms pressure level at a range of 100 m, or the 160 dB re µPa rms pressure level at a range of 1000 m than the measurements will be repeated at increasing ranges until the actual range of the isopleths for these levels are determined. Further, pile driving operating conditions will be changed in an attempt to lower the levels, and the measurements will be repeated. This includes lowering the impact force, the potential use of an air curtain, and/or a wooden suppression block between the diesel hammer and pile [or pile follower].

Table 2. Pile Driving Techniques and Sequencing

Priority	Method
1	Impact hammer (no suppression)
2	Impact hammer (with sound absorption blocks)
3	Vibratory hammer (no suppression)

Due to the many possible configurations of the pile-driving equipment, it is crucial that all parameters be logged alongside each measurement. This includes the above mentioned optional equipment configurations as well as ambient environmental conditions and the time of day. As an additional correction for the variability of the pile driving source function, the near-field recording taking during each measurement can be utilized to normalize the observed levels to a nominal source level.

For each record, an in-air sound level measurement will be collected as well as the in-water measurements. These will be collected from a tripod mounted sound level meter (SLM) located on Goose Island nearby the pile-driving site and at the proposed location of the Lubec shore station (only one site will be collected for a given record). The SLM is to be calibrated each day prior to the start of data collection and following the cessation of collection. Along with the measured level a log will be kept of the ambient and weather conditions at the in-air recording site. For the impact pile driving measurements will be given as dB//20 μPa^2 Peak and for vibratory pile driving as narrow band and third octave band spectral levels.

4.4 DATA PROCESSING

To determine the near-field sound level the rms and peak pressure of recordings taken from the near-field system will be calculated for the duration of the pile driving operation. The hydrophones will be deployed as close to 10 m from the pile being driven as practical. The levels will be normalized to a 10 m range if required by correcting for cylindrical spreading transmission loss from the 10 m radius to the actual location of the buoy. This calculation will be completed for each record and for each pile-driving configuration employed (i.e. impact hammer, vibratory hammer, suppression block in place, etc).

To determine the far-field noise the measurements from the DNMS will be used in conjunction with the near-field measurements from each recorded pile drive. The near-field measurements will be used to determine the source level of each pile. The rms pressure will be calculated from each record and the resultant rms pressure will normalized to the average/nominal source level of the employed pile-driving configuration. The range of each isopleth of interest will be located for each equipment configuration measured by calculating the transmission loss from the observed far-field pressure levels and the near-field source level.

The far-field recordings will also be analyzed in 1/3 octave bands. This groups the observed energy into more meaningful bands and will be used to determine the frequency content of the propagating pile-driving noise.

The in-air sound level meter will provide direct output of the in-air sound-level which will be recorded for each operation and correlated with the source levels to provide any additional insight or illuminate any observed anomalies. Additionally, the in-air results will be tabulated in 1/3 octave bands provided by the SLM's on-board filter for the sake of future research into the in-air effects of these activities.

5.0 REPORTING

If hydroacoustic monitoring indicates that the threshold isopleths are greater or less than originally calculated, ORPC will contact NMFS within 48 hours and make the necessary adjustments.

Thirty days after completion of the pile driving activity, the SSI will submit a report to NMFS. The report will include the details of the acoustic measuring methods employed including:

- Methods and Systems Review
- Data Review
- Summary of Findings

6.0 SCHEDULE

Pile driving activities are schedule to occur between March 1 and April 9, 2012 in accordance with regulatory concerns related to Atlantic salmon occurrence. If acoustic measurements indicate levels below those harmful to marine life ORPC will request further consultation with appropriate regulatory agencies to modify or remove the date restrictions.

Pile driving activities will occur during slack water period which provide approximate 1 hour duration per event. Depending on daily tidal cycles, pile driving may occur during one or two occasions per day.

ORPC
OCEAN RENEWABLE POWER COMPANY

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December 20, 2011

Michelle Magliocca
National Marine Fisheries Service
Office of Protected Resources
1315 East West Highway
Silver Spring, MD 20910

RE: Marine Mammal Incidental Harassment Authorization for Pile Placement for ORPC's Cobscook Bay Tidal Energy Pilot Project

Dear Ms. Magliocca:

ORPC Maine has revised our application for a Marine Mammal Incidental Harassment Authorization for pile placement for ORPC's Cobscook Bay Tidal Energy Pilot Project in Eastport, Maine from March 1, 2011 through October 1, 2012, to NOAA's Office of Protected Resources.

Using the guidance provided by your office, ORPC has addressed each of the fourteen areas of interest as mandated by Section 7 of the Endangered Species Act and the National Environmental Policy Act (NEPA).

If you have any questions or comments, please reply to Herbert C. Scribner at ORPC.

Thank you.

Sincerely,

Herbert C. Scribner
Director of Environmental Affairs

MARINE MAMMAL INCIDENTAL HARASSMENT AUTHORIZATION FOR PILE PLACEMENT FOR ORPC'S COBSCOOK BAY TIDAL ENERGY PILOT PROJECT

QUESTIONNAIRE TO NOAA'S OFFICE OF PROTECTED RESOURCES

December 19, 2011

Ocean Renewable Power Company, LLC
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Phone: (207) 772-7707
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MARINE MAMMAL INCIDENTAL HARASSMENT AUTHORIZATION FOR PILE PLACEMENT FOR ORPC'S COBSCOOK BAY TIDAL ENERGY PILOT PROJECT

Questionnaire to NOAA's Office of Protected Resources

1. Description of Activity

Purpose of IHA Application

ORPC Maine, LLC, a wholly owned subsidiary of Ocean Renewable Power Company, LLC (collectively ORPC), filed a FERC final pilot license application on September 1, 2011 for our Cobscook Bay Tidal Energy Pilot Project (Project), a hydrokinetic project to be deployed in Cobscook Bay, Eastport/Lubec, Maine (FERC Project No. 12711). In conjunction with this deployment, ORPC is requesting a Marine Mammal Incidental Harassment Authorization (IHA) for the placement of foundational piles below the mud line at the deployment site.

ORPC is applying for an IHA for pile placement because the vibratory hammer (and possibly a diesel impact hammer) that will be used for pile driving will potentially generate noise levels above NOAA's guidelines (for continuous and impact noise) under the Marine Mammal Protection Act of 1972.

This IHA request does not cover activities proposed for Phase II of the Project. If Phase I monitoring indicates that deployment is generating noise exceeding allowable limits, ORPC will file a second IHA request for Phase II.

Project Overview

The Project will be carried out in two separate phases over an expected eight-year pilot license term. In Phase I, ORPC will build, deploy, monitor and test a single-device TidGen™ Power System for one year. In Phase II, ORPC will add four additional TidGen™ devices to the power system, for a total of five. ORPC will also deploy environmental monitoring equipment within the project boundary. Electricity generated by the pilot project will be delivered by an underwater power cable to the on-shore station in Lubec, Maine, where it will be power-conditioned and connected to the Bangor Hydro Electric Company power grid.

The primary project works include: 1) the TidGen™ Power System (made up of the TGU [turbine generator unit], bottom support frame, and underwater power and data [P&D] cables); 2) the on-shore station; and 3) environmental monitoring equipment. The TGU is approximately 98 ft long, 17 ft high and 17 ft wide. It is attached to a bottom support frame, which holds the TGU in place approximately 15 ft above the sea floor. The TGU weighs approximately 69,000 pounds (lbs). The coupled TGU and bottom support frame comprise the TidGen™ device (Figure 1).

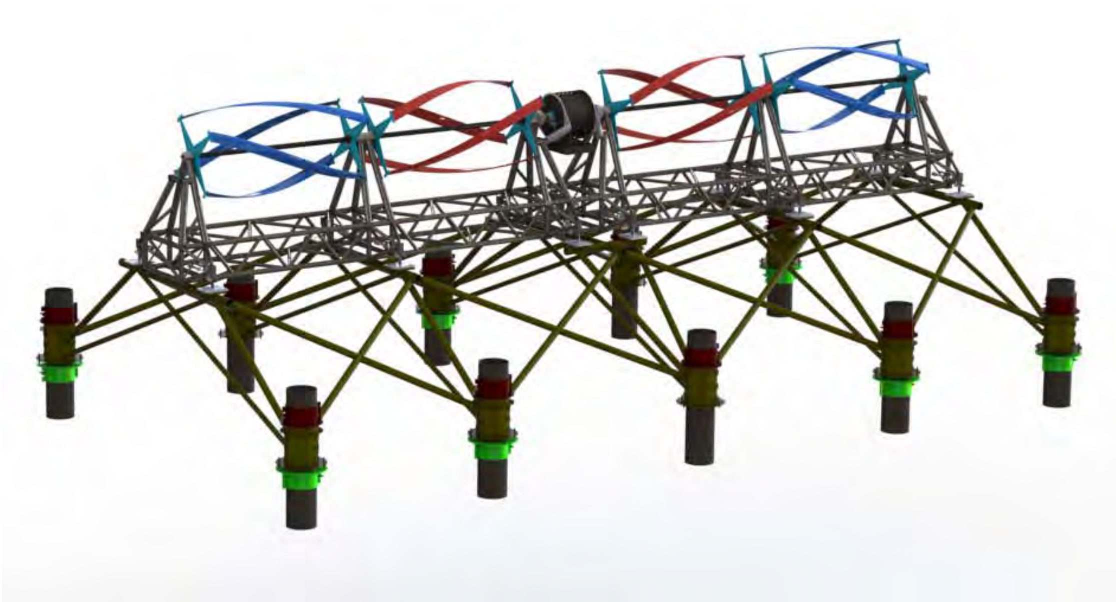

Figure 1. TidGen™ device.

Foundation Requirements
At the interface with the seabed, the bottom support frame requires a site-specific design based on the Project's deployment area conditions (Figure 2). ORPC has conducted bathymetric and geophysical surveys of the deployment area to identify bottom conditions for the design of the bottom support frame and foundation and has completed a geotechnical survey of the deployment. Geotechnical data shows that the TidGen™ devices will be located in areas with up to 40 ft of marine clay and some thin layers of glacial till overlaying bedrock.

At the Project site, the foundation design for the single-device TidGen™ Power System is a pile bent arrangement consisting of ten piles. Each pile will have a three-foot diameter and a one-inch wall thickness, and will rest on bedrock. The piles will vary in length due to bottom sediment depth, but each pile will be driven to the top of the bedrock and will protrude 10+ ft above the seafloor.

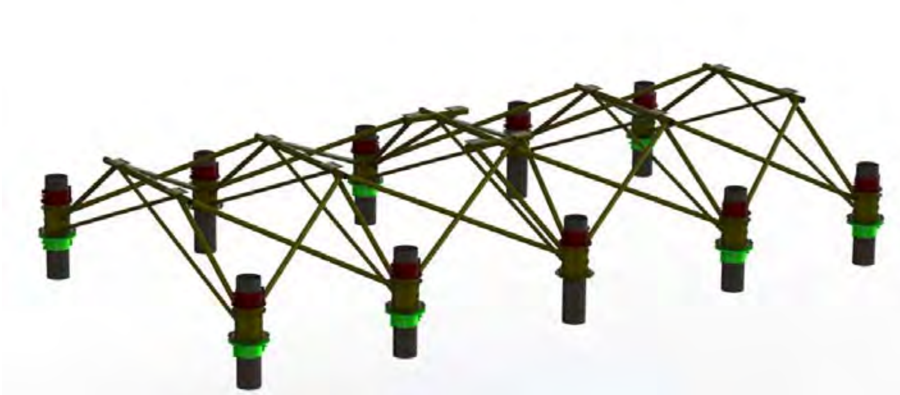

Figure 2. Bottom support frame.

Pile Driving Plan

A total of 11 piles (ten for the foundation and one for mounting environmental monitoring equipment) will be driven for Phase I of the Project. Placing and driving these 11 piles will require the following equipment:

- Deck barge, *Cap't E*, 150 ft long x 54 ft wide x 10 ft high
- 250-ton Linkbelt crane LS 718H with 150 ft of boom or equivalent
- Push boat "Workhorse"
- A second push boat/workboat to assist in setting anchors, moving the barge into position and quick demobilization in the event of a extreme weather event
- Material barge to deliver the bottom support frame to the deployment location. This barge will be configured from sectional barge sections and will be 60 ft long x 40 ft wide x 5 ft high
- Small crane on the small barge to assist in the installation of anchors and deadmen
- Crane mats on top of the *Cap't E* to distribute the crane load
- +/- 100 ton of barge counterweight consisting of +/- 50 concrete Jersey barricades or other similar concrete or granite weights
- Diesel powered vibratory hammer
- Diesel powered impact hammer model Berminghammer B-3505 with a maximum capacity of 46 ft-kips
- 4 deck winches to position and secure the deck barge on location
- 2 additional deck winches to facilitate positioning the bottom support frame
- Hydraulic power pack to power the winches
- Tool crib on the barge with typical tools for marine construction, including welders, torches, hand tools, spare parts, etc.
- Ground tackle, including anchors and lines
- Granite deadmen to assist in positioning the bottom support frame

The steel pipe piles each have a 30 in diameter and a ½-inch wall thickness with an open shoe of hardened steel attached to the bottom for seating itself into bedrock without deformation. The piles will be delivered with the hardened shoes attached and will be uncoated. The piles will be configured in two rows of five piles each, as illustrated in Figure 2.

The individual piles will be approximately 20 ft apart in each row, and the rows will be approximately 50 ft from each other. The piles will be approximately 60 ft long; 10 ft to 15 ft will be above the mud line when driven to refusal. Prior to driving the pile, a follower will be attached to the pile, which will enable the pile to be driven from the surface. Based on extensive soil studies of the area, the piles will sink in the soft bottom under its own weight plus the weight of the follower and vibratory hammer for most of the 40 ft of marine clay. The piles will then be driven the remaining depth using vibratory and impact pile driving procedures from barge-based pile driving equipment.

During the pile driving, a pile for mounting environmental monitoring equipment will be installed with the same pile-driving equipment used for the foundation. This monitoring pile will have a 30 in diameter and a ½-inch wall thickness, and will protrude approximately 20 ft above the sea floor. As with the other 10 other piles, the monitoring pile will be driven to refusal into bedrock.

The vibratory hammer, an H&M model H-1700, will drive the pile by applying a rapidly alternating force to the pile by rotating eccentric weights about the shaft, resulting in a downward vibratory force on the pile. The vibratory hammer will be attached to the pile head with a clamp. The vertical vibration in the pile functions by disturbing or liquefying the soil next to the pile, causing the soil particles to lose their frictional grip on the pile. The pile moves downward under its own weight, plus the weight of the hammer. It takes approximately one to three minutes to drive one pile.

If additional energy is required to reach bedrock, the vibratory hammer will be removed and a diesel impact hammer (Berminghammer model B-3505 diesel, 34,500 lb hammer with maximum rated impact energy of 21,533 ft-lb) will be rigged to the crane and used to seat the pile to bedrock or "proof" the pile. Pile driving with a diesel impact hammer takes approximately one to five minutes. Although driving piles with an impact hammer generally results in the greatest noise production, this noise is not constant. It is expected that the need for an impact hammer will be minimal and for very short durations (less than five minutes per pile).

To ensure alignment of the pile array, a driving template, which is a semi-permanent base structure, will be set into place prior to the pile driving operation to help guide the piles to the required location. This template will later be raised to become the support structure for the single-device TidGen™ Power System. It is expected that divers will be required to help guide the piles to the structure to get them started into the template.

Due to the presence of strong currents during tide changes, pile driving will occur during slack tides only. Due to the short window of slack tide, it is expected that only one pile will be driven per tide cycle. The total time spent at the mooring is anticipated to be between 7 and 12 days.

Cold weather will not have an effect on pile driving activities. Only foul weather such as high winds/seas, icy conditions, and conditions limiting visibility would prohibit pile-driving operations. Prior to commencing work, there the long-term weather forecast will be consulted to pinpoint a likely stretch of favorable weather.

A detailed pile placement plan submitted by the contractor is included in Attachment 1.

Foundation Installation

The foundation will be installed before any other power system component, with the exception of the P&D cable. For foundation installation, ten piles will be placed into the seabed using a driving template as well as pile driving equipment located on a moored barge. Temporary moorings will be used to hold the position in position for these operations. Subsea construction will begin with the setting of the template, followed by the placing and driving of the individual piles. After the piles are driven, they will be surveyed for elevation from the surface to allow for positioning and installation of subsequent fixtures and components, and will be cut to final dimension if necessary.

Once the foundation is installed, the template will be removed, and receiving fixtures for the bottom support frame will be installed. Next, the bottom support frame will be installed by aligning it with the foundation piles and lowering it into place on top of them. When it is positioned on the lower receiving fixtures, the bottom support frame must be able to withstand the force of the maximum tidal current experienced at the site. To accomplish this, a set number of supporting piles will need to be immediately engaged with the bottom support frame in order to provide the necessary uplift resistance. Once the bottom support frame has been initially stabilized, it will be thoroughly affixed to the foundation during subsequent operations.

2. Date, Duration and Location of Activity

Date of Activity
Piling driving will begin as soon as ORPC receives a FERC pilot license. We therefore anticipate that the start date will be no sooner than March 1, 2012.

ORPC plans to extend pile driving activities into the NMFS suggested restriction window if we can demonstrate that noise levels from this activity are below NOAA/NMFS guidelines. To bring down the level of noise caused by the diesel impact hammer, mitigative measures, such as the use of wooden sound absorption cushions and bubble curtains, will be applied (see above for details).

Duration of Activity
It is estimated that pile driving will take approximately one to three minutes and that seating each pile will take approximately five minutes. It is expected that only one pile will be driven per tide cycle due to the short window of slack tide. It is anticipated that placement of all eleven piles will occur over a period of seven to twelve days.

ORPC understands that an IHA can only have a one-year duration, and since there are several other permits also pending for Phase I of the Project, ORPC requests an IHA for the period of March 1, 2012 to November 30, 2012. ORPC believes that this time period will provide ample opportunity for permitting delays, weather events, and other unforeseen delays. Pile driving will only occur during daylight hours and in weather that provides adequate visibility for marine mammal monitoring activities.

Geographical Region of Activity
The foundation installation will take place in Cobscook Bay off of Lubec/Eastport, Maine (Figure 3). The piles and other deployment materials will be brought by barge from an on-shore staging area at the Eastport Boat School and/or other access points in the vicinity.

Specific Activities that ORPC Anticipates Could Result in Marine Mammal Takes
Pile driving activities have the potential to harass marine mammals by temporarily elevating sound levels around the proposed project location.

Figure 3. Cobscook Bay Tidal Energy Project site location and project area map.

3. Species and Number of Marine Mammals in Area of Activity

ORPC has been conducting incidental visual observations of marine mammals in the Cobscook Bay since 2007, during turbine testing, travel to and from ORPC's research vessel *Energy Tide 2*, and acoustic, fisheries, subtidal, and avian surveys (Table 1). During this time, ORPC personnel and contractors, who have received specialized training in marine mammal observation and documentation, have recorded approximately 252 observational periods over 222 days. During these periods, ORPC observed two dolphins, 47 harbor porpoises, and 57 seals. The most intensive effort was conducted in 2010, when approximately 71 marine mammals were observed over the course of 132 observation days between March 8 and December 31. Of these, there were two dolphins, 27 harbor porpoises, and 42 harbor seals. This information is documented in ORPC's Marine Mammal Monitoring Plan for the Cobscook Bay Tidal Power Project (FPLA Appendix C) and submitted to NOAA separately (Attachment 2).

All 2010 marine mammal observations were made near the Cobscook Bay deployment area. No observations of any whale species have been made in Cobscook Bay by ORPC personnel or those contracted to work for ORPC since the observation program began in 2007. Table 1 presents the number of each species observed and the months in which the observations were made.

Table 1. *Marine Mammal Observations in Cobscook Bay and Western Passage between December 2007 and December 2010.*

Month	Number of 4-hour Observation Periods Over 3 yrs	Number of Observed Harbor and Grey Seals (3yrs)	Number of Observed Harbor Porpoise (3yrs)	Number of Observed Atlantic White-Dolphins (3 yrs)
January	4	0	0	0
February	9	0	1	0
March	17	1	0	0
April	40	4	3	0
May	17	1	3	0
June	21	8	1	0
July	21	4	10	0
August	30	16	24	2
September	25	9	5	0
October	24	8	0	0
November	18	4	0	0
December	26	2	0	0
Total Number Observed		**57**	**47**	**2**

4. Description of Status, Distribution, and Season Distribution of Affected Species or Stocks of Marine Mammals Likely to be Affected by Such Activities

Gray seal (*Halichoerus grypus*), harbor porpoise (*Phocoena phocoena*), harbor seal (*Phoca vitulina*), and Atlantic white-sided dolphin (*Lagenorhynchus acutus*) are commonly observed in Cobscook Bay (NMFS, 2009). Other species that could theoretically occur in the Project vicinity include North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaengliae*), fin whale (*Balaenoptera physalus*), minke whale (*Balaenoptera acutorostrata*), and sei whale (*Balenoptera borealis*). However, because these marine mammal species are generally associated with opean ocean habitats in more offshore locations, they are unlikely to occur in Cobscook Bay (NMFS letter to FERC dated November 24, 2010).

Table 2. *Marine mammals likely to be affected.*

SPECIES	STATUS OF STOCK	DISTRIBUTION	POPULATION SIZE	TYPICAL HABITATS
Gray seal (*Halichoerus grypus*)	MMPA	Western North Atlantic stock located in eastern Canada and the northeastern United States	Over 250,000 in western North Atlantic	Coastal waters, islands, sandbars, ice shelves and icebergs. When hunting, they use the entire water column--from the surface to the sea floor.
Harbor porpoise (*Phocoena phocoena*)	MMPA	In the North Atlantic, range from West Greenland to Cape Hatteras, NC	89,054 in Gulf of Maine/Bay of Fundy area	Northern temperate and subarctic coastal and offshore waters: bays, estuaries, harbors, and fjords less than 650 ft deep.
Harbor seal (*Phoca vitulina*)	MMPA	On the East Coast, found from the Canadian Arctic to southern New England, New York and occasionally the Carolinas	91,000 in New England	Temperate coastal habitats and use rocks, reefs, beach, and drifting glacial ice as haul out and pupping sites
Atlantic white-sided dolphin (*Lagenorhynchus acutus*)	MMPA	Found in the western North Atlantic from 35°-80° N, from North Carolina to Greenland. Exhibits seasonal movements, moving closer inshore and north in the summers and offshore and south in the winters	63,000 in the western North Atlantic	Found only in temperate waters of the North Atlantic Ocean. Inhabit the oceanic waters of the continental shelf and slope.

Source: http://www.nmfs.noaa.gov/pr/species/mammals/
MMPA = Protected under the Marine Mammal Protection Act

5. Type of Incidental Taking Authorization Requested

ORPC requests an IHA for incidental takes by harassment of the four species of marine mammals identified in Table 2 that may occur during pile placement activities (the harbor seal, the grey seal, the harbor porpoise and the Atlantic white sided dolphin). There is a potential for noise generated by the pile placement activities to exceed the harassment levels for both continuous and impact levels. ORPC's Pile Placement Plan identifies the types of pile driving equipment that our contractor proposes for installation activities; Attachment 3 provides the equipment nameplate noise levels from the manufacturer.

ORPC contracted with Dr. Peter Stein of Scientific Solutions, Inc. to analyze this data and provide ORPC with guidance on the need for an IHA. Dr. Stein's recommendation for an IHA and the area of influence is attached (see Attachment 4).

6. Marine Mammals That May Be Taken

Species for which authorization is sought include the four species cited in Question 4 that have the highest likelihood of occurring in the project area: gray seal, harbor porpoise, harbor seal, and Atlantic white-sided dolphin. As Table 3 below indicates, in the worst case, we may harass four seals and two porpoise during the pile driving phase of this project. Cobscook Bay is characterized by the substantial mixing and redistribution of water resulting from strong tidal currents. Marine mammal critical habitats, as designated by the resource agencies, have not been identified for Cobscook Bay.

ORPC's Marine Mammal Monitoring Plan (Attachment 2) includes a mitigation action plan based upon trained observers and deployment activity curtailment. This plan was developed to minimize loud noise-generating activities if marine mammals are observed in Cobscook Bay, and to cease such noises if the animals come within 500 ft of the project area. ORPC does not expect to create noise at levels that harasses marine mammals for prolonged periods of time. There may be some limited peripheral harassment if a marine mammal comes into the work area underwater and is not spotted by our observers.

Based upon the history of marine mammal sightings summarized in Table 1 above, there is only a very small chance of such an interaction. Based on our marine mammal observations in the area, it is possible that seals or porpoises could enter the deployment area during the pile placement, but would probably focus on the salmon aquaculture operation several thousand feet from the deployment area.

Table 3. *Calculated Incidental Harassment Incidents by Species and by Month of the IHA.*

Month	Total Number of 4 Hour Observation Periods (3yrs)	Calculated # of hours of Observations Per Month/ year	Estimated Hrs of Pile Driving per month	Total Observed Harbor and Grey Seals (3yrs)	Calcu Takes Seals	Total Observed Harbor Porpoise (3yrs)	Calcu Takes Porpoise	Total Observed Atlantic White-Dolphins (3 yrs)	Calcu Takes White Dolphins
			(11 piles total)						
March	17	31.4	10	1	0	0	0	0	0
April	40	53.2	4	4	0	3	0	0	0
May	17	22.4	4	1	0	3	0	0	0
June	21	28.0	4	8	1	1	0	0	0
July	21	28.0	2	4	0	10	1	0	0
August	30	40	1	16	1	24	2	2	0
September	25	33.2	1	9	1	5	0	0	0
October	24	32.0	1	8	1	0	0	0	0
November	18	24.0	1	4	0	0	0	0	0
			Total 28 hrs						
Observation Periods =4 hours average				**TOTAL TAKES**	**4**		**2**		**0**

Note: These are very conservative numbers, based on the low number of hours of pile driving during high-observation months. The mitigation measures committed to by ORPC should lower these incidents even further.

7. Anticipated Impact upon the Species and Subsistence Uses

Any takes would be temporary and it is anticipated that no effect on the reproduction, survival, or recovery of the identified species would occur.

ORPC contracted with Dr. Peter Stein of Scientific Solutions Inc. to help define the zones of influence that will be potentially be created by the pile driving noise. According to Dr. Stein, a 112 dB in-air vibratory source level at the operator (presuming 1 m away) equates to roughly 174 dB re µPa2 @ 1 m in water. The 131 dBA from the plate on the impact hammer would equate to 193 dB re µPa2 @ 1 m in water. Tables in Appendix 4 show source levels (rms) averaging about 190 dB re µPa2 @ 1 m for impact measurements (190 dB for a 1-meter diameter pipe) and 175 dB re µPa2 @ 1 m for the vibratory hammer. Presuming Level A harassment is above 180 dB for the impact hammer, Dr. Stein has calculated ORPC's zone of influence for Level A harassment to be roughly 30-100 m. Presuming Level B harassment levels for the continuous vibratory source is 120 dB, and assuming 15logR propagation loss in shallow waters (cylindrical spreading would be 10logR and spherical spreading would be 20logR), Dr. Stein has calculated that the

175 dB vibratory levels do not attenuate to 120 dB until one is 4600 meters, or roughly 2.5 miles, from the source. Since this covers virtually the entire bay, ORPC will require an IHA for Level B harassment for the bay area.

8. Anticipated Impact on the Availability of Marine Mammals for Subsistence Uses

There are no traditional subsistence hunting areas in the project area.

9. Anticipated Impact on the Habitat of Marine Mammal Populations, and the Likelihood of Restoration of the Affected Habitat

ORPC proposes driving 11 piles. The benthic impact of the foundation for Phase I of the Project will be approximately 113 square ft. There should therefore be no adverse impacts to the marine mammal habitat after the pile placement is complete.

ORPC has filed a Biological Assessment with our FPLA that covers in detail the overall benthic impacts of the Project, which we anticipate to be minimal. In addition, ORPC has developed a benthic monitoring plan to assess benthic disturbance based upon a pre-deployment investigation and follow-up assessments through the duration of the Project.

10. Anticipated Impacts of the Loss or Modification of Habitat

ORPC does not anticipate any loss to or modification of the habitat for the marine mammal populations involved.

11. Availability and Feasibility of Alternative Methods

To mitigate the effects of noise from pile placement, energy applied to the hammers will be slowly ramped up. ORPC will also evaluate the use of wooden sound absorption cushions and/or bubble curtains to ensure noise levels are below the impact noise criteria suggested by NMFS. ORPC plans to initiate pile driving with a trial procedure that monitors ambient and sub-surface noise levels for the three different pile driving methods (vibratory, diesel impact, and drop-weight or “close-pin” hammers) and the two mitigation methods (sound suppression block and bubble curtains). The purpose of this trial procedure is to identify which combination of driving method and sound mitigation best assures that ORPC will not generate impact noise at the acute levels identified by NMFS (203dB). It is not anticipated that this trial will bring the pile driving noise above the continuous or impulse levels set by NOAA/Office of Protected Resources but if we find that it does, we will promptly notify the Office of Projected Resources. ORPC also plans to visually monitor the Level A harassment zone (out to 180 dB) for half an hour before, during, and for half an hour after impact pile driving (see Question 13 for more information). Acoustic monitoring will also be carried out during the pile driving trial to verify estimated sound levels and sound propagation.

Hydrokinetic power systems are an evolving technology that still holds numerous technical challenges. Foundation requirements and bottom fixity are foremost among these challenges.

Although ORPC has been closely following the development of international hydrokinetic projects to learn from their advances and disappointments, there are currently only a small number of deployed hydrokinetic devices around the world with which to compare.

This will be ORPC's first deployment of a full-scale hydrokinetic device. We have no previous experience or field data regarding the optimal foundational structure for such devices below the mud line. ORPC has therefore contracted several experts in marine structures for foundation designs and deployment strategies. These experts have evaluated gravity bases, suction caissons, rock anchors, cable and anchor systems and other oil-industry-developed methods, and have chosen this pile approach as the most cost-effective, low-failure risk, locally familiar, local infrastructure supportable, and safest path forward for our pilot project. We also believe that this design will have the least practicable adverse impact on marine mammals and their habitats.

12. Arctic Subsistence Evaluation

There are no Arctic subsistence marine mammals to consider at the Project site.

13. Monitoring Plans and Observation Data

ORPC has provided NOAA/Office of Protected Resources with our Marine Mammal Monitoring Plan (Attachment 2), which we will implement prior to and during the pile placement. During pile driving activities, ORPC will employ two dedicated marine mammal observers whose credentials will be approved by NOAA/Office of Protected Resources. Observations will commence a half-hour prior to pile driving, will continue through the work period, and will extend for a half-hour after pile driving has ceased. The watch will cover 180 degrees fore and 180 degrees aft of the area of activity. The fore and aft watches may take place on two different vessels to assure a full view for each. All watchers will use binoculars and record number, type, activity, and location of all sightings. Each watcher will carry a hand held radio for immediate communication to the ORPC project lead. The project lead will responsible for communicating to all aspects of the Project that a marine mammal has been spotted within the vicinity of the Project. The watchers will continue to observe the marine mammal and report to the project lead if the marine mammal is moving towards the Project area. The project lead will alert work crews of the marine mammal's activities and determine whether pile driving has to be suspended if the animal continues to approach the Deployment Area. All pile driving will cease if and when a marine mammal comes within 500 ft of the work area, and may not recommence until the marine mammal is outbound and more than 1000 ft from the work area.

We have further committed to NOAA/Office of Protected Resources that we will initiate a sub surface and ambient air acoustic monitoring study to monitor the actual noise levels during pile placement.

The data from our observers and our acoustic monitoring efforts will be provided to NOAA as a summary report after pile placement is complete.

14. Learning and Further Research

Over the past several years, ORPC has demonstrated our commitment to advancing hydrokinetic technology and studying the interaction of our devices with the marine environment. We have funded the innovative environmental and biological research needed to assess this new technology. ORPC has secured DOE funding and Congressional appropriations for marine mammals and fisheries studies in Maine and Alaska, through the University of Maine, Maine Maritime Academy, University of Alaska Fairbanks, Denali Commission, and several state funding organizations. We jointly support several professors and graduate students, as well as leaders in acoustic research and developments in environmental monitoring.

ORPC has successfully developed a drifting noise measurement system for assessing acoustic impacts of hydrokinetic power systems. With continued guidance and input from NOAA, we have been able to develop alternative methods for monitoring subsurface sites where hydrokinetic devices might be deployed. These sites are complicated by very high currents, deep and unforgiving bottom bathymetry, and other industrial and commercial source acoustic impacts.

This science-based approach to development has also been at the forefront of the fisheries studies with which ORPC has been involved. Rather than employing the past practices of large trawls and extensive netting studies needed for surface impoundment dams, we have been utilizing a much less invasive approach. Dr. Gayle Zydlewski at the University of Maine has utilized active acoustic echosounders in the deployment area and at a control site to identify fish population distribution and interaction. This work uses some limited netting for speciation and calibration, but provides the interaction data needed to best assess the environmental interaction and impacts of this technology.

As we move forward with Phase I of the Project, we will deploy a single-device TidGen™ Power System on a pile foundation. This power system will be instrumented with strain and load measuring devices—the data from which ORPC and its consultants will use to refine and modify the current foundation design. ORPC believes this approach will allow us to optimize future foundation designs, while reducing deployment costs and minimizing environmental impacts. ORPC has applied for a FERC pilot project license for this first-of-a-kind hydrokinetic device, and it will be from these efforts that we and others within the emerging hydrokinetic industry will achieve commercialization. ORPC has provided our approaches, our collected data, and our lessons learned to all interested parties worldwide.

The results of the pile testing trials and noise measurements will be provided to the regulatory agencies as a Report from our acoustics consultant, Scientific Solutions Inc. This Report will be utilized as baseline data to support an IHA for Phase 2 of OPRC's TidGen™ project if it is deemed necessary.

References

National Oceanic and Atmospheric Association. 2009. NOAA Fisheries, Office of Protected Resources – Harbor porpoise (*Phocoena phocoena*). [Online] URL: http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/harborporpoise.htm. (Accessed June 3, 2009).

National Oceanic and Atmospheric Association. 2011. Comments, Recommendations, Terms and Conditions, and Intervention Notice for Ocean Renewable Power Company, LL's Final Hydrokinetic Hydropower Pilot License Application for the Cobscook Bay Tidal Energy Proejct (FERC No. P-12711), November 4, 2011.

Attachments

1. Pile Placement Plan
2. Marine Mammal Monitoring Plan
3. Pile Hammer Manufacturer Correspondence
4. Stein, Peter. Calculation of Noise Levels due to Pile Driving.

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Cobscook Bay Tidal Energy Project
TidGen™ Foundation Placement Plan

Pile Driving

The Cobscook Bay Tidal Energy Project will require the placement of a series of steel pilings for the purpose of providing a stable foundation for the TidGen™ power system. The surface vessels and equipment required for the placement and driving of the 10 piles for each TidGen™ will consist of 1ea 50'X130' deck barge; 1ea push boat 25'loa manufactured by 'Work Horse' powered by 2 ea 225HP John Deere 6068 inboard motors; 1ea Linkbelt LB 518 150-ton crane; deck winches with power pack and 1ea 185cfm air compressor.

The barge will be held in position with 4 large anchors positioned at the four corners located somewhere between 500' and 800' from the barge. The barge will be attached to the four anchors with 1000' of line each, running through a fairlead and spooled onto a deck-mounted winch. The winches will be used to position and move the barge to its proper location. This is similar to the mooring design that was successfully used for ORPC's geotechnical investigation in Cobscook Bay.

Steel pipe piles will be used for the foundation for the TidGen™ devices, which will be 36" diameter and have a 1"inch wall with an open shoe of hardened steel attached to the bottom for seating itself into bedrock without deformation. The piles will be delivered with the hardened shoes attached and will be uncoated.

The piles will be transferred from the delivery truck to the barge with either the crane on the barge or one on shore at either the Staniels Road launch facility or the boat school property. Both of these sites are less than two miles by water from the Project area. Ten piles will be required to provide a stable foundation for each TidGen™ device. These piles will be configured in two rows of 5 piles in each row. The individual piles will be approximately 20 feet apart in each row and the rows will be approximately 50 feet from each other. The piles will be in the order of 50' to 60' long and 10' to 15' will be above the mud line when driven to refusal. Prior to driving the pile a follower will be attached to the pile, which will enable the pile to be driven from the surface. This follower will be an H-pile section, approximately 100' long and its size will be in the order of an HP 12X53. Based on extensive soils study of the area the piles will sink in the soft bottom under its own weight plus the weight of the follower and vibratory hammer, for most of the 40' of marine clay, then will be driven the remaining depth using vibratory and impact pile driving procedures from barge-based pile driving equipment.

The TidGen™ device foundation(s) will be constructed in an area that is completely submerged (below low tide). Two main methods used to install piles are impact and vibratory pile driving. An impact hammer is a large metal ram that is attached to a crane. A vertical support (leads) holds the pile in place and the ram is dropped or forced downward. The energy is then transferred to the pile that is driven into the seabed. The ram is typically lifted by mechanical, air steam, diesel, or hydraulic power sources. A Berminghammer model B-3505 diesel, 34,500 lb hammer with maximum rated impact energy of 21,533 ft-lb will be used (*See attachment for vendor specifications*). Driving piles using an impact hammer generally results in the greatest noise production, however this noise is not constant and is considered as a multiple pulse source by NMFS. NMFS current acoustic threshold for pulsed sounds (*e.g., impact pile driving*) is 180 and 190dB re 1 microPa for Level A harassment of cetaceans and pinnipeds, respectively, and 160 dB re 1 microPa for Level B harassment. As mentioned prior, this noise is not constant and it is expected that the need for a diesel hammer will be minimal and for very short durations (less than 5 minutes per pile). Information provided by the manufacturer was provided as follows; "We did testing on a similar hammer back in 2005 and the actual sound levels were read to be: 109.5 dBAI @ 50 BPM; 110.5 dBAI @ 45BPM; 112.3 dBAI @ 40 BPM; and 112.6 dBAI @ 36.5 BPM. These actual readings were taken 30 feet away from the hammer when the hammer was at around ground level and the pile was at refusal. I would use those values for the 3505. These readings were taken without any cushioning (using our direct drive system). I do have readings with the use of a cushion also, which is less then the ones stated above."(*See attachments for vendor correspondence*)

Vibratory hammers install piles by applying a rapidly alternating force to the pile by rotating eccentric weights about shafts, resulting in a downward vibratory force on the pile. The vibratory hammer to be used will be an H&M model H-1700(*See attachments for manufacturer's specification sheet*), hydraulically powered using an environmentally sensitive product, AMERIgreen AW hydraulic oil to minimize environmental impacts in the event of a ruptured hose or other spill. (*See attachments for Hydraulic oil Specification*).The CPM spill plan provides that containment booms and other clean-up devices will be onboard in a 'spill-kit' if such an event should occur.

The vibratory hammer attaches to the pile head with a clamp and the vertical vibration in the pile disturbs or liquefies the soil next to the pile causing the soil particles to lose their frictional grip on the pile. The pile moves downward under its own weight plus the weight of the hammer. This method is very effective for non-displacement piles such as sheet piles, H-beams, and open-end pile or caissons. The noise source of this hammer is from the power pack, which drives the hydraulic pump. It consists of a John Deere 6068HE 225 HP engine. There is no manufacturer information on the noise output of this power pack, but field measurements may be a possibility. Correspondence with the vibratory hammer manufacturer provided in-air noise levels (*see attachments for correspondence*) which have been used by ORPC's acoustic expert SSI, (Scientific Solutions Inc), to calculate the in-water noise levels (*see Attachments for SSI correspondence*) and the calculated zone of acoustic influence.

The type of hammer used depends on subsurface conditions and the effort required to advance the pipe pile to final elevation. The soils study performed by Haley and Aldrich has found the marine deposits in the area where the TidGen™ device foundation piles will be driven to be very soft clay, indicating that little effort will be required to seat the piles to bedrock.

For the vibratory hammer, driving is in progress from less than 1 to approximately 3 minutes. If it is determined by a member of Haley and Aldrich onboard soils scientist that additional energy is required to seat the pile to bedrock, the vibratory hammer will be removed and the impact hammer will be rigged to the crane and used to seat the pile to bedrock or 'proof' the pile. When the impact hammer is being used, driving takes place from 1 to 5 minutes. All piles will be driven with the vibratory hammer and the impact hammer used only when vibratory methods are not sufficient to reach bedrock. Due to strong currents during tide changes, pile driving will occur during slack tides only and it is expected that only one pile will be driven per tide cycle due to the short window of slack tide. Total anticipated time at mooring is between 7 to 12 days. Lights will be as required by U.S. Coast Guard and local Harbor Master; local fishermen will also be notified prior to operations.

To ensure alignment of the pile array, the semi-permanent base structure, which will later be raised and become the support structure for the TidGen™ device, will be used as a driving template. (*See attached drawing of base*). This structure will have alignment features built into it to help guide the piles to the location required. It is expected that divers will be required to help guide the piles to the structure to get them started into the template. This semi-permanent structure will be set into place prior to the pile driving operation and the setting of it will be included in the section following this pile driving as part of the setting of the base structure plan to follow.

Diesel fuel on deck will be in a double walled storage tank with less than 250 gallons capacity. Every effort will be made to prevent spillage; however in the event of a spill; a spill kit with absorbent pads and containment boom will be present to contain and clean up as needed.

Cold weather will not have an effect on pile driving activities. Only foul weather would prohibit pile-driving operations such as high winds/seas or icy conditions. It is expected that this work will occur during the early spring of 2012 (March 1, 2012), so icing should not be a problem. A look ahead at the long-term weather forecast for a stretch of favorable weather will be done prior to starting.

Setting, Raising and Securing Bottom Support Frame

The dimensions of the bottom support frame are 50'X100'. It is a three-dimensional truss made of 36" and 8" to 10" steel pipe. This unit shall be hoisted with a single crane (on the order of 150-ton capacity) mounted on a 50' X 120' barge. This crane and barge configuration will be used throughout the pile driving and setting of the TidGen™ device and installing the cable.

The bottom support frame will be manufactured at either the Staniel's Road launch facility or the boat school property. It will be brought to the water by a special trailer and loaded onto a material barge with either a land-based or barge-mounted crane. The bottom support frame will be motored out to the deployment area. With the assistance of divers, the bottom support frame will be lowered to the sea floor with the barge mounted 150-ton crane, aligned and checked for levelness and laid to rest to be used later as a pile-driving template, prior to being raised to the proper elevation and affixed to the pipe piles where it will be utilized as the bottom support frame for the TGU.

Once all ten piles are driven as described above, they will be marked for the bottom or top of bottom support frame. The bottom support frame will then be raised to the proper elevation, and secured to the piles using friction collars. This will be a slack tide operation and divers will be required to perform this work. It is intended to use the 150-ton crane on a 50' X 120' barge to raise the frame. With the assistance of divers, during one slack tide cycle, the frame will be secured to the piles. No additional anchoring will be required for this process and will utilize that which had been installed for the pile-driving phase earlier.

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ORPC
OCEAN RENEWABLE
POWER COMPANY

STUDY PLAN 5:
MARINE MAMMAL MONITORING PLAN

FINAL PILOT LICENSE APPLICATION
COBSCOOK BAY TIDAL ENERGY PROJECT
FERC PROJECT No. 12711
ORPC MAINE, LLC

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STUDY PLAN 5
MARINE MAMMAL MONITORING PLAN

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1.0 INTRODUCTION

1.1 GENERAL DESCRIPTION OF THE COBSCOOK BAY TIDAL ENERGY PROJECT

ORPC Maine, LLC, a subsidiary of Ocean Renewable Power Company (collectively, ORPC), is applying to the Federal Energy Regulatory Commission (FERC) for a pilot project license for the Cobscook Bay Tidal Energy Project (Project). The Project will evaluate the potential for a new source of clean, renewable energy generation using tidal energy resources in Cobscook Bay, Maine. ORPC obtained an initial preliminary permit for the project area in Cobscook Bay from FERC on July 23, 2007; FERC issued a successive preliminary permit on January 13, 2011. Feasibility studies, including environmental surveys, and pre-filing consultation were conducted, resulting in ORPC's filing of a draft pilot license application (DPLA) with FERC for the Eastport Tidal Energy Project on July 24, 2009. The DPLA included project areas within Cobscook Bay and Western Passage. Since submitting the DPLA, ORPC has conducted extensive consultation with regulatory and resource agencies as well as other stakeholders, has collected additional environmental data, and has continued to refine its proprietary technology. As a result of these additional studies and consultations, ORPC now plans to deploy a commercial-scale hydrokinetic power system in gradual stages, with the Project, a small pilot project, as the first stage. The FERC preliminary permit Project boundary for the Cobscook Bay Tidal Energy Project (FERC Project No. 12711) encompasses the proposed development area.

The Project will be carried out in two separate phases over an expected eight-year pilot license term. In Phase I, ORPC will deploy, monitor and test a single-device TidGen™ Power System for one year. In Phase II, ORPC will add four additional TidGen™ devices to the power system, for a total of five. During both phases, ORPC will deploy environmental monitoring equipment on the TidGen™ Power System and within the Project boundary (Figure 1).

The core component of the TidGen™ Power System is ORPC's proprietary turbine generator unit (TGU). The TGU utilizes four advanced design cross flow (ADCF) turbines to drive a permanent magnet generator mounted between the turbines on a common driveshaft. The ADCF turbines rotate in the same direction regardless of tidal flow direction; rotational speed of the turbines is directly related to water flow speed. The TGU is 98 feet in length, 17 feet high and 17 feet wide. It is attached to a bottom support frame, which holds the TGU in place approximately 15 feet above the sea floor. The bottom support frame is 98 feet long by 50 feet wide by 15 feet high. The bottom support frame is constructed of steel and the TGU is constructed of steel and composite material. Together, the coupled TGU and bottom support frame comprise the TidGen™ device (Figure 2 shows the conceptual design for the TidGen™ device). The depth at the proposed Deployment Area is 85 feet at Mean Lower Low Water (MLLW); the TidGen™ devices will thus be placed 49 feet below the surface at MLLW. Each TGU will have a maximum design capacity of 180 kilowatts (kW). During the Project each TGU will operate at a rated capacity of 60 kW. The five-device TidGen™ Power System will have a maximum design capacity of 900 kW and a rated capacity of 300 kW. The power generated will be connected to the grid using a single subsea transmission cable with a line voltage of 13 kilovolts (kV) DC. The total cable length is approximately 4,200 feet (3,700 feet from the TidGen™ Power System to the shore in Lubec, Maine and approximately 500 feet from shore to the on-shore station). ORPC has chosen an underwater cable route that avoids abrupt changes in bottom topography. Based on consideration of environmental concerns, ORPC proposes to bury the cable at all feasible locations along the cable route. The power generated by the TidGen™ Power System will be conditioned at the on-shore station and delivered to the Bangor Hydro Electric Company power grid.

Figure 1. Cobscook Bay Tidal Energy Project location map.

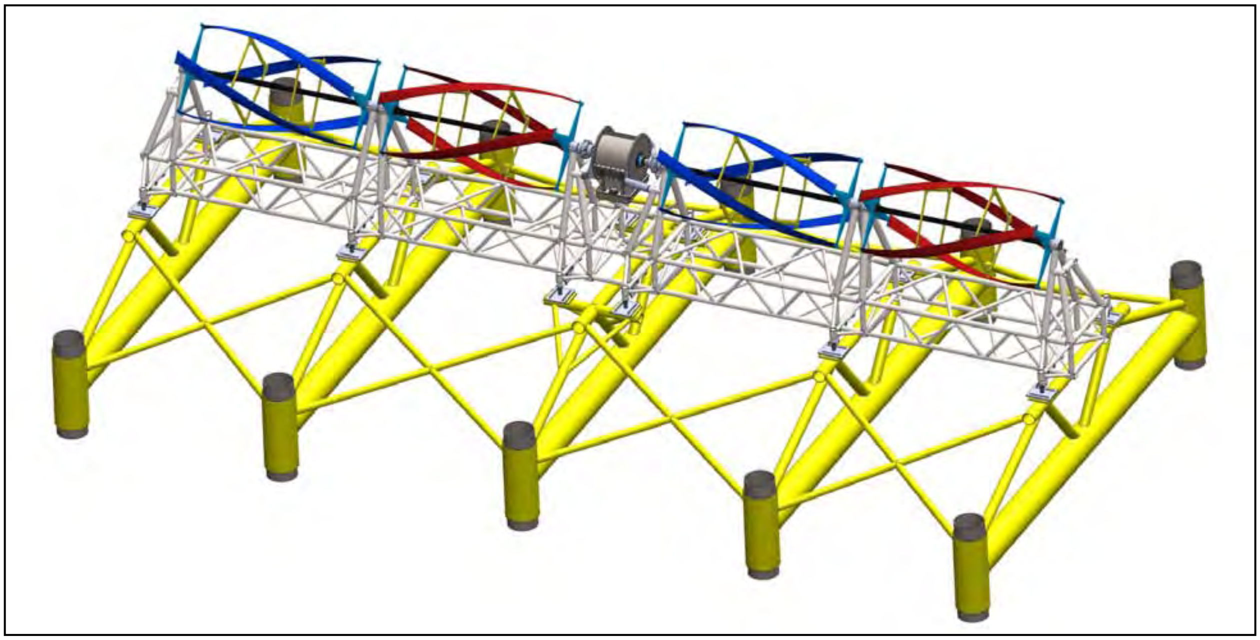


Figure 2. TidGen™ device.

In preparation for the Project, ORPC designed, built, deployed and tested a beta pre-commercial TidGen™ Power System (Beta TidGen™ System) in Cobscook Bay in 2010 (see Figure 3). The Beta TidGen™ System was comprised of a beta pre-commercial TGU (Beta TGU); ORPC's *Energy Tide 2* research, testing and deployment vessel; a mooring system for the *Energy Tide* 2; and data acquisition and environmental monitoring equipment. Rather than being mounted on a bottom support frame, the Beta TGU was deployed top-down from the *Energy Tide 2* and suspended 21 feet below the water surface.

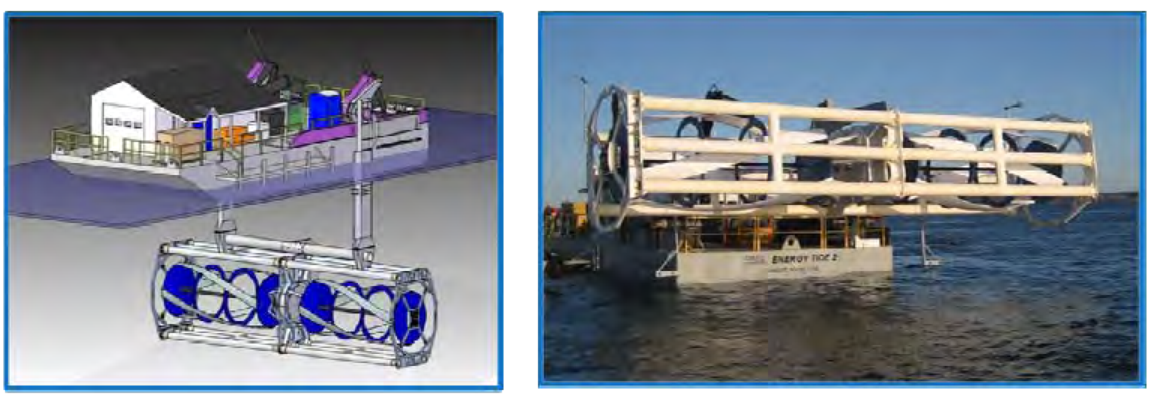


Figure 3. Beta TidGen™ System.

1.2 PILOT LICENSING PROCESS

ORPC's proposed Project is intended to study the short-term installation of ORPC's TidGen™ Power System and its effect on the marine environment. FERC's pilot licensing program has been designed to support the advancement and orderly development of innovative hydrokinetic technologies for projects that are small, short-term, removable and carefully monitored. The purposes of FERC's pilot license program are to test new hydrokinetic technologies, to determine the appropriate sites for hydrokinetic projects, and to collect information on the environmental and other effects of these new generating devices.

ORPC filed its DPLA for review and comment on July 24, 2009. Federal and state resource agencies and other stakeholders submitted comments on the DPLA. FERC also issued an additional information request (AIR) on September 23, 2009 in response to the DPLA. FERC's AIR Item #24 requested that the mandatory monitoring and safeguard plans required for hydrokinetic pilot licenses be reformatted in compliance with the Integrated Licensing Process study plan criteria at 18 CFR 5.11. Accordingly, this study plan has been revised to conform to the Integrated Licensing Plan study plan requirements.

Since filing the DPLA, ORPC has continued discussions on its pilot license proposal with the Cobscook Bay fishing community and the resource agencies to resolve potential conflicts in the marine environment, and to revise the proposed studies to address comments submitted on the DPLA. As a result of this continuing consultation, ORPC has modified the Project and updated this study plan to reflect the updated Project.

The concept of adaptive management is foundational to ORPC's Project study plans. As stated by FERC (2006), "adjustments to measures required during the license term will be based on information gleaned from ongoing monitoring or other post-license studies." ORPC believes that given the uncertainty associated with the relatively new pilot project process, being able to adjust the monitoring studies through adaptive management, based on experienced gained through the Project, allows for more effective studies. ORPC is proposing the adaptive management approach as the most responsible path forward, considering the available ecological and environmental data. This approach is also more appropriate to the pilot license program's goals and objectives than attempting to finalize each study plan prior to deploying the Project's first phase.

ORPC's proposed environmental study plans include this Marine Mammal Monitoring Plan. As described in the study methodology below, ORPC plans to conduct marine mammal observations in the deployment area for the eight-year term of the Project, beginning with the deployment of the single-device TidGen™ Power System. This will allow the monitoring to occur: during Phase I of the Project, with the installation of a single TidGen™ device; during the first two years of Phase II, with the installation of a five-device TidGen™ Power System; and during any major on-water activities. Based on the results of these observations, ORPC and its marine mammal scientific advisor, Dr. Brandon Southall of Southall Environmental Associates, in consultation with the appropriate resource agencies, will review and, if appropriate, modify the Marine Mammal Monitoring Plan at regular reporting intervals.

2.0 GOALS AND OBJECTIVES

The primary goal of the proposed Marine Mammal Monitoring Plan is to characterize changes in marine mammal use in and around the deployment area (Figure 1) due to the deployment of hydrokinetic devices. This will be accomplished by ORPC personnel and contractors: 1) conducting multi-season marine mammal observations to characterize the species presence, relative frequency of occurrence, and habitat use prior to the deployment of a single-device TidGen™ Power System; 2) conducting multi-season marine mammal observations around the single-device TidGen™ Power System after its Phase I deployment; and 3) conducting multi-season marine mammal observations on the five-device TidGen™ Power System after its Phase II deployment. In addition, dedicated and trained marine mammal observers will 4) conduct marine mammal watch prior to and during major deployment, maintenance and retrieval activities. The Marine Mammal Monitoring Plan will use the data gathered to characterize marine mammal presence in Cobscook Bay and the effects (if any) of the TidGen™ Power System on marine mammals, in accordance with the requirements of the FERC pilot license process.

Since marine mammals are known to utilize the Cobscook Bay area, ORPC will provide a dedicated marine mammal watch, by qualified personnel, before and during major on-water deployment, maintenance and/or retrieval activities. This independent service will provide ORPC and its contractors with advance notification of the approach, presence and all-clear for marine mammals. ORPC will take all precautions to minimize harassment of and/or contact with marine mammals during these periods of higher risk. ORPC will consult with National Oceanic and Atmospheric Association (NOAA)/National Marine Fisheries Service (NMFS) regarding the credentials of the persons to be assigned to this task. ORPC will also follow work stop and avoidance procedures to be approved by NOAA/NMFS (Office of Protected Resources) to assure minimal harassment and risk to marine mammals.

Additional information on potential direct interactions between marine mammals and the TidGen™ Power System will be monitored as outlined in the Fisheries and Marine Life Interaction Monitoring Plans. The effect of noise produced by the installation and operation of the TidGen™ Power System on marine mammals is addressed in the Acoustic Monitoring Plan. Separate from these study plans, ORPC is working with Scientific Solutions, Inc. (SSI) under a grant from the Department of Energy (DOE) to develop an active acoustic monitoring (AAM) system, a real-time, automated system capable of tracking the movements of fish and mammals in the vicinity of the TidGen™ Power System. ORPC has chosen not to include the AAM system in the pilot license application because it is still in the research and development phase.

3.0 STUDY AREA

The geographic scope of the study will generally include the Cobscook Bay deployment area (Figure 1). Additional information regarding the study area is provided below in Section 6.0.

4.0 BACKGROUND AND RELEVENT INFORMATION

4.1 RESOURCE DISCUSSION

Gray seal (*Halichoerus grypus*), harbor seal (*Phoca vitulina*) and harbor porpoise (*Phocoena phocoena*) are commonly observed in Cobscook Bay. Other species that may occur in the vicinity of the Project include Atlantic white-sided dolphin (*Lagenorhynchus acutus*), North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaengliae*), fin whale (*Balaenoptera physalus*), minke whale (*Balaenoptera acutorostrata*), and sei whale (*Balenoptera borealis*); however, NMFS has stated that none of these species is expected in the proposed deployment area (NMFS 2010).

ORPC has been conducting incidental visual observations of marine mammals in the Cobscook Bay and Western Passage areas since 2007, during turbine testing, travel to and from ORPC's research vessel, and acoustic, fisheries, subtidal, and avian surveys (Table 1). During this time, ORPC personnel and contractors, who have received specialized training in marine mammal observation and documentation, have recorded approximately 252 observational periods over 222 days. During these periods, ORPC observed two dolphins, 47 harbor porpoises, and 57 seals. The most intensive effort was conducted in 2010, when approximately 71 marine mammals were observed over the course of 132 observation days between March 8 and December 31. Of these, there were two dolphins, 27 harbor porpoises, and 42 harbor seals. All 2010 marine mammal observations were made near the Cobscook Bay deployment area. No observations of any whale species have been made in Cobscook Bay by ORPC personnel or those contracted to work for ORPC since the observation program began in 2007. Table 1 presents the number of each species observed and the months in which the observations were made.

Table 1. *Marine Mammal Observations in Cobscook Bay and Western Passage between December 2007 and December 2010.*

Month	Number of Observation Periods	Harbor and Grey Seals	Harbor Porpoise	Atlantic White-Dolphins
January	4	0	0	0
February	9	0	1	0
March	17	1	0	0
April	40	4	3	0
May	17	1	3	0
June	21	8	1	0
July	21	4	10	0
August	30	16	24	2
September	25	9	5	0
October	24	8	0	0
November	18	4	0	0
December	26	2	0	0
Total Observed		**57**	**47**	**2**

5.0 PROJECT NEXUS

The direct and in-direct interaction of tidal turbines and aquatic resources, including marine mammals, has not been fully characterized. There is also limited information on marine mammal use of the deployment area. The purpose of conducting small demonstration testing activities through a pilot project is to collect the environmental information needed to more completely evaluate the potential effects of these technologies. Post-deployment monitoring plans are also a mandatory requirement of pilot license applications under FERC's current hydrokinetic pilot license policy. Information collected by this monitoring plan can provide some essential information on how marine mammals use the deployment area.

The Project poses the greatest risk to marine mammals in Cobscook Bay when the TidGen™ Power System's project components are being placed, partially removed for maintenance, or fully removed. Other Project activities, such as cable laying, foundation setting, or subsurface drilling have the potential to present risks to marine mammals in Cobscook Bay.

6.0 METHODOLOGY

6.1 MONITORING BY ORPC PERSONNEL AND CONTRACTORS

ORPC proposes to conduct visual observations of marine mammals in and around the proposed deployment area in Cobscook Bay (Figure 1). These observations will be carried out by ORPC personnel and contractors concurrently with other project-related tasks. ORPC has developed a comprehensive Marine Mammal Observation Training document for use by personnel and contractors conducting work in Cobscook Bay (Attachment A). This document provides education and identification instructions on the different marine mammal species that may occur in Cobscook Bay (including all species noted in Section 4.1 above), to ensure consistency among all staff in recording marine mammal sightings.

Surveys will be conducted from both onshore areas and from the water in and around the deployment area. Marine mammal species visible from the water's surface will be recorded and logged as part of this monitoring effort. Observers will use binoculars, spotting scopes, and telescopes where practical to identify and observe marine mammals while performing other scheduled activities for the Project. If a marine mammal is observed, the observer will document the location where the observation was made, using latitude and longitude or a place name in order to provide perspective of the marine mammal sighting in relation to the TidGen™ Power System location, species identification and count, observed behavior (e.g., apparent foraging; floating with tide), weather conditions, and estimated distance from observation point (see Attachment A for a sample Marine Mammal Species Observation log sheet).

ORPC personnel and contractors are currently conducting numerous pre-deployment testing activities in Cobscook Bay in addition to performing environmental resource surveys. These activities occur throughout the year, during all seasons, and will continue through Phase I and into Phase II of the Project. ORPC personnel will continue to conduct marine mammal observations during these activities. In addition, other contractors such as the Center for Ecological Research (CER), the University of Maine (UMaine) School of Marine Sciences, UMaine Cooperative Extension, and SSI have been and will continue to be responsible for recording marine mammal observations in Cobscook Bay while conducting fisheries studies, bird observations, AAM system testing, and drift noise measurement system studies.

CER is proposing to conduct sea and shore bird surveys in Cobscook Bay as described in the Sea and Shore Bird Monitoring Plan. During these surveys, CER personnel will conduct incidental visual marine mammal observations. The avian surveys will have an expected frequency of eight 8-hour on-site surveys in years 2011 through 2014. These surveys are scheduled to be conducted during expected peak bird occurrence. Peak bird densities are likely to also be coincident with increased marine mammal activity during feeding activities.

UMaine is proposing to conduct hydroacoustic fish surveys in Cobscook Bay as described in the Fisheries Monitoring Plan. During these surveys, UMaine personnel will conduct incidental visual marine mammal observations. The fisheries surveys will have an expected frequency of 16 full 24-hour on-site surveys in 2011, 16 survey days in 2012, 8 survey days in 2013, and 6 survey days in 2014. These surveys are scheduled to be conducted during expected peak fish occurrence. Peak fish densities are likely to also be coincident with increased marine mammal activity, as marine mammals follow prey fish.

SSI is proposing to conduct radiated noise monitoring as well as testing of its AAM system in Cobscook Bay. The activities proposed under the radiated noise monitoring studies are described in the Acoustic Monitoring Plan. During testing of the AMM system, SSI will employ two dedicated marine mammal observers to conduct marine mammal observations concurrently with the radiated noise work. The frequency of the acoustic measurements will be driven by the changing environmental and mechanical conditions. The frequency of AAM system testing will be driven by progress made in the development of that system. The following is the proposed schedule for activities in Cobscook Bay during which SSI will conduct marine mammal observations. SSI will be performing pre-deployment acoustic ambient noise study work and testing of its AAM system in May 2011 for a period of five days. In July 2011, radiated noise monitoring will be performed around the Beta TidGen™ System and additional AAM testing will be conducted for a period of five days. After the deployment of the single-device TidGen™ Power System radiated noise monitoring will be performed in the deployment area and additional AAM testing will be conducted for a period of five days. After the deployment of the single-device TidGen™ Power System, AAM system testing will be conducted quarterly for periods of five days. In October 2012, radiated noise monitoring will be performed around the five-device TidGen™ Power System for a period of three days. After the deployment of the five-device TidGen™ Power System, AAM system testing will be conducted quarterly for periods of five days.

6.2 Monitoring by Dedicated Marine Mammal Observers

ORPC understands that some of the greatest risks to marine mammals can occur during the deployment, maintenance, and retrieval of large, heavy structures using moored vessels. ORPC has included Section 6.2 in this Marine Mammal Monitoring Plan specifically to address monitoring efforts during these high-risk portions of the Project. ORPC will employ two dedicated marine mammal observers during the deployment and retrieval of the TGUs and bottom support frames. NOAA/NMFS will approve the credentials of all dedicated marine mammal observers. Observations will commence a half-hour prior to construction or maintenance activities and will continue through the work period. Observations will cover 180 degrees fore and aft of the area of activity. The fore and aft observations may take place on two different vessels to assure a full view for each. All observers will use binoculars and record number, type, activity, and location of all sightings. Each observer will carry a hand held radio for immediate communication to the ORPC project lead. The project lead will responsible for communicating to the operations leader that a marine mammal has been spotted within the vicinity of the Project. The observers will continue to monior the marine mammal and report to the operations leader if the marine mammal is moving towards the Project area. The operations leader will alert work crews of the marine mammal's activities and determine if construction activities will be suspended if the animal continues to approach the deployment area. All construction activities will cease if a marine mammal comes within 500 feet of the work area, and may not recommence until the marine mammal is outbound and 1000 feet from the work area.

For small-scale, on-water work such as subsurface drilling, and light maintenance utilizing a single work boat (like work from the *Energy Tide 2*), ORPC will utilize one dedicated marine mammal observer at the work site. The physical location of the deployment area allows one dedicated observer to view it from either end of Cobscook Bay. The observer will follow the procedures described in Section 7.0 for communicating the presence and location of marine mammals in the vicinity of the Project so that the ORPC operations leader can prepare for a possible cessation of work activity.

7.0 REPORTING

All marine mammal observations will be recorded on a daily log sheet (Attachment A).

The daily observation log will include:

- Name of Observer
- Observation period (date and time)
- Location from which observations are made
- Estimated bearing and distance from observation location to marine mammal
- Weather conditions
- Number and species of marine mammal
- Notes on behavior (floating, actively foraging, diving activities, direction of travel, etc.)

ORPC will file full summary reports with the regulatory agencies on a biannual basis for the duration of Project operations, beginning six months after the deployment of the single-device TidGen™ Power System. Should altered marine mammal activity be noted at any time during the observations, the appropriate federal and state resource agencies will be notified for immediate consultation.

8.0 SCHEDULE

ORPC proposes to conduct visual marine mammal observations in and around the deployment area. ORPC and its contractors will be in the vicinity of the Project for fishery and bird surveys, and equipment testing frequently during and after deployment. Marine mammal observations are expected to occur incidentally while other activities are being performed, except during periods of deployment, maintenance, and retrieval activities, when dedicated marine mammal observers will be employed.

9.0 BUDGET

The total cost of this monitoring effort will be $184,000 over eight years. ORPC will be performing marine mammal observations in the vicinity of the Project incidentally, as other activities are conducted in support of the Project. A staff dedicated uniquely to marine mammal observation will not be employed, except during deployment, maintenance and retrieval activities. OPRC estimates the cost of dedicated marine mammal observers during deployment, maintenance, and retrieval to be $15,000 per year for eight years. ORPC estimates the cost of compiling the marine mammal observation logs and issuing biannual reports to be approximately $8,000 for each year of the Project.

10.0 DISCUSSION OF ALTERNATIVE APPROACHES

ORPC believes the Project has little potential to affect marine mammal species. ORPC has been testing tidal power devices in Cobscook Bay since 2007 and during this time period has not observed any negative environmental effects of these devices. In addition, the pilot Project is small relative to the available habitat in Cobscook Bay and will be monitored for direct interaction with aquatic life. Marine mammals are known to avoid structures in the ocean environment and it is expected they will similarly avoid direct contact with the proposed power system. In addition to this plan, Fisheries and Marine Life

Interaction Monitoring Plans have been developed to confirm no direct effects based on in-situ data collection. Potential indirect effects associated with underwater radiated noise are being addressed in the Acoustic Monitoring Plan. ORPC believes that the Marine Mammal Monitoring Plan, in conjunction with additional proposed monitoring plans, is sufficient to inform licensing decisions, that it is appropriate to the size and scope of the pilot Project, and that the approaches proposed in the study are in general accordance with those recommended by the resource agencies.

11.0 REFERENCES

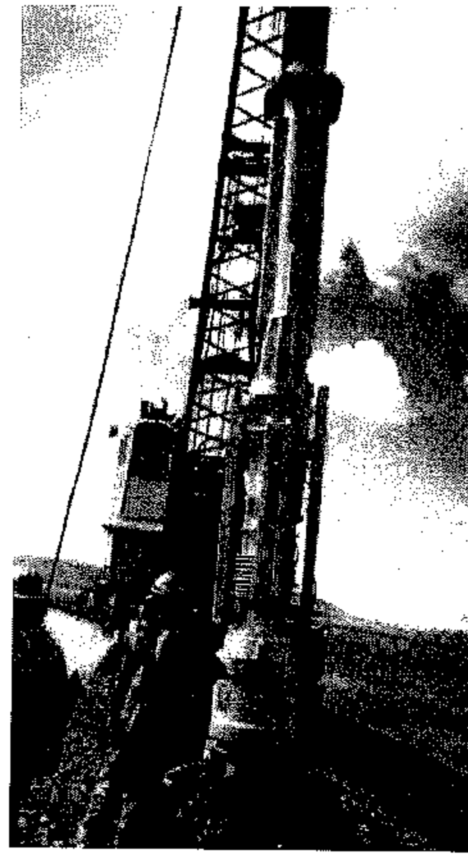
Federal Energy Regulatory Commission (2006). Policy Statement on Hydropower Licensing Settlements. September 21, 2006. Retrieved from http://www.ferc.gov/whats-new/comm-meet/092106/H-1.pdf.

National Marine Fisheries Service (2010). Letter to HDR|DTA providing list of rare, threatened, and endangered species near the Project Area.

ATTACHMENT A
ORPC MARINE MAMMAL OBSERVATION TRAINING DOCUMENT

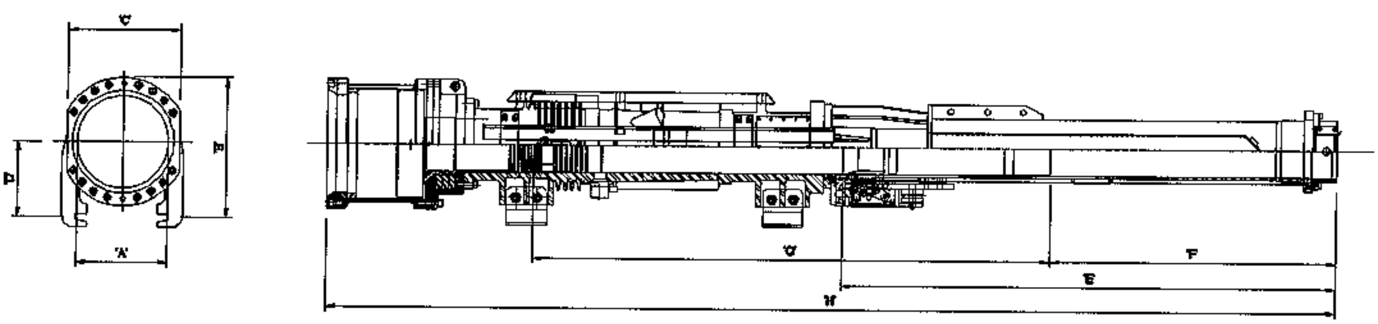
B-3005 General Specifications

Performance		
Ram Weight X Max. Stroke	34,500 ft•lb	47 kN•m
Impact energy	21,533 ft•lb	29 kN•m
Ram weight/mass	3,000 lb	1,400 kg
Maximum ram stroke	11.5 ft	3.5 m
Impact block weight/mass	802 lbs	364 kg
Blows per minute	36-60	36-60
Operating Weight		
Total operating weight/mass	11,000 lb	4,989 kg
Weight of tool box	150 lb	68 kg
Total shipping weight/mass	11,150 lb	5,056 kg
Capacity		
Fuel tank capacity	16 gal (U.S)	62 liters
Fuel consumption	1.4gal/hr.	5.3 liters/hr.
Oil tank capacity	1.9 gal (U.S)	7.3 liters
Oil consumption	0.16 gal/hr.	0.6 liters/hr.



Impact Hammers B-3005

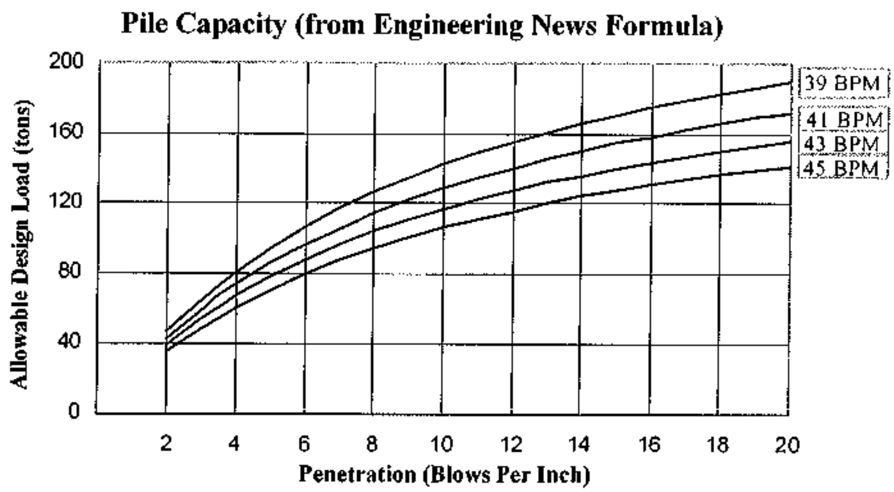
Dimensional Specifications



Dimensions	Model-3005							
Units	A	B	C	D	E	F	G	H
Imperial	21.5 in	27.5 in	24 in	15 in	109 in	63.7 in	114 in	222.7 in
Metric	546 mm	699 mm	610 mm	380 mm	2769 mm	1618 mm	2896 mm	5657 mm

B-3005	3000 lb Piston				
BPM	Stroke (ft)	Potential Energy (ft.lb)	Velocity (ft/s)	Maximum Impact Force (tons)	Impact Energy (ft.lb)
35	11.8	35,400	22.5	243	24,780
36	11.2	33,600	22.0	238	22,547
37	10.6	31,800	21.5	233	21,533
38	10.0	30,000	21.0	228	20,543
39	9.5	28,500	20.5	222	19,577
40	9.0	27,000	20.0	217	18,633
41	8.6	25,800	19.5	211	17,714
42	8.2	24,600	19.0	206	16817
43	7.8	23,400	18.5	200	15943
44	7.5	22,500	18.0	195	15093
45	7.1	21,300	17.5	190	14266

Stroke height is a function of soil resistance and may not be attainable in certain driving conditions.
Standard Operating Range.



WEAP Input Data

Ram			Stroke		
Weight	Length	Diameter	Minimum	Maximum	Efficiency
3.00 Kips	113.80 in	11.70 in	4.00 ft	11.80 ft	0.800

Impact Block Information				
Weight	Length	Diameter	C.o.R	RoundOut
0.80 Kips	25.87 in	11.81 in	0.900	0.0100

Diesel Hammer Combustion Chamber Information							
Combustion Chamber Inf.			Combustion			A I Volume	
C-Stroke	Area	Volume	Delay	Duration	ExpCoef	Ignition	Fin.Comb
15.75 in	109.61 in^2	141.00 in^3	0.000	0.000	1.250	155.1 in^3	186.7 in^3

Pressure						
Atmosphere	FS 1	FS 2	FS 3	FS 4	FS 5	Coeff. Conf.
14.7 psi	1400 psi	1300 psi	1200 psi	1100 psi	1000 psi	1.0

Helmet And Hammer Cushion Properties					
Helmet	Hammer Cushion				
Weight	Material	WEAP Input	CoR	Cushion Area	Thickness
1.60 Kips	Steel	30000 Ksi	0.70	280 in^2	6.00 in

B3505

SINGLE ACTING DIESEL PILE HAMMER

SERIAL NO.

__-___-35

Lwa

131 dB

CE

MODEL **B3505**

RATED ENERGY **62.4kJ/46,000ftlb**

BARE HAMMER WEIGHT(Mass)	4,809kg/10,602lb
TYPICAL OPERATING WEIGHT(Mass)	5,443kg/12,000lb
RAM WEIGHT(Mass)	1,814kg/4,000lb
RATED STROKE	3.5m/11.5ft
OPERATING FREQUENCY	36-60 BPM
FUEL TANK CAPACITY	59L/15.6gal
OIL TANK CAPACITY	7L/1.9gal

**ADDITIONAL SPECIFICATIONS AT WWW.BERMINGHAMMER.COM*

MANUFACTURE DATE:

Berminghammer

FOUNDATION EQUIPMENT.

HAMILTON ONTARIO CANADA

B3505

SINGLE ACTING DIESEL PILE HAMMER

SERIAL NO.
00 01 -35

Lwa
131 dB

CE

MODEL	B3505
BARE HAMMER WEIGHT(Mass)	4,809kg/10,602lb
TYPICAL OPERATING WEIGHT(Mass)	5,443kg/12,000lb
RAM WEIGHT(Mass)	1,814kg/4,000lb
MAX. PHYSICAL STROKE	4.0m/13.0ft
RATED STROKE	3.5m/11.5ft
OPERATING FREQUENCY	36-60 BPM
FUEL TANK CAPACITY	59L/15.6gal
OIL TANK CAPACITY	7L/1.9gal
RATED POTENTIAL ENE	62.4kJ/46,000ftlb
MAX. KINETIC ENERGY	46.1kJ/34,000ftlb

MANUFACTURE DATE: 12-2000

Berminghammer

FOUNDATION EQ

HAMILTON ONTARIO CANADA

Midwest Vibro

Pile Drivers - Vibratory Hammers - Augers - Air Hammers - Lead Systems - Extractors and Drilling Equipment

- MIDWEST VIBRO /
- DRIVERS / EXTRACTORS /
- Model H-1700 /

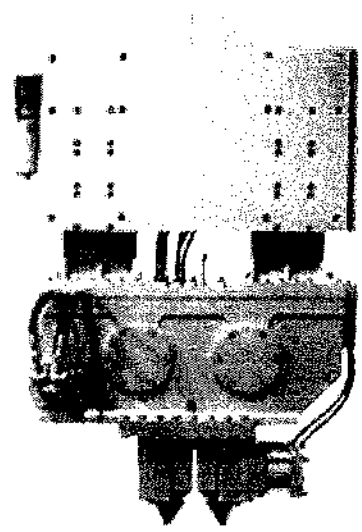
- MIDWEST VIBRO
- DRIVERS / EXTRACTORS»
- DEALERS
- SERVICE SCHEDULE
- GALLERY
- CONTACT

H&M Vibro Inc. Vibratory Driver/Extractor

Model H-1700

Vibrator Specifications

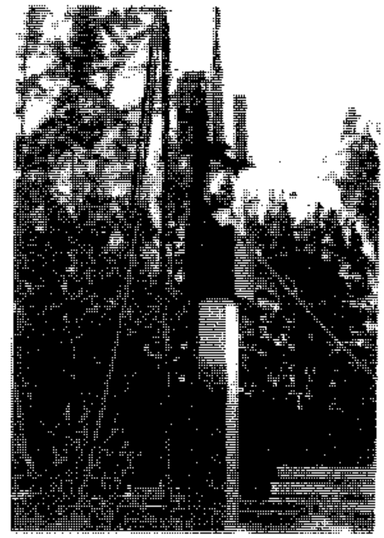
- **Hydraulic** — Type
- **180** — Horsepower
- **1,200** — Frequency
- **7/8 inch** — Amplitude
- **1,740 in. lbs.** — Eccentric Moment
- **30 ton** — Max Line Pull for Extraction
- **75 ton** — Pile Clamping Force
- **107 inches** — Height with Head
- **55 inches** — Length
- **12 inches** — Throat Width
- **7,000 lbs.** — Weight with Standard Clamp
- **3,600 lbs.** — Optional Counterweight



Power Pack Specifications

- **John Deere 6068HE** — Engine
- **225** — Rated HP
- **62 gallons** — Fuel Tank Capacity
- **100 gallons** — Hydraulic Tank Capacity
- **75 gallons** — Eccentric Pump Capacity
- **8 gallons** — Clamp Pump Capacity

- **10 micron** — Hydraulic Filters
- **110 inches** — Length
- **42 inches** — Width
- **55 inches** — Height
- **5,000 lbs.** — Weight



Next Product

Contact Us 800-648-3403
midwestvibro@sbcglobal.net

AMERIgreen AW

BIODEGRADABLE ANTI-WEAR HYDRAULIC FLUIDS

DESCRIPTION:

Amerigreen AW Biodegradable Anti-Wear Hydraulic Fluids are formulated from readi biodegradable renewable resources, high lubricity base oils coupled with proprietary nontoxic anti-wear and anticorrosion additives. These high performance products can reduce operating temperatures, friction, and component wear in mobile and industrial hydraulic systems. Excellent thermal and oxidative stability assure superior service life with minimal viscosity change over a broad range of operating temperatures. Amerigreen AW fluids are suitable for use in ecologically sensitive applications. Available in ISO grades 32, 46 and 68.

FEATURES:

- Readily biodegradable renewable resource.
- Superior anti wear and extreme pressure protection.
- Advanced rust and corrosion protection.
- High viscosity index/temperature stability.
- Low sustainable operating temperature.
- Ultra-low toxicity.

TECHNICAL DATA:

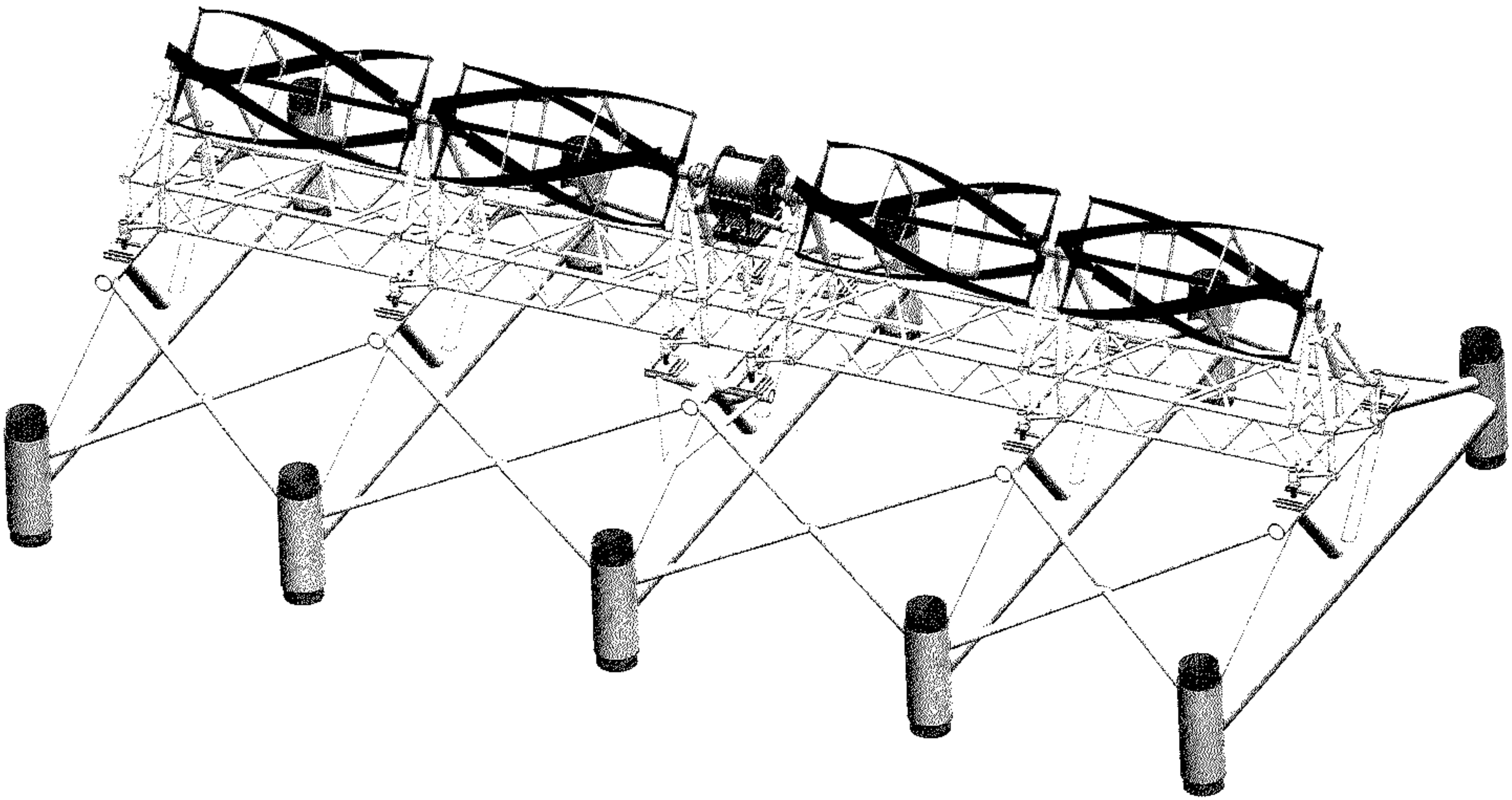
		AW32	AW46	AW68		
ISO Grade:		32	46	68		
Specific Gravity:		.913	.913	.913		
Viscosity	ASTM D445					
@ 40°C, cSt:		32	46	68		
Viscosity Index:	ASTM D2270	>188	>200	>200		
Pour Point °F (°C):	ASTM D97	-20 (-28)	-6 (-21)	-6 (-21)		
Flash Point °F (°C):	ASTM D92	>325(163)	>500 (260)	>500 (260)		
Copper Corrosion:	ASTM D4048	1A	1A	1A		
Rust Test, A & B:	ASTM D665	Pass	Pass	Pass		
Biodegradability, %:	CEC-L-33-A-94	>95	>95	>95		
Suggested Operating Range		Zero to 170F	20F to 170F	20F to 170F		
Dielectric Breakdown Voltage	ASTMD877	>55 kV	>55 kV	>55 kV		
Aquatic Toxicity, Fathead						
Minnow, LC50, 48hrs., ppm	EPA-821-R-02-012	>10,000	>10,000	>10,000		

AVAILABLE PACKAGING:

5 Gallon Pails, 55 Gallon Steel or Plastic Drums, 275 Gallon Totes, and Bulk.

AMERIgreen

Amerigreen
55 Doe Run Road
Manheim, PA 17545 / 888-423-8357 (Bioblend Mfg.)



TID-GEN BASE

Subject: FW: decibel readings
Date: Tuesday, August 23, 2011 9:23:25 AM ET
From: Herb Scribner
To: 'Martha Gray'

The vibratory hammer levels are in the email string
Herb

From: Doug Haverkamp [mailto:doughaverkamp@aol.com]
Sent: Tuesday, August 16, 2011 4:56 PM
To: hscribner@orpc.co
Subject: Fwd: decibel readings

Doug Haverkamp V.P.
Midwest Vibro Inc.
H&M Vibro Inc.
office.800-648-3403
cell.616-822-3651
p.o.box 224 Grandville,M.I.49468-0224
3715 28th sw Grandville,M.I.49418
www.midwestvibro.com

-----Original Message-----
From: Doug Haverkamp <doughaverkamp@aol.com>
To: hsribner <hsribner@orpc.co>
Sent: Tue, Aug 16, 2011 12:23 pm
Subject: Fwd: decibel readings

Herb nice talking with you today,here is the info on the H-1700 vibro that C.P.M. is using.If can help you with anything else please call.

Thanks Doug

Doug Haverkamp V.P.
Midwest Vibro Inc.
H&M Vibro Inc.
office.800-648-3403
cell.616-822-3651
p.o.box 224 Grandville,M.I.49468-0224
3715 28th sw Grandville,M.I.49418
www.midwestvibro.com

-----Original Message-----
From: Doug Haverkamp <doughaverkamp@aol.com>
To: j.zito <j.zito@american-equipment.com>
Sent: Thu, Aug 4, 2011 10:52 am
Subject: decibel readings

John we did a decibel reading on our H-1700 power unit today,the readings are as follows. at the operators position db was 112 ,15' 94 db,at 40' 82 db, at 80' 78 db.The engine was at full throttle position.

John if you need more readings please feel free to contact me.

Thanks Doug

Doug Haverkamp V.P.
Midwest Vibro Inc.
H&M Vibro Inc.
office.800-648-3403
cell.616-822-3651
p.o.box 224 Grandville,M.I.49468-0224
3715 28th sw Grandville,M.I.49418
www.midwestvibro.com

From:	Peter Stein
To:	hscribner@orpc.co; Patrick Edson; "Martha Gray"
Subject:	Pile driving zones of influence
Date:	Thursday, August 18, 2011 6:08:53 PM
Attachments:	pile_driving_snd_comp9_27_07.pdf

Herb,

I have been able to come up with a good estimate of pile driving noise and zones of influence based on the in-air estimates you sent me (112 dB at the operator) and Table 1.2-1 (impact pile driving) and Table 1.2-2 (vibratory pile driving) of the attach report.

On a constant radiated energy level, one can transfer in-air data to in-water data by adding 62 dB to account for differences in reference levels and specific acoustic impedance (ratio of particle velocity to pressure). Thus your 112 dB in-air vibratory source level at the operator (presume 1 m away) equates to roughly 174 dB re μPa^2 @ 1 m in water. The 131 dBA from the plate on the impact hammer would equate to 193 dB re μPa^2 @ 1 m in water.

From the tables in the attached report we are looking at source levels (rms) that average around 190 dB re μPa^2 @ 1 m for impact measurements (190 dB for a 1 meter diameter pipe) and 175 dB re μPa^2 @ 1 m for the vibratory hammer. So this is very consistent with the in-air measurements you passed to me once adjusted for energy conversion into the water. Thus these are good estimates to determine your mitigation requirements.

Presuming Level A harassment is above 180 dB for the impact hammer, your zone of influence for level A harassment is roughly 30-100 m. You will therefore need mitigation measurements to insure that no marine mammals get within 100 m of the pile driving.

Presuming Level B harassment levels for the continuous vibratory source is 120 dB, and we assume 15logR propagation loss in shallow waters (cylindrical spreading would be 10logR and spherical spreading would be 20logR), then the 175 dB vibratory levels do not attenuate to 120 dB until you are 4600 meters, or roughly 2.5 miles from the source. This is basically the entire bay. So you need an IHA for level B harassment for the bay area.

Please give me a call if you need anything further.

Peter

Dr. Peter J. Stein
President
Scientific Solutions, Inc.
99 Perimeter Road
Nashua, NH 03049
603-880-3784

Hydrophone TC4013

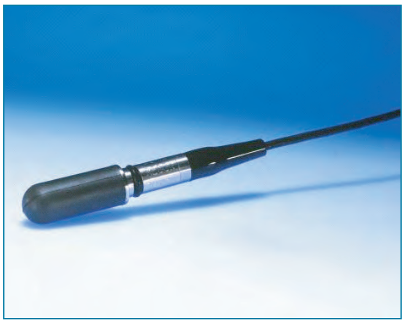
Miniature Reference Hydrophone

TC4013

- High sensitivity
- Omnidirectional to high frequencies
- Broad banded
- O-ring sealed mounting
- Individually calibrated

The TC4013 offers a usable frequency range of 1Hz to 170kHz and a high sensitivity relative to its size. It further more provides uniform omnidirectional sensitivities in both horizontal and vertical planes up to high frequencies.
The TC4013 is an excellent transducer for making absolute sound measurements and calibrations within a broad frequency range. It can also be applied as an omnidirectional reference projector.
The overall characteristics makes TC4013 extremely applicable for laboratory as well as industrial uses.

TECHNICAL SPECIFICATIONS	
Usable Frequency range:	1Hz to 170kHz
Receiving Sensitivity:	-211dB ±3dB re 1V/μPa
Transmitting Sensitivity:	130dB ±3dB re 1μPa/V at 1m at 100kHz
Horizontal Directivity Pattern:	Omnidirectional ±2dB at 100kHz
Vertical Directivity Pattern:	270° ±3dB at 100kHz
Nominal capacitance:	3.4nF
Operating depth:	700m
Survival depth:	1000m
Operating temperature range:	-2°C to +80°C
Storage temperature range:	-40°C to +80°C
Weight (in air):	75g
Cable length:	Standard length 6m Optional cable lengths available on request
Encapsulating material:	Special formulated NBR



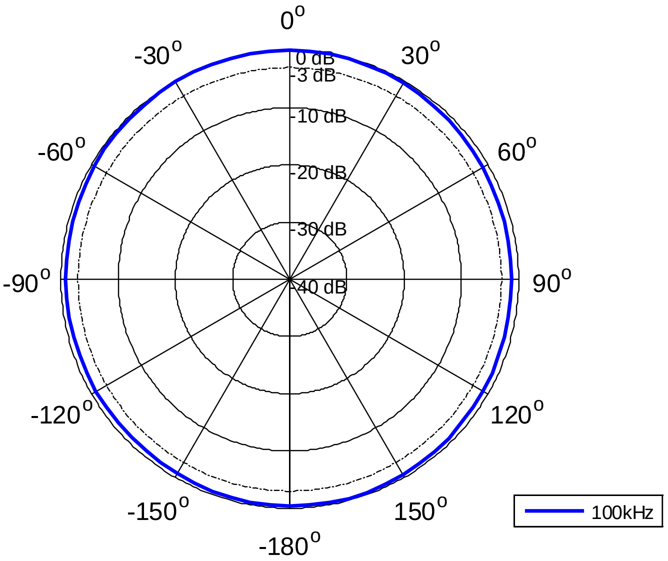
NBR means Nitrile Rubber

The NBR rubber is first of all resistant to sea and fresh water but also resistant to oil.
It is limited resistant to petrol, limited resistant to most acids and will be destroyed by base, strong acids, halogenated hydrocarbons (carbon tetrachloride, trichloroethylene), nitro hydrocarbons (nitrobenzene, aniline), phosphate ester hydraulic fluids, Ketones (MEK, acetone), Ozone and automotive brake fluid.

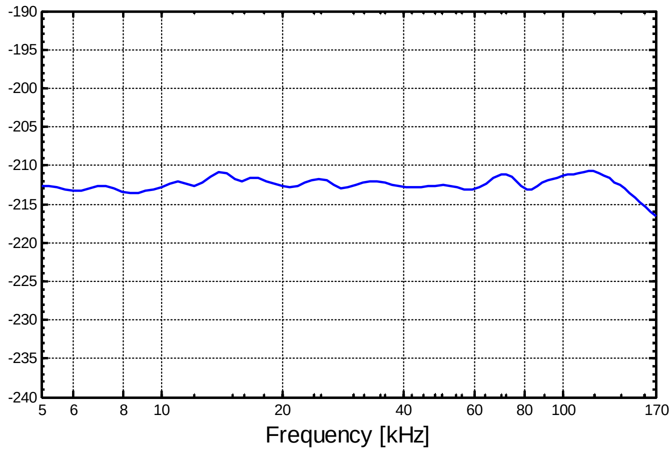
Hydrophone TC4013

Miniature Reference Hydrophone

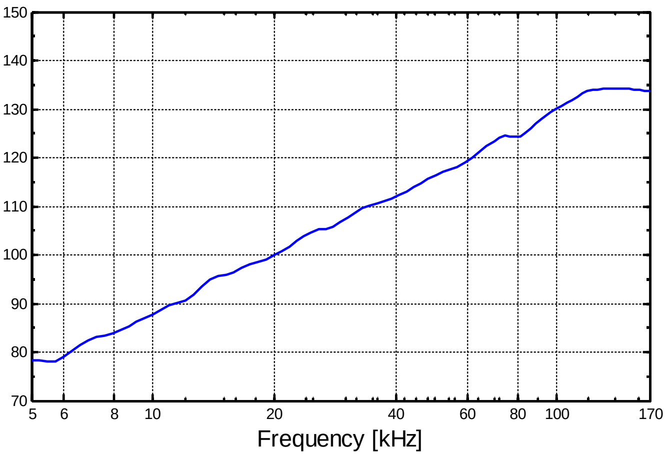
Horizontal directivity pattern



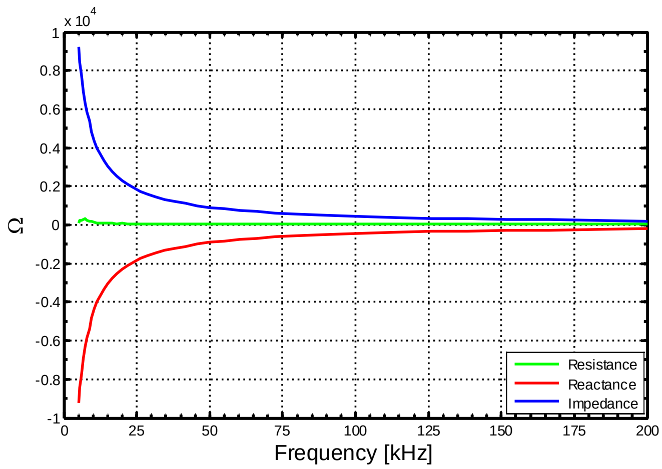
Receiving Sensitivity [dB re 1V/µPa @ 1m]



Transmitting Sensitivity [dB re 1µPa/V @ 1m]



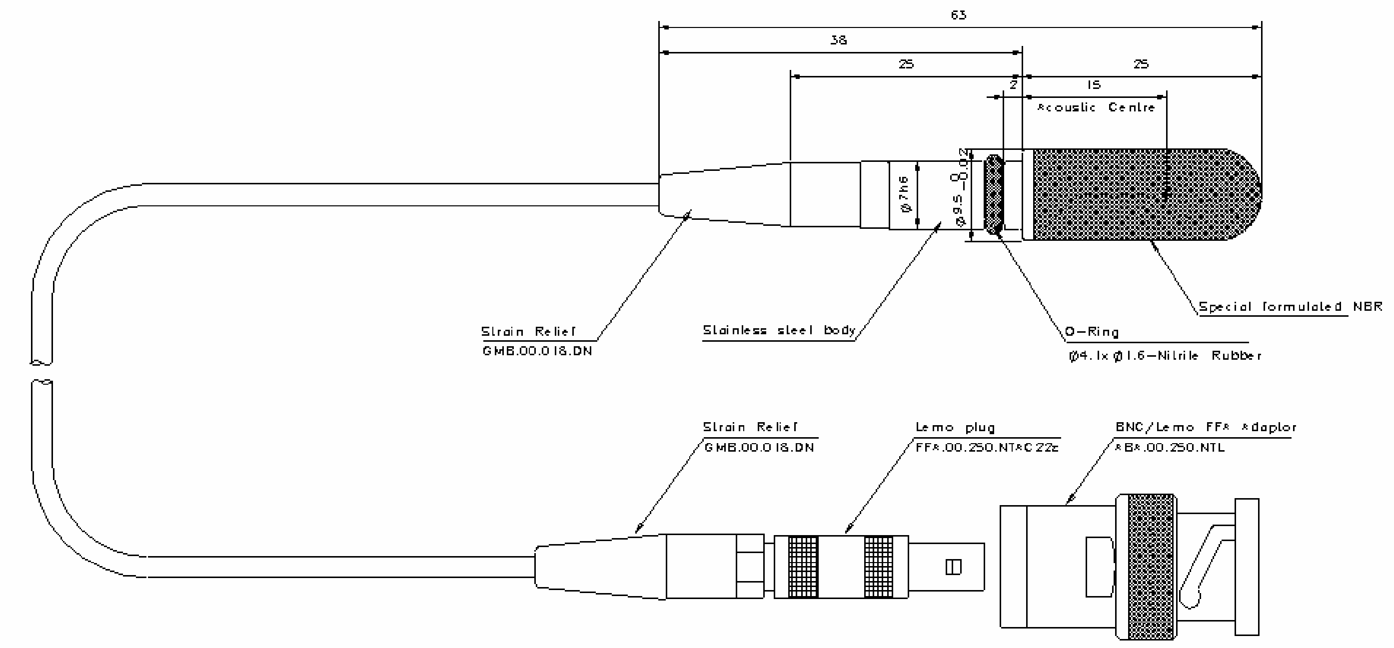
Impedance



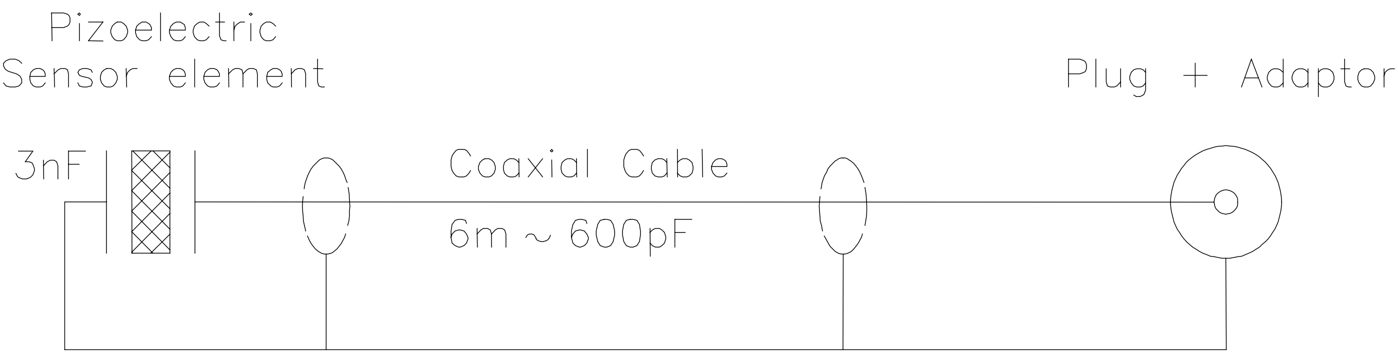
Hydrophone TC4013

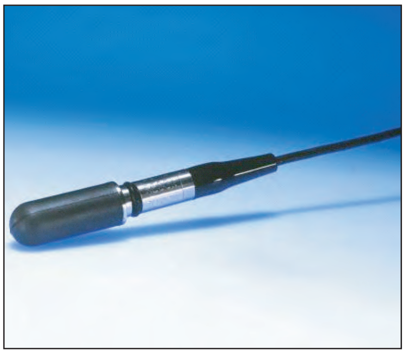
Miniature Reference Hydrophone

Outline Dimensions



Electrical Diagram





For Acoustical Measurement Accuracy please refer to www.reson.com or contact sales.

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RESON B.V.
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Tel: +31 (0)10 245 1500
info@reson.nl

RESON (Pte.) Ltd
Singapore
Tel: +65 6725 9851
sales@reson.com

Version: B108 070711 / A4

WaveBook/516E

Ethernet-Based Portable High-Speed Waveform Acquisition

Features

- 16-bit/1 MHz A/D
- 1 µs/channel scanning of any combination of channels
- Single and multichannel analog triggering with programmable level & slope
- Digital TTL-level and pattern triggering
- Pulse trigger and external clock
- Programmable pre- and post-trigger sampling rates
- Sixteen digital inputs can be scanned synchronously with analog signals
- Operable from AC line, a 10 to 30 VDC source, such as a car battery, or optional compact rechargeable battery module
- Expandable up to 288 high-speed channels
- SYNC connection allows multiple units to sample synchronously
- Add up to 854 lower-speed thermocouple channels
- DSP-based design provides real-time digital calibration on all channels

Signal Conditioning Options

- IEPE dynamic signal inputs
- Strain gages
- Programmable filtering
- Simultaneous sampling
- Quadrature encoder inputs
- Pulse/frequency measurements
- Thermocouples
- High-voltage measurements
- Vehicle bus network

Software

- Includes WaveView for *Out-of-the-Box* setup, acquisition, & real-time display:
  - Scope mode for real-time waveform display
  - Logger mode for continuous streaming to disk
- Comprehensive drivers for DASYLab®, LabVIEW®, MATLAB®, Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET
- WaveCal software application for easy user calibration
- Supported Operating Systems: Windows 7/Vista/XP SP2, 32-bit or 64-bit

The WaveBook/516E is ideal for measuring dynamic signals in portable and laboratory applications

The WaveBook/516E digitizer offers multichannel waveform acquisition and analysis for portable or laboratory applications. The WaveBook includes 8 built-in channels expandable up to 72 channels of voltage, accelerometer, microphone, strain gage, thermocouple, position encoder, frequency, high voltage, and other signal types. For applications beyond 72 channels, up to four WaveBooks can be combined within one measurement system, for a total capacity of 288 channels. You can also add up to 854 thermocouples, without consuming measurement bandwidth of the WaveBooks, using the WBK40 Series, and DBK90 signal conditioning options.

WaveBooks are supported with a wide variety of software to address different applications and skill levels. Included WaveView software allows effortless set-up, time-domain waveform viewing, and real-time storage of acquired data to disk*. Also included is PostView, a post-acquisition waveform viewing application, allowing you to visually scroll through multiple waveforms on your PC screen. For users who prefer to program, the WaveBook also includes comprehensive drivers for DASYLab, LabVIEW, MATLAB, Visual C++, Visual C#, Visual Basic, and Visual Basic .NET.

Also included is DaqCOM, an ActiveX/COM-based set of development tools that allow users to easily develop their own custom applications in either Visual Basic, or C/C++. DaqCOM allows users to distribute WaveBooks throughout a facility of net-enabled PCs, allowing data acquired on any WaveBook attached on the network to be viewed on other PCs on the network.

DASYLab is also available for the WaveBook, allowing a user to simply connect icons to develop custom test and analysis applications.

WaveBook system with 8 strain inputs and 8 accelerometer inputs

* WaveView supports up to 72 high-speed input channels. Applications with multiple WaveBooks, or with WBK40/41 thermocouple options, should use DASYLab or other programming applications supported by the WaveBook, including C++, Visual Basic, or LabVIEW.

WaveBook/516E

General Information

A family of 8-channel WBK expansion options provide volts, accelerometer, strain gage, frequency, and quadrature encoder measurements. Other WBK options provide isolated inputs as well as temperature measurement capability. Most WBK options are fully programmable for gain/range, filter cut-off frequency, AC/DC coupling, etc.

The WaveBook's design is optimized for expansion, reconfiguration and portability. There are no bulky expansion chassis that must be purchased in anticipation of future applications. The compact, all-metal chassis features a low-profile package with front panel inputs.

The WaveBook provides sophisticated multichannel triggering, usually associated with larger, more expensive waveform recorders. The DSP-based design also makes the system more compact than others of similar performance.

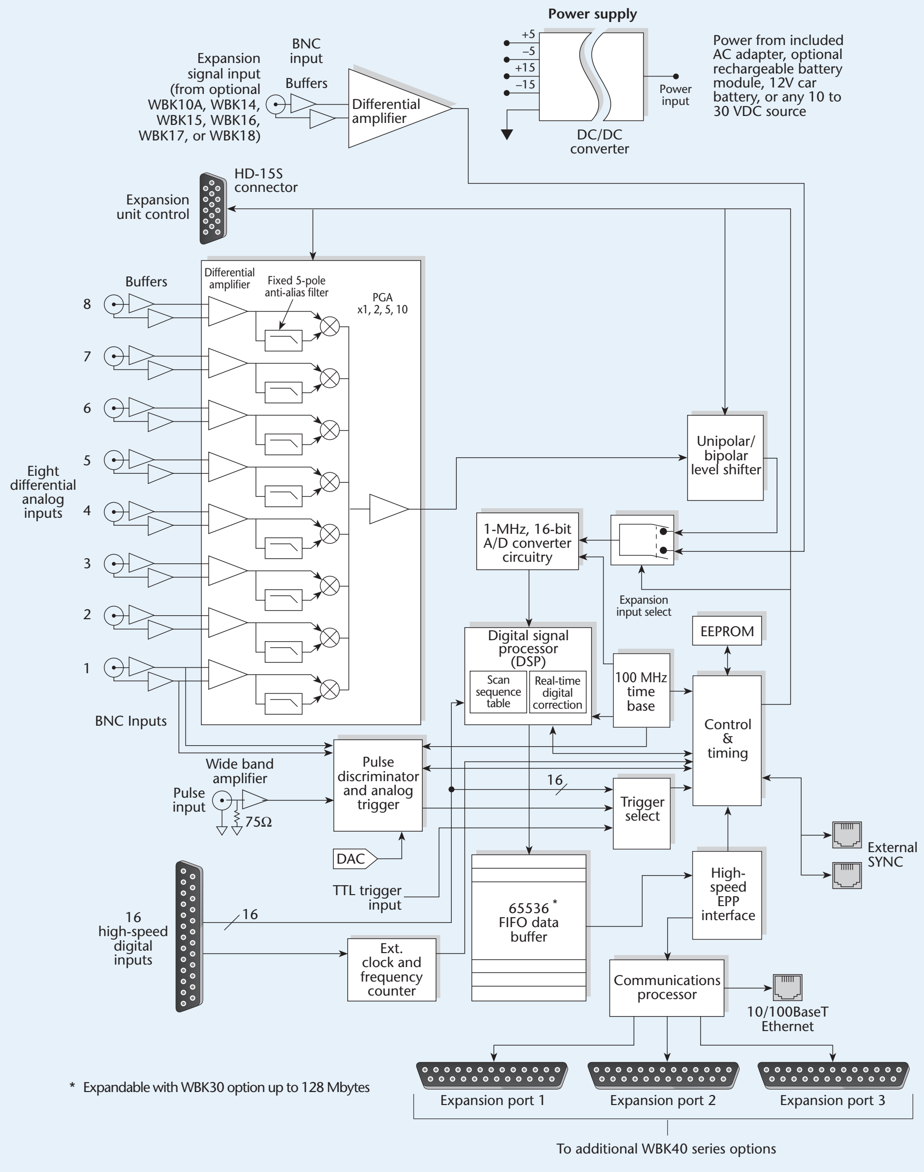
The WaveBook operates on a wide range of power sources, such as a standard AC line, an optional rechargeable battery supply, or even a 12V car battery.

All WaveBooks feature an input buffer amplifier on each of its eight channels. This architecture isolates the input signals from any multiplexing transients and greatly improves frequency response. It also provides far less sensitivity to input-signal source impedance.

To achieve superior signal fidelity, excellent noise immunity, and greater accuracy, the WaveBook follows the input buffer amplifier with individual differential and programmable gain amplifiers on each channel. In addition, a 5-pole, 20 kHz Butterworth anti-aliasing filter can be software-enabled on a per-channel basis to protect against aliasing of high-frequency signal components. For additional gain and filtering, the WaveBook can be factory configured with a WBK11A, WBK12A, or WBK13A.

The WaveBook's DSP automatically compensates for offset and gain errors in each of its amplifiers, including those found in the WBK expansion options on a per-reading, real-time basis. This compensation is based on calibration constants calculated during the system's calibration process. The constants are stored in the system's non-volatile memory. The DSP also permits the WaveBook to accept user-supplied calibration constants, enabling it to automatically scale the input signal for gain and offset individually on every channel.

WaveBook/516E Block Diagram



The WaveBook offers both bipolar and unipolar input ranges, which are per-channel programmable via the sequencer. Bipolar ranges can extend from ±0.05V to ±10V. Unipolar ranges can span from 100 mV to 10V.

The WaveBook also features a 16-bit high-speed TTL digital I/O port for recording discrete TTL-level signals at the beginning of each scan, providing time correlation with the analog inputs.

Triggering

The WaveBook offers a variety of trigger modes. Selection of the optimal trigger mode for your particular application requirements saves time and disk space by ensuring that you capture only the data of interest.

A wide selection of programmable analog and digital trigger modes are available for starting an acquisition. All trigger modes, along with the number of scans and the sample rate for pre- and post-trigger data, are software programmable prior to the start of a scan sequence. The WaveBook also supports digital pattern and pulse triggering. Trigger latency (the maximum time from the trigger to the first reading of a scan group) and jitter (the variation of the latency from acquisition to acquisition) depend on the specific trigger source and type of acquisition. Descriptions of each trigger source and the various trigger modes follow.

Software Trigger. A software trigger is issued by the PC, and causes the WaveBook to begin scanning the setup predefined in the scan buffer. The trigger latency in this mode is longer than in other trigger modes and is a direct function of the PC's performance. It is typically 100 µs or less in post-trigger acquisitions.

Digital TTL Trigger. The WaveBook accepts a single TTL-level signal input to the DB25 digital I/O connector with rising- or falling-edge trigger sensitivity selected through software. Trigger latency in this mode is less than 300 ns for post-trigger acquisitions.

Digital Pattern Trigger. In addition to digital trigger, the WaveBook supports digital pattern triggering. This allows data collection to start when a user-defined 16-bit digital pattern is matched on the digital I/O connector. For example, it is useful when trying to capture noise, vibrations, or some other physical disturbance which occurs at a particular point in a digitally sequenced process, from a PLC or relay logic control system. Trigger latency of the digital pattern trigger is less than 300 ns for post-trigger acquisitions.

Pulse Trigger. This high bandwidth input enables the triggering and the correlation of lower speed waveforms with the occurence of a high speed pulse. With Pulse Trigger, the user defines a pulse by an amplitude between ±5V and a pulse width from 300 ns to 0.8 sec.

Analog Trigger Source. Analog sources are the most commonly used triggers. The WaveBook supports both single-channel analog triggers for quick captures, as well as multichannel analog triggering.

Single-Channel Analog Trigger. Simple single-channel trigger performs analog comparison of channel one to a programmable 12-bit DAC value. You can also select rising- or falling-edge criteria. Trigger latency is less than 500 ns.

When a WBK11A, WBK12A, or WBK13A option is installed (providing simultaneous sample and hold or filtering), the trigger input signal is amplified by the simultaneous sample and hold amplifier before being compared against the analog trigger level. This can increase the trigger signal's sensitivity by a factor of 100.

Multichannel Analog Trigger. Multichannel triggering eliminates spurious data by letting you enter a more selective trigger condition to capture events of specific interest. In multichannel mode, any combination of up to 72 analog channels can contribute to the trigger condition. You can individually program each channel to satisfy its trigger criteria using one of eight states from a combination of above/below level, rising/falling edge, and instantaneous/latched duration. In addition, you can also define a hysteresis band for each channel, reducing false triggers when used with auto re-arm. Finally, you can join all trigger channels together using "ANY" (logical "OR" condition) or "ALL" (logical "AND" condition) Boolean logic operands to form a single, unified trigger condition.

The maximum latency possible in post-trigger acquisitions of the multichannel trigger mode is 2 µs per designated trigger channel, plus 4 µs. For example, if five trigger channels are designated, the maximum latency is 14 µs. The minimum latency in this mode is half the maximum rate; thus, the multichannel trigger jitter time is 1 µs per trigger channel, plus 2 µs.

Acquisition Modes

The WaveBook lets you select one of several acquisition modes for collecting your pre- and post-trigger data. The system offers four post-trigger modes and two pre-trigger modes. The WaveBook uses a combination of internal memory, PC RAM, and your PC's hard disk to seamlessly record all acquired data during the acquisition process.

Post-Trigger Acquisition

In post-trigger acquisition, the WaveBook acquires data only after a trigger condition has been met. You have a choice of four post-trigger acquisition modes, each offering benefits suited to particular applications.

Infinite Linear Mode. In infinite linear mode, the system acquires data for an infinite amount of time after a trigger occurs. This mode is most useful for chart-recorder replacement applications that require long recordings. Once started, the system keeps digitizing until a "stop" command is issued by your PC. The amount of data you can acquire depends on your PC's available memory resources.

Infinite Circular Mode. In infinite circular mode, the system acquires data into a circular buffer indefinitely until it receives a "stop" command from the PC. When the circular buffer is full, it overwrites previously acquired data; thus the buffer always contains the most recently acquired data. This mode is most useful for applications in which file size is limited by PC resources, or an indeterminate number of scans will occur before the stop condition occurs and only the last scans are required. A typical application is destructive testing in which acquisition is complete when the device fails, and only the final failure mode characteristics need to be captured.

Finite Linear Mode. When operating in finite linear mode, the system acquires data after receipt of the trigger until a specified number of scans (from 1 to 100 million) are acquired. Finite linear mode is suitable for applications in which the duration of the event is known.

Re-arm. Finite linear mode permits the specification of the "re-arm" condition. Under such a condition, after a specified number of scans is acquired, the system automatically prepares for a new acquisition by re-arming and re-enabling the trigger, and then capturing a new finite number of scans without the need for either user or computer intervention. This capability is useful in emulating a DSO (Digital Storage Oscilloscope), which typically offers continuous retrace. It is also beneficial for unattended captures in which critical trigger events occur at indeterminate intervals, making manual re-arms awkward. It is further useful for applications in which trigger events occur so quickly that it is difficult to respond manually or under software control.

Finite Circular Mode. In this mode, the WaveBook acquires data into a circular buffer until a specified number of scans (from 1 to 100 million) is acquired. When the circular buffer becomes full, it writes over previously acquired data, and thus always contains the most recently acquired data. This mode is useful for trigger delays; for example, the unit can be pre-configured to record 100,000 scans (after the trigger) at 10 µs intervals and to save only the last 10,000 of the 100,000. In this example, the final record would contain only data acquired 900 ms after the trigger.

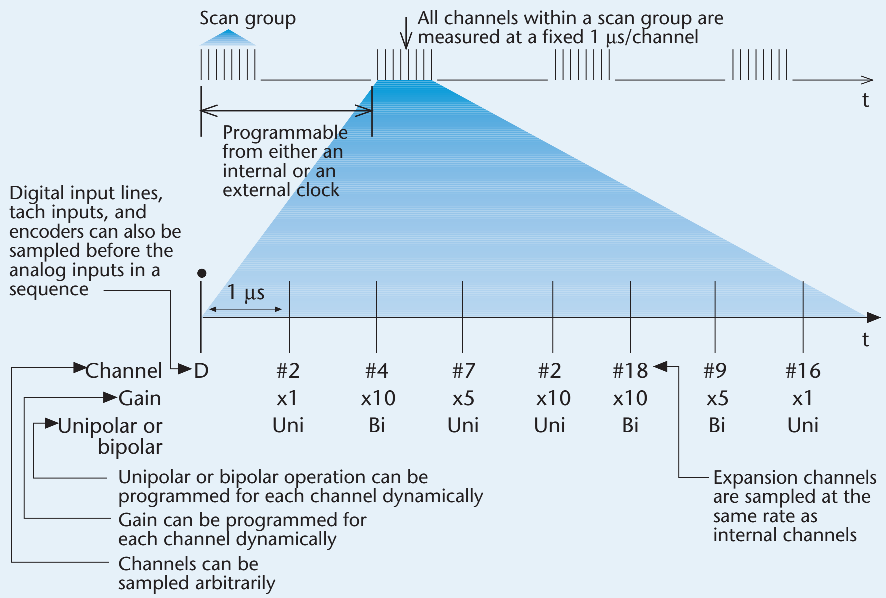
Channel-Scanning Flexibility

The WaveBook provides maximum scanning flexibility via a programmable channel/range sequencer. You can load the sequencer with any combination of channels and associated ranges. Once loaded, the sequencer waits for the trigger condition to be satisfied, after which it begins scanning and digitizing. When scanning begins, the WaveBook selects the appropriate channel and gain, digitizes the input signal, calibrates the reading, and transmits it to the PC via the on-board, 65 Kword FIFO buffer (or into optional internal memory, up to 128 Mbytes). This process is repeated at a 1 µs/sample rate until all channels within a scan group are completed.

Upon completion of a scan group, the WaveBook can be configured to proceed in one of several fashions. For example, the system can be programmed to begin the next scan after a period of 1 µs to 100s, programmable in 0.05 µs increments. It can also be programmed to wait indefinitely until the trigger condition is next satisfied, after which it will again perform a specified number of scans, from 1 to 100 million.

The WaveBook also supports pre-triggering, and is capable of acquiring up to 100 million scans prior to satisfaction of the trigger condition. The pre-trigger buffer is circular, and thus always provides the most recently acquired readings prior to the occurrence of the trigger. In addition, the system permits pre-trigger scan group repetition at one rate and post-trigger scan group repetition at another rate. For example, the system can be configured to repeat scans 1,000 times per second prior to the trigger, and then 100,000 times per second after receipt of the trigger.

WaveBook Scanning Example



Pre-Trigger Acquisition

Pre-trigger permits the acquisition of readings prior to the receipt of a trigger condition. Pre-trigger can be used with any of the four trigger modes described above.

When pre-trigger is selected, the rate at which a scan group repeats can differ before and after a trigger*. (Please note while the sample rates between pre- and post-trigger scan groups can differ, the time between consecutive samples within a group is fixed at 1 µs.) For example, a scan group of 8 channels can be repeated at 1000 scans per second prior to a trigger condition, and at 100,000 scans per second after the trigger. The number of scans acquired during both time periods is also programmable.

The WaveBook first acquires a specified number of pre-trigger scans at the pre-trigger scan rate, and then arms the trigger, guaranteeing that at least the specified number of scans have been acquired before the trigger. The system continues to collect scans at the pre-trigger scan rate until the trigger occurs. Once the trigger is detected, the system finishes collecting the current pre-trigger scan, switches to the post-trigger scan rate, acquires readings using one of the four post-trigger modes described above, and then stops the acquisition. The number of pre-trigger and post-trigger scans are each independently programmable from 1 to 100 million.

Pre-Trigger Circular Mode (requires WBK30 installed). In this mode, data is placed into a circular buffer until the buffer fills, after which the buffer writes over previously acquired data. The system stays in this mode, waiting for the pre-set trigger condition to be met, until the condition occurs or the acquisition is halted by the PC. Upon detection of the trigger condition, the system begins the post-acquisition readings. Since, for practical applications, the WaveBook is only limited by the PC's resources, extremely deep circular buffers can be configured for both the pre- and post-trigger data.

Pre-Trigger Linear Mode.** In this mode, the WaveBook continues collecting data without writing over old data. Since the amount of pre-trigger data can be nearly infinite (if the trigger takes a very long time to occur), this mode may require extensive PC resources to avoid data loss. Unlike the pre-trigger circular mode, which delays the trigger arm condition until a predefined number of scans is collected, the pre-trigger linear mode permits the WaveBook to begin recording post-trigger data as soon as the trigger condition is met, regardless of the number of pre-trigger scans collected. This mode is useful for applications in which the desired number of pre-trigger scans is indeterminate prior to the start of acquisition and all data must be acquired.

External Clock Input***

The WaveBook supports an external clock input, allowing the scanning of data to be dependent upon an external pulse train. This feature is useful in rotating machine or motion applications where data collection is dependent upon rotational speed or axial position. In addition to allowing one scan per pulse, the WaveBook's external clock input features a programmable divider capable of reducing the incoming clock by up to 255. This is useful when the external clock source is faster than the optimum sample rate for the data collection task.

External Clock Timer†. The WaveBook features an internal timer capable of reporting the period of the external clock input. This value can be read with each scan†† of the analog data and is reset by the rising edge of the incoming clock. This is often beneficial in later analysis where physical phenomena needs to be correlated to speed.

Multi-Unit Synchronization

Multiple WaveBook/516Es and WBK40/41s can be synchronized via the rear-panel SYNC ports. Simply connect 2, 3, or 4 WaveBooks together using SYNC cables (CA-74-1). WaveBook software establishes one of the WaveBooks as the *master* and the others as *slaves*. Master WaveBooks can run at the full 1 MHz aggregate sampling rate; slave WaveBooks must have 0.1 µs of unassigned sampling time in the scan group (some trigger modes are not supported in multi-WaveBook systems).

Simultaneous Sampling†††

The WaveBook samples each channel in sequence, at a fixed 1 µs/channel rate. For example, when eight channels are scanned sequentially, the time between sampling the first channel and the eighth channel is 7 µs. For applications that require simultaneous sampling (within 100 ns) of all channels, the optional WBK11A eight-channel simultaneous sample and hold card and the WBK13A programmable low-pass filter card with simultaneous sample and hold are available. The WBK11A or WBK13A can be installed in the WaveBook, or the WBK10A expansion chassis; they provide simultaneous sampling of all channels in a module. Even when multiple WBK11A or WBK13A cards are used within one system, all channels with simultaneous sample and hold active are sampled within 100 ns of one another. Some WBK options include built-in simultaneous sampling, including the WBK16/SSH and WBK18.

* PostView software does not support pre-trigger scan rates that differ from post
** Pre-trigger linear mode and auto re-arm in the WaveBook hardware are not supported in WaveView
*** Full 1M rate not available with external clock
† External clock counter and the high-speed digital inputs are mutually exclusive; adding the external clock counter to the scan list is equivalent to adding two analog channels
†† Requires two locations in the scan sequencer
††† The maximum scan rate when using SS&H is $\frac{1\text{ MHz}}{(n+1)}$ where n=number of channels in the scan list

WaveBook/516E

System Power Connection

The WaveBook and its associated WBK modules offer the flexibility to be powered either directly from a 10V to 30V DC source or via the included TR-40U AC power adapter. Options such as the WBK11A, WBK12A, and WBK13A signal conditioning cards install directly into the WaveBook or WBK10A and derive their power from those units.

Table 1

Input	Maximum Output
DBK30A	1.9 Amps
DBK34A	5.0 Amps
TR-40U	3.3 Amps

If you are operating each module with its included TR-40U AC power adapters, then no calculations are required; just connect the power adapters. In certain applications, however, it may be advantageous or more convenient to operate all components from a single source such as a battery or UPS such as the DBK34A. In those cases, the following worktables provide the necessary information for calculating current requirements for your particular system.

The table below shows the current draw available from IOtech's DBK30A rechargeable battery module, the DBK34A DC UPS, and the included TR-40U AC power adapter. To minimize cabling, each module has a pass-through connector allowing a number of modules to be daisy chained, up to the 5-ampere limit of the connector and CA-115 power expansion cable. The exact number of daisy chained modules is dependent upon your exact configuration.

Calculating the Current

Table 2 provides the approximate required amperage for each component in your system when using a 15V supply. Using this table, calculate the maximum amount of amperage your system will draw by multiplying the quantity of components used by the amperage. Total the values in the last column to arrive at the maximum amperage; then verify that your power source has enough current capacity (see Table 1).

Table 2: Wavebook & Option Current Usage

Units	Qty.	Amps	Total
WaveBook/516E	x	2.10	=
WBK10A, 8-channel expansion module	x	0.30	=
WBK11A, 8-channel simultaneous sample & hold card	x	0.45	=
WBK12A, 8-channel programmable low-pass filter card	x	0.45	=
WBK13A, 8-channel programmable low-pass filter card with SS&H	x	0.50	=
WBK15, 8-channel 5B signal conditioning module	x	0.10	=
WBK15, with 8 5B strain modules (max load)	x	0.75	=
WBK16, 8-channel strain gage module (no load)	x	1.00	=
WBK16/SSH, 8-channel simultaneous sample & hold module	x	1.20	=
WBK17, 8-channel counter/encoder module	x	0.52	=
WBK18, 8-channel dynamic signal conditioning module	x	1.20	=
WBK30, memory option for the WaveBook	x	0.01	=
WBK40 series, modules for WaveBook/516E, with no expansion	x	0.60	=
WBK40 series, modules for WaveBook/516E, with five DBK84's	x	1.30	=
DBK65, 8-channel transducer interface module	x	0.83	=
DBK70, vehichle network interface*	x	0.50	=
		Max. Amps:	

* Typically draws power from diagnostic connector

WaveBook/516E

General Information

External Power Modules

DBK30A

For small, portable applications, the optional DBK30A rechargeable battery module provides up to 3.5 hours of operation at 2.0A current draw. The DBK30A, which is housed in a rugged metal enclosure of the same footprint as the WaveBook, and can be mounted under the system by using the built-in mounting brackets. The DBK30A includes an AC charging supply.

The DBK30A rechargeable battery/excitation module

DBK34A

The DBK34A provides back-up power as an uninterruptible power supply (UPS) to the WaveBook. If DC power is interrupted during an acquisition, this module provides temporary power so the measurement is not disturbed. The DBK34A is powered from an external DC power supply; it does not include an AC charger.

The DBK34A rechargeable lead-acid battery/UPS (uninterruptible power supply) module

The CA-116 optional cigarette-lighter power adapter provides DC power to the WaveBook in automotive applications

Ethernet Features

The WaveBook/516E includes a 10/100BaseT Ethernet interface

The WaveBook/516E transfers acquired data to the PC via 10/100BaseT Ethernet, allowing a continuous stream of a virtually unlimited amount of data to be collected and stored in a PC's memory or hard drive.

The 8-channel WaveBook/516E can be expanded up to 72 channels using 8-channel WBK expansion options. The WaveBook/516E also has 3 built-in parallel expansion ports, permitting connection of up to three additional WBK40 Series units. A sync signal between all devices insures that multi-device systems acquire data synchronously. In total, up to 288 channels of high-speed input can be measured via one Ethernet link*. Also, additional channels are possible using an Ethernet expansion hub, allowing multiple WaveBook/516E units to be attached to one PC.

The WBK40 Series of options connect to one of the WaveBook/516E's parallel expansion ports. Since the WBK40 has its own 200 kHz A/D converter, it does not consume bandwidth from the WaveBook's 1 MHz A/D. The SYNC connection insures that both A/Ds measure synchronously.

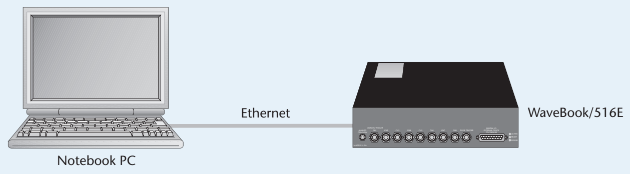
There are two advantages of seamlessly supporting multiple WaveBooks in one system. First is the ability to expand beyond the 72 channel capacity of a single WaveBook. Second, if the per-channel sampling rate of a single WaveBook system is inadequate, then additional WaveBooks can provide more bandwidth per channel.

* The maximum continuous data transfer rate from a multiple WaveBook system to the PC on a dedicated Ethernet link is 2 Mreadings/s

WaveBook/516E

General Information

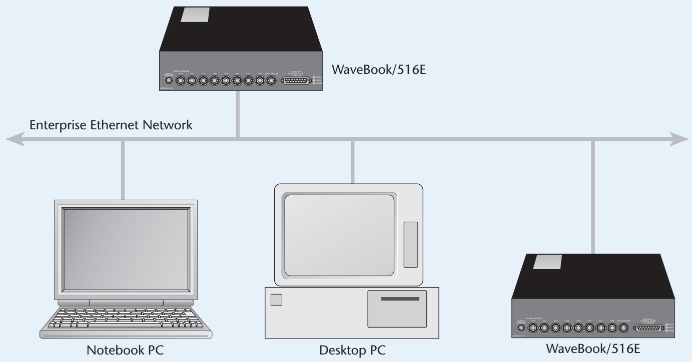
The most common and highest-performance WaveBook/516E connection is with dedicated, point-to-point Ethernet link between the PC and the WaveBook/516E. Data transfer rates in this configuration will accommodate continuous, 1 Mreading/s transfers from the WaveBook/516E to the PC.



Point-to-point Ethernet connection

With an enterprise-wide Ethernet network connection, any number of WaveBook/516E's can be connected to the network, which is shared amongst a potentially large number of Ethernet-connected devices. In this mode, the data transfer rates from the WaveBook/516E will be dependent on other network traffic at the time of data transfer.

This connection method is not recommended when continuous, 1 Mreading/s transfers from the WaveBook/516E are required. To improve the data transfer performance of WaveBook/516E's in this configuration, the WBK30 memory options may be installed into the WaveBook.

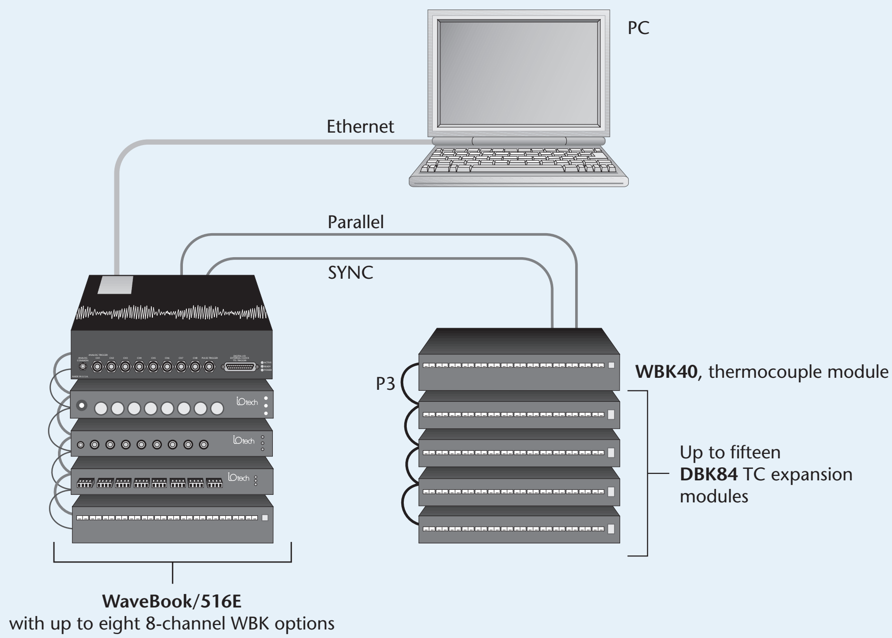


Enterprise-wide Ethernet connection

The parallel expansion ports on a WaveBook/516E can also be used to attach a fourteen channel WBK40 thermocouple interface module. The WBK40 has an internal A/D converter, so that it does not consume valuable bandwidth from the WaveBook516E's 1 MHz A/D converter. The SYNC signal on the WaveBook attaches to the SYNC input on the WBK40, insuring that both A/D's are operating synchronously to one another. The WBK40 can be expanded up to 244 thermocouple channels using DBK84 14-channel TC interface modules.

In synchronous master/slave systems or when using a WBK40/41 module, it is possible to run the slave units at a slower clock rate than that of the master device in the system. This configuration may be necessary when it is desirable to have a system which has signals that need to be sampled at widely varying rates while remaining time synchronous to the master unit.

WBK40 Example



Note: The WBK40 and WBK41 are not currently supported in WaveView. We recommend using DASYLab® when using these modules, which includes full support for the WBK40/41. The WBK40/41 are also supported in LabVIEW®, and DaqCOM. If it is necessary to use these modules in conjunction with a WaveView application, then it is necessary to launch a second, concurrent application to acquire data from the WBK40/41 into separate data files.

Module-to-Module Connection

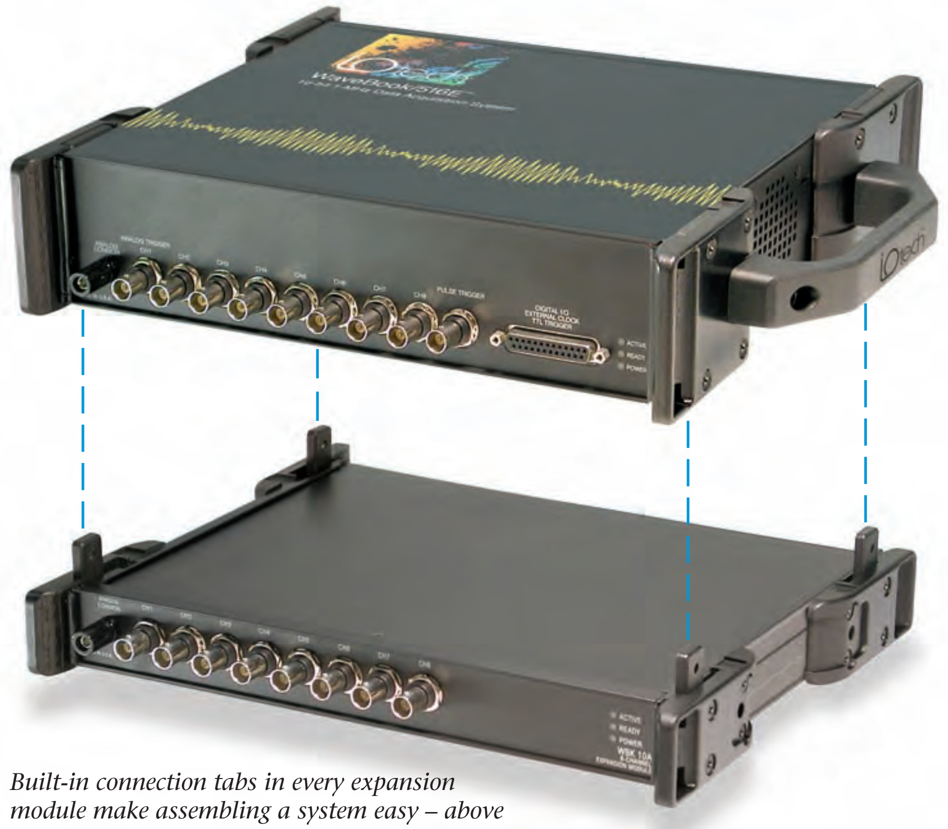
for WaveBook Systems

MEASUREMENT COMPUTING

Assembling a WaveBook system is easy with our new packaging and module-to-module connection system. Every WaveBook and WBK option is housed in an all-metal enclosure, and is encased with rugged molded bumpers on all corners. The bumpers serve to protect the connectors as well as to attach multiple modules together. Within each bumper is a tab which can be rotated 90˚ to lock with other modules attached to either the top or bottom of each module.

One handle is included with each WaveBook, and additional handles can be purchased for in-vehicle applications where a handle on both sides of the system is desirable for securing the system to the vehicle. When multiple modules are attached in a system, the handle can be easily moved from the WaveBook to any other module in the system.

For owners of existing WaveBook and/or WBK systems, the new bumpers can be easily added to your existing hardware. Contact IOtech or your local IOtech representative for details.



Built-in connection tabs in every expansion module make assembling a system easy – above illustrates how a WBK18 would attach to a WaveBook/516E

An assembled system consisting of a WaveBook/516E plus one WBK18 accelerometer module plus one WBK16 strain gage module

WaveView

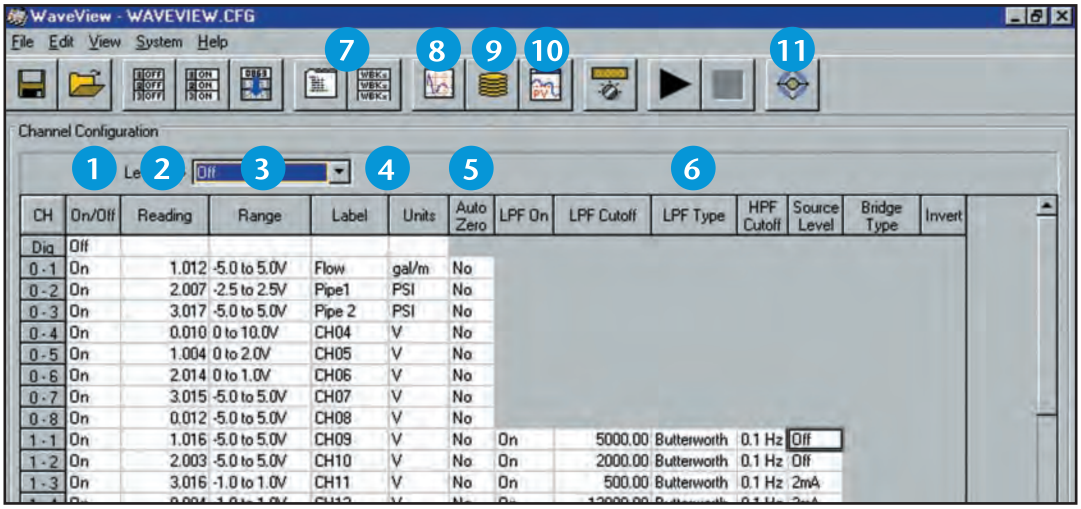
Out-of-the-Box Software

WaveView

WaveView* is a Windows-based setup and acquisition application that allows you to configure, display, and save data to disk within minutes of taking the WaveBook *Out-of-the-Box*. WaveView provides a point-and-click interface that simplifies operation of the WaveBook by allowing setup of all hardware, including the field-installable WBK options, without programming or connecting icons.

Unlike the mere example programs that many suppliers provide with data acquisition hardware, WaveView is a full-featured acquisition and display engine that provides all the functionality needed for many data-logging and display applications. For more frequency-domain analysis applications, use DASYLab®.

WaveView's intuitive approach to hardware control simplifies system setup by automatically querying the WaveBook upon connection to your PC. As WBK options are added for signal conditioning or increased system channel count, WaveView's channel configuration spreadsheet automatically expands to accommodate the additional channels. Specific channel characteristics, such as gain, unipolar/bipolar, and channel labels, are automatically updated, and any additional functionality (such as low-pass filtering, filter cutoff, or excitation output), also automatically appear in the channel-configuration spreadsheet. WaveView is also designed for easy operation with display and analysis packages. WaveView provides data in formats compatible with a variety of sophisticated display and analysis packages, including MATLAB®.



Included WaveView is an Out-of-the-Box setup, acquisition, and real-time display program

Note: The WBK40 and WBK41 are not currently supported in WaveView. We recommend using DASYLab® when using these modules, which includes full support for the WBK40/41. The WBK40/41 are also supported in LabVIEW®, and DaqCOM. If it is necessary to use these modules in conjunction with a WaveView application, then it is necessary to launch a second, concurrent application to acquire data from the WBK40/41 into separate data files.

1. Designate an individual data channel as active or inactive by clicking on a select channel.
2. Reading column provides quick indication of sensor condition before acquisition begins.
3. Choose different ranges or gains for each channel, based on the particular WBK options installed. Bipolar and unipolar scales can also be selected for each channel.
4. Assign each channel a unique label, which will be automatically referenced throughout WaveView. Choose the desired engineering units in which to display acquired data, based on the installed WBK options. Parameters can also be entered to perform mX+b scaling on each reading before displaying it.
5. Use auto-zero to remove small offsets such as transducer drift or pre-load conditions prior to acquisition.
6. Enhanced features such as filter type, cutoff frequency, IEPE current source, and bridge configuration automatically appear when hardware is added to the WaveBook system. There are no switches to set and WaveView automatically updates itself for new configurations.
7. Click to review system configuration and acquisition parameters such as scan rate, pre- and post-trigger usage, and trigger criteria.
8. Scope Mode allows customizing and displaying of multiple traces; it supports cursors, re-scaling, and more.
9. Store data to disk in real-time; the auto re-arm function, with automatic file naming, supports back-to-back acquisition of over one million captures without user intervention.
10. Review acquired waveforms with a strip chart style display via PostView.
11. Strain gage setup to calibrate WBK16 strain gage channels.

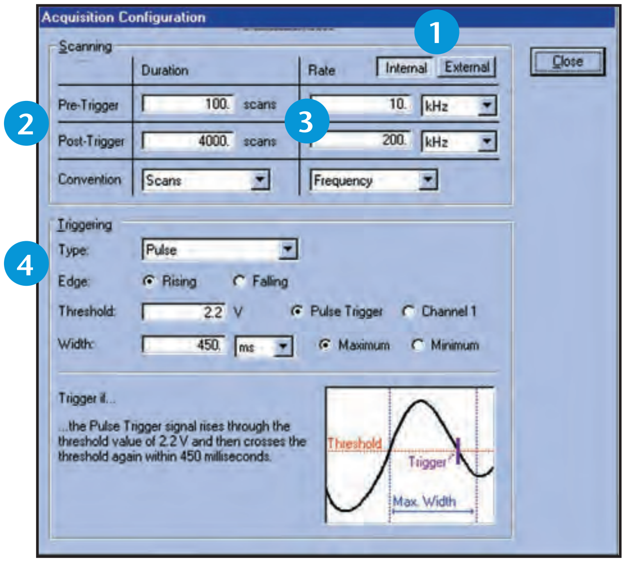
* **Supported Operating Systems:** Windows 7/Vista/XP SP2, 32-bit or 64-bit

WaveView

Out-of-the-Box Software

Scan and Trigger Configuration. The WaveBooks' powerful event-capture capability is made available through the simple, fill-in-the-blank style boxes in WaveView. In addition to single-channel, manual, and external TTL, advanced triggering for multichannel, digital pattern, and pulse trigger is also available. When using multichannel trigger all channels can be combined with boolean "AND" & "OR" operators to begin the acquisition at just the right time. In digital pattern mode, the WaveBook triggers on a user-defined bit pattern making it easy to associate analog data with digital sequences.

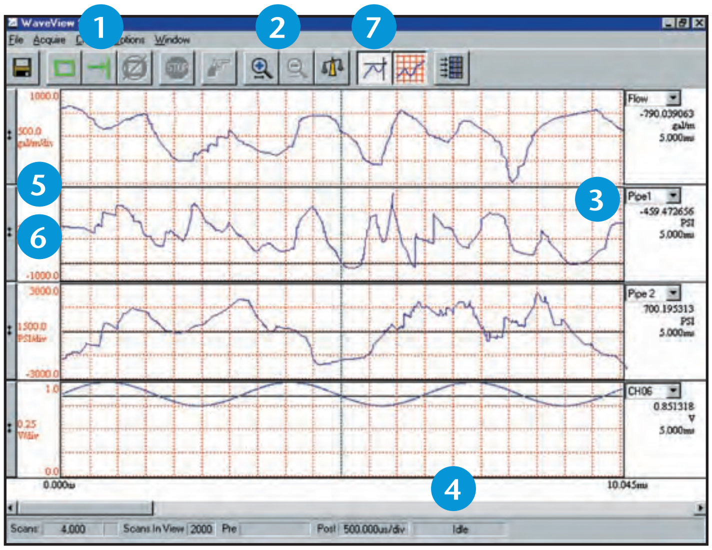
Unique to the WaveBook is the pulse trigger capability shown below. Typically available in systems many times its price, pulse trigger allows capturing that elusive event by defining the level of the signal and pulse width criteria. Now "runt" pulses or glitches buried in apparently good signals can be easily captured.



You can configure the WaveBook via WaveView's scan and trigger configuration screen

1. Allows selection of internal or external clock.
2. Lets you individually set acquisition duration for both pre- and post-trigger data.
3. Offers separate scan rates for both pre- and post-trigger data.
4. Select the trigger mode you need: immediate, manual, multichannel, digital pattern, or pulse.

Scope Mode. Unlike a traditional scope with only two to four channels, WaveView's Scope Mode allows any eight channels to be displayed. Furthermore, WaveView is not handicapped by the small memory limitations of DSOs. In fact, WaveView dynamically and transparently allocates a PC's RAM prior to beginning an acquisition. A simple point-and-click is all that's necessary to initiate multi-Msample acquisitions. In addition, because the data is already in the PC's RAM, a second point-and-click on the disk icon automatically saves this data to disk for import into PostView, a post-acquisition waveform review package, or into analysis packages, such as MATLAB®, DADiSP®, or Excel®.

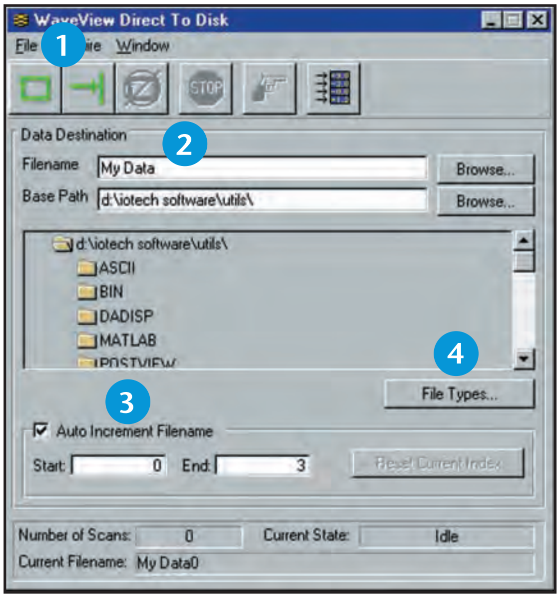


Scope Mode allows you to display any eight of the WaveBooks' channels

1. Supports continuous or single-shot capture and display modes.
2. Provides zoom-in and zoom-out window control of the x-axis.
3. Displays user label and cursor data values.
4. Scroll through all data.
5. Provides auto-scale for quick maximization of the y-axis display.
6. Automatically scales axis in user-defined engineering units.
7. Enables cursor for on-screen measurements.

Logger Mode. For applications where PC RAM is insufficient to record the entire test or where rapid back-to-back recordings need to be saved to disk, WaveView provides a Logger Mode. It complements WaveView's Scope Mode by allowing continuous* recording data directly to disk.

Logger Mode can auto-increment file names to provide the unattended capture of millions of back-to-back events, without user intervention. Acquired data can be stored in several data formats for direct import to packages such as Excel® or PostView.

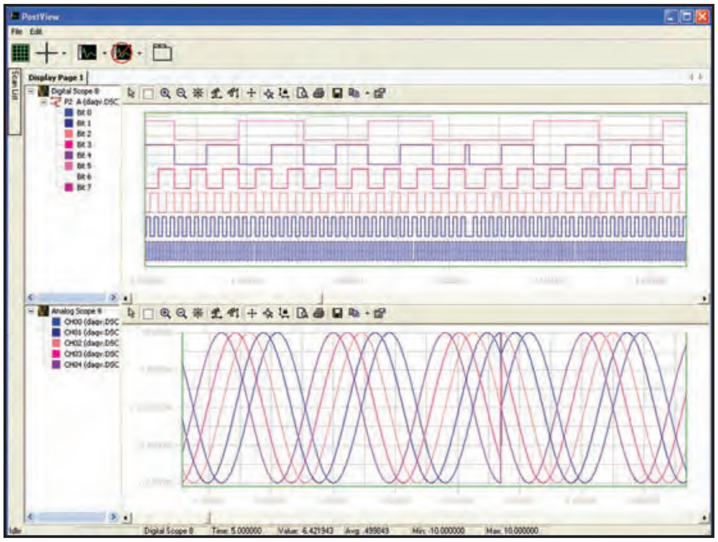


WaveView's Logger Mode can stream data direct to disk in a variety of formats

1. Allows the collection of single-shot or auto-increment file names for back-to-back acquisitions.
2. File name, path, and auto-increment index can be entered by simply filling in the blank.
3. Auto increment creates multiple data files, one per trigger.
4. Choose from an ever-growing list of data file formats for easy importing into other software packages such as DADiSP, DASYLab, MATLAB, Snap-Master, ASCII/Excel Universal File Format (UFF) 58A (ASCII), Universal File Format (UFF) 58B (Binary), and .WAV.

PostView

PostView is a time-domain post-acquisition data viewing package which is integrated and ready to use from within your View package when you install it. PostView provides easy to use basic time-domain data viewing for IOtech data acquisition *Out-of-the-Box* View packages.



PostView, a Windows®-based, post-acquisition waveform viewing application

WaveCal

The WaveBook is also shipped with WaveCal, an application that facilitates periodic calibration of the system. Although all WaveBook components are factory-calibrated to their rated accuracies prior to shipment, annual recalibration is recommended. WaveCal's simple on-screen instructions and direct access to the WaveBook's components, make recalibration fast and easy.

* For acquisitions in excess of 100 million scans, use DASYLab® or other available software

WaveBook/516E

Specifications & Ordering Information

MEASUREMENT COMPUTING

General Specifications

Warm-up: 30 minutes to rated specifications
Environment
Operating: 0 to 50 ˚C, 0 to 95% RH, non-condensing
Storage: -20 to 70 ˚C
Power Consumption: 1.8A max @ 15 VDC
Input Power Range: 10 to 30 VDC
Vibration: MIL STD 810E
PC Communication: 10/100BaseT Ethernet (300 ft. max)
Channel Capacity: 8 built-in voltage channels, expandable to 72 channels with WBK options. Also can accommodate up to 3 additional WBK40 Series options (any combination). Maximum WBK41 capacity is 854 TC input channels, 4 analog output channels, 272 digital I/O channels, and 6 counter/timer channels (see WBK40 on for details).
Dimensions: 285 mm W x 220 mm D x 70 mm H (11" x 8.5" x 2.70")
Weight: 1.9 kg (4.2 lbs)
Handle: One carrying handle is included with each WaveBook

Analog Inputs (18 to 28 ˚C)*

Channels: 8 differential, expandable up to 72 differential
Connector: BNC
Resolution: 16 bit
Ranges: Unipolar/bipolar operation is software selectable via sequencer
Unipolar*: 0 to +10V, 0 to +4V, 0 to +2V
Bipolar: ±10, ±5V, ±2V, ±1V
Maximum Overvoltage: ±35 VDC
Input Bandwidth: DC to 500 kHz
Input Impedance
Single-Ended: 5M Ohm in parallel with 30 pF
Differential: 10M Ohm in parallel with 30 pF
Accuracy
±2 to ±10V: ±0.012% of reading; 0.006% of range
±1V: ±0.018% of reading; 0.008% of range
Input Noise: <2 LSB (RMS)
Total Harmonic Distortion: -84 dB typ
Signal to Noise and Distortion: +74 dB typ
CMRR: 80 dB typ; 70 dB min; DC to 20 kHz

Anti-Alias Filter**

Type: 5-pole Butterworth; 20 kHz, low-pass software enabled

* The following applies when outside 18 to 28 ˚C and is additive to the above specification:

Range	±Gain Error	±Offset Error
±10V	24 ppm/˚C	60 µV/˚C
±5V or 0 to 10V	24 ppm/˚C	30 µV/˚C
±2V or 0 to 4V	24 ppm/˚C	12 µV/˚C
±1V or 0 to 2V	36 ppm/˚C	8 µV/˚C

** No unipolar mode or anti-alias filter with WBK11A, WBK12A, or WBK13A installed

Triggering

Channel 1 Analog & Pulse Trigger
Input Signal Range: -10 to +10V
Bandwidth: 1 MHz
Latency: 300 ns
Multi-Channel Analog Trigger (up to 72 channels)
Range: Selectable per channel to input range
Latency: 2 µs/channel, plus 4 µs max
TTL Trigger
Input Signal Range: 0 to 5V
Input Characteristics: TTL-compatible with 10k Ohm pull-up resistor
Latency: 300 ns
Software Trigger
Latency: 100 µs typical
Pulse Trigger Input
Input Signal Range: ±5V
Input Characteristics: 75 Ohm
Input Protection: ±10V max
Minimum Pulse Width: 100 ns
Maximum Pulse Width: 0.8 sec
Latency: 300 ns

External Clock

Connector: Available on DB25 digital input
Input Signal Range: 5V TTL compatible
Input Characteristics: 50k Ohms pull up (to +5V) in parallel with 50 pF
Input Protection: Zener clamped -0.7 to +5V
Delay: 200 ns
Signal Slew Rate Requirement: 20V/µs min
Rate: Up to 1 MHz
Divisor Ratio: Divide by 1 through 255, selectable
Clock Counter Accuracy: <0.02% error
Clock Counter Range: 0.01 Hz to 100 kHz

Sequencer

Operation: Programmable for channel, gain, and for unipolar/bipolar range in random order
Depth: 128 location
Channel-to-Channel Rate: 1 µs to 1.1 µs/channel, all channels equal
Maximum Repeat Rate: 1 MHz
Minimum Repeat Rate: 100 seconds per scan
Expansion Channel Sample Rate: Same as on-board channels, 1 to 1.1 µs, fixed

High-Speed Digital Inputs/General-Purpose Outputs

Connector: DB25 Female
Configuration: 16 TTL-compatible pins, selectable for input or output
Input Characteristics: TTL-compatible
Output Characteristics: ALS TTL output in series with 33 Ohms
Output Updates: Outputs may be changed via program control
Input/Output Protection: Diode clamped to ground and +5V

Ordering Information

Description	Part No.
16-bit Ethernet, 1 MHz portable data acquisition system includes WaveView, and PostView; comprehensive drivers for DASYLab®, LabVIEW®, MATLAB®, Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET; WaveCal software application; and AC adapter	WaveBook/516E

Accessories

Tough, rugged, and lightweight carrying case	HA-212
Rack mount kit for WaveBook/516E	RackDBK4

Cables

Ethernet patch cable, 1.5 ft.	CA-242
Ethernet patch cable, 7 ft.	CA-242-7
DB25 male to DB25 female parallel cable, 2 ft.	CA-35-2
SYNC cable, 1 ft.	CA-74-1
5-pin male DIN to 5-pin male DIN	CA-115
5-pin DIN to automobile cigarette lighter power cable, 8 ft.	CA-116
DB25 to external clock BNC	CA-178
CE Compliant Cables	
1 male BNC to male BNC	CA-150-1
8 male BNC to male BNC	CA-150-8

Software

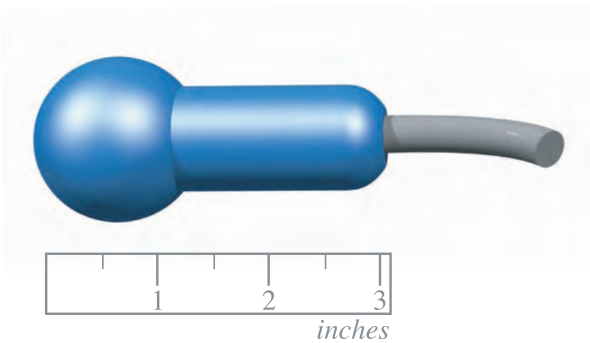
Icon-based data acquisition, graphics, control, and analysis software with WaveBook driver	DASYLab

Model ITC-1042

Spherical Omnidirectional Transducer

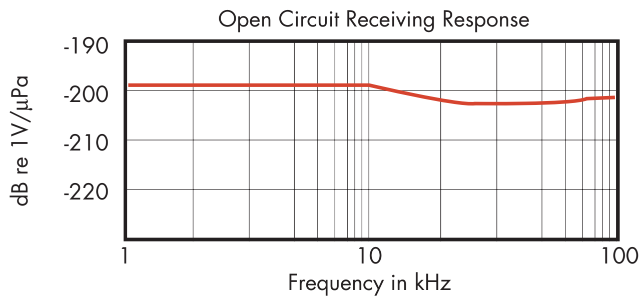
Model ITC-1042

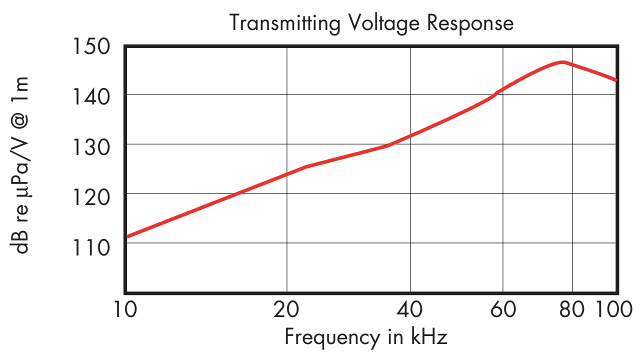
The Model ITC-1042 spherical transducer offers broadband omnidirectional transmitting and receiving response with efficiencies of over 50%. This transducer is fabricated of Channelite-5400 lead zirconate titanate ceramic and is particularly well suited for noise sources as a broadband hydrophone and applications where an omnidirectional response is required. This unit can be supplied with Channelite-5800 for high power applications.

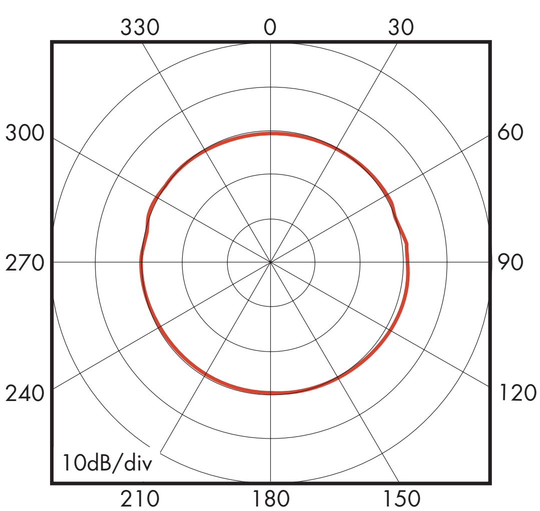


Specifications (Nominal)

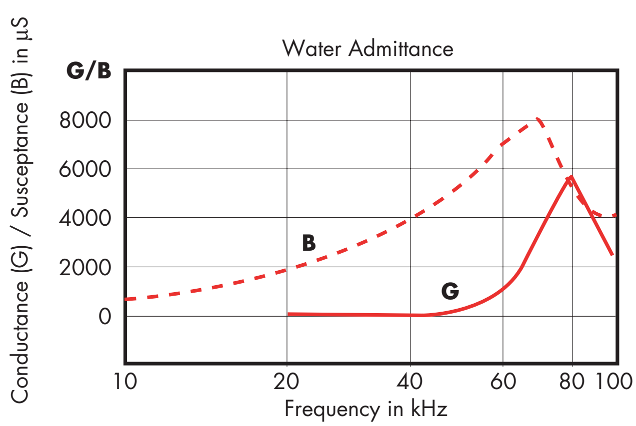
Type	Projector/Hydrophone
Resonance Frequency f_r	79 kHz
Depth	1250 meters
Envelope Dimensions (in.)	1.4D
TVR at f_r	148 dB//µPa/V@1m
Midband OCV	-200 dB//1V/µPa
Suggested Band	.01 - 100 kHz
Beam Type	Spherical
Input Power	100 watts







Directivity Pattern at 20.0 kHz



International Transducer Corporation
869 Ward Drive, Santa Barbara, CA 93111
805.683.2575 • 805.967.8199 FAX
www.itc-transducers.com

LGR-5320 Series

Stand-Alone, High-Speed, Multifunction Data Loggers

MEASUREMENT COMPUTING

Features

- Up to 200 kS/s correlated sampling of all data
- 16 analog inputs up to ±30 V
- 16-bit resolution
- 16 industrial digital inputs up to 30 V
- Single Form C relay digital output configurable for triggering/alarming
- 4 counter inputs (quadrature available)
- 4 GB SD memory card included, supports up to 32 GB
- Multi-channel analog and digital triggering
- Push-button controls for field operation

Software

- Includes DAQLog™ software for easy setup, configuration, and data retrieval
- Multiple trigger and alarming functions
- Ability to save data in .csv format for easy import into Excel®

LGR-5320 Series of high-speed, stand-alone data loggers allow users to collect correlated analog and digital data without a computer

Overview

The LGR-5320 Series are high-speed, stand-alone data loggers for analog and digital signals. Each module offers 16 analog inputs, 16 digital inputs, one single Form C relay (0.5A) digital output for triggering/alarming, and four counter/encoder inputs. These devices allow users to collect high-speed correlated analog and digital data without a computer.

LGR-5320 devices perform high-speed, correlated measurements, up to 200 kS/s, directly to a Secure Digital (SD) or SDHC memory card. Utilizing the advanced analog and digital triggering options, users can collect data to monitor systems and events without dedicating a PC. The LGR-5320 loggers include easy-to-use DAQLog software to configure the devices and retrieve data via the USB interface or SD memory card.

Three models are available in the LGR-5320 Series. The LGR-5325 features up to ±10 V analog inputs, 100 kS/s sampling, four conventional counter inputs (non-quadrature), and single-channel trigger modes. The LGR-5327 features up to ±30 V analog inputs, 200 kS/s sampling, four quadrature encoder inputs, and multi-channel trigger modes. The LGR-5329 includes all the functionality of the LGR-5327 plus isolated digital inputs.

LGR-5320 Series Module Overview

Feature	LGR-5325	LGR-5327	LGR-5329
Sample rate*	100 kS/s	200 kS/s	200 kS/s
Analog inputs	16 SE/8 DE	16 SE/8 DE	16 SE/8 DE
Analog input range	up to ±10 V	up to ±30 V	up to ±30 V
Digital inputs**	16-channel TTL	16-channel TTL	16-channel industrial isolated
Counters	4 conventional	4 quadrature	4 quadrature
Triggering	single-channel	multi-channel	multi-channel

* Sample rates aggregate
** Each logger includes one single Form C relay output

Analog Input

16SE/8DE analog inputs are included on each data logger. The LGR-5325 features multiple analog input gain ranges up to ±10 V. The LGR-5327 and 5329 add a ±30 V analog input range for increased measurement capability. Each data logger provides 16-bit resolution.

Correlated, High-Speed Sampling

The LGR-5327 and LGR-5329 can sample input data at up to 200 kS/s while the LGR-5325 offers a 100 kS/s sample rate. Each module can sample all analog, digital, and counter data synchronously, making it easy to compare time between all channels.

Configuration, Data Storage, and Retrieval

Each data logger can be configured through the SD memory card or via the on-board USB port. Simply configure the logging session with the included DAQLog software. All logging parameters are captured on the SD memory card. A 4 GB SD memory card is included with each data logger. Memory cards up to 32 GB are supported for extended data collection. Data is retrieved by removing the SD memory card from the logger and uploading to a PC or by connecting to the USB port on the logger.

LGR-5320 Series

General Information

Triggering

LGR-5320 Series data loggers offer multiple triggering options for starting and stopping a data scan. These options vary by model. The LGR-5325 features single-channel analog and digital triggering. The LGR-5327 and LGR-5329 offer multi-channel and pattern triggering options. Multiple trigger options allow collection of only the desired data. External clocking is also supported.

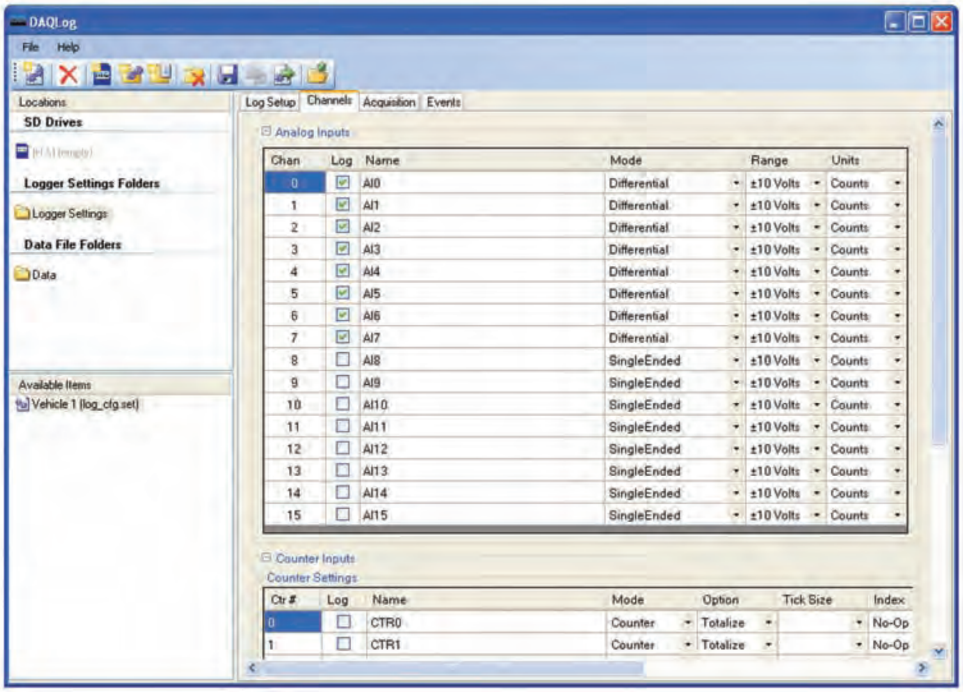
Digital I/O

16 digital inputs are included with each data logger. These inputs can be sampled synchronously with analog input data. The LGR-5325 and LGR-5327 feature up to 28 V digital inputs while the LGR-5329 features up to 30 V digital inputs. The digital inputs on the LGR-5329 also provide 500 VDC isolation.

Each data logger also features one digital output relay channel. The Form C relay can be programmed via the included DAQLog software to alarm when desired conditions are met.

Counters

Four counter inputs are built into the LGR-5320 Series. The LGR-5325 features conventional up/down counters. The LGR-5327 and LGR-5329 include quadrature and conventional counter inputs. Multiple count modes are also supported.



Included DAQLog software for configuration, channel setup, logging parameters, and data retrieval

Push Button Logging Controls

Onboard one touch logging controls are featured on each module for quick and simple operation. These controls can be used for a variety of functions including:

- Configuration loading from SD memory card
- Start/stop logging
- Force trigger/user event
- Device reset
- Control of status LEDs

LEDs on each module provide instant logging and trigger status and activity state.

DAQLog Software

DAQLog Software is an easy to use application included with each LGR-5320 Series data logger. DAQLog uses a spreadsheet style interface that allows simple setup of channel and logging parameters.

DAQLog includes the following functions:

- Data logger configuration
- Channel setup
- Trigger setup
- Data conversion
- Scan rate and acquisition length
- Trigger, event, and alarm parameters

Data can be saved in .csv format for easy import into Excel®.

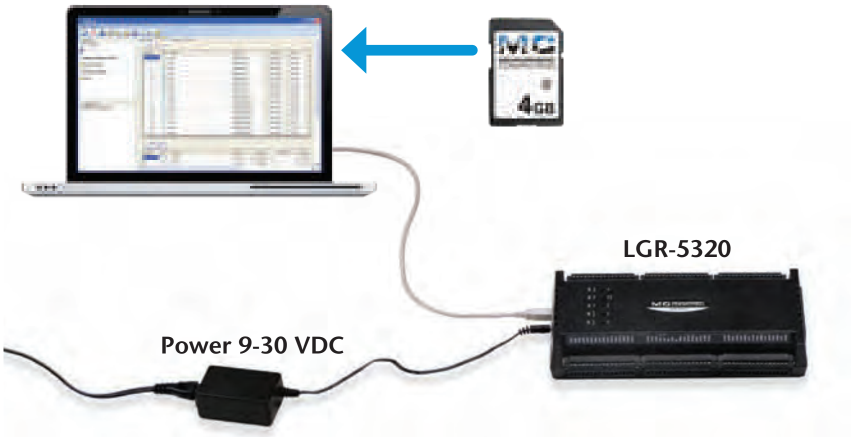
LGR-5320 Series

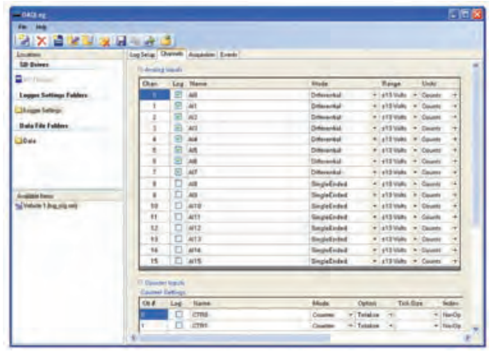
General Information

MEASUREMENT COMPUTING

Configuration, Data Logging, and Retrieval

Configuration via USB or SD Memory Card





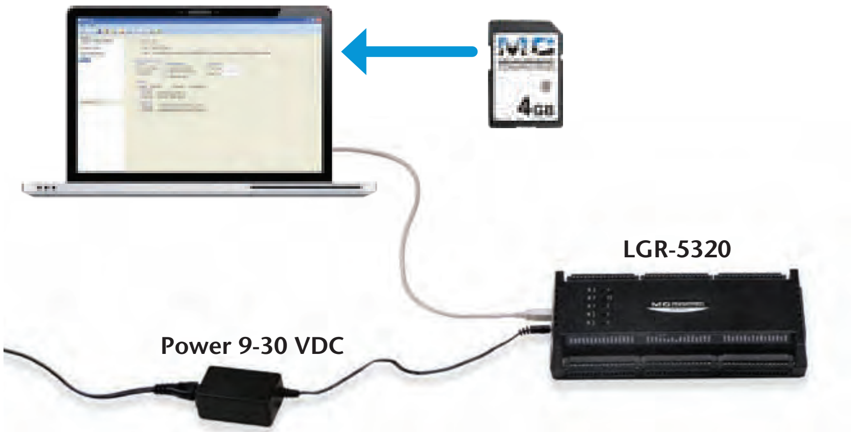
Logging parameters are configured via DAQLog software. The LGR-5320 Series data logger can be setup via USB or by inserting the SD memory card into a PC.

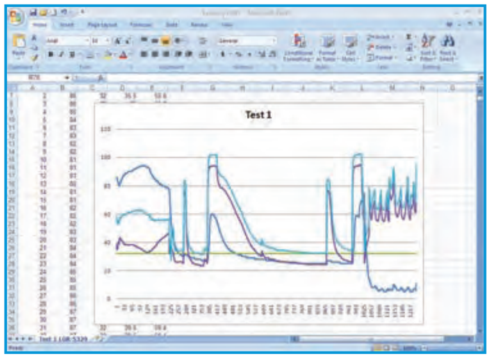
Data rate, scan length, channel parameters, triggers, and alarms are all quickly and easily configured using spreadsheet style setup pages in DAQLog.

Data Logging

The LGR-5320 Series will log data when pre-defined trigger conditions are met. You can also start/stop logging and set trigger, alarm, and event conditions with the push-button controls located on top of the module.

Data Retrieval and Analysis





Retrieval of data can be done by connecting the logger to a PC via USB or by removing the SD memory card and inserting it into a PC.

Once data is uploaded to a PC, the .csv file can be opened in programs such as Excel.

LGR-5320 Series
Specifications

All specifications are subject to change without notice.
Typical for 25°C unless otherwise specified.

Analog input
A/D Converter: 16-bit successive approximation type
Input Ranges: Software selectable per channel;
  5325: ±10 V, ±5 V, ±1 V
  5327, 5329: ±30 V, ±10 V, ±5 V, ±1 V
Number of Channels: 8 differential/16 single-ended, software configurable
Input Configuration: Multiplexed
Absolute Max Input Voltage
  5325: CH_x to AGND, ±25 V max (power ON/OFF)
  5327, 5329: CH_x to AGND, ±38 V max (power ON/OFF)
Input Impedance
  5325: ±10 V, ±5 V, ±1 V range, 10 GΩ (power ON), 1 kΩ (power OFF)
  5327, 5329: ±30 V range, 1 MΩ (power ON), 1 GΩ (power OFF);
    ±10 V, ±5 V, ±1 V range, 10 GΩ (power ON), 1 GΩ (power OFF)
Input Leakage Current: ±100 pA
Input Capacitance: ±30 V range, 90 pf; ±10 V, ±5 V, ±1 V range, 55 pf
Max Working Voltage (signal+ common mode): ±30 V range, ±30.05 V;
  ±10 V, ±5 V, ±1 V range, ±10.2 V
Common Mode Rejection Ratio: fin = 60 Hz, ±30 V range, 65 dB min;
  fin = 60 Hz, all other ranges, 75 dB min
Crosstalk: DC to 25 kHz, adjacent differential mode channels, -80 dB
ADC Resolution: 16 bits
Input Bandwidth (-3 dB): All input ranges, 450 kHz min
Input Coupling: DC
Max Sample Rate
  5325: 100 kHz
  5327, 5329: 200 kHz
A/D Pacing Sources: See input sequencer section
Warm Up Time: 30 minutes, min
Absolute Accuracy: All ranges, 0.07% FSR
Noise: Differential mode, 2 LSB rms

Analog Input Calibration
Calibration Method: Factory calibration
Calibration Interval: 1 year

Triggering
Mode
  External Digital via DTRIG (pin 76): Software configurable for rising or falling edge
  External Analog via ATRIG (pin 78): See external analog trigger
  5327, 5329:
    Multi-Channel Analog: Level-sensitive based on acquired data. Up to 16 channels may be used as independent trigger sources.
    Digital Pattern Trigger: Trigger when a user-defined 1 to 16 bit digital pattern is matched on the DIN0-DIN15 pins. Programmable mask bits.
External Digital Trigger Latency
  Non-Pretrigger Acquisition: 100 ns typical, 1 µs max
  Pretrigger Acquisition: 1 scan period max
External Trigger Pulse Width: 1 µs min
Internal Trigger Latency: 2* (1/per-channel sample rate)

External Analog Trigger
External Analog Trigger Source: ATRIG input (pin 78)
Analog Trigger Input Ranges
  5325: ±10 V
  5327, 5329: ±30 V, ±10 V, software selectable
Absolute Maximum Input Voltage
  5325: ATRIG_IN to AGND, ±25 V max (power ON/OFF)
  5327, 5329: ATRIG_IN to AGND, ±38 V max (power ON/OFF)
Input Impedance
  5325: ±10 V range, 10 GΩ (power ON), 1 kΩ (power OFF)
  5327, 5329: ±30 V range, 1 MΩ (power ON), 1 GΩ (power OFF);
    ±10 V range, 10 GΩ (power ON), 1 GΩ (power OFF)
Trigger Modes: Configurable for positive or negative slope, level
Trigger/Hysteresis Resolution: 12 bits, 1 in 4096
Trigger/Hysteresis Levels: ±10 V/4096 or ±30 V/4096, software selectable
Trigger/Hysteresis Accuracy: ±2% of reading, ±50 mV offset
Latency: 1.5 µS
Full Power Bandwidth (-3 dB): 1 MHz

Digital Input
Number of Inputs: 16 channels
5325
  Input Type: TTL
  Input Voltage Range: 0 to +28 V
  Input Characteristics: 47 kΩ pull-down resistor, 39.2 kΩ series resistor
  Max Input Voltage Level: 0 to +32 V (power ON/OFF)
  Min High Level Input Voltage Threshold: 2.0 V max
  Max Low Level Input Voltage Threshold: 0.8 V min
5327
  Input Type: TTL
  Input Voltage Range: 0 to +28 V
  Input Characteristics: 47 kΩ pull-down resistor, 39.2 kΩ series resistor
  Max Input Voltage Level: 0 to +32 V (power ON/OFF)
  Min High Level Input Voltage Threshold: 2.0 V max
  Max Low Level Input Voltage Threshold: 0.8 V min
  Event Logging: Change of state, pattern recognition; event time stamped using real time clock
5329
  Input Type: Industrial
  Input Voltage Range: 0 to +30 V
  Input Characteristics: Resistor divider 39.2 kΩ series resistor and 10 kΩ shunt resistor connected to IGND
  Max Input Voltage Level: +36 V (power ON/OFF)
  Min High Level Input Voltage Threshold: 10.04 V max
  Max Low Level Input Voltage Threshold: 3.85 V min
  Event Logging: Change of state, pattern recognition; event time stamped using real time clock
  Isolation: 500 VDC min

Digital Output
Number of Outputs: 1
Type: Mechanical relay, NEC ED2/EF2 series
Relay Configuration: 1 Form C
Relay Contact Resistance: 0.075 Ω
Relay Contact Operate Time: 3 mS (excluding bounce)
Relay Contact Release Time: 2 ms (excluding bounce)
Relay Insulation Resistance: 1000 MΩ at 500 VDC
Relay Contact Ratings
  Max Switching Voltage: 220 VDC/250 VAC
  Max Switching Current: 1.0 A
  Max Carrying Current: 2.0 A

LGR-5320 Series

Specifications and Ordering Information

MEASUREMENT COMPUTING

Counters

5325

- **Counter Type:** Conventional
- **Number of Channels:** 4
- **Inputs:** Counter, Up/Down, Gate
- **Resolution:** Fixed 32-bit or as sized by the modulo register
- **Count Modes:** Up/down, period/frequency, Modulon
- **De-Bounce Times (programmable):** 16 steps from 500 ns to 25 ms; positive or negative edge sensitive; glitch detect mode or de-bounce mode
- **Time-Base Accuracy:** 50 ppm
- **Input Voltage Range:** 0 to 5.5 V
- **Input Type:** TTL
- **Input Characteristics:** 49.9K pull-down resistor
- **Max Input Voltage Range:** -0.5 V to +7.0 V
- **Input High Voltage:** 2.0 V
- **Input Low Voltage:** 0.8 V

5327, 5329

- **Counter Type:** Quadrature and conventiobal (x1, x2, x4)
- **Number of Channels:** 4
- **Inputs:** Phase A+/A-, Phase B+/B-, Index ±
- **Resolution:** Fixed 32-bit or as sized by the modulo register
- **Count Modes:** Quadrature, up/down, period/frequency, Modulon
- **De-Bounce Times (programmable):** 16 steps from 500 ns to 25 ms; positive or negative edge sensitive; glitch detect mode or de-bounce mode
- **Time-Base Accuracy:** 50 ppm
- **Receiver Type:** Quad differential receiver
- **Configuration:** Each channel consists of Phase A input, Phase B input and Index input; each input switch selectable as single-ended or differential
- **Differential:** Phase A, Phase B and Index (+) inputs at user connector routed to (+) inputs of differential receiver. Phase A, Phase B and Index (-) inputs at user connector routed to (-) inputs of differential receiver.
- **Single-Ended:** Phase A, Phase B and Index (+) inputs at user connector routed to (+) inputs of differential receiver. Phase A, Phase B and Index (-) inputs at user connector routed to ground. (-) Inputs of differential receiver routed to +3 V reference.
- **Common Mode Input Voltage Range:** ±12 V max
- **Differential Input Voltage Range:** ±12 V max
- **Input Sensitivity:** ±200 mV
- **Input Hysteresis:** 50 mV typ
- **Input Impedance:** 12 kΩ min
- **Absolute Maximum Input Voltage:** Differential, ±14 V max

Power

External Power Supply: +9 V min, +30 V max

Enironmental

Operating Temperature Range: 0 to 55 °C
Storage Temperature Range: -40 to 85 °C
Humidity: 0 to 90% non-condensing

Mechanical

Dimensions: 9.5" L x 5.0" W x 1.75" H

Shock and Vibration Specifications

Mechanical Shock

- **Operating:** 50 g, 3 msec half sine; 30 g, 11 msec half sine; 3 hits per face for a total of 18 hits (18 hits at 50 g, 18 hits at 30 g)
- **Standard:** IEC 60068-2-27

Random Vibration

- **Frequency Hz:** 10-500
- **Vibration Level:** 5 g_{rms}
- **Test Time:** 100 minutes/axis
- **Standard:** IEC 60068-2-64

Ordering Information

Description	Part No.
Stand-alone, high-speed 100 kS/s, multifunction data logger; includes a 4 GB SD memory card, USB cable, and external power supply	LGR-5325
Stand-alone, high-speed 200 kS/s, multifunction data logger; includes a 4 GB SD memory card, USB cable, and external power supply	LGR-5327
Stand-alone, high-speed 200 kS/s, multifunction data logger with isolated digital inputs; includes a 4 GB SD memory card, USB cable, and external power supply	LGR-5329

Accessories

DIN-rail kit	ACC-202
DST kit with 6 detachable screw terminals	ACC-216
External power supply	PS-9V1AEPS230V

BUY NOW!

For complete product specifications, pricing, and accessory information, call 1-800-234-4232 (U.S. only) or visit **mccdaq.com/LGR**.

Preliminary Technical Specifications

STANDARD AND APPROVALS	
Acoustics:	EN/IEC 61672, ANSI S1.4-1983, ANSI S1.43-1997 EN/IEC61260, ANSI S1.11-2004, (Also fulfills all requirements of IEC 60651 and IEC 60804)
European:	EMC: Pending testing on production products.
GENERAL	
Key Pad:	14 pushbuttons
Display Type:	Transflective 128 x 64 dot matrix
Backlighting:	Fiber-optic
Languages:	English, Spanish, German, French, Italian, Portuguese
MEASUREMENTS	
Available Measurements:	SPL, MAX, MIN, Peak, Ln, Leq, Lavg, Sel, TWA, Taktm, DOSE,PDOSE, Ldn, CNEL, Exposure
Ranges: Frequency: Amplitude: Maximum PEAK Level:	 Class 1: 3Hz – 22.4 kHz; Class 2: 20Hz – 8Khz; Filters: 1/1 octave (Optional); 1/3 octave (Optional) Broadband: (8) selectable 100 dB Dynamic Ranges . RTA: (8) selectable 80 dB Dynamic Ranges. 3dB above full scale reading
Parameters: Weighting: Response Time: Octave Band Filters (Optional): Class/Type 1: Threshold: Exchange Rates:	 A, C, Z, (Linear) Fast, Slow, Impulse Class 1, ANSI S1.11-2004, EN/IEC61260 Center Frequencies: (1/3 Mode) 33 center frequencies from 12.5 Hz to 20 kHz. (1/1 Mode) 11 center frequencies from 16 Hz to 16kHz 0 – 140dB 3,4,5,6dB
Run Modes:	Level triggered Run/Pause, Clock/Date triggered power on and Run for programmed duration, External logic input Run/Pause, Keypad initiated Run/Pause for programmed duration.
References: SPL: Frequency: Direction:	 114 dB 1 kHz 0 degrees using a Free Field response microphone.
CALIBRATION	Calibration history is maintained and post study verification logged with calibration history
Calibrators:	QC-10 (114 dB, 1 kHz), QC-20 (94 dB, 114 dB, 250 Hz, 1 kHz)
DATALOGGING OPTION	Requires SD Card
Summary Data and Time History Data Logged:	MAX, MIN, Peak, Ln, Leq/ Lavg
Exceedence Level Data Logged:	2 user selectable Ln levels
Memory Capacity:	Size of installed SD memory card
Intervals:	1sec, 10sec, 15sec, 30sec, 60sec, 5min, 10min, 15min, 30min, 60min
SPECIAL FUNCTIONS	
Back-Erase:	Selectable 1 sec to 20 seconds.
Storage System:	Removable secure digital memory card (SD-Card). Required to store multiple session/studies, setup storage, and for the datalogging option. File formats are PC compatible binary files. QuestSuite is required to interpret data files.
PORTS AND CONNECTIONS	
Secure digital (SD) card:	Used for datalogging, storing setups, and storing session/studies.
Power Jack:	External power supply 9-16 Vdc
AC/DC output:	3.5MM stereo (tip AC, Ring 1 DC, Ring 2 Gnd)
10 pin auxiliary connector :	RS-232, 3 digital outputs, 1 digital input
USB :	Conforms to USB 2.0, Mini B connector

Preliminary Technical Specifications (cont'd)

ENVIRONMENTAL CHARACTERISTICS	
Temperature:	
Operating:	(< ±0.5dB effect) - 10ºC to + 50ºC
Storage:	-25ºC to + 70ºC
Humidity:	TBD
Shock & Vibration:	Magnetic:80 A/m, 50/60 Hz, no effect
External Fields:	Electric: 10 V/m, 1 kHz modulated, 30 MHz – 1 Ghz, < 55 dBC
ELECTRICAL CHARACTERISTICS	
Batteries:	(4) disposable AA Alkalines: 10 hours minimum continuous use depending on configuration/options. Excludes use of backlight.
External DC Power Input:	Voltage: 9 – 16 VDC
External DC Power Supply:	Input: 90 – 264VAC 50/60Hz Output: 9 VDC
Microphones:	Type/Class 2: QE7052 Type/Class 1: BK4936 (Standard)
Meter Input:	50 Kohm nominal input impedance
Preamplifier:	Directly accepts 1/2 in. (0.52" or 13.2 mm) microphone. Other sizes require an adapter
Pre-Amp Assembly:	Preamp is removable
Cable:	Will drive up to 30 meters of cable with negligible signal loss
Input Impedance:	Greater than 1Gohm with 1pf loading
Signal Limit:	11VAC
MECHANICAL CHARACTERISTICS	
Tripod Mount:	A threaded insert on back of the meter accepts a standard 1/4" – 20 tripod mounting screw
Housing:	Stainless fiber filled ABS/Polycarbonate with internal EMC shielding
Size:	3.1″ W x 11.1″ H (w/preamp no microphone) x 1.6″ Thick
Weight:	0.54Kg or 1.2 lbs (including batteries)

Specifications subject to change without notice. For the most current specifications and additional information about Quest Technologies visit our web site at www.Quest-Technologies.com.

Appendix C

Marine Mammal Observation Plan for Pile Driving Activities

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MARINE MAMMAL OBSERVER AND REPORTING PLAN FOR PILE PLACEMENT

INCIDENTAL HARASSMENT AUTHORIZATION
COBSCOOK BAY TIDAL ENERGY PROJECT
FERC PROJECT NO. 12711
ORPC MAINE, LLC

February 21, 2012

Ocean Renewable Power Company, LLC
120 Exchange Street, Suite 508
Portland, ME 04101
Phone (207) 772-7707
www.orpc.co

CONTENTS

1.0 INTRODUCTION

1.1 General Description: Cobscook Bay Tidal Energy Project

ORPC Maine, LLC, a subsidiary of Ocean Renewable Power Company (collectively, ORPC), has applied to the Federal Energy Regulatory Commission (FERC) for a pilot project license for the Cobscook Bay Tidal Energy Project (Project) on September 1, 2011. The Project will evaluate the potential for a new source of clean, renewable energy generation using tidal energy resources in Cobscook Bay, Maine. ORPC obtained an initial preliminary permit for the project area in Cobscook Bay from FERC on July 23, 2007; FERC issued a successive preliminary permit on January 13, 2011. Feasibility studies, including environmental surveys, and pre-filing consultation were conducted, resulting in ORPC's filing of a draft pilot license application (DPLA) with FERC for the Eastport Tidal Energy Project on July 24, 2009. The DPLA included project areas within Cobscook Bay and Western Passage. Since submitting the DPLA, ORPC has conducted extensive consultation with regulatory and resource agencies as well as other stakeholders, has collected additional environmental data, and has continued to refine its proprietary technology. As a result of these additional studies and consultations, ORPC now plans to deploy a commercial-scale hydrokinetic power system in gradual stages, with the Project, a small pilot project, as the first stage. The FERC preliminary permit Project boundary for the Cobscook Bay Tidal Energy Project (FERC Project No. 12711) encompasses the proposed development area.

The Project will be carried out in two separate phases over an expected eight-year pilot license term. In Phase I, ORPC will deploy, monitor and test a single-device TidGen™ Power System for one year. In Phase II, ORPC will add four additional TidGen™ devices to the power system, for a total of five. During both phases, ORPC will deploy environmental monitoring equipment on the TidGen™ Power System and within the Project boundary (Figure 1).

The core component of the TidGen™ Power System is ORPC's proprietary turbine generator unit (TGU). The TGU utilizes four advanced design cross flow (ADCF) turbines to drive a permanent magnet generator mounted between the turbines on a common driveshaft. The ADCF turbines rotate in the same direction regardless of tidal flow direction; rotational speed of the turbines is directly related to water flow speed. The TGU is 98 feet in length, 17 feet high and 17 feet wide. It is attached to a bottom support frame, which holds the TGU in place approximately 15 feet above the sea floor. The bottom support frame is 98 feet long by 50 feet wide by 15 feet high. The bottom support frame is constructed of steel and the TGU is constructed of steel and composite material. Together, the coupled TGU and bottom support frame comprise the TidGen™ device (Figure 2 shows the conceptual design for the TidGen™ device). The depth at the proposed Deployment Area is 85 feet at Mean Lower Low Water (MLLW); the TidGen™ devices will thus be placed 49 feet below the surface at MLLW. Each TGU will have a maximum design capacity of 180 kilowatts (kW). During the Project each TGU will operate at a rated capacity of 60 kW. The five-device TidGen™ Power System will have a maximum design capacity of 900 kW and a rated capacity of 300 kW. The power generated will be connected to the grid using a single subsea transmission cable with a line voltage of 13 kilovolts (kV) DC. The total cable length is approximately 4,200 feet (3,700 feet from the TidGen™ Power System to the shore in Lubec, Maine and approximately 500 feet from shore to the on-shore station). ORPC has chosen an underwater cable route that avoids abrupt changes in bottom topography. Based on consideration of environmental concerns, ORPC proposes to bury the cable at all feasible locations along the cable route. The power generated by the TidGen™ Power System will be conditioned at the on-shore station and delivered to the Bangor Hydro Electric Company power grid.

Figure 1. Cobscook Bay Tidal Energy Project location map.

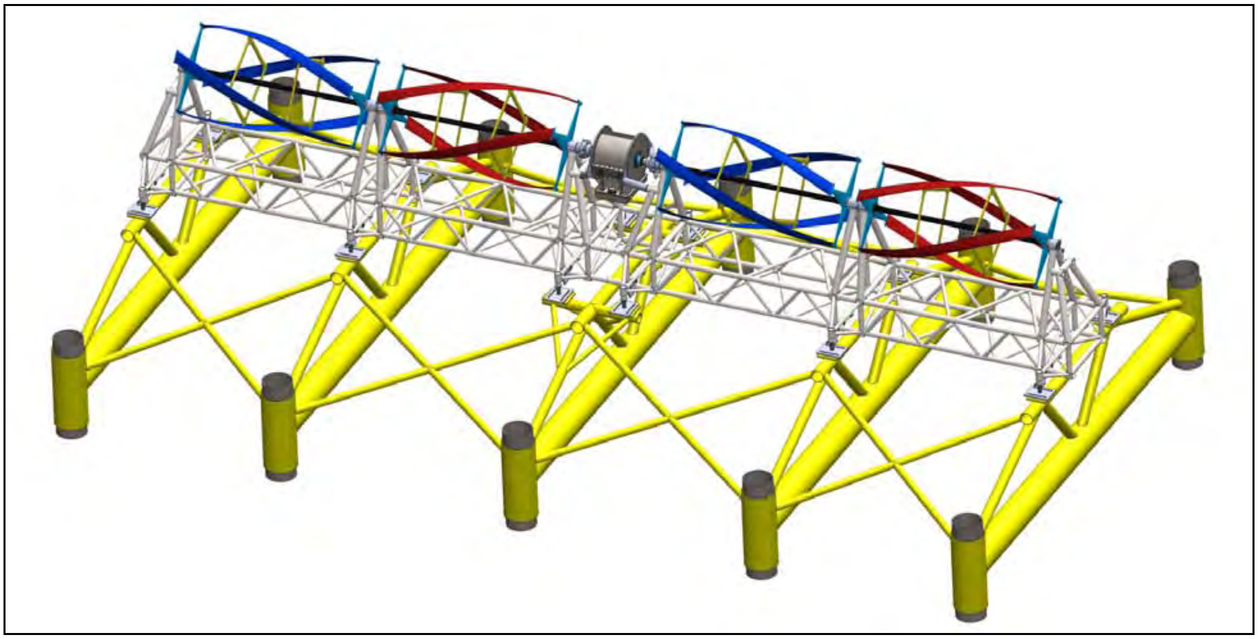


Figure 2. TidGen™ device.

In preparation for the Project, ORPC designed, built, deployed and tested a beta pre-commercial TidGen™ Power System (Beta TidGen™ System) in Cobscook Bay in 2010 (see Figure 3). The Beta TidGen™ System was comprised of a beta pre-commercial TGU (Beta TGU); ORPC's Energy Tide 2 research, testing and deployment vessel; a mooring system for the Energy Tide 2; and data acquisition and environmental monitoring equipment. Rather than being mounted on a bottom support frame, the Beta TGU was deployed top-down from the Energy Tide 2 and suspended 21 feet below the water surface.

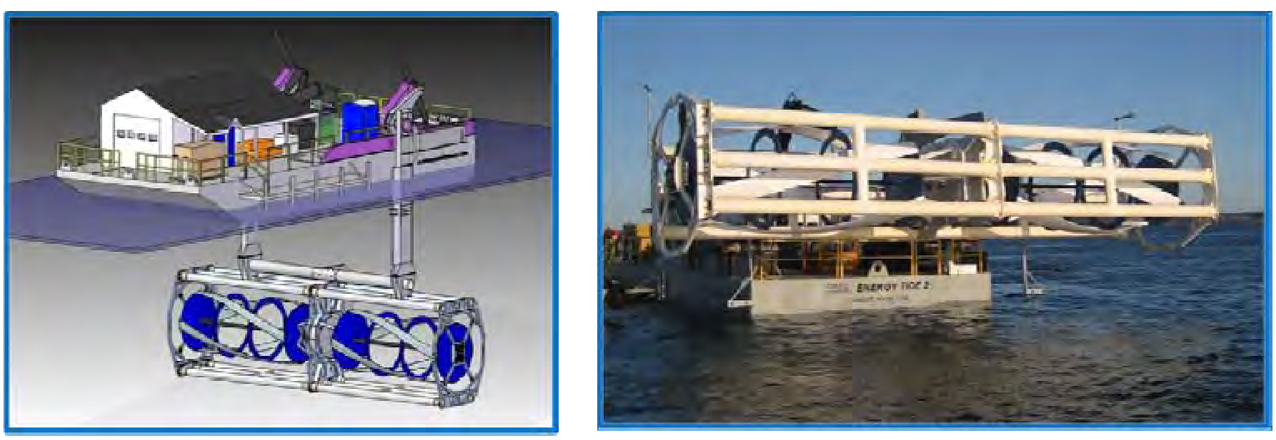


Figure 3. Beta TidGen system.

1.2 Installation Site and Deployment

The TidGen™ Power System installation site is located in the eastern entrance to Cobscook Bay between Goose Island and Seward Neck at 44˚54'.597547 N x 67˚02'.756085 W (Figure 1). The distance between the two closest land masses is 0.500 nm (926 m, 3,038 ft) at low tide and 0.620 nm (1,148 m, 3,766 ft) at high tide (Figure 1).

Deployment activities for the placement of 11 pilings will be carried out between March 1, 2012 and April 9, 2012. Pile driving will only occur during slack tides and is restricted to daylight hours. ORPC estimates that, with installation of one piling per slack tide, the 11 pilings will be installed over 7-12 days.

2.0 Incidental Harassment Authorization Process

ORPC has applied for an Incidental Harassment Authorization (IHA) for the placement of foundation piles below the mud line at the deployment site, due to the potential for the associated noise levels generated by the use of the vibratory hammer (and possibly a diesel impact hammer) during pile installation to exceed NOAA's guidelines for continuous and impact noise. In addition, although ORPC does not anticipate the incidental taking of any marine mammals as a result of pile placement, there are specific activities during pile placement that could theoretically pose a risk to marine mammals, including lowering piles into the water; installing the foundation; installing the bottom support frame; and installing environmental monitoring equipment. The goal of the Marine Mammal Observer and Reporting Plan for Pile Placement (Plan) is to minimize loud noise-generating activities if marine mammals are observed in Cobscook Bay, and to cease such noises if the animals come within 152 m (500 ft) of the installation site until the marine mammal moves 305 m (1000 ft) away from the installation site or 30 minutes has passed since the last observation. In addition, behavioral monitoring of marine mammals will be conducted out to a distance of 1 nm from the installation site.

ORPC incidental visual monitoring of marine mammals in Cobscook Bay area between 2007 and 2010 indicated that harbor porpoise (*Phocoena phocoena*), Atlantic white-sided dolphins (*Lagenorhynchus acutus*), grey seals (*Halichoerus grypus)* and harbor seals (*Phoca vitulina*) could be present in the vicinity. Other species that may occur in the vicinity of the project include North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaengliae*), fin whale (*Balaenoptera physalus*), minke whale (*Balaenoptera acutorostrata*), and sei whale (*Balenoptera borealis*). These marine mammals are generally associated with open ocean habitats and occur locally in more offshore locations in the Bay of Fundy. Thus, the four species with the greatest likelihood of occurring in the project area are harbor and grey seals, harbor porpoise and to a lesser extent, Atlantic white-sided dolphins. ORPC does not expect to create noise at levels that harasses marine mammals for prolonged periods of time. There may be some limited peripheral harassment if a marine mammal comes into the work area underwater and is not spotted by our observers.

This Plan provides additional details to ORPC's Marine Mammal Monitoring Plan and includes the Protected Species Observer (PSO) skills, PSO training program, equipment needed, survey methods, data collection and management protocols and associated data sheets, and an incident reporting form. Marine mammal observations will be conducted 30 minutes prior to, during, and 30 minutes after deployment activities. In the event that a marine mammal is observed entering or within a 152 m (500 ft) marine mammal exclusion zone around the installation site during pile deployment activities, a mitigation action plan and curtailment of deployment activity is provided. A summary report of the data collection will be provided to NMFS at the conclusion of pile placement.

3.0 MARINE MAMMAL OBSERVATION AND REPORTING PLAN

3.1 Protected Species Observer Skills

The ideal trainee for the PSO is an individual who is comfortable on the water, has some previous experience observing wildlife, pays close attention to detail, and is available for training on two days in mid February and for working on the observer program from March 1, 2012 through April 9, 2012. ORPC will be responsible for coordinating suitable installation events based on weather and tide, scheduling PSOs, end of day data proofing and management, and end of installation data management and preparation of summary report to NMFS. Four PSOs are required for each deployment event. In the event of illness or a change in PSO availability, 10 PSOs will be trained for this program.

3.2 Observation Platform

Two boats are required for the observer program. The ideal boat will be 30-40 ft in length, have a wheelhouse, an operational head (or suitable replacement), room on deck for two PSOs, and the capability of powering an independent data computer on board. The captain will be available for PSO and computer training for two days in mid February and for the observation program March 1, 2012 through April 9, 2012. The captain and team on the observer boat will depart with the equipment for the observation program from Eastport, Maine, deploy and anchor several reference markers around the installation site, and anchor at the appointed location. The boat will be required for about three hours per installation event. The captain will be trained to set up and run the data computer and record redundant paper data. In the event of illness or a change in the boat or captain's availability, three boats and captains will be selected for training. Recorder/captain training will take one day and include the lead PSO.

3.3 Protected Species Observer and Boat Captain Training Program

Goal: To train PSOs in the identification of the marine mammal species known to occur in and around the waters of Cobscook Bay Seward Neck in Lubec, Maine and Shackford Head in Eastport, Maine. Each PSO will be provided with a waterproof whale identification guide that includes the common species in the area with their unique identifying features. The PSO training will require two days.

3.3.1 Syllabus

1. *Species Identification*: The instructor will present several images of each one of the species known to occur in the area and identify the specific characteristics unique to each one to determine species identification. Each image shown will be ones that were obtained from a vessel platform to most closely approximate what the PSOs will see. Additional information will be given on typical seal and whale behaviors and on the legal status of each species.

Table 1. *Common and Less Common Species in Cobscook Bay.*

Common species in Cobscook Bay	Less Common Species
Harbor seal	Minke whale
Grey seal	Fin whale
Harbor porpoise	Sei whale
Atlantic white-sided dolphin	Humpback whale
	Right whale

2. *PSO skills*: The instructor will provide the PSOs with specific guidelines on how to set up the PSO team for maximum coverage of the area, how the PSOs should scan the surface of the water, which sighting cues to focus on, and how to distinguish whale species from other marine life (e.g. basking sharks, tuna, ocean sunfish).

3. *Data recording*: The recorder/boat captains will receive additional training on how to record data on paper data sheets. PSOs will be familiarized with the program and data entry and protocols. Paper data sheets will be summarized and digitized into a database for further analysis and reporting.

4. *Distance estimation*: Distance estimation is difficult, and varies between individuals; the PSOs will be introduced to a range finder device and given an opportunity to practice with the device outdoors. PSOs will be trained to use a compass to get a bearing to the marine mammal. The range finder distance and compass bearing will permit calculation of a sighting to provide for higher resolution data for mapping the sightings collected for the summary report.

4. *Testing*: The PSOs will be shown a series of images of marine mammal species expected in the area and be asked to write down their own species identification for each test image. There will be a mix of images they have seen before and novel images. The PSO will be expected to identify 80% of the test images correctly to be considered qualified.

See Appendix A, Cobscook Bay TidGen™ installation Marine Mammal Observer Training Course: February 16-17, 2012; Appendix B, Training Attendees; and Appendix C, PSO Training Applications.

3.3.2 Equipment List

The following table lists the equipment required for the PSOs, data collection on the observer boats and for setting up the reference markers. If possible, it would be prudent to have extra equipment available in case of damage or loss overboard.

Table 2. *Equipment List.*

Description	Minimum Number Required
Floater coat – USCG approved Type III	4 – 1 per PSO
Binoculars 8-10 power	4 – 1 per PSO
Range finder – distance measurement to sighting	4 – 1 per PSO
Compass – bearing to sighting	4 – 1 per PSO

VHF radio – either a handheld or boat radio for communication with installation operators	2 – 1 per observer boat
Data logging computer	2 – 1 per observer boat
External hard drive for data back up	1 unit
Handheld GPS, computer cable and batteries	2 – 1 per observer boat
Inverter for powering computer on boat	2 – 1 per observer boat
Clipboard, data sheets, pencils	2 sets
Digital SLR camera with telephoto lens	2 – 1 per observer boat
Equipment case for binoculars, range finders, computers, GPS, cameras, and data sheets	2 – 1 per observer boat
Polyform buoys (5) for reference markers, anchor rope and anchors	5 sets
Option – combined range finder binoculars Bushnell Fusion 1600	2 - 1 per observer boat for use by PSO looking outward to 1 nm

4.0 PILE DRIVING

4.1 Pile Driving Event Planning and Coordination

ORPC will be responsible for coordinating the scheduling of pile driving events. The constraints are that the pile driving will be done around slack tide only and during daylight hours (see Table 5 for tide and daylight hours) in suitable weather conditions. Weather conditions that would preclude pile driving include gale force winds, blizzard snow conditions, or torrential rains.

Once a suitable start time for piling driving is determined, ORPC will contact observer boat captains and 4 PSOs to be available per event (preferably the day prior to an event). The team will meet at the ORPC office in Eastport, collect the observer and reference marker equipment, load the boat and depart from Eastport in time to be anchored in position to start observations 30 minutes before pile driving activity begins.

4.2 Protocol for setting up the Marine Mammal Exclusion Zone and Observer Plan

For each pile driving event, the two observer boats will depart from Eastport and head to the pile driving (hereafter installation) site, approximately75 - 90 minutes before the start of pile driving activities. The team on each vessel will be comprised of two PSOs and one recorder/boat captain.

Once the observer boats have arrived in the vicinity of the project site, the team on each vessel will deploy several reference buoys to help identify when marine mammals are entering or within the exclusion zone (152 m, 500 ft) and have departed the vicinity (305 m, 1000 ft).

The downstream observer boat will deploy reference buoys 1 and 2 and then anchor on the downstream edge of the exclusion zone. The upstream observer boat will deploy reference buoys 3 and 4. When installation activities are taking place at high tide, the upstream boat will deploy an additional reference buoy 5 before anchoring on the upstream edge of the exclusion zone. At low tide, it will not be possible to install reference buoy 5. Instead PSOs will use the low tide shoreline of Goose Island for this reference point. The final reference buoy 6 will be the green can navigational marker no. 7.

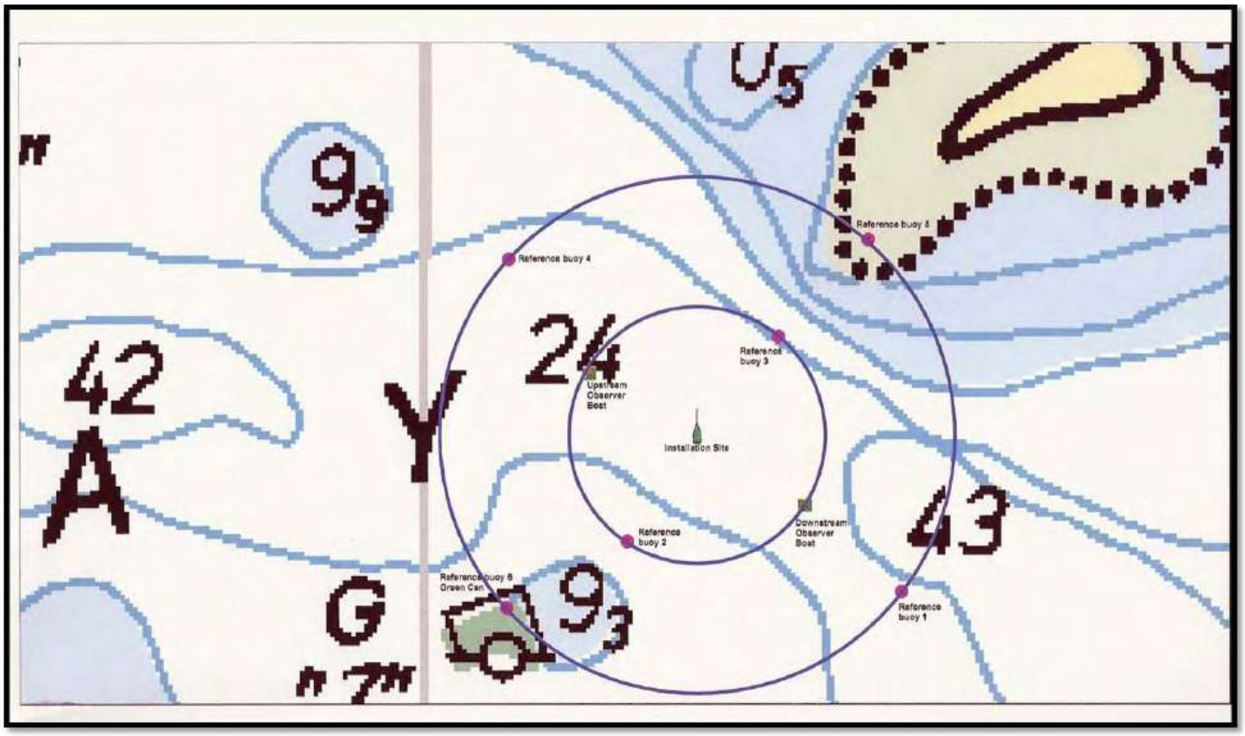
Thus reference buoys 2 and 3 and the two anchored observer boats will denote the 152 m (500 ft) marine mammal exclusion zone, and reference buoys 1, 4, and 5 (at high tide only) or the shoreline of Goose Island and the green can no. 7 will denote the 305 m (1000 ft) zone.

Table 3. *Anchoring positions, in latitude and longitude, for the reference buoys and the two observer boats. Cross referenced with Figure 4.*

Reference Markers	Distance from Installation Site 152 m (500 ft, or 0.082nm)	Distance from Installation Site 305 m (1000 ft, or 0.165 nm)
Buoy 1		44 54.498 N x 67 02.574 W
Buoy 2	44 54.530 N x 67 02.817 W	
Buoy 3	44 54.659 N x 67 02.683 W	
Buoy 4		44 54.707 N x 67 02.922 W
Buoy 5		44 54.720 N x 67 02.603 W At high tide only (shoreline at low tide)
Buoy 6		Use green can navigational marker no. 7 44 54.488 N x 67 02.925 W
Boat	Downstream observer boat 44 54.553 N x 67 02.660 W	
Boat	Upstream observer boat 44 54.632 N x 67 02.855 W	

The vessels must be in place and the team ready to start the observation period no later than 30 minutes prior to the start of pile driving activities for the event. Once anchored, the recorder on each boat will start up the data logging computer, enter environmental conditions and the time the observation period begins. Data sheets will be provided to the recorder in case there is a failure in the computer logging system. A data sheet with an example is provided on page 18.

Figure 4. The location of reference buoys (pink circles) and observer boats (labeled upstream and downstream positions on 152 m edge of the marine mammal exclusion zone) around Cobscook Bay installation site. Cross reference with Table 3 for anchoring positions of the reference buoys and observer boats.



5.0 SURVEY METHODS

Four PSOs will be stationed on two observer boats, one boat anchored at 152 m (500 ft) upstream and one at 500 ft downstream from the installation site (Figure 4). On each boat, the two PSOs will be positioned so that one PSO will survey inward toward the installation site (i.e. two PSOs dedicated to scanning continuously only the 152 m, 500 foot exclusion zone) while the second PSO on each boat will scan outward to a distance of 1 nm to conduct behavioral monitoring . The reference marker buoys (Table 3) anchored at 152 m (500 ft) and 305 m (1,000 ft) are located around the installation site to help the PSOs identify when marine mammals are entering or within the exclusion zone. For behavioral observations from the 305 m (500 ft) marine mammal exclusion zone out to 1 nm, natural land marks can be used (Figure 5). There is water at a distance of 1 nm outward from the installation site on three sides of the installation site, to the southeast, west, and northwest (Table 4 – Boundary A, B and C at 1 nm respectively).

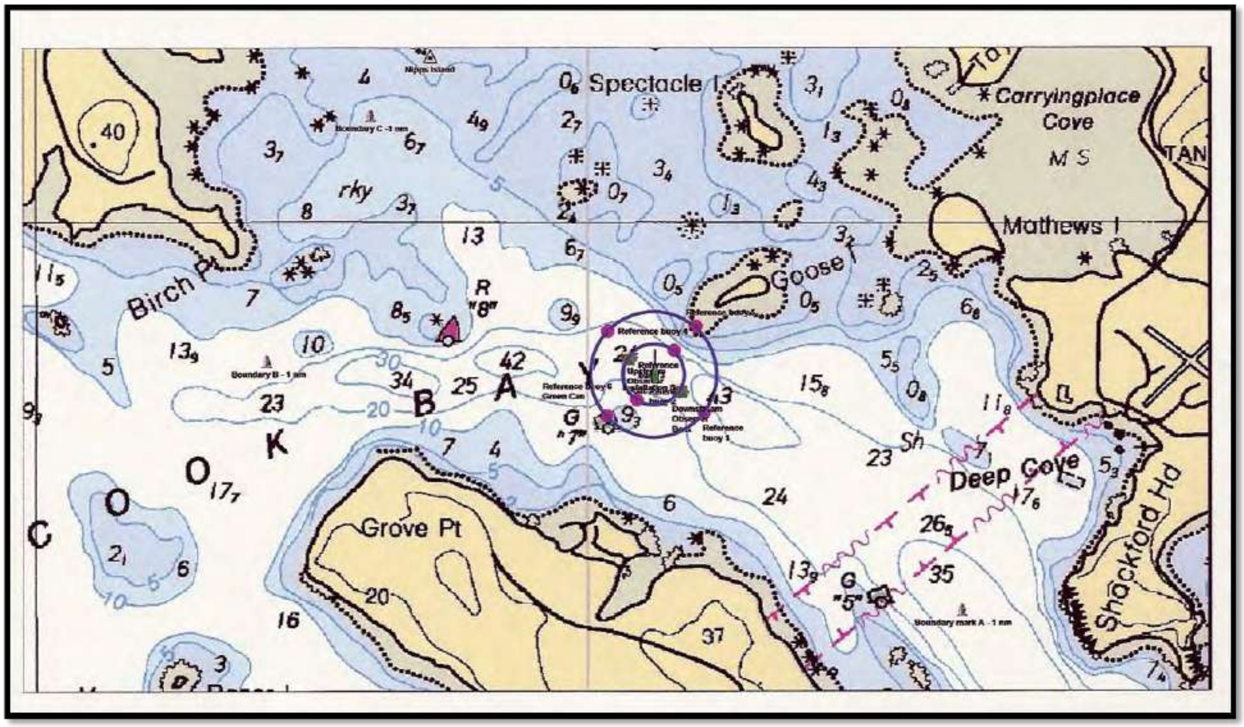
Table 4. *The location of the 1 nm boundaries A, B and C and the natural landmarks.*

1 nm Boundary	Position	Landmark
Boundary A – southeast of installation site	44 53.985 N x 67 01.640 W	Between Shackford Head and Green can #5
Boundary B – west of installation site	44 54.630 N x 67 04.159 W	Between Grove Point on Seward Neck and Birch Point on mainland
Boundary C – northwest of installation site	44 55.265 N x 67 03.783 W	Between Birch Point on mainland and Nipps Island

All sightings of marine mammals will be reported to the recorder who will log an entry on the data computer for each sighting, including the species, number, and behavior. The location of the marine mammal(s) will be estimated using a compass to determine the magnetic bearing to the animal and a range finder to determine the distance from the observation vessel to the animal. The information will be entered on the paper data; the actual geo-referenced location will be calculated after the observation period has been completed and entered into the computerized record.

The exclusion zone will be monitored continuously during impact pile driving to ensure that any marine mammals that enter the area will be seen, recorded and if within the exclusion zone, lead to the cessation of pile driving activities until the marine mammal observed is beyond 305 m (1000 ft) or 30 minutes have passed with no further sighting. The PSOs will continue scanning the marine mammal exclusion zone and outwards to 1 nm until 30 minutes after the pile driving activity has ceased for that event. At the conclusion of the observation period, the team will return to Eastport. The reference buoys and anchoring system will remain in place for the duration of the pile installation.

Figure 5. The location of the 1 nm mark and natural landmarks for reference. There are three boundary markers indicated on Chart A - southeast at 1 nm off Shackford Head, B is west at 1 nm between Grove and Birch Points, and C is northwest at 1 nm between Birch Point and Nipps Island. Cross Reference with Table 4 for boundary positions and summary of landmark reference.



6.0 Pile Driving Delay and Shutdown Procedures

1. In the event that a PSO sees a marine mammal within or approaching the 152 m (500 ft) exclusion zone prior to start of impact pile driving, the PSO will notify the on-site project lead (or other authorized individual) who will then be required to delay pile driving until the marine mammal has moved 305 m (1,000 ft) from the sound source or if the animal has not been resighted within 30 minutes.

2. If a marine mammal is sighted within or on a path toward the 152 m (500 ft) exclusion zone during pile driving, pile driving would cease until that animal has moved beyond 305 m (1,000 ft) and is on a path away from the exclusion zone or 30 minutes has lapsed since the last sighting.

7.0 REPORTING TO NMFS

7.1 Incident Reporting to NMFS

In the unanticipated event that the pile driving activity clearly causes the take of a marine mammal in a manner prohibited by the IHA, such as an injury (Level A harassment), serious injury, or mortality, ORPC would immediately cease the specified activities and immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources and the Northeast Regional Stranding Coordinator, NMFS. The lead PSO will be equipped with the list of NMFS personnel, their emails and telephones numbers for reporting an incident. The report will include the following:

- Time, date, and location (latitude/longitude) of the incident
- If the incident is a vessel strike of a marine mammal
    - Name and type of vessel involved
    - Vessel's speed during and leading up to the incident
- Description of the incident
- Status of all sound source use in the 24 hrs preceding the incident
- Water depth
- Environmental conditions (e.g., wind speed and direction, Beaufort sea state (page 20), cloud cover, and visibility)
- Description of all marine mammal observations in the 24 hrs preceding the incident
- Species identification or description of the animal(s) involved
- Fate of the animal(s)
- Photographs or video footage of the animal(s) (if available)

ORPC will not resume activities until NMFS is able to review the circumstances of the prohibited take and have determined how to minimize the likelihood of further prohibited take and ensure MMPA compliance.

In the event that ORPC discovers an injured or dead marine mammal, and the lead PSO determines that the cause of the injury or death is unknown and the death is relatively recent (i.e., in less than a moderate state of decomposition), ORPC would immediately report the incident to the Chief of the Permits and Conservation Division, Office of Protected Resources and the Northeast Regional Stranding Coordinator, NMFS. The report will include the same information identified above. However, ORPC activities will continue while NMFS reviews the circumstances of the incident and work with ORPC to determine whether modifications in the activities are appropriate. A blank incident report form is provided on page 17.

7.2 Data Management

At the completion of the observer program for each pile driving event, the observer boats will return to Eastport. The lead PSO will download the electronic data from both computers, proof the data, and store the data on a designated computer in the ORPC office with back up to an external hard drive. Paper data will be proofed against the electronic data, scanned and stored on a computer as a PDF and backed up on an external hard drive. Original paper data will be filed by date and time of deployment event. All optical equipment will be cleaned, dried and stored.

7.3 Final Report

Ninety days after the completion of the pile driving activity, the ORPC marine mammal consultant and the lead PSO will submit a report to NMFS. The report will include the details of the observation methods employed by the PSOs including the following:

- Data on the PSO effort by day of activity
    - Date and time of pile driving activity
    - Time on watch
    - Duration on watch before start up, during pile driving activities, and after pile driving is completed for the day
- Environmental data for each data of activity
    - Wind speed and direction
    - Beaufort sea state (page 20)
    - Cloud cover

- Visibility

Observation data on marine mammals that were collected before, during and after pile driving activities each day will be recorded on a computer for each pile driving event and will be provided in an electronic format (Excel™ file):

- Date of pile driving event
- Time of pile driving event (on some days there may be two events)
- Location in latitude and longitude (based on calculation using compass and range finder from fixed observation station) of any marine mammals observed
- Species of marine mammal observed (indicate if photos were obtained)
- Group size
- Behavior
- Any observed reactions to construction
- Distance to operating pile hammer
- Construction activities occurring at time of sighting

The written report will be provided in electronic format following standard reporting procedures and include the following sections: introduction, methods, results, and discussion. The marine mammal data will be presented in a table (date, time, location, species, behavior etc) and a geo-referenced figure.

Table 5. *Projected pile driving events based on Eastport Tide Table. Slack tide occurs 30-40 minutes later at the installation site than at the Eastport tide station.*

Date 2012 March/April		**High**				**Low**					
		am	**ft**	**pm**	**ft**	**am**	**ft**	**pm**	**ft**	**rise**	**set**
1	Thu	4:23	16.9	4:55	15.8	10:48	2.6	11:10	3.3	6:01	5:18
2	Fri	5:20	16.8	5:53	15.7	11:46	2.6			5:59	5:19
3	Sat	6:18	17	6:51	16.2	12:08	3.2	12:45	2.3	5:58	5:20
4	Sun	7:15	17.6	7:46	17	1:07	2.7	1:41	1.6	5:56	5:22
5	Mon	8:08	18.5	8:36	18	2:02	1.8	2:33	0.6	5:54	5:23
6	Tue	8:58	19.5	9:24	19.2	2:54	0.7	3:22	-0.4	5:52	5:24
7	Wed	9:45	20.4	10:09	20.3	3:43	-0.5	4:09	-1.4	5:51	5:26
8	Thu	10:31	21.1	10:54	21.2	4:30	-1.5	4:54	-2	5:49	5:27
9	Fri	11:17	21.5	11:39	21.7	5:16	-2.3	5:40	-2.4	5:47	5:28
10	Sat			12:04	21.5	6:03	-2.7	6:26	-2.3	5:45	5:30
11	Sun	12:25	21.9	1:52	21.2	7:52	-2.7	8:14	-1.9	6:43	6:31
12	Mon	2:14	21.7	2:43	20.4	8:42	-2.3	9:05	-1.2	6:41	6:32
13	Tue	3:06	21	3:38	19.5	9:36	-1.5	9:59	-0.2	6:40	6:34
14	Wed	4:02	20.2	4:37	18.5	10:34	-0.6	10:58	0.7	6:38	6:35
15	Thu	5:03	19.3	5:41	17.7	11:36	0.2			6:36	6:36
16	Fri	6:09	18.6	6:48	17.3	12:02	1.4	12:41	0.7	6:34	6:37
17	Sat	7:17	18.4	7:55	17.5	1:09	1.6	1:47	0.8	6:32	6:39
18	Sun	8:22	18.5	8:56	17.9	2:15	1.4	2:50	0.6	6:30	6:40
19	Mon	9:20	18.8	9:49	18.5	3:15	0.9	3:45	0.2	6:28	6:41
20	Tue	10:12	19.2	10:36	19	4:08	0.3	4:34	-0.2	6:27	6:43
21	Wed	10:57	19.4	11:17	19.4	4:55	-0.1	5:17	-0.3	6:25	6:44
22	Thu	11:39	19.5	11:56	19.6	5:37	-0.4	5:57	-0.3	6:23	6:45
23	Fri			12:17	19.4	6:17	-0.5	6:34	-0.1	6:21	6:46
24	Sat	12:33	19.6	12:55	19.1	6:54	-0.4	7:11	0.3	6:19	6:48
25	Sun	1:10	19.4	1:33	18.7	7:32	-0.1	7:48	0.8	6:17	6:49
26	Mon	1:48	19.1	2:11	18.2	8:10	0.3	8:26	1.3	6:15	6:50
27	Tue	2:27	18.6	2:52	17.6	8:50	0.8	9:07	1.8	6:13	6:51

28	Wed	3:08	18.1	3:35	17	9:32	1.3	9:50	2.4	6:12	6:53
29	Thu	3:54	17.6	4:23	16.5	10:19	1.8	10:39	2.8	6:10	6:54
30	Fri	4:44	17.2	5:16	16.2	11:10	2.2	11:32	3	6:08	6:55
31	Sat	5:39	17	6:12	16.3			12:06	2.3	6:06	6:56
1	Sun	6:37	17.2	7:10	16.7	12:30	2.9	1:04	2	6:04	6:58
2	Mon	7:35	17.7	8:07	17.6	1:29	2.4	2:01	1.4	6:02	6:59
3	Tue	8:32	18.5	9:00	18.7	2:27	1.4	2:56	0.5	6:00	7:00
4	Wed	9:25	19.5	9:50	19.9	3:21	0.2	3:48	-0.5	5:59	7:02
5	Thu	10:16	20.4	10:39	21.1	4:13	-1	4:38	-1.3	5:57	7:03
6	Fri	11:05	21.1	11:27	21.9	5:04	-2.1	5:27	-2	5:55	7:04
7	Sat	11:54	21.5			5:53	-2.9	6:15	-2.3	5:53	7:05
8	Sun	12:15	22.4	12:43	21.5	6:42	-3.3	7:04	-2.2	5:51	7:07
9	Mon	1:04	22.4	1:34	21.1	7:33	-3.2	7:54	-1.7	5:49	7:08

ORPC COBSCOOK BAY MARINE MAMMAL OBSERVER DATA SHEET

Date: ______________________ **Time:** start _______________ end ___________

Observer boat name: _________________ downstream / upstream (circle one)

Observer names: ____________________ (inward) ____________________ (outward)
(MM exclusion zone) (Out to 1 nm)

Environmental Conditions

Wind Speed and Direction _____________________ Cloud cover ___________

Visibility ________________ Beaufort sea state _________________________

Recorder's name: ____________________________________

Time (24 hour time)	**Species and number**	**Behavior and direction of travel**	**Bearing to animal (magnetic)**	**Distance to animal (meters)**
11:10	Harbor Porpoise – 5	Swimming toward exclusion zone	170˚	220 m

INCIDENT REPORTING FORM

TIME ___________ DATE ___________

LOCATION ________________________________ (Latitude/longitude)

WATER DEPTH __________

ENVIRONMENTAL CONDITIONS

- WIND SPEED AND DIRECTION ________________________
- BEAUFORT SEA STATE ________________________
- CLOUD COVER ________________________
- VISIBILITY ________________________

NAME AND TYPE OF VESSEL INVOLVED ___________________________________
VESSEL'S SPEED DURING AND LEADING UP TO THE INCIDENT ________________

DESCRIPTION OF THE INCIDENT

____
____
____
____
____

STATUS OF ALL SOUND SOURCE USE IN THE 24 HRS PRECEDING THE INCIDENT

____
____
____
____

DESCRIPTION OF ALL MARINE MAMMAL OBSERVATIONS IN THE 24 HRS PRECEDING THE INCIDENT

____
____
____
____

SPECIES IDENTIFICATION OR DESCRIPTION OF THE ANIMAL(S) INVOLVED

____
____

FATE OF THE ANIMAL(S) ____
PHOTOGRAPHS OR VIDEO FOOTAGE OF THE ANIMAL(S) (IF AVAILABLE)

____

Beaufort Sea State scale

Beaufort number	**Description**	**Wind speed**	**Wave height**	**Sea conditions**	**Land conditions**
0	Calm	< 1 mph < 1 kn	0 ft	Flat	Calm. Smoke rises vertically
1	Light air	1–3 mph 1–2 kn	0–1 ft	Ripples without crests	Smoke drift indicates wind direction and wind vanes cease moving
2	Light breeze	4–7 mph 3–6 kn	1–2 ft	Small wavelets. Crests of glassy appearance, not breaking	Wind felt on exposed skin. Leaves rustle and wind vanes begin to move
3	Gentle breeze	8–12 mph 7–10 kn	2–3.5 ft	Large wavelets. Crests begin to break; scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	Moderate breeze	13–17 mph 11–15 kn	3.5–6 ft	Small waves with breaking crests. Fairly frequent whitecaps	Dust and loose paper raised, small branches begin to move
5	Fresh breeze	18–24 mph 16–20 kn	2–3 m	Moderate waves of some length. Many whitecaps. Small amounts of spray.	Branches of a moderate size move. Small trees in leaf begin to sway

Wind speed: Estimate speed in knots, and direction with compass
Cloud cover: < 10%, 10 – 50%, 50 – 90%, >90%.
Visibility: measured in nautical miles 0 nm, 1 nm, 2 nm, 3 nm, 4 nm, 5 nm to unlimited
Weather conditions: clear, haze, patchy fog, fog, drizzle, light rain, both rain and fog, snow

Course Syllabus:

Cobscook Bay TideGen™ installation Marine Mammal Observer Training Course: February 16-17, 2012

Instructor: Moira Brown, New England Aquarium, Boston, MA

Goal: To train observers in the identification of the marine mammal species known to occur in and around the waters of Cobscook Bay Seward Neck in Lubec Maine and Shackford Head in Eastport Maine. Training to include instruction on data recording (paper and electronic), distance estimation, observer plan for pile driving delay and shutdown procedures, communication procedures, and data storage.

Each observer will be provided with a waterproof whale identification guide that includes the common species in the area with their unique identifying features.

Syllabus:

1. Introductions and review of experience of trainees.
2. Presentation from ORPC on the project and need for the marine mammal observer program
3. Review of Survey Area and Observation Plan
4. Species Identification: Review of marine mammal species that are seen in the area and their identifying features. The instructor will present several images of each one of the species known to occur in the area and identify the specific characteristics unique to each one to determine species identification. Each image shown will be ones that were obtained from a vessel platform to most closely approximate what the observers will be seeing. Additional information will be given on typical seal and whale behaviors.

   <u>Common species</u>:
   Harbor seal
   Gray seal
   Harbor Porpoise
   White-sided dolphin
   Minke whale
   Fin whale
   Humpback whale

   <u>Less common species</u>:
   Right whale
   Pilot whale
   Sperm whale

   <u>Rare Species</u>:
   Orca (killer whale)
   Beluga

5. Observer skills: The instructor will provide the observers with specific guidelines on how to set up the observer team for maximum coverage of the area, how the observers should scan the surface of the water, which sighting cues to focus on, how to distinguish whale species from other marine life (e.g. basking sharks, tuna, ocean sunfish) and how to record their data.
6. Distance estimation: Distance estimation is difficult and variable between individuals; the observers will be introduced to a range finder device and given an opportunity to practice with the device out of doors. Distance estimation to the sighting will provide a higher resolution of data for mapping the sightings collected.
7. Review of communication procedures between observer vessels and barge for pile driving delay and shut down procedures.

8. Testing: The observers will be shown a series of images of the marine mammal species expected in the area and be asked to write down their own species identification for each test image. There will be a mix of images they have seen before and novel images.
9. For data recorders: Instruction in data recording on paper, data storage.

Course Plan:

Feb 16 and 17 – Observer Training Program – Instructor: Moira Brown and ORPC staff

<table>
<tr><td></td><td>Thursday, Feb 16</td><td></td><td>Friday, Feb 17</td></tr>
<tr><td>8:30 - 10:15</td><td>Introductions
Overview of TideGen™ Project (ORPC)
Why a marine mammal observer program is needed</td><td>8:00 - 9:15</td><td>Review species id for common species
Data recording
Distance Estimation</td></tr>
<tr><td>10:15 - 10:30</td><td>Break</td><td>9:15 - 9:30</td><td>Break</td></tr>
<tr><td rowspan="2">10:30 - 12:00</td><td rowspan="2">Survey area and observation plan
Marine mammal survey methods</td><td>9:30 - 10:30</td><td>Communication protocol between observer vessels and barge, pile driving delay and shut down procedures (ORPC)</td></tr>
<tr><td>10:30- 12:00</td><td>Data recording and processing</td></tr>
<tr><td>12:00 - 1:00</td><td>Lunch</td><td>12:00 - 1:00</td><td>Lunch</td></tr>
<tr><td>1:00 - 2:15</td><td>Species identification</td><td>1:00 - 2:15</td><td>Species id test</td></tr>
<tr><td>2:15 - 2:30</td><td>Break</td><td>2:15 - 2:30</td><td>Break</td></tr>
<tr><td>2:30 - 4:00</td><td>Species identification</td><td>2:30 - 4:00</td><td>Review of species id and course material, Q and A.</td></tr>
</table>

Attendee	Contact number 1	Email
Alethea (Lee) Leddy	207-853-2341	Aletha.LeeLeddy@gmail.com
Aubrey Jollotta	207-853-2095	daddybear1978@yahoo.com
Bob Lewis	207-233-1256	blewis@orpc.co
Butch Harris	207-853-4859	N/A
Cecil Cates	207-853-4300	pennamaquaw@localnet.com
Chris Bartlett	207-214-7061	cbartlett@maine.edu
Darius Neptune	207-853-2459	dneptune718@gmail.com
David Turner	207-231-4988	dturner@orpc.co
Fiona Jensen	814-933-9504	fjensen@orpc.co
Jaime Mitchell	207-233-8262	jmitchell@orpc.co
Jesse Smith	207-853-4790	nijeguhz@yahoo.com
Jim Mitchell	207-712-2919	jmitchell2@orpc.co
John Turner	207-358-4986	jturner@orpc.co
Matt LaCasse	207-214-2568	mlacasse1@gmail.com
Nate Johnson	207-712-2927	njohnson@orpc.co
Nathan Spear	207-214-3828	nathan-spear@hotmail.com
Ralph DeWitt	207-853-0662	N/A
Royce Richards	207-263-4822	dentalgals@gmail.com
Sean Anderton	207-400-7090	sanderton@orpc.co
Steve Erwin	207-853-9430	mr.smallhat@maine.rr.com
Tessa Ftorek	207-454-2130	tfortek@pwless.net

ORPC

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Jaime Mitchell Date: 2-7-12

Address: 45 Old County Rd. Pembroke, Me. 04? (Number, Street, City, State, Zip)

Phone: 726-9520 Email: jmitchell@orpc.co

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Eastport Elementary

Middle School: Eastport Elementary

High School: Shead High School 1998-2002 H.S. Diploma: ☒ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): business admin. University of Maine Machias

Work History (Please list your most recent employment and include dates of employment)

ORPC - Jan 2010 to present

Eastport Health Care - Jan. 2006 to Jan. 2010

Machias Motor Inn - June 2004 to Jan. 2006

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

Have lived on the water my entire life

Spend many days on the water observing marine mammals.

Jaime L M [signature] 2/7/12

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Nathan Johnson - ORPC Date: February 7, 2012

Address: Ocean Renewable Power Company, 120 Exchange St, Suite 508, Portland, ME 04101

Phone: 207-712-2927 Email: njohnson@orpc.co

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☐ Yes ☐ No
Current ORPC full-time employee

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Long Island Elementary School, Long Island, Maine

Middle School: King Middle School, Portland, Maine

High School: Portland High School, Portland, Maine, 1994 H.S. Diploma: ✓ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended):

Tufts University, Medford, Massachusetts, B.S. Geology, 1998

Work History (Please list your most recent employment and include dates of employment)

Commercial lobsterman, Long Island, Maine – 1990 to 1998

AECOM (formerly Earth Tech), Environmental Engineer/Geologist, 1998 to December, 2011

Ocean Renewable Power Company (ORPC), Environmental Affairs Manager, January 2012 to present

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

Extensive experience working on the ocean, knowledge of marine ecosystems and marine hydrokinetic devices. Live on Long Island in Casco Bay, Maine.

2/7/2012

Please Sign Here Date

ORPC

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Fiona Jensen Date: 2/7/12

Address: 8 Burnham St. Apt 5B South Portland ME 04106
Number Street City State Zip

Phone: 814-933-9504 Email: Fjensen@orpc.co

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☑ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Greenwood Friends School

Middle School: University School of Nashville

High School: University School of Nashville H.S. Diploma: ☑ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): Connecticut College - Government, Spanish, Environmental Studies

Work History (Please list your most recent employment and include dates of employment)

Appalachian Mountain Club - Trail Crew leader Summer 2011

Appalachian Mountain Club - Conservation Policy Intern Fall 2011

Randolph Mountain Club - Trail Crew Summers 2008, 2009, 2010

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

I participated in a Manatee observation project in San San Pond Sak Wetlands, Panama in 2010. I am also an aquarium enthusiast.

[signature] 2/7/12
Please Sign Here Date

ORPC

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: David W Turner Date: 2/6/12

Address: 214 So Meadow Rd Perry ME 04667
Number Street City State Zip

Phone: 231-4988 Email: dturner@orpc.co

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? € Yes € No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar:

Middle School:

High School: Shead 84-88 H.S. Diploma € Yes € No

Higher Education (Please indicate course of study, when and where attended): WCTC Calais 1990-1

Work History (Please list your most recent employment and include dates of employment)

With ORPC since 2009

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

David W Turner 2/6/12

Please Sign Here Date

ORPC

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: John Turner Date: 2-7-12

Address: 172 Golding rd Perry ME 04667
Number Street City State Zip

Phone: 853-4770 Email: jTurner@orpc.co

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? € Yes € No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: wildwood elementary sch

Middle School: wildwood elementary sch

High School: 4 years Wilmington high Sch H.S. Diploma: € Yes € No

Higher Education (Please indicate course of study, when and where attended):

Work History (Please list your most recent employment and include dates of employment)

orpc Jan 23 - Present

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

4 years State of Maine boat operator

[signature] 2-7-12

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Capt Ralph DeWitt Date: 2-6-12

Address: 9 High Eastport Me 04631
Number Street City State Zip

Phone: Home 207 853 0662 Cell 263 6402 Email:

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Eastport Elementary

Middle School: Eastport Grammar

High School: Shead High School H.S. Diploma: ☐ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): W.C.C.C.

Marine Paint Applacation Techuition 1981 1982

Work History (Please list your most recent employment and include dates of employment)

R.J. Peacock Lubec 1991-2010

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

20 years Pilot Boat Captain

10 years painting fiberglass repair

Capt Ralph DeWitt 2-6-12

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: James Smith Date: 2-6-12

Address: 9 (Number) High St. (Street) Eastport (City) ME (State) 04631 (Zip)

Phone: 207-853-0662 Email: nijeguhz@yahoo.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☑ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar:

Middle School:

High School: Calais High H.S. Diploma: ☐ Yes ☑ No

Higher Education (Please indicate course of study, when and where attended): 100GT Master's Lisence, AB certification

Work History (Please list your most recent employment and include dates of employment)

Deckhand - Eastport Pilot Boat

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

Refer to higher education and work history

James Smith 2-6-12

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Nathan Spear Date: 2-6-12

Address: 9 high St Eastport ME 04631
Number Street City State Zip

Phone: 853-0662 Email: nathan_spear@hotmail.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ■ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Calais Elementary

Middle School: Calais middle/high School

High School: Calais high School H.S. Diploma: ☒ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended):

University of Maine Liberal arts

Work History (Please list your most recent employment and include dates of employment)

Blue Iris Agust 11-Sept 11

Dunkin Donuts Feb 11-July 11

Walmart April 2010-Jan 11

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

I Have taged Bear Cubs with Maine National Wildlife Rangers. I have alot of interest with animal field work and considering getting a degree.

Nathan Spear 2-6-12

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Cecil Cates Date: 2-7-2011

Address: 4 Wilson St. Eastport Me 04631
Number Street City State Zip

Phone: 853 4300 Email: Pennamaquan@localnet.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Eastport

Middle School: Eastport

High School: Shead Eastport H.S. Diploma: ☒ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): Trades school 100T capt. course

Work History (Please list your most recent employment and include dates of employment)

D.M.R. Biotoxin monitoring 2 yrs to present
Quoddy Pilots 1999 to date
Capt. Lubec Eastport Ferry June - Sept 2011

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

I have lived and worked on the bay all my life. I been involved in salmon, urchins, shell fish and nori Aquaculture, Field rep. for Airmar sea mammal protection and control systems from 1985 - 2002

Cecil Cates 2/7/2011
Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Matt Lacasse Date: 2/2/12

Address: 3 Evans St. Eastport ME 04631
Number Street City State Zip

Phone: 207 214 2568 Email: MLacasse1@Gmail.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Calais Elem.

Middle School: Calais Middle

High School: Calais High Class of 2002 H.S. Diploma: ☒ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): WCTC "The Boat School" Eastport ME

Work History (Please list your most recent employment and include dates of employment)

Moose Island Marine Yard Manager, Commercial Fisherman, Tug crew, Harbormaster Eastport, AB on ocean going tug, Tradewinds towing, seaweed harvester, Boat Builder.

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

Years of experience on the water, trained in safety CPR, First Aid, 100 GT Licenced Captain, very familiar with the area.

Matt Lacasse 2/2/12

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Darius J Neptune Date: 2/3/12

Address: Po box 65 Perry ME 04667
Number Street City State Zip

Phone: (207) 853-2459 Email: DNeptune718@Gmail.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☑ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Beatrice Rafferty School

Middle School: Beatrice Rafferty

High School: Washington Academy H.S. Diploma: ☑ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): Washington County Community College Starting July 2012

Work History (Please list your most recent employment and include dates of employment)

Butch Harris 07 - Present

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

Worked on a whale watching boat for 5 years

Worked On water ~~[illegible]~~ for 5 Years

Darius Neptune 2/3/12
Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: George HARRIS Jr Date: 2/1/12

Address: 13 Old Bedbubt Rd Eastport Me 04631
Number Street City State Zip

Phone: Cell 207-214-8783
Home 207-853-4859
Email:

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☐ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Eastport Elementary

Middle School: Eastport Elementary

High School: Shead High Eastport H.S. Diploma: ☑ ~~Yes~~ ☐ No

Higher Education (Please indicate course of study, when and where attended): None

Work History (Please list your most recent employment and include dates of employment)

Owner operator of whale watching & fishing charter business for 25 years, 100 Ton Master near coastal with sail endorsement, Selfemployed Fisherman + Boat Builder

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

I have worked on the wate my entire life, I have been involved in many fisheries including scalloping, urchins, lobster & herring. I'm a member of the Marine Advisory Council, Have owned & operated my charter business for over 25 years Have built Boat ranging from 12' up to 118 Schooners. I think my knowledge & experience will be useful on this project.

George Harris Jr 2/1/12

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Sean Anderton Date: 1-31-2012

Address: 58 Crossing Brook Rd. Cumberland, ME 04021
Number Street City State Zip

Phone: 207-221-6336 Email: sanderton@orpc.co

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Southlake Elementary 85-87, Strawberry Knoll Elem. 87-92

Middle School: Gaithersburg Middle School 92-94

High School: Gaithersburg High School 94-98 H.S. Diploma: ☒ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): Weber State University Communication/Broadcasting/Sales 98-99, 2001-2004

Work History (Please list your most recent employment and include dates of employment)

Ocean Renewable Power Company 2008-Present

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

I am the site assessment manager for ORPC. As part of my work duties I spend a lot of time on the water working, measuring current speeds, mapping

Sean Anderton Digitally signed by Sean Anderton DN: cn=Sean Anderton, o, ou, email=sanderton@orpc.co, c=US Date: 2012.01.31 15:03:49 -05'00' 1-31-2012

Please Sign Here Date

✓

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Royce F. Richards Date: 01/11/2012

Address: P.O. Box 126 East Machias Me. 04630

Number Street City State Zip

Phone: (207) 255-8727 Email: dentalgals@gmail.com

(207) 263-4822 (mobile)

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☑ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Rose M. Gaffney Machias, Me. 1-8

Middle School: " "

High School: Machias Memorial High School H.S. Diploma: ☑ Yes ☐ No (1991)

Higher Education (Please indicate course of study, when and where attended):

B.A. Biology (Marine Concentration) University of Maine at Machias (2001)

Work History (Please list your most recent employment and include dates of employment)

Self Employed Carpenter (2007-present) Acadia National Park 04/10-10/2010

Dunbar Custom Homes 12/2005-3/2007 Shawn Johnson (Owner lobster Vessel) - sternman 10/2004 - 11/200

Charles Huntley (lobster Vessel owner) sternman 04/2004-10/2004 Atlantic Salmon of Maine

Fisheries Technician + Diver → ~~12~~ 12/2001-12/2003

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

1) Extensive experience Working aboard Commercial Fishing Vessels in all Weather Conditions (Winter, high Seas + winds, Thick Fog, slippery decks, etc) Safely.

2) Extensive experience Working in the Salmon Aquaculture Industry - Working on Ocean year round in all Weather conditions + Operation of Vessels up to 65 ft. in length.

[signature] 1/11/2012

Please Sign Here Date

3) Earned B.A. In Biology (Marine Concentration) - Intense Courseload in Marine areas including Ichthyology, Invertebrate Biology, Taxonomy, Marine Ecology, etc. ... See Back

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Christopher Bartlett Date: 1/31/12

Address: 6 County Rd Eastport ME 04631
Number Street City State Zip

Phone: 207 214 7061 Email: cbartlett@maine.edu

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Lake St. School, Auburn, ME

Middle School: Castner Middle School, Darnariscotta, ME

High School: Lincoln Academy, Newcastle, ME H.S. Diploma: ☒ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended):

B.S. Microbiology, University of Maine

Work History (Please list your most recent employment and include dates of employment)

Marine Extension Associate, University of Maine Sea Grant
Feb. 1995 - Present.

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

I'm competent at identifying the marine mammal species common to the Cobscook Bay area. I have served as a fisheries observer on several research and monitoring efforts and I'm experienced with safe watercraft operations

C Bartlett 1/31/12
Please Sign Here Date

Limited availability

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Alethea (Lee) Leddy Date: 11/11/11

Address: 1348 US Rt 1 Perry Me 04667
Number Street City State Zip

Phone: 207-853-2341 Email: Alethea.LeeLeddy@gmail.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Jamaica Queens NY - cant remember #

Middle School: P.S. 117 - N.Y

High School: Southampton H.S. - N.Y. H.S. Diploma: ☒ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): S.U.N.Y. Cobleskill 1972-1974 - animal husbandry

Work History (Please list your most recent employment and include dates of employment)

Naturalist onboard schooner ADA C LORE for Butch Harris - 2010/2011 season

Veterinary technician at Perry Vet. Clinic 1994 - 2007

CNA/perdiem Atlantic Rehab nursinghome - 2008 - 2011

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

worked for 8 years in NY as volunteer onboard whale watch research vessel, recording/photographing finback/minke behavior, Was on tri state marine mammal stranding network during those years helping in live strandings, necropsies of whales, seals, dolphins, sea turtles, Am trying to photo ID the finbacks and minkes in our waters as no one in this vicinity is doing them only humpbacks and rights

marine mammals my passion,
hold maine vet. tech license

Please Sign Here Date

Alethea Leddy 11/11/11

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Brian M Duffy Date: 1/19/12

Address: PO Box 177 Eastport ME 04667
Number Street City State Zip

Phone: 853-6111 Email: BDuffy@Roadrunner.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☑ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar:

Middle School:

High School: The Heights School, Potomac, MD H.S. Diploma: ☑ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): University of Maryland, BA in Economics, 1997 WCTC Marine Technology Center, 2000

Work History (Please list your most recent employment and include dates of employment)

The Boat School, Husson University, Boat Building instructor 2009- present

Shead High School 2007-2009

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

Lifelong interest in outdoor activities including, rowing, sailing, powerboating and fishing. Experience as sailing instructor with Hurricane Island Outward Bound School.

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Stephen Erwin Date: 11/29/11

Address: 27 Washington St. Eastport, ME 04631
Number Street City State Zip

Phone: 207-853-9430 Email: mcsmallhat@maine.rr.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☑ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Kenilworth Elem (5th, 6th grade) Bowie, MD.

Middle School: Belair Jr. High (7-9) Bowie, MD

High School: Bowie High (10-12) Bowie H.S. Diploma: ☑ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): Maryland Univ. Music Major College Park, MD.

Work History (Please list your most recent employment and include dates of employment)

Shop N' Save - Calais, ME. 2-10 to present

Royal Books · Baltimore, MD. 12-2001 - 7-2007

Whole Foods - Baltimore, MD 1-~~2007~~ 1997 - 12-2007

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

Attention to detail. Interest in marine life. A love of being on the water.

[signature] 11/29/11

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: PATRICIA CAYA Date: 11/15/2011

Address: 27 WASHINGTON ST, EASTPORT ME 04631
Number Street City State Zip

Phone: 207 853 9430 Email: stellavoce@maine.rr.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☑ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Columbia Park Elementary, Columbia Park, MD 1961-67

Middle School: Kent Jr. High School, Palmer Park, MD 1967-1970
Largo Sr. High, Largo, MD - Autumn 1970

High School: Boise Sr High 1971 - 1973 H.S. Diploma: ☑ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): ① ST MARY'S COLLEGE OF MD ST MARY'S CITY, MD BA/ENGLISH 1973-1977

② ACADEMY OF MUSIC + DRAMATIC ARTS, VIENNA, AUSTRIA 1982 + 1988 - VOICE, OPERA, ORATORIO, [illegible]

Work History (Please list your most recent employment and include dates of employment)

QUODDY TIDES - MARCH 2010 - PRESENT; U MAINE MACHIAS JAN 2011 - PRESENT; US CENSUS - JAN 2010 - JULY 2010; please see attached resume for more details.

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

I am an avid kayaker and sailor. I love being out on the water, and love watching and observing wildlife. I am at home on the water, and I can carry out instructions. I also have experience photographing on the water.

[signature] 11/18/2011

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Tessa Ftorek Date: Dec. 21, 2011

Address: 13 Woodcock Way Robbinston ME 04671
Number Street City State Zip

Phone: 454-2130 Email: tftorek@pwless.net

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: Eastport Grammar School

Middle School:

High School: Shead Memorial High School, Eastport H.S. Diploma: ☐ ~~Yes~~ ☐ No 1969

Higher Education (Please indicate course of study, when and where attended): University of Maine at Presque Isle, B.S. in education, graduated 1973

Work History (Please list your most recent employment and include dates of employment)

Washington County Community College 1987-present

Cobscook Hikes and Paddles 2000-present

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

Registered Maine Guide-certifications in sea kayaking, boat operation and recreation; volunteer water quality monitor; member of board of Cobscook Bay Resource Center

Tessa Ftorek 12-21-2011

Please Sign Here Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Aubrey Rosslin Jollotta Date: 7 Feb 12

Address: 79 County rd Eastport Maine 04631
Number Street City State Zip

Phone: 207-853-2093 Email: daddybear1978@yahoo.com

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? ☒ Yes ☐ No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar:

Middle School:

High School: Dexter Christian Acadamy H.S. Diploma: ☒ Yes ☐ No

Higher Education (Please indicate course of study, when and where attended): Colorado School of Trades Gunsmith

Work History (Please list your most recent employment and include dates of employment)

US Army retired 2001 - 2009 Disabled veteran

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

worked on several boats; I enjoy whales; seals A Avide Animal Lover, been working on Boats repair and service

[signature]

Please Sign Here

7 Feb 12

Date

APPLICATION FOR MARINE MAMMAL OBSERVER TRAINING

Name: Jim MITCHELL Date: 2/10/2012

Address: 45 OLD COUNTY RD Pembroke ME 04666
Number Street City State Zip

Phone: 207-726-9526 Email: Jmitchell2 @ ORPC.CO

This temporary position requires 4 to 6 hours on the water daily. Can you meet this expectation? € Yes € No

Formal Education (Please indicate name of school, location and years you attended school):

Grammar: PERRY ELEMENTARY, Robbinston ELEMENTARY, EASTPORT Elementary

Middle School: CALAIS middle

High School: SHEAD HIGH SCHOOL EASTPORT, ME 4 YRS H.S. Diploma: € Yes € No

Higher Education (Please indicate course of study, when and where attended):

Work History (Please list your most recent employment and include dates of employment)

OCEAN RENEWABLE POWER COMPANY OCT 2010 - PRESENT

What attributes and experience would make you a marine mammal observer if you complete the training? (List any on the water experience, volunteer work, courses, hobbies, special interest, etc.)

CAPTAIN 50T MASTER, NEAR COASTAL MATE

CAPTAIN FOR ORPC

James Mitchell 2/10/2012

Please Sign Here Date

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Appendix D

Impact of TidGen™ Power System Installation on Birds, Center for Ecological Research, April 2012

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Report to ORPC on Impact of TidGen™ Power System Installation on Birds

in the Deployment Area

in Cobscook Bay, Maine

Period of Investigation

March 31, 2012

Prepared by
Peter D. Vickery, Ph.D.
Center for Ecological Research

April 2012

Introduction

The Center for Ecological Research (CER) conducted seabird inventories off the waters of North Lubec where Ocean Renewable Power Company (ORPC) was installing the underwater foundation for the first TidGen™ Power System in Cobscook Bay (Fig. 1). CER monitored the waters off North Lubec on March 31, 2012, to determine if the construction and deployment of the support pilings would adversely affect seabirds using the Deployment Area. We determined the species and numbers of seabirds that used the proposed Deployment Area, and then determined if the behaviors of the seabirds in the area were affected by construction activities, particularly the noises generated when using a vibratory hammer and a diesel impact hammer to drive foundation piles. These results should help ORPC minimize potential impacts when it deploys future TidGen™ systems.

Figure 1. Land-based surveys were conducted from the Landing Site in North Lubec, Maine. The surveys were separated into the near shore area (A) just offshore from the Landing Site and the mid-channel area (B) where the TidGen™ Power System was deployed in late March and early April 2012.

Background

Cobscook Bay is a rich marine environment with 5-7 meter tides and strong currents (Larsen 2004). This bay is an important fishing area and we regularly observed 12-20 scallop draggers and fishing vessels in the bay during our surveys. Numerous salmon pens are also scattered throughout the bay; boats service these pens on a daily basis.

We paid special attention to federal and state endangered, threatened, and special-concern species and communicated with the Maine Department of Inland Fisheries and Wildlife to confirm that the updated list of these bird species in Maine was accurate (http://www.maine.gov/ifw/wildlife/species/endangered_species/state_federal_list.htm; see Appendix 1).

STUDY OBJECTIVES

The objective of this study was to determine if the seabirds that use the proposed Deployment Area of the TidGen™ Power System were affected by the installation of the support structure for the TidGen™ on March 31, 2012.

SURVEY SITE

ORPC Landing Site - North Lubec

We used the ORPC Landing Site in North Lubec as the location for our land-based observations. These surveys were conducted from the defunct landing dock (Fig. 1).

The land-based survey area for the nearshore Landing Site and the mid-channel was delineated by an imaginary line extending from the ORPC Landing Site to the east end of Goose Island (Fig. 1). The west side of the survey area was defined by a line extending from the western boundary of the Landing Site to a white building on a salmon farm directly northwest of the Landing Site. The northern edge of the inshore area (A) was marked by a green navigation buoy north of the Landing Site. The mid-channel area (B) was delimited by the green buoy and a white marker west of Goose Island. The beach and adjacent pond to the east of the Landing Site were clearly visible from this position.

SURVEY METHODS

This phase of this study documented the number of seabirds that used the general Deployment Area on March 31, 2012 during both vibratory and diesel impact hammer operations and compared the results to previous survey data from the area.

Wintering Waterfowl and Seabirds

CER conducted two surveys from the Landing Site at North Lubec on March 31, 2012. Each survey was conducted for a period of 2 hours. Each survey was divided into 15-minute periods and the maximum number of each species and its behavior (see below) were recorded during each period. For reporting purposes, CER condensed the 15-minute observation periods into 30-minute units by selecting the largest count in each of the two 15-minute periods, e.g., if 7 eiders were counted in the first 15 minute period and 11 eiders were counted in the second period, CER used the higher number, in this case, 11 individuals. We used a continuous scan method to identify and count all species present (Martin and Bateson 1986). Observers used 8x or 10x binoculars and a 20-60x telescope for the land-based surveys.

Behaviors

We registered all behaviors of birds on the water's surface. Birds were identified as Loafing (floating on the surface), Diving (active feeding below the surface), or Surface Feeding (active feeding on the surface) (Holm and Burger 2002). We noted when construction activities were initiated and recorded bird movements and behaviors during those construction activities.

RESULTS

CER conducted two land based surveys from North Lubec on March 31, 2012 The first survey was conducted between 10:30 and 12:30 hrs during the vibratory hammer phase of the construction (Fig. 2). The second survey was conducted between 16:30 and 18:30 hrs when the diesel impact hammer was used (Fig. 3).

The responses of seabirds to the vibratory hammer noises were generally minimal or of short duration, except for three Canada Geese (Branta canadensis) in the near shore that appeared to be disturbed by the noise and departed the study site at 11:00. Red-necked Grebe (Podiceps grisegena) numbers did not change during vibratory hammer operation. Common Loon (Gavia immer) numbers declined from 3 to a single individual during vibratory hammer operation and then returned to three individuals within 15 minutes. There were 7 Common Eiders (Somateria mollissima) in the Deployment Area at 10:45 am, the number increased to 15 eiders at 11:00, then declined to 5 individuals at 11:15 when a loud fishing boat passed through the Deployment Area and displaced the eiders that had been foraging adjacent to the barge. The fishing vessel overwhelmed the noise of the vibratory hammer. After the fishing boat passed through the Deployment Area, the eiders circled and returned to the same area, increasing to 17 eiders by 11:30. There were no Red-breasted Mergansers (Mergus serrator) in the Deployment Area at 10:45. Six mergansers were observed at 11:00, but had departed by 11:15. These mergansers appeared to be moving through the Deployment Area (Fig. 2).

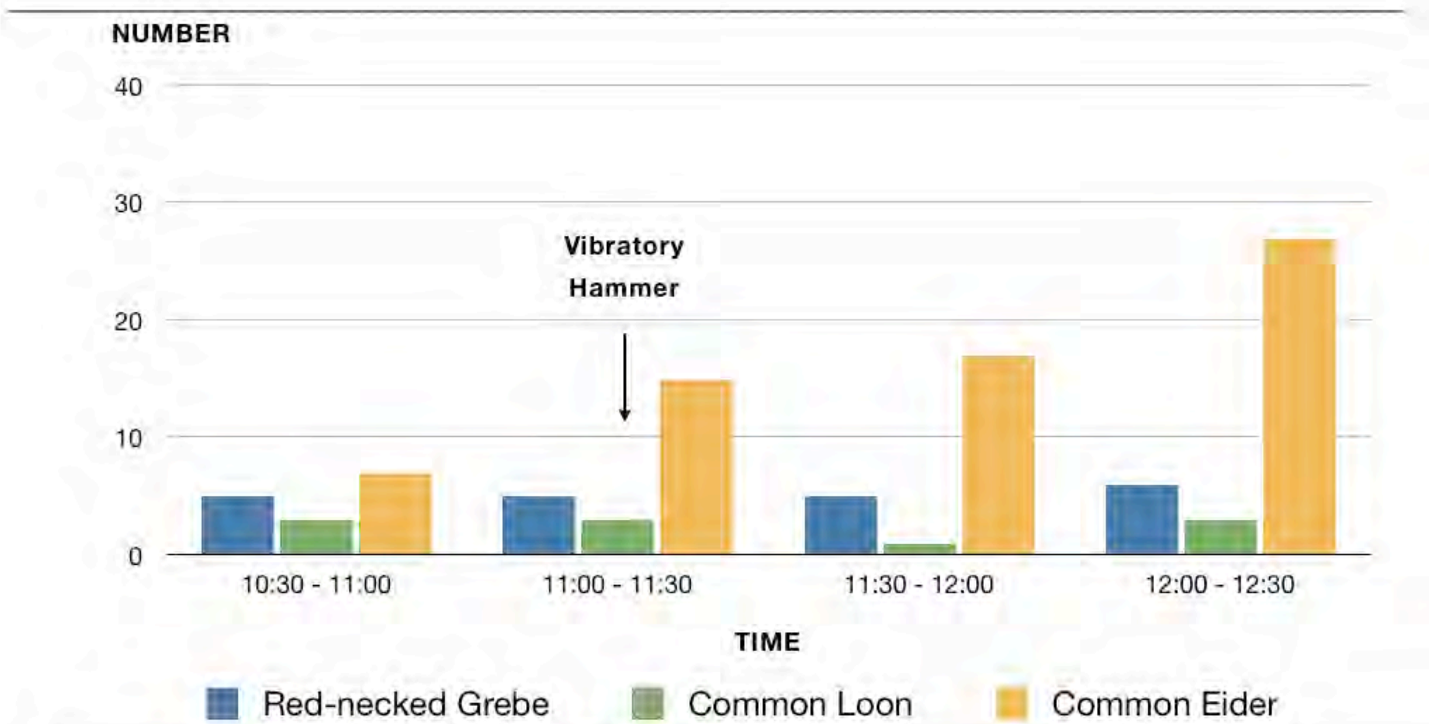

Figure 2. Red-necked Grebe (blue) numbers did not change during the use of the vibratory hammer at the TidGen™ Power System Deployment Site in North Lubec, Maine, March 31, 2012. Common Loons (green) declined from three individuals to a single loon for a 15 minute period after the use of the vibratory hammer. Common Eider (orange) numbers increased during the survey period.

Seabirds did not seem to be affected by diesel impact hammer noise and the number of birds did not change appreciably during operation (Fig. 3). Diesel impact driving began at 18:00 hrs, when there were 3 sets of 3 hammer strikes and 1 set of 4 hammer strikes. Impact driving was completed by 18:31. Red-necked Grebes increased slightly from 2 to 3 individuals during operation, and a single Red-necked Grebe was observed foraging within 100 m of the barge at this time. A single Common Loon was present throughout the survey. Common Eiders numbers ranged between 4 and 8 individuals during this survey. At 18:00 hrs, Common Eiders declined from 8 to 5 individuals when the diesel impact hammer was in operation.

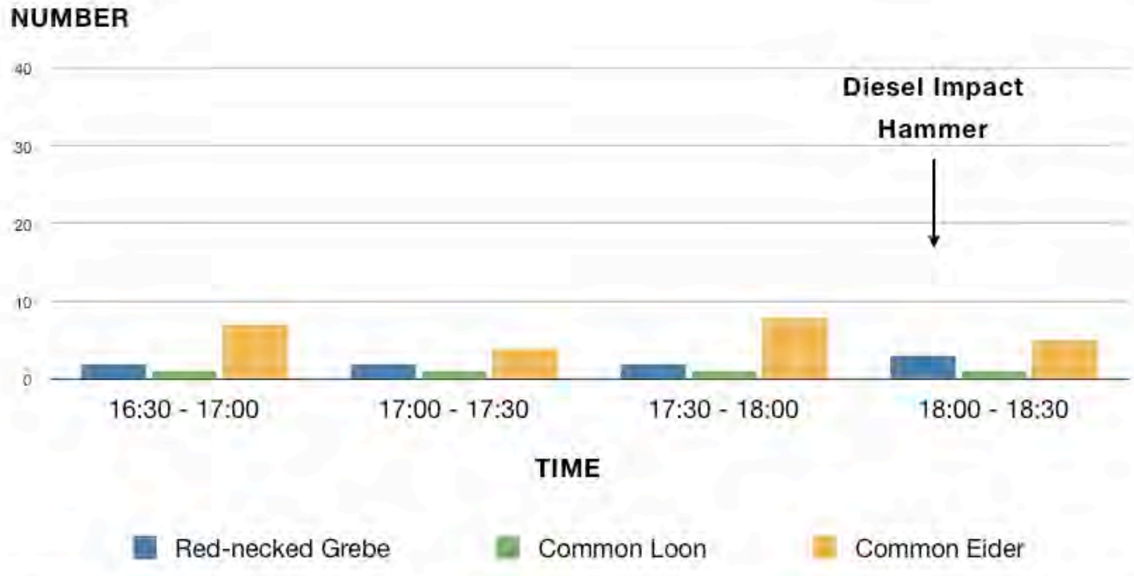

Figure 3. Red-necked Grebe (blue) numbers did not change during the use of the diesel impact hammer at the TideGen Deployment Site in North Lubec, Maine, March 31, 2012. A single Common Loon (green) remained in the area during the use of the vibratory hammer. Common Eider (orange) numbers decreased from seven to four individuals during the use of the diesel impact hammer and then increased to 8 individuals within 30 minutes post use.

<u>Diving Behavior</u>

All the seabirds were observed feeding (diving) actively. The use of the vibratory and the diesel impact hammer did not change this behavior, other than the three Canada Geese that departed the area.

<u>Bald Eagle</u>:

No Bald Eagles (Haliaeetus leucocephalus) were seen during the two surveys in the study area on March 31, 2012. This species is regular in this area and is usually seen flying over the study area. Formerly, Bald Eagle was listed as federally and state endangered, but because eagle numbers have recovered, this species was down-listed to threatened and is no longer listed at any level (http://www.maine.gov/ifw/wildlife/species/endangered_species/state_federal_list.htm).

DISCUSSION

There was little response of seabirds to the vibratory hammer noises. Any effects were generally minimal or of short duration. Given the general boat activity in the area, CER could only detect brief displacements that were less than 15 minutes long and it was not possible to determine if the seabird response was precipitated by the installation activities. Three Canada Geese near the Landing Site appeared to be disturbed by the vibratory hammer and departed the area when this equipment started operation. Common Eiders were displaced by a fishing vessel that passed through the Deployment Area while the vibratory hammer was in use but these birds quickly settled in the same area where they had been foraging. This suggests that eiders were not impacted by the noise or action on the barge.

We observed no obvious seabird response to the louder diesel impact hammer. Common Eider numbers declined from 8 to 5 individuals during operation but this was within the normal fluctuation of this species in this area at the time (Fig. 3). Common Loon numbers declined briefly but it was not clear whether this was in response to the diesel impact hammer noise or it was part of the normal loon movements in this area. Loon numbers returned to previous levels (3 individuals) within 15 minutes.

All seabirds were actively feeding prior to and during installation activities. The fact this behavior did not change when the vibratory or diesel impact hammers were in use seems to indicate that the seabirds present were not affected by the noise.

Endangered and Threatened Species:

CER surveys did not find any federal or state endangered or threatened species on March 31, 2012. Bald Eagles are regular in the study area but this species was removed as a threatened species in 2009 (Charles Todd, pers. comm.; MDIF&W).

Potential Impact for ORPC Activities in Winter:

Early spring, between March and April, is an excellent time of year to conduct installation activities because there are few seabirds in the Deployment Area and along the near shore at the Landing Site. Given that CER staff observed a general lack of seabird response to these installation activities, it seems unlikely that installation activities will have any adverse affect on non-breeding seabirds at any season. It also seems unlikely that general maintenance activities will disturb seabirds at this site. It does appear that major installation and maintenance activities could affect Canada Geese but previous observations confirm that this species geese is rare in the study area at any season, and Canada Geese have not been observed in the Deployment Area. CER staff did not observe any Canada Geese during winter surveys from November 2010 through May 2011, nor from September 2011 through February 2012. The three individuals on March 31, 2012 were the only geese seen on CER surveys.

Literature Cited

Maine Department of Inland Fisheries and Wildlife. http://www.maine.gov/ifw/wildlife/species/endangered_species/state_federal_list.htm

Holm, K. J., and A. E. Burger. 2002. Foraging Behavior and Resource Partitioning by Diving Birds during Winter in Areas of Strong Tidal Currents. Waterbirds 25:312-325.

Larsen, P. F. 2004. Introduction to ecosystem modeling in Cobscook Bay, Maine: a boreal, macrotidal estuary. Northeastern Naturalist 11:1-12.

Martin, P., and P. Bateson. 1986. Measuring behaviour: an introductory guide. Cambridge University Press, Cambridge.

Appendix E

Final Acoustic Report for Pile Driving Activities

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ACOUSTIC MONITORING RESULTS FOR PILE DRIVING ACTIVITIES

INCIDENTAL HARASSMENT AUTHORIZATION

COBSCOOK BAY TIDAL ENERGY PROJECT

FERC PROJECT No. 12711

ORPC MAINE, LLC

April 24, 2012

Scientific Solutions, Inc.

99 Perimeter Road

Nashua, NH 03063

Tel: +001 603 880 3784

http://www.scisol.com

CONTENTS

EXECUTIVE SUMMARY

Measurements of the in-water noise level related to pile driving activity prior to April 09, 2012 during installation of the TidGen™ Power System demonstrate that near-source sound level limits (peak pressure level or sound exposure level) for operation after a work window ending April 09, 2012 were not exceeded for impact hammer activity, and were marginally exceeded for sound exposure level during two of five activities using a vibratory hammer.

It was noted that vibratory hammer levels were exceeded during the first two vibratory driving activities after which time the connections between the hammer, follower, and piling itself were improved. In addition, a mitigation method was identified to limit the likelihood of exceeding the sound exposure level limit with the vibratory hammer given the improper hammer connection. However, this mitigation is deemed unnecessary for future operations due to the use of best management practices related to the hammer, follower, and pile connections.

Measurements in the mid- to far-field indicate that the Level A and Level B harassment isopleths are closer than the conservative estimates provided in the original Acoustic Monitoring Plan.

In-air measurements at the Lubec come-ashore location and on Goose Island indicated that the pile driving activity was detectable for both vibratory and impact hammer sources based on the ambient noise level during the pile driving. As both the pile driving noise levels and ambient noise levels were variable, the results varied from pile activity being completely masked by ambient noise to levels 5 – 10 dB above ambient.

1.0 INTRODUCTION

1.1 PROJECT BACKGROUND

ORPC Maine, LLC, a subsidiary of Ocean Renewable Power Company, LLC (collectively, ORPC), received a pilot project license for the Cobscook Bay Tidal Energy Project (Project) from the Federal Energy Regulatory Commission (FERC) on February 27, 2012 (FERC Project No. P-12711). The Project will evaluate the potential for a new source of clean, renewable energy generation using tidal energy resources in Cobscook Bay, Maine. ORPC obtained an initial preliminary permit for the project area in Cobscook Bay from FERC on July 23, 2007; FERC issued a successive preliminary permit on January 13, 2011. Feasibility studies, including environmental surveys, and pre-filing consultation were conducted, resulting in ORPC's filing of a draft pilot license application (DPLA) with FERC for the Eastport Tidal Energy Project on July 24, 2009. Since submitting the DPLA, ORPC has conducted extensive consultation with regulatory and resource agencies as well as other stakeholders, has collected additional environmental data, and has continued to refine its proprietary technology. As a result of these additional studies and consultations, ORPC now plans to deploy a commercial-scale hydrokinetic power system in stages, with the Project, a small pilot project, as the first phase. The FERC preliminary permit Project boundary for the Cobscook Bay Tidal Energy Project (FERC Project No. 12711) encompasses the proposed development area. The FERC pilot project license boundary for the Cobscook Bay Tidal Energy Project encompasses the proposed development area.

Figure 1: Cobscook Bay Tidal Energy Project location map.

1.2 Foundation Design and Installation

The foundation design for the TidGen™ devices at the project site consists of a pile bent arrangement consisting of ten steel piles, each with a 30-inch diameter and ½-inch wall thickness. The piles were designed to vary in length due to bottom sediment depth with each driven to the top of the bedrock and protruding 15+ ft above the seafloor.

The bottom support frame (BSF) for the first TidGen™ device was deployed on the seabed on March 20, 2012 (Figure 2). The deployed BSF acted as a template for the driving of piles to secure the foundation in place.

The Contractor's deployment plan included the use of both a vibratory and diesel impact hammer to drive the piles to refusal. Hammers specifications were included in the Acoustic Monitoring Plan for Pile Driving Activities submitted to NOAA NMFS, Office of Protected Resources on March 1, 2012.

Figure 2: Bottom Support Frame (BSF) deployment, March 20, 2012.

1.3 Restrictive Work Window for Endangered Species

ORPC anticipated the use of driven piles to fix the TidGen™ to the sea floor during the Final Pilot License Application process. In our consultation with NOAA NMFS, Protected Resource Division, it was identified that the potential sound levels of driving such piles may emit sound levels that could damage young salmon. Below is an excerpt from correspondence from Dan Tierney, NOAA NMFS, to Herb Scribner, ORPC on October 28, 2011.

> *Pile driving that occurs within Cobscook Bay between November 8th and April 9th will not affect listed salmon because they are not anticipated to be present in the action area. The piles driven for Phase 1 of the proposed project (ten of the fifty) will be driven during March 2012; therefore, their installation is not anticipated to adversely affect listed salmon. Although ORPC will endeavor to install the piles for Phase 2 during the preferred work window (November 8th and April 9th), it will likely not be possible to install all forty of the remaining piles during that timeframe. Therefore, ORPC will conduct acoustic monitoring during the driving of the Phase 1 piles to determine if noise levels are below the thresholds of injury to fish as described above. If it is determined that the noise levels exceed these thresholds, ORPC will work within the recommended November 8th to April 9th work window and/or use a combination of attenuation devices (cushion or bubble curtain) to reduce levels to a point where they will not harm listed fish. So, if during the monitoring of Phase 1 pile driving it is determined that noise levels are significantly below the thresholds for injury, the work window and the attenuation methods will be unnecessary.*

As a condition of a subsequent Incidental Harassment Authorization (See Section 1.5) from NOAA NMFS, Office of Protected Resources, ORPC included a separate Acoustic Monitoring Plan for Pile Driving Activities that included monitoring during initial pile placement by several methods and mitigation measures that covered the range that NMFS had indicated in their correspondence. It was intended by NMFS to require ORPC to drive the initial piles and collect data regarding the monitored sound levels when no salmon were present.

1.4 Incidental Harassment Authorization (IHA)

ORPC applied for an IHA for pile placement because the pile's vibratory hammer setting and diesel impact hammer could potentially generate noise levels above NOAA's guidelines for continuous and impact noise under the Marine Mammal Protection Act of 1972.

ORPC's IHA application included the estimation of noise source levels and associated isopleths based on calculations performed by SSI on in-air hammer specifications and nameplate information provided by the manufacturer.

On a constant radiated energy level it was determined that in-air data can be transferred to in-water data by adding 62 dB to account for differences in reference levels and specific acoustic impedance (ratio of particle velocity to pressure). Thus the 112 dB in-air vibratory source level at the operator (presume 1 m away) equated to roughly 174 dB re µPa2 @ 1 m in water. The 131 dBA from the plate on the impact hammer equated to 193 dB re µPa2 @ 1 m in water.

Based on Level A harassment above 180 dB for marine mammals for the impact hammer, the Level A harassment isopleths was determined to be roughly 30 to 100 m from the source. Therefore mitigation measurements were recommended to insure that no marine mammals be within 100 m of the pile driving.

Based on Level B harassment levels for the continuous vibratory source at greater than 120 dB, and assumed 15logR propagation loss in shallow waters (cylindrical spreading would be 10logR and spherical spreading would be 20logR), SSI determined the 175 dB source levels for the vibratory hammer do not attenuate to 120 dB until a distance of 4600 meters, or roughly 2.5 miles from the source.

NOAA NMFS grants authorization for incidental takings of marine mammals if it finds that the taking will have a negligible impact on the species or stock(s), will not have an immitigable adverse impact on the availability of the species or stock(s) for subsistence uses (where relevant), and if the permissible methods of taking and requirements pertaining to the mitigation, monitoring and reporting of such takings are set forth. NMFS has defined "negligible impact" in 50 CFR 216.103 as "...an impact resulting from the specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival."

Except with respect to certain activities not pertinent here, the MMPA defines "harassment" as:

> *any act of pursuit, torment, or annoyance which (i) has the potential to injure a marine mammal or marine mammal stock in the wild [Level A harassment]; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering [Level B harassment].*

ORPC consulted with NMFS prior to submittal of an IHA for the CBTEP and subsequently prepared and submitted detailed Acoustic Monitoring and Marine Mammal Observation Plans for the pile driving activity.

ORPC was granted an IHA by NMFS on March 8, 2012 for the take, by Level B harassment only, 72 total grey and harbor seals (Halichoerus grypus and Phoca vitulina), 72 harbor porpoises (Phocoena phocoena), and two Atlantic white-sided dolphins (Lagenorhynchus aculus) incidental to pile driving associated with the tidal turbine project. The IHA included specific monitoring and reporting requirements to determine actual source levels and harassment isopleths ranges.

2.0 ACOUSTIC MONITORING OBJECTIVES

ORPC conducted pile-driving activities between March 24th, 2012 and April 4th, 2012. Of concern was the effect of the pile driving noise on endangered species of fish (primarily Atlantic salmon) and marine mammals. Acoustic monitoring was conducted to quantify noise levels generated from various pile driving techniques and to determine the effectiveness of mitigation methods to ameliorate the April 10th through November 7th work-window. The following were the specific objectives of the acoustic monitoring:

- Measure near field noise levels in dB re1μPa peak pressure and sound exposure levels (SEL) to confirm impact hammer levels are maintained at less than 206 dB re1μPa@1m peak and below 187 dB re 1μPa^{2}s SEL at a range of 10 m. In addition, vibratory hammer levels were to be maintained at less than 206 dB re1μPa@1m peak.
- Establish the 180 dB re 1μPa@1m rms pressure isopleth for both vibratory and impact hammers (thresholds for Level A harassment are 190 dB for pinnipeds and 180 dB for cetaceans).
- Establish the 160 dB re 1μPa@1m rms pressure isopleth for impact (level B transient source) using sound attenuation devices.
- Establish the 120 dB//1μPa@1m rms pressure isopleth for vibratory (level B continuous source).
- Monitor ambient air noise levels with a sound level meter at Goose Island and at the Lubec shore station to identify in air noise levels at a potential bird rookery and seal haul-out areas within this area of Cobscook Bay concurrent with bird surveys being conducted by others.

These limits are summarized in Table 1 and

Table 2.

Table 1: Thresholds for injury at 10 m for fish[1].

Peak Absolute Pressure Limit (Threshold for Injury)	Sound Exposure Level (SEL) Limit (Threshold for Injury)
206 dB re 1 μPa	187 dB re 1 μPa^{2}s

Table 2: NOAA guidelines for root men square (rms) pressure levels for Level A and Level B harassment of marine mammals due to continuous (vibratory hammer) and transient (impact hammer) sources.

Type	Level A	Level B
Vibratory	180	120
Impact	180	160

[1] Correspondence between Herb Scribner and Dan Tierney, NOAA NMFS "*The noise produced by driving 3 foot or 6 foot piles with an impact hammer will likely exceed the injury thresholds for noise (206 dB Peak and 187 dB SEL) set by the Fisheries Hydroacoustic Working Group, an interagency (USFWS and NMFS included) work group on the West coast that considers the effects of pile driving on fish,*" October 4, 2011.

3.0 METHODOLOGY

3.1 STUDY AREA

The geographic scope of the study generally includes the Cobscook Bay Deployment Area (Figure 1).

Piles were driven by vibratory or diesel impact hammer in nominally 100 feet of water during high slack periods and approximately 85 feet of water during low slack periods (Figure 3 and Figure 4).

Figure 3: Diesel impact hammer and pile, March 25, 2012.

Figure 4: Vibratory hammer and pile, April 1, 2012.

3.2 Measurement System Methods and Equipment

ORPC and Scientific Solutions Inc. (SSI) utilized in-water methods to measure the pile-driving noise in the environment related to the TidGen™ Power System installation. Underwater measurements were made at both a fixed position on the deployment barge approximately 10 meters from the pile and on a drifting boat at varying distances from the pile activity.

Figure 5: Acoustic monitoring from barge (right) and vessel at 100m (left), April 25, 2012

3.2.1 In-Air Noise Measurement System Equipment and Methods

In-air measurements were performed using a sound level meter mounted on an industrial tripod at a fixed location during a particular pile activity. A GPS recording device was also attached to the tripod to determine the distance to the pile activity. The sound level meter was a Quest Technologies SoundPro DL-1-1/3 Octave-20 sound level meter that meets Type 1 requirements of the American National Standards Specifications for sound level meters, SI.4-1971.

Each day the sound level meter was deployed on either Goose Island or at the Lubec shore station location. The meter was calibrated prior to and after each day of recording using the methods and calibrator provided by the meter manufacturer. An observer remained with the unit (at a distance) to ensure that the equipment was not engaged by wildlife and to note if boats passed near or between the barge and the measurement location during the driving activity.

3.2.2 In-Water Noise Measurement Equipment and Methods

In-water measurements consisted of near-source barge measurements at approximately 10 meters from the pile and boat measurements ranging from 100 meters to 2 km. Barge measurement involved deploying a pair of hydrophones approximately 10 and 20 ft below the surface. Measurements were made as a series 75 second (s) records with approximately 10 s between records using an IOTech WaveBook/516E data acquisition system. Boat measurements were made using a similar pair of hydrophones at similar depths and captured as a series of 60 s records without breaks using a Measurement Computing LGR-5320 data acquisition system. Specification sheets for the equipment can be found in the appendices of the Acoustic Monitoring Plan.

Barge Data Acquisition Component Summary

- Hydrophones: 2 X Reson TC4013
- Preamplifiers: 2 X low-noise 1-100 kHz battery operated preamplifier (EPAC)
- Data Acquisition: IOTech Wavebook/516E to laptop computer over Ethernet

Boat Data Acquisition Component Summary

- Hydrophones: 2 x Reson TC4013
- Preamplifiers (stage 1): 2 X low-noise 1-100 kHz battery operated preamplifier (EPAC)
- Preamplifiers (stage 2): SSI custom low-noise preamplifier
- Data Acquisition: Measurement Computing LGR-5320 (2-channels @ 100kHz/channel sampling rate)

Prior to every deployment of the barge and boat measurement systems, the hydrophone sensitivity was calibrated through the entire system using a pistonphone recommended by the hydrophone manufacturer. A calibration was also performed at the end of each deployment. This ensured that there was no degradation in the performance of the hydrophones or acquisition system.

3.3 In-Water Mitigation Equipment

Figure 6 shows the mitigation equipment used during impact hammer activity. For the first impact pile, a single, ¾" piece of plywood was used. Subsequent drives used two layers for 1-½" total.

Figure 6: Plywood sound mitigation measures for the diesel impact hammer after pile driving. The first file used ¾" thick plywood (right photo). Subsequent impact drives used two layers for 1-½" total (shown on left and center in photo in various stages of assembly).

4.0 IN-AIR MONITORING RESULTS

In-air noise data was collected on Goose Island and the Lubec shore for impact hammer and vibratory hammer activity. The Goose Island monitoring equipment was located at a distance approximately 1,500 ft northeast of the pile driving. The monitoring at the Lubec come-ashore location was approximately 3,250 ft southwest of the pile driving. The ability to detect the activity with in-air measurements depended largely on the level of background noise at the time.

Figure 7 shows the measurements on Goose Island during the first impact hammer activity on March 25th. Here the hammer noise level is readily observable over the ambient sound level by approximately 10 dB. Figure 8 shows the measurements on the Lubec shore during later impact hammer activity March 31st where the hammer sound was not observable.

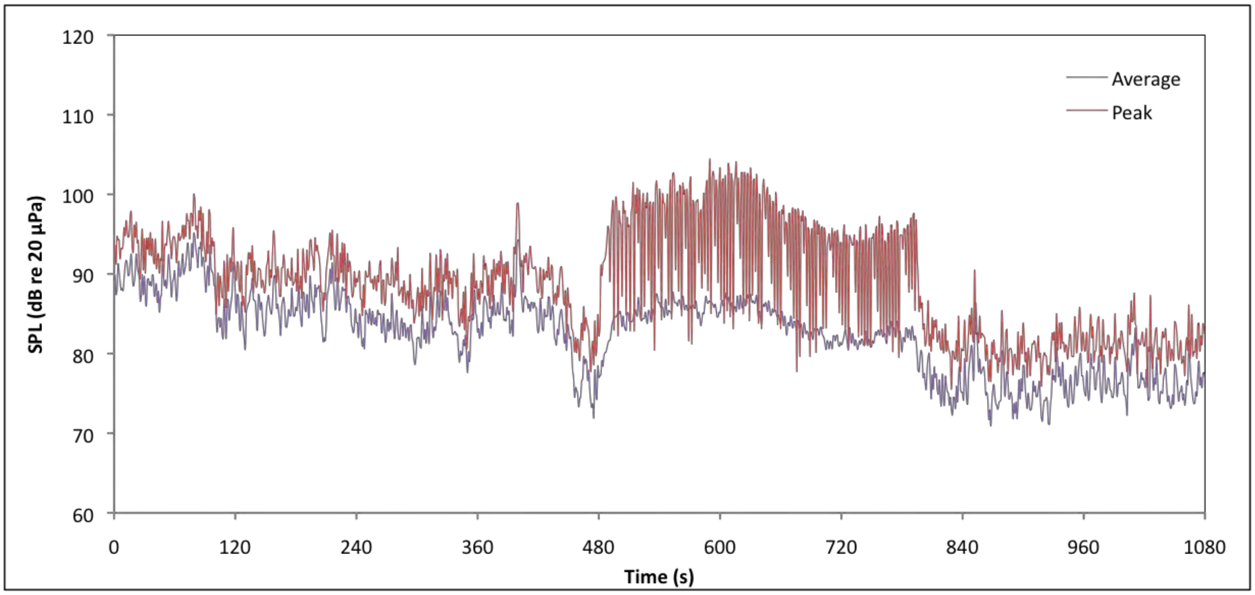

Figure 7: In-air measurements on Goose Island during impact hammer activity, March 25th starting at approximately 2:07 pm.

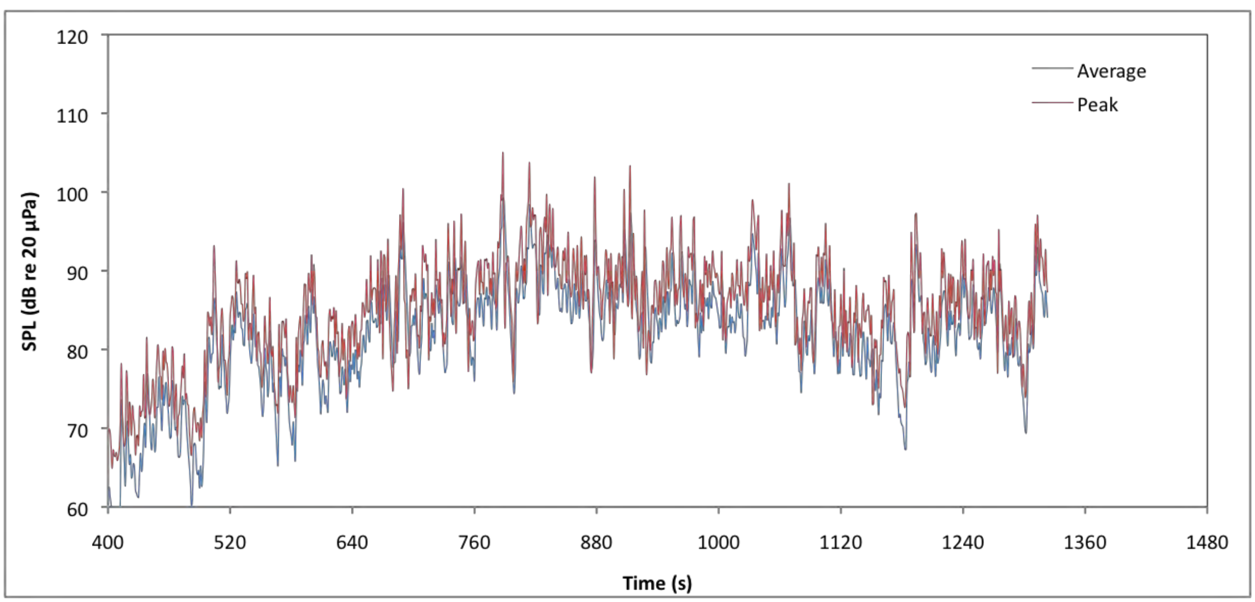

Figure 8: In- air measurements at the Lubec shore station location during impact hammer activity, March 31st starting at approximately 6:00 pm.

Figure 9 shows measurements on Goose Island and Figure 10 shows measurements on the Lubec shore during vibratory activity. During the pile driving associated with the Lubec measurement, the ambient noise was much lower (likely due to lower wind speeds) and noise due to the pile driving is up to 5 dB higher between 10 and 15 minutes of the displayed data record. The vibratory hammer was not detectable over the ambient noise levels on Goose Island during the collection times.

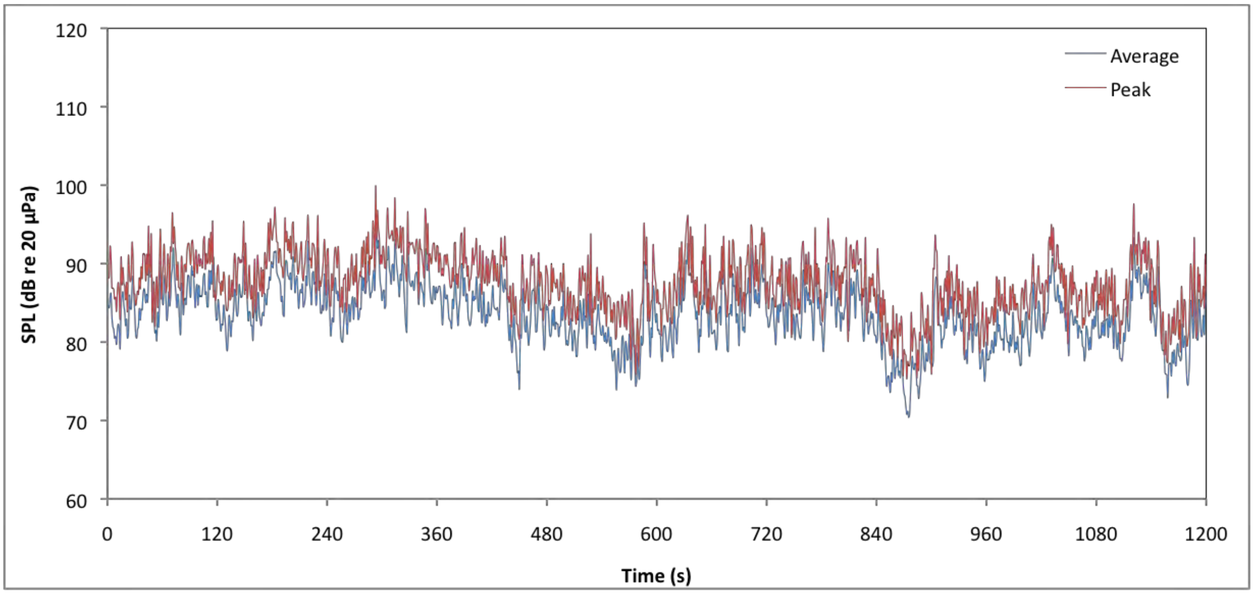

Figure 9: In-air measurements on Goose Island during vibratory hammer activity, March 29th starting at approximately 10:25am.

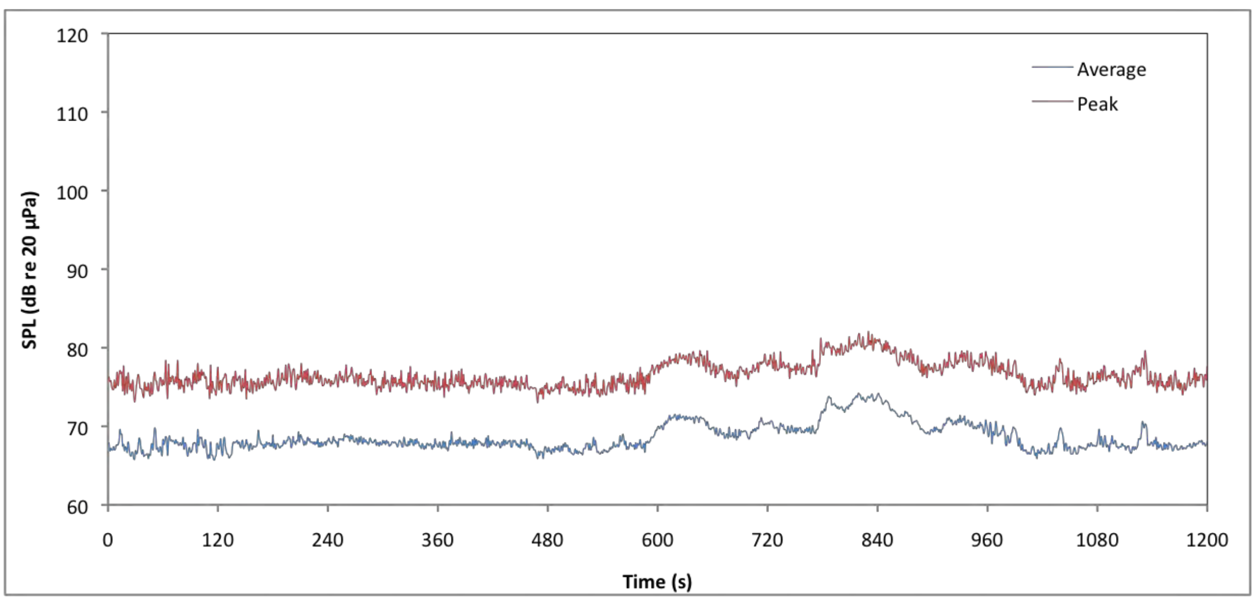

Figure 10: In- air measurements at the Lubec shore station location during vibratory hammer activity, April 1st starting at approximately 6:25am.

5.0 In-Water Monitoring Results

5.1 Barge Measurements (Near-source)

Near-source measurements are intended to determine the peak absolute pressure level and the sound exposure level. Peak absolute pressure is determined by evaluating the measured pressure across all time records during pile-driving activity. For impact hammer activity, the sound exposure level is calculated in a window containing 90% of the relative cumulative energy (SEL_{90}) for various individual impacts to determine a nominal value. For the vibratory hammer, the sound exposure level is calculated as a function of time based on the full duration of the activity.

5.1.1 Impact Hammer

Figure 11 shows the time series of the measured pressure (linear scale) for a subset of the impact hammer activity for pile 8. This is the raw data collected approximately 20 meters from the pile. All subsequent plots of the impact hammer data, and all analysis are performed using a correction for spreading losses to determine the sound level at 10 meters (whether in linear or decibel scale).

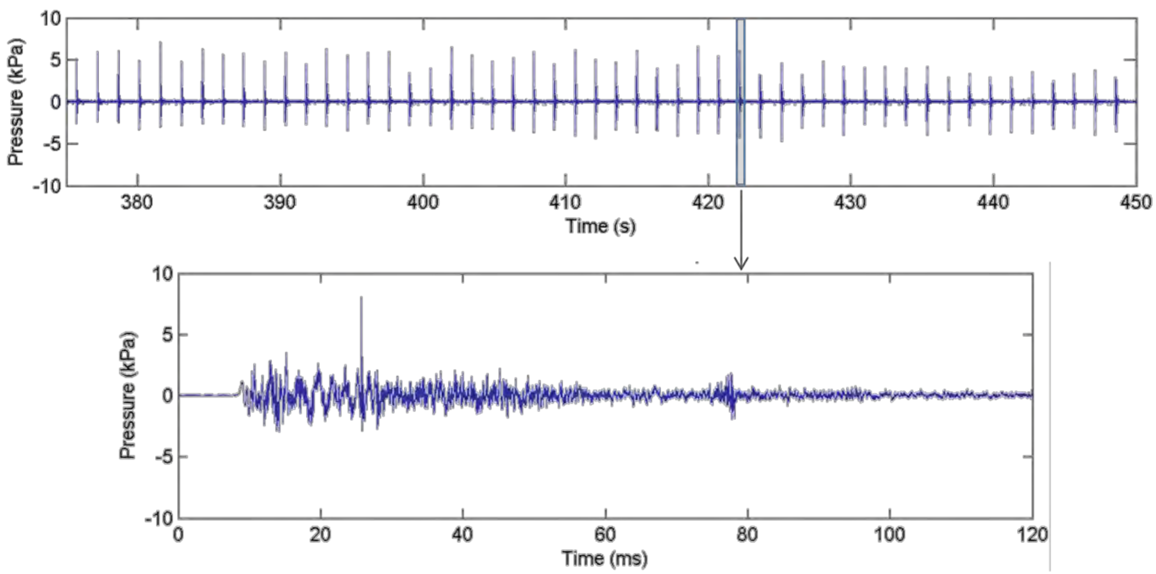

Figure 11: Example impact hammer time series data (not corrected for 10 meter range). The upper plot shows a series of discrete impact hammer "hits". The bottom plot shows an expanded view of a single hit (highlighted in top plot), for pile 8 on March 25th.

Given the nature of the source (the pile and follower), the water depth, and the range between the pile and hydrophones, cylindrical spreading is assumed when correcting for the relatively small (less than 10 meters in all cases, typically 5 meters) variation in the actual pile to hydrophone distance from 10 meters. In general this results in a correction on the order of 3 dB re 1µPa or less.

Figure 12 shows the peak absolute pressure as a function of recorded time for the impact hammer activity on pile 8. Note that recorded time indicates the sum of the 75 second data records collected over the course of the activity without the approximately 10 second intervals between each record.

Note that for these barge-data figures, the data from all records have been plotted consecutively (without gaps for these ~10 second intervals between records). Therefore it is important to note that the elapsed time seen in these plots between the start and end of activity will generally be 10-15% less than the noted time for the activity as a whole. This must be accounted for when comparing the apparent elapsed time in these figures with the known real-time duration of each hammer activity.

The pile 8 measurement contained the highest peak pressure value of all recorded impact hammer data with a value of 202 dB re 1µPa for a single hit. Across more than 200 hits between multiple piles, the average peak pressure of the individual hits was less than 200 dB re 1µPa.

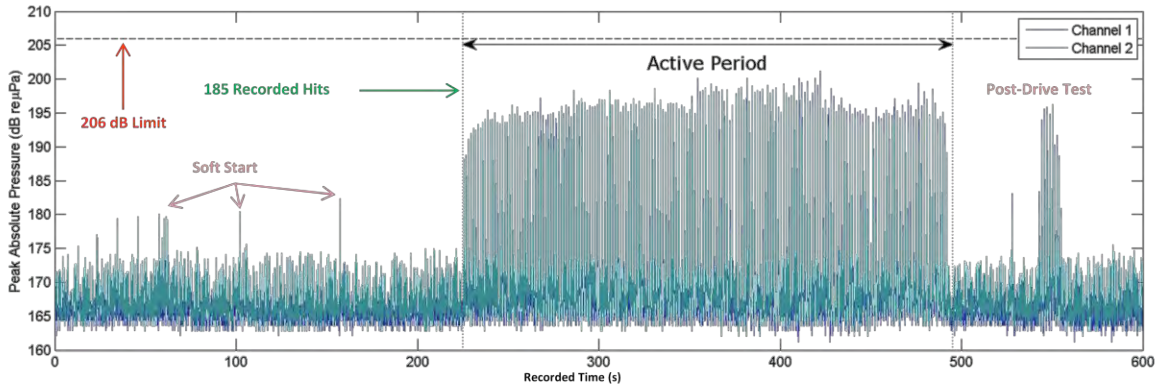

Figure 12: Peak absolute pressure as a function of recorded time for impact hammer activity of pile 8 on March 25th, including soft-start. The peak amplitudes of the impacts never reach or exceed to the 206 dB peak absolute pressure limit.

The SEL_{90} value for the 202 dB impact is 168 dB re $1\mu Pa^2s$ and the associated time series, relative cumulative energy, and window boundaries are shown in Figure 13. This value is representative of the impact hammer hits which were consistently well below the 187 dB SEL limit.

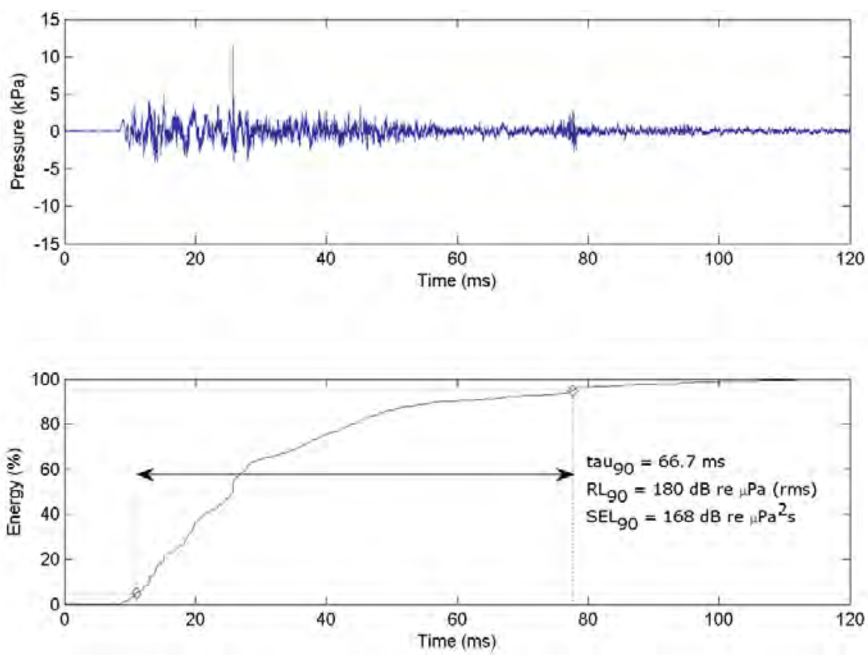

Figure 13: Sound exposure level in a window containing 90% of the energy of the transient impact (SEL_{90}) for the strongest peak (highest peak absolute pressure) of pile 8 on March 25th. The time series data in the top plot has been corrected to the pressure at 10 meters based on the measurement range and spreading loss. Note that the RMS_{90} pressure at nominally 10 meters is 180 dB re 1 µPa, or the Level A harassment level for transients.

5.1.2 Vibratory Hammer

Figure 14 shows the time series data for ambient data prior to vibratory hammer activity, the vibratory hammer at 50% power during a soft-start process, and at 100% power. Unlike the impact hammer, it is a continuous source after the soft-start process and any breaks at 100% power.

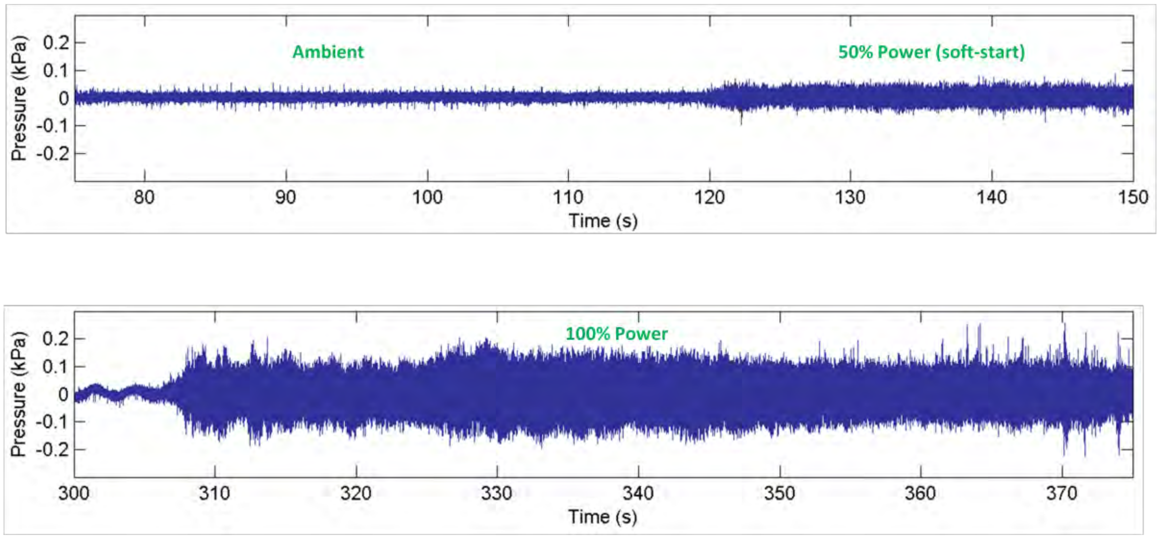

Figure 14: Time series data for vibratory hammer during ambient, soft start (~50% power) and full power periods for pile 1 on April 1st.

Several pile-driving issues were noted during the initial pile driving activity that contributed to noise levels higher than found with later piles. Issues noted with the first pile driven (skirt 8) included the attachment between the vibratory head and pile being looser than expected. This pile was not driven to refusal using the vibratory driver as a result. During vibratory pile driving over the next several piles some unexpected behavior was also observed. Ramping from 50% of hammer power to 100% hammer power led to a loss of pressure in the pile gripper attachment. On April 1st, during vibratory pile driving at skirt 7 the hammer grippers became disconnected from the pile. An examination of the vibratory hammer hydraulics system by a mechanic on April 2nd showed an air bubble in the hydraulic lines, which was vented by the mechanic. From this point forwards the pile gripper provided full hydraulic pressure at all times and no further issues were noted when using the vibratory pile driver.

In addition, during vibratory and impact pile driving the pile was connected to the follower using a bolted joint. For the first pile driven using the vibratory hammer the nuts on the bolts connecting the pile and the follower vibrated loose and the connection between the pile and follower loosened. The lack of connectivity between the pile and the follower caused the follower to cant over relative to the pile. These two factors reduced the efficiency with which energy was transferred from the vibratory hammer to the pile. The lack of connectivity between the pile and the follower was most likely a contributing factor in the increase of RMS peak pressures detected.

For all later piles driven with either the vibratory or impact hammers the bolted connection between the pile and pile follower was tightened to a higher torque level, and this addressed the joint separation issues. Figure 15 and Figure 16 illustrate what is likely the difference between well connected and driven piles and two initial piles-those where issues with the connections between the hammer and the follower as well as the follower and pile were identified and later corrected.

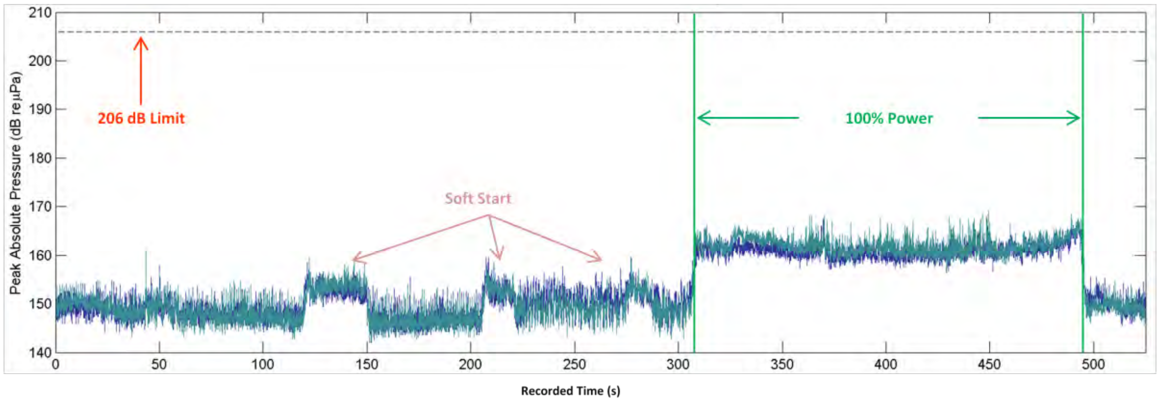

Figure 15: Peak absolute pressure as a function of recorded time for vibratory hammer activity after improving connections between the hammer and follower and the follower and pile. Under normal conditions the vibratory hammer showed fairly consistent output at 100% power. Pile 1, April 1st.

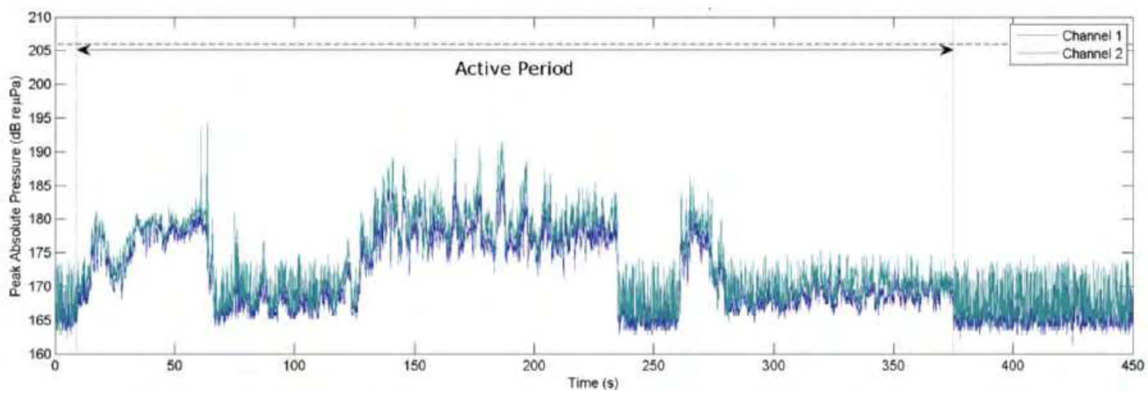

Figure 16: Peak absolute pressure as a function of recorded time for vibratory hammer activity of pile 8. For this first pile a number of issues with connectivity of the hammer to the follower and follower to the pile were identified. As a result, the pressure levels were higher overall, were not as consistent in level, and included occasional peaks that were higher than any other level recorded during vibratory operations. Pile 8, March 24th.

Peak Absolute Pressure

In all cases, the peak absolute pressure fell far below the near-source limit of 206 dB re 1µPa for the vibratory hammer.

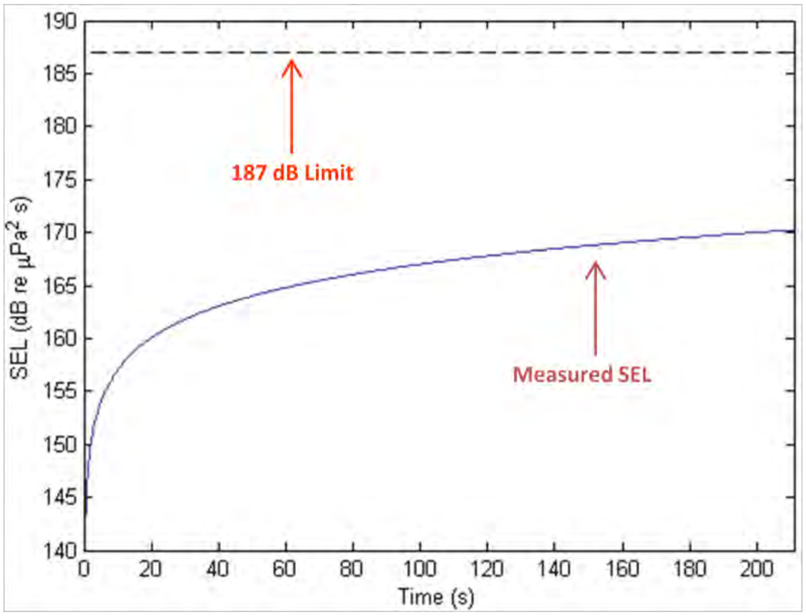

Figure 17: Sound exposure level as a function of time for pile 7, April 1st. This example was typical for the last 3 piles monitored.

Sound Exposure Level

The last three piles monitored did not exceed the sound exposure limit, and in fact would not have for vibratory activity lasting several times longer (Figure 17). However, the first two piles (piles 8 and 5) did exceed the SEL limit by approximately 25%. The results for pile 8 can be seen in Figure 18. In this case the SEL limit was reached after 5 minutes and 16 seconds of activity. The cause of the higher noise levels associated with these piles was most likely the improper connection between the vibratory hammer head and the pile and was rectified for further operations.

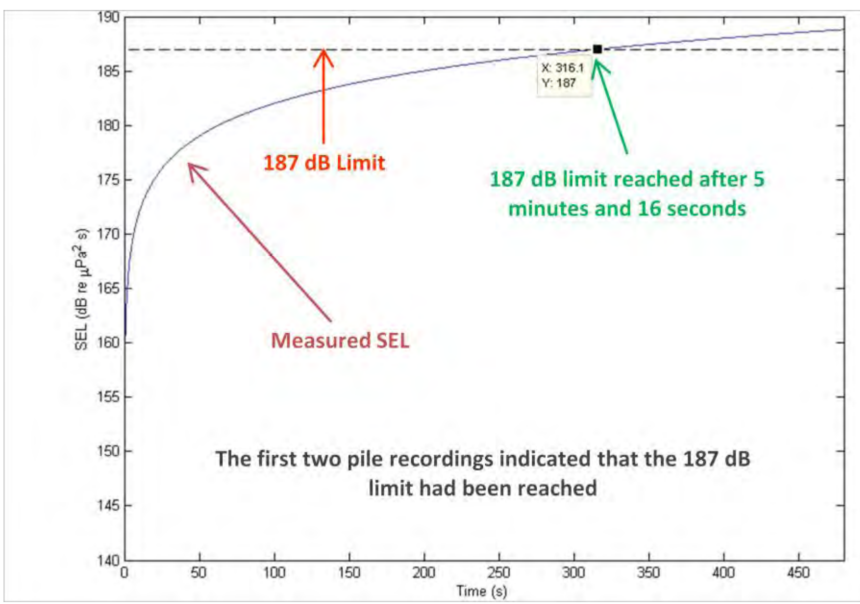

Figure 18: Sound exposure level as a function of time for pile 8, March 24th. Poor connections between the hammer and follower and the follower and pile led to higher pressure levels and associated sound exposure levels.

5.1.3 *Vibratory Hammer Mitigation*

During initial pile driving where hammer connections issues with the follower and pile were documented, hydroacoustic monitoring indicated sound exposure levels that exceeded thresholds. The sound exposure level is a function of the rms sound pressure level and the duration of the activity. In the case of the first two piles, the limit was exceeded after approximately 5 minutes of activity. Therefore ORPC tested a mitigation strategy to prevent exceedance during subsequent pile driving.

To minimize the likelihood of exceeding any sound exposure level thresholds for injury during any restricted periods, vibratory activity could be limited to interval of 4 minutes in duration before requiring a break in activity for a minimum of 1 minute. As seen in Figure 19, limiting activity to 4 minutes is a conservative approach that would limit sound exposure levels to 50% of the acceptable limit, and therefore allow for rms pressure levels 25% than any recorded value (even during the “worst” piles) and still not exceed the threshold.

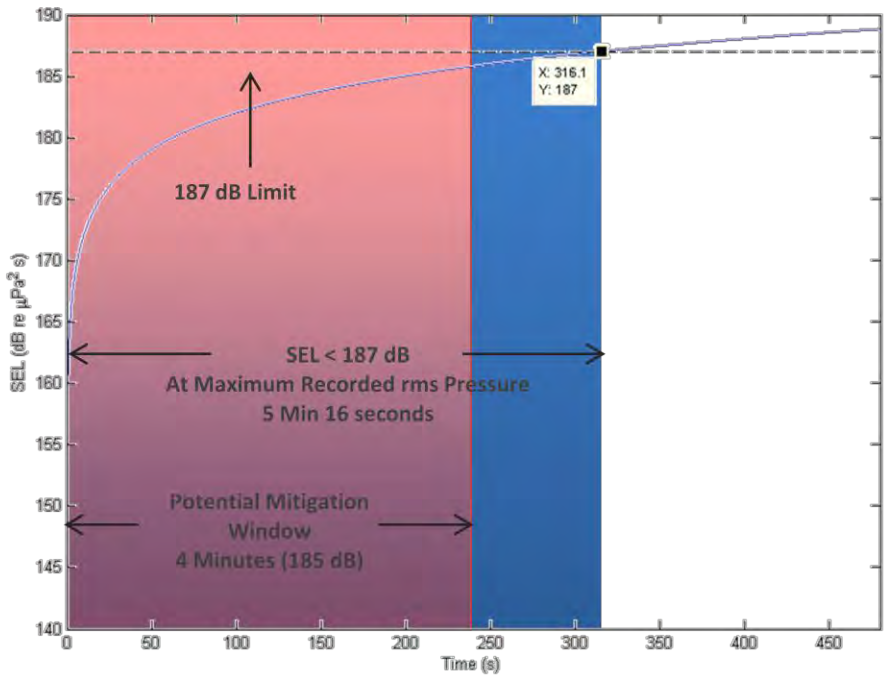

Figure 19: Sound exposure level as a function of time and associated time windows where the limit was exceeded in the first two piles and for the proposed mitigation strategy.

ORPC and its contractor implemented the 4-minute duration mitigation measure for pile 5 on March 29th to demonstrate that the strategy was effective in reducing the SEL. The results of the demonstration were successful in maintaining an SEL below the threshold.

In addition to the mitigation strategy, the Contractor made modifications to the pile assembly (hammer, follower, and pile) to tighten connections and prevent flexibility. These modifications proved vibratory hammer operation could continue for durations longer than 4 minutes without exceeding the SEL threshold for injury. Moving forward ORPC will incorporate the hammer assembly best management practices in order to prevent excessive noise levels and the need for 4-minute restrictive drive operations.

5.2 Boat Measurements

To identify the Level A and B isopleths for marine mammal harassment, receive level measurements were made at distances ranging from (nominally) 100 m to 2 km from the pile driving activity. The configuration (as listed in Section 3.2.2) was very similar to the near-source measurements on the pile-driving barge. The primary differences were additional amplification components to compensate for greater transmission loss and continuous data acquisition that did not require 10 second breaks between data records.

Table 3 lists the boat measurements with the associated range, hammer type, receive level measured at 10 meters with the barge measurement system, and a nominal source level based on the 10 meter measurement. These measurements, in addition to the near-source measurements, provide direct measurements for the vibratory and impact hammer Level A and B harassment isopleths (with the exception of Pile 9).

Table 3: Measured receive level as a function of range with the associated barge measurement at 10 meters (where applicable) and a nominal source level assuming cylindrical spreading losses between the source and 10 meters.

Pile	Type	Range (m)	Receive Level (dB re 1 µPa rms)	Receive Level @ 10 m (dB re 1 µPa rms)	Source Level (dB re 1 µPa rms)
5	Vibratory	100	150	160	170
1	Vibratory	500	120	147	157
7	Vibratory	1000	116	147	157
9	Vibratory	2000	104	Not measured	Not measured
8	Impact	100	169	180	190

Based on the near-source measurements in Section 5.1, it can be determined that the vibratory Level A harassment isopleth range is less than 10 meters. The rms pressure levels for the vibratory hammer do not exceed the Level A threshold for a continuous source. Similarly, near-source measurements of the impact hammer show that the Level A harassment isopleths range is approximately 10 meters based on the approximately 190 dB re 1 µPa rms source level.

As shown in

Table 3, the vibratory Level B harassment isopleths range is approximately 500 meters. This was observed for pile 1 and is consistent in the values measured from a distance of 1 km and 2 km that show approximately a 6 dB loss as the range doubles, consistent with expected spreading losses.

Table 4: Transmission loss based on various models for spreading loss using source levels from Table 3. The mixed model assumes a spreading loss of 15log(r). The fitted model assumes a transition from primarily cylindrical spreading to primarily spherical losses at 75 meters and provides slightly better overall agreement with the data.

	Receive Level for Transmission Loss Model				
Pile	Cylindrical	Spherical	Mixed Model	Fitted Model	Measured
5-V	150	130	140	149	150
1-V	131	104	117	122	120
7-V	127	97	112	116	116
9-V[†]	124	91	108	110	104

[†] Assumes the same source level as 1-V and 7-V from the previous day in a similar location.

8-I	170	150	160	169	169

For the final harassment isopleths range (Level B impact/transient), the measurements were used to determine an approximate model for the transmission loss as a function of range. From this transmission loss as a function of range, the source level for the impact hammer for pile 8, and the measured pressure level at 100 m during impact hammer activity for pile 8 the Level B range can be extrapolated.

Table 4 shows the relative agreement between various models for spreading loss using source levels from

Table 3. Cylindrical spreading uses a loss term of 10log(r) and spherical uses 20log(r). The mixed model assumes a combination of cylindrical and spherical in an unknown combination by using 15log(r). Finally, the fitted model assumes a transition from primarily cylindrical spreading (10log(r)) to primarily spherical losses (20log(r)) at 75 meters and provides slightly better overall agreement with the data. Using the fitted model, the Level B harassment isopleth range is approximately 275 meters from the source.

6.0 SUMMARY OF FINDINGS

6.1 AIR MONITORING SUMMARY

In-air measurements at the Lubec come-ashore location and on Goose Island indicated that the pile driving activity was detectable for both vibratory and impact hammer sources based on the ambient noise level during the pile driving. As both the pile driving noise levels and ambient noise levels were variable, the results varied from pile activity being completely masked by ambient noise to levels 5 – 10 dB above ambient.

6.2 NEAR-SOURCE SUMMARY

Table 5 summarizes the near-source measurements, associated pile activity and relevant noise threshold levels (peak absolute pressure level and sound exposure level). The measurements show that ORPC did not exceed either noise threshold during the observed impact hammer activity and did not exceed either threshold during the majority of the vibratory hammer activity. For the two initial vibratory hammer piles that exceeded the SEL limit, the cause is attributable to an improper connection between the vibratory hammer and the pile, which was addressed in later vibratory pile driving events. Upon correction of the connection issue the SEL for vibratory pile driving was within allowable limits.

Table 5: Summary of pile driving activity including hammer type, duration, drive depth and near-source receive levels (peak absolute pressure and sound exposure level) at 10 m.

Pile	Type	Drive Distance (vertical ft)	Duration (min)	Peak Pressure (206 dB re 1 µPa Threshold for Injury)	SEL re 1 $\mu Pa^2 s$ (187 dB Threshold for Injury)
8	Vibratory	32	7:30	195	188 (25% over limit)
8	Impact	15	5:17	202	168
5	Vibratory	38	8:09‡	184	188 (25% over limit)
3	Vibratory	36	8:30†	177	180
3	Impact	0	3:00	200	170
5	Impact	0	1:00	198	169
1	Vibratory	29	7:31†	170	171
7	Vibratory	48.5	13:30†	171	178

6.3 ISOPLETH SUMMARY

Table 6 summarizes the isopleth ranges for Level A and B harassment using the vibratory hammer (continuous source) and impact hammer (transient source) based on direct measurements and the measured transmission loss. These values show that measured Level A and B ranges were significantly closer to the pile driving than the conservative ranges included in the Acoustic and Marine Mammal Observation Plans.

‡ Includes soft start period of 2 minutes at 50% energy

† Includes soft start period of 4 minutes at 0% (off) and 50% energy

Table 6: Summary of isopleth ranges based on near-source and far-field measurements for Level and B harassment of vibratory and impact hammer types.

Type	Level A range (m) (Vibratory 180 dB re 1 µPa rms) (Impact 180 dB re 1 µPa rms)	Level B range (m) (Vibratory 120 dB re 1 µPa rms) (Impact 160 dB re 1 µPa rms)
Vibratory	N/A	500
Impact	10	275

Figure 20: Level B harassment isopleth for vibratory hammer.

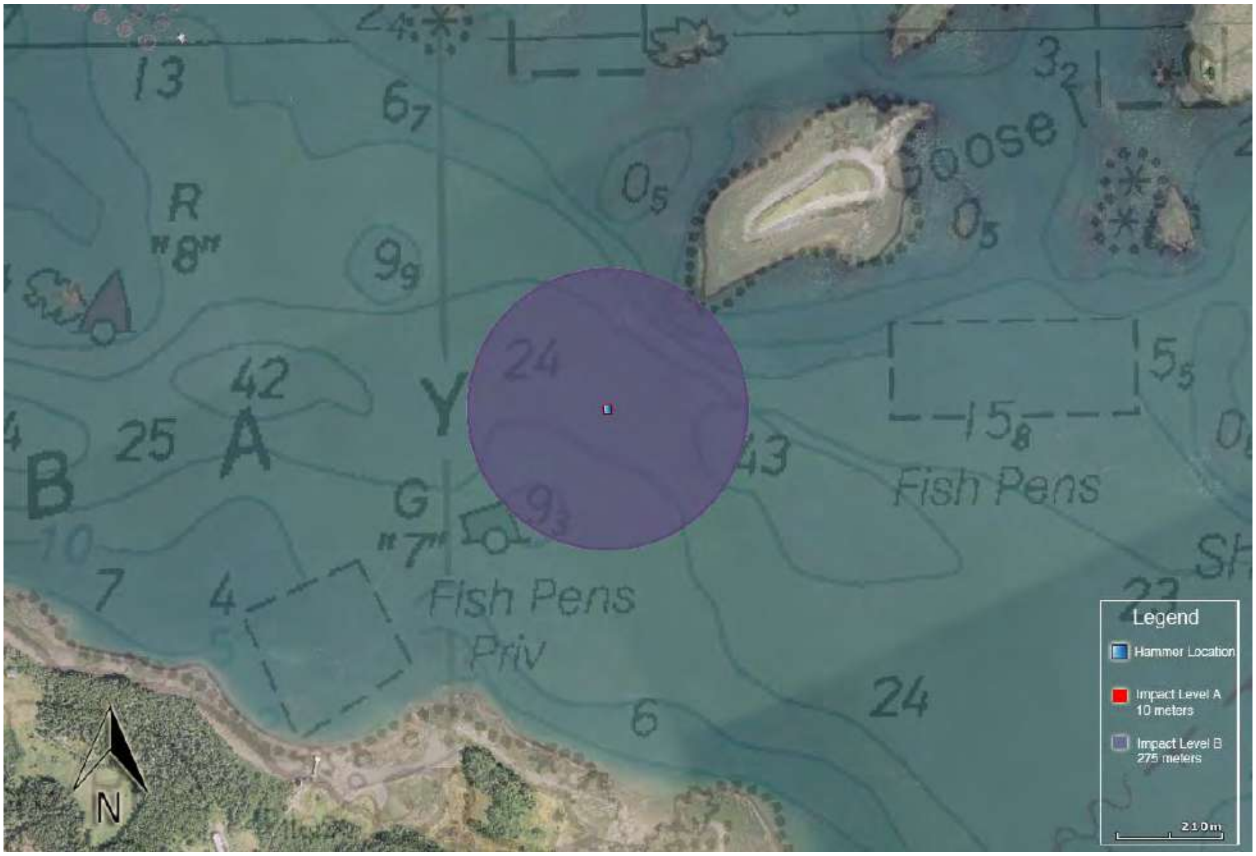

Figure 21: Level A and B harassment isopleths for diesel impact hammer.

Appendix F

Marine Mammal Recorder Sheets

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ORPC Marine Mammal Sighting Log
CBTEP Phase I Pile Driving
March 24 to April 4, 2012

Date	ORPC Ref #	Time	Sighting Sequence (for figure)	After Pile Driving?	Within Level B?	Description	Species	No.	Behavior	Vessel Position - degrees latitude	Vessel Position - minutes latitude	Vessel Position - degrees longitude	Vessel Position - minutes longitude	Bearing to animal (degrees)	Distance to animal (feet)	Animal heading (degrees)
3/24/2012	pile #6 sleeve #8	12:24	1		Y	sighting	harbor seal	1		44	54.569	67	2.580	315	300	n/a
3/24/2012	pile #6 sleeve #8	12:30	2		Y	sighting	harbor seal	1		44	54.569	67	2.580	120	200	n/a
3/24/2012	pile #6 sleeve #8	12:34	3		Y	sighting	harbor seal	1		44	54.569	67	2.580	310	125	n/a
3/24/2012	pile #6 sleeve #8	12:46	4		Y	sighting	harbor seal	1		44	54.569	67	2.580	210	85	East 900
3/24/2012	pile #6 sleeve #8	12:49	5		Y	sighting	harbor seal	1		44	54.569	67	2.580	210	150	n/a
3/24/2012	pile #6 sleeve #8	12:56	6		Y	sighting	harbor seal	1		44	54.569	67	2.580	220	160	n/a
3/24/2012	pile #6 sleeve #8	13:06	7		Y	sighting	harbor seal	1		44	54.569	67	2.580	60	200	n/a
3/24/2012	pile #6 sleeve #8	13:12	8		Y	sighting	harbor seal	1		44	54.569	67	2.580	95	250	n/a
3/24/2012	pile #6 sleeve #8	13:26	9		Y	sighting	harbor seal	1		44	54.569	67	2.580	120	600	n/a
3/24/2012	pile #6 sleeve #8	13:46	10		Y	sighting	harbor seal	1		44	54.569	67	2.580	240	350	180
3/24/2012	pile #6 sleeve #8	14:02	11	Y	Y	sighting	harbor seal	1		44	54.569	67	2.580	90	75	stationary
3/25/2012	pile #6 sleeve #8	12:12	1		Y	sighting	harbor seal	1	swimming	44	54.546	67	2.580	210	400	East 900
3/25/2012	pile #6 sleeve #8	12:30*	2		N	sighting	harbor seal	1	swimming	44	54.546	67	2.580	150	750	Northwest
3/25/2012	pile #6 sleeve #8	12:46	3		N	sighting	harbor seal	1	n/a	44	54.546	67	2.580	110	300	n/a
3/25/2012	pile #6 sleeve #8	12:54	4		N	sighting	harbor seal	1	n/a	44	54.546	67	2.580	124	250	155
3/25/2012	pile #6 sleeve #8	13:24	5		N	sighting	harbor seal	1	n/a	44	54.546	67	2.580	132	250	n/a
3/25/2012	pile #6 sleeve #8	14:05	6		N	sighting	harbor seal	1	n/a	44	54.546	67	2.580	140	300	170
3/25/2012	pile #6 sleeve #8	14:10	7		Y	sighting	harbor seal	1	n/a	44	54.546	67	2.580	250	250	n/a
4/2/2012	sleeve #9	6:52	1		Y	sighting	harbor seal	1	n/a	44	54.555	67	2.604	210	200	300
4/2/2012	sleeve #9	7:07	2		Y	sighting	harbor seal	1	bottling	44	54.652	67	2.978	127	1650	n/a
4/2/2012	sleeve #9	7:08	3		Y	sighting	harbor seal	1	n/a	44	54.555	67	2.604	265	100	30
4/2/2012	sleeve #9	7:20	4		Y	sighting	harbor seal	1	n/a	44	54.555	67	2.604	130	150	n/a
4/2/2012	sleeve #9	7:26	5		Y	sighting	harbor seal	1	bottling	44	54.652	67	2.978	250	298	270
4/2/2012	sleeve #9	7:39	6		Y	sighting	harbor seal	1	n/a	44	54.555	67	2.604	264	50	n/a
4/2/2012	sleeve #9	8:11	7	Y	Y	sighting	harbor seal	1	bottling	44	54.652	67	2.978	315	525	46
4/2/2012	sleeve #9	8:18	8	Y	Y	sighting	harbor seal	1	bottling	44	54.652	67	2.978	90	470	n/a
4/4/2012	sleeve #2	8:38	1		Y	sighting	harbor seal	1	bottling	44	54.564	67	2.580	55	200	
4/4/2012	sleeve #2	8:45*	2		Y	sighting	harbor seal	1	bottling	44	54.564	67	2.580	35	50	North
4/4/2012	sleeve #2	8:54*	3		Y	sighting	harbor seal	1	bottling	44	54.564	67	2.580	95	200	North
4/4/2012	sleeve #2	9:00	4		N	sighting	harbor seal	1	bottling	44	54.564	67	2.580	110	900	
4/4/2012	sleeve #2	9:27	5		Y	sighting	harbor seal	1	bottling	44	54.564	67	2.580	230	30	West
4/4/2012	sleeve #2	9:39	6		Y	sighting	harbor seal	1	bottling	44	54.564	67	2.580	180	300	n/a
4/4/2012	sleeve #2	9:46	7		Y	sighting	harbor seal	1	bottling	44	54.564	67	2.580	110	400	n/a
4/4/2012	sleeve #2	10:25	8	Y	Y	sighting	harbor seal	1	normal	44	54.656	67	3.000	200	200	150

*Time recorded from notes in N. Johnson field book

Operation Notes - Sightings occuring during "active" observations (30 min prior to 30 min following event) colored orange above

		30 min prior	Start hammer	Stop hammer	30 min after
3/24/2012	Vibratory	13:19	13:49	13:57	14:27
3/25/2012	Impact	13:46	14:16	14:21	14:51
4/2/2012	Vibratory	7:09	7:39	7:50	8:20
4/4/2012	Vibratory	9:23	9:53	10:00	10:30

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ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3 /20/12
(dd/mm/yyyy)

ORPC Reference # BSF

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Miss Behavin' **downstream vessel** / upstream vessel (circle one)

*Vessel not moored, located approx. 1,000 ft. SE of site.
Observer Vessel location (lat/long): N____° ____.____ x W ____° ____.____

Observer names: Lea Leddy (inward) (500 ft exclusion zone) Steve Irwin (outward) (Out to 1 nm)

Recorder's name: Cecil Cates (vessel captain and radio operator)

Time (24 hrs): **Start observation** 15:32 **End observation** 17:45

Start construction 16:47 **End construction** 17:17

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: 90 East ° 7 (knots)

Visibility: 0nm 1nm 2nm 3nm **unlimited** (circle one)

Weather: **clear** haze cloudy light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: **<10%** 10-50% 50-90% >90% (circle one)

Beaufort Sea State: 0 **1** 2 3 4 5 (circle one)

Comments: 16:05 Hazing fog bank enveloping Grand Manan
17:16 wind picking up

Photographs or video collected: Yes **No** (circle one)

Were there incidents involving endangered or protected species? Yes **No** (circle one)

Which species? (complete incident form)________

Recorder's signature at end of event: Cecil Cates

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/20/2012
(dd/mm/yyyy)

ORPC Reference # BSF

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Lady H. **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 • 54 . 622 x **W** 67 • 02 . 928

Observer names: Nathan Spear (inward) (500 ft exclusion zone) Darius Neptune (outward) (Out to 1 nm)

Recorder's name: James Smith (vessel captain and radio operator)

Time (24 hrs): **Start observation** 15:42 **End observation** 17:47

Start construction 16:43 **End construction** 17:17

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: SE ° 5-10 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form) N/A

Recorder's signature at end of event: James E. Smith

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Land
Shackford Head

Date: 22/03/2012
(dd/mm/yyyy)

ORPC Reference # Pile #6 - Cancelled

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: n/a **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N____ ° ____.____ x W ____ ° ____.____

Observer names: ________ (inward) ________ (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Alethea Leddy (vessel captain and radio operator)

Time (24 hrs): **Start observation** 11:00 AM **End observation** 12:25 PM

Start construction n/a **End construction** n/a

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: SE ° 1 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: Harbor Seal sighted approximately 2.25 mile from installation site. No pile driving occurred.

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)________

Recorder's signature at end of event: Alethea Leddy

Marine Mammal Observation Data
Data sheet

3/22/12

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
11:20am	Harbor Seal	Seal	1	feeding	West - Seal @ 300yds west of Red Buoy by Broad Cove	1/4 - 1/2 mile	South

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Land

Date: 3/22/2012
(dd/mm/yyyy)

ORPC Reference # Pile #6 - Cancelled

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Birch point **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N____ ° ____.____ x W ____ ° ____.____

Observer names: Nathan Spear (inward) (500 ft exclusion zone) ________ (outward) (Out to 1 nm)

Recorder's name: Nathan Spear (vessel captain and radio operator)

Time (24 hrs): **Start observation** 11:00 **End observation** 12:25

Start construction n/a **End construction** n/a

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: SW ° 5 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Nathan Spear

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/22/2012
(dd/mm/yyyy)

ORPC Reference # Pile #6 - Cancelled

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Miss Behavin' **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 564 x W 067 ° 02 . 591

Observer names: Royce ~~Ritchie~~ Richards (inward) (500 ft exclusion zone) Tess Floreck (outward) (Out to 1 nm)

Recorder's name: Matt Lacasse (vessel captain and radio operator)

Time (24 hrs): **Start observation** 1100 **End observation** 1225

Start construction n/a **End construction** n/a

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: SE ° 1 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program

Page ____ of ____

Marine Mammal Observation Data

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
1100	Start Watches						
1121	Sighting M.M.	H.S.		Swim/Feed	126° TN	2 KM	
1225	END M.M.O.						

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 2/22/17
(dd/mm/yyyy)

ORPC Reference # Pile #6 - Cancelled

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Lady H **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): **N** 44 ° 54 . 654 x **W** 67 ° 02 . 954

Observer names: Steve irwin (inward) (500 ft exclusion zone) Jamie mitchell (outward) (Out to 1 nm)

Recorder's name: Darius Nephew (vessel captain and radio operator)

Time (24 hrs): **Start observation** 1100 **End observation** 1225

Start construction n/a **End construction** n/a

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: Se ° 1 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Darius Nephew

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 24/03/2012
(dd/mm/yyyy)

ORPC Reference # pile #6/sleeve 8

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: N/A **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N____°______.______ x W ______°______.______

Observer names: ______________________ (inward) ______________________ (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Alethea Leddy-Shackford (vessel captain and radio operator)

Time (24 hrs): **Start observation** 12:30 PM **End observation** 2:40 PM (14:40)

Start construction__________ **End construction**__________

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 5 MPH (knots)

Visibility: 0nm 1nm 2nm 3nm **unlimited** (circle one)

Weather: **clear** haze **cloudy** light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: <10% **10-50%** 50-90% >90% (circle one)

Beaufort Sea State: 0 1 **2** 3 4 5 (circle one)

Comments:____

Photographs or video collected: Yes **No** (circle one)

Were there incidents involving endangered or protected species? Yes **No** (circle one)

Which species? (complete incident form)______________________________

Recorder's signature at end of event: Alethea Leddy

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/24/2012
(dd/mm/yyyy)

ORPC Reference # pile #6 | Sleeve #8

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Lady H **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 569 x W 067 ° 02 . 580

Observer names: Tess Fortek (inward) (500 ft exclusion zone) Steve Ervin (outward) (Out to 1 nm)

Recorder's name: Cecil Gates (vessel captain and radio operator)

Time (24 hrs):
Start observation 12:20 **End observation** 14:43
Start construction 13:49 **End construction** 14:06

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N 0° 5 (knots) Gusts to 10

Visibility: 0nm 1nm 2nm 3nm **unlimited** (circle one)

Weather: **clear** haze cloudy light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: **<10%** 10-50% 50-90% >90% (circle one)

Beaufort Sea State: 0 1 **2**+ 3 4 5 (circle one)

Comments: Anchor location 44°54.564 N
067°02.580
Harbor Seal w/in 1nm radius during vibratory pile driving

Photographs or video collected: Yes No (circle one)

Were there incidents involving endangered or protected species? Yes **No** (circle one)

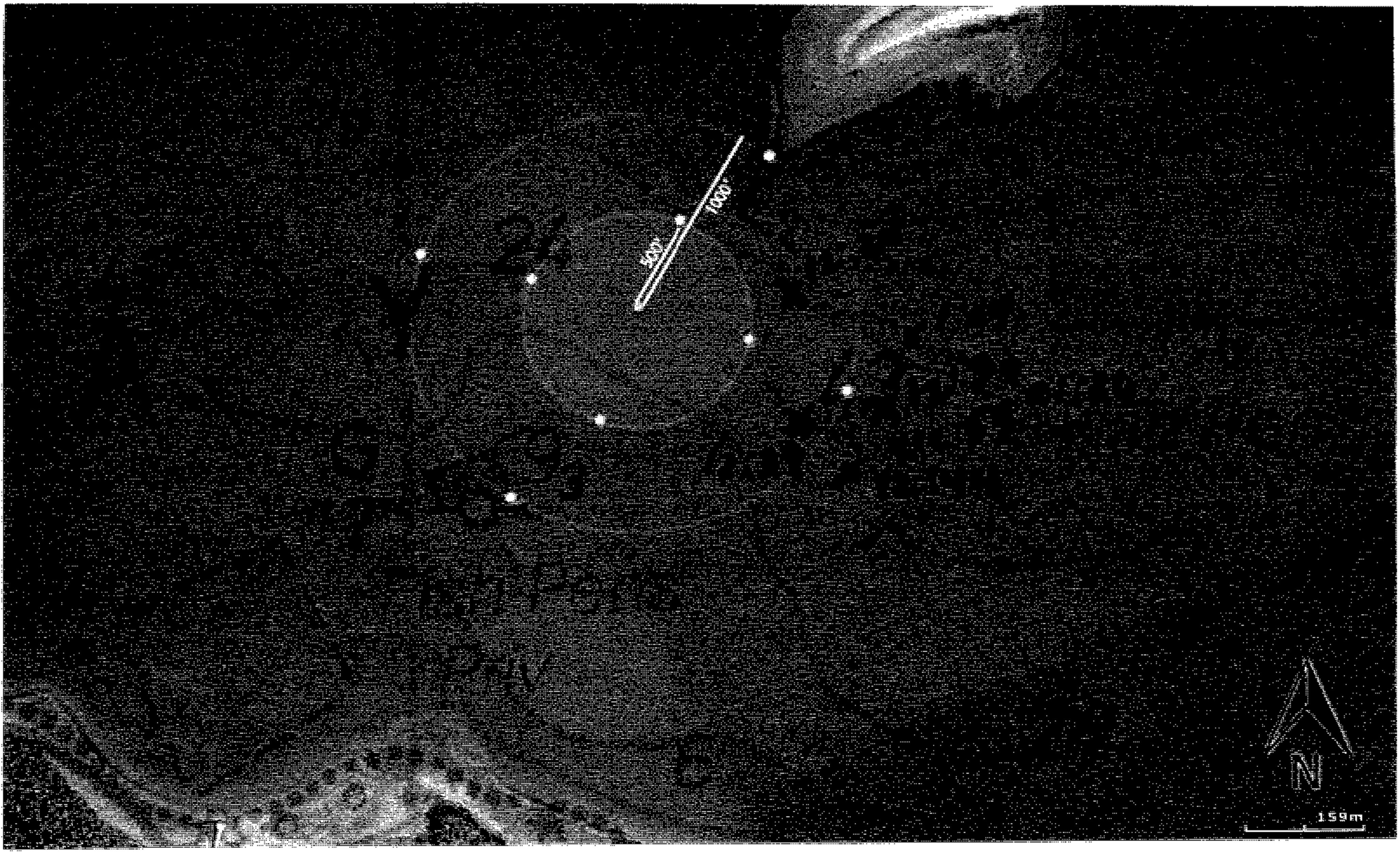
Which species? (complete incident form)

Recorder's signature at end of event: Cecil Gates

ORPC Cobscook Bay Protected Species Observer Program
Marine Mammal Observation Data
Data sheet

CE

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
12:24	Harbor Seal →		1				
12:30	"						
12:39	"			Hanging around	310°	125'	N/A
12:46	"			think same	210°	85'	East 90°
12:49	"				210°	150'	N/A
12:56	"				220	160'	N/A
13:06	"				60°	200'	N/A
13:12	"				95°	250'	N/A
13:26	"				120°	600'	N/A
13:46	"				240°	350'	180°
14:02	"				90°	75'	stationary
	- See Chart -						



ORPC
OCEAN RENEWABLE POWER COMPANY

Vessel Name: Lady H

PSO: Tess Ftorek | Steve Irwin

Recorder/Captain: Cecil Cates

Vessel Location: N 44°54-569 W 067°02-58

Date: 3-24-2012

Time: 12:24 - 14:02

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3 / 24 / 2012
(dd/mm/yyyy)

ORPC Reference # pile #6 / sleeve #8

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Miss Behavin' **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): **N** 44 ° 54 . 657 x **W** 067 ° 03 . 008

Observer names: Darcy Neptune (inward) (500 ft exclusion zone) Royce ~~Ritchie~~ Richards (outward) (Out to 1 nm)

Recorder's name: Matt Lacasse (vessel captain and radio operator)

Time (24 hrs): **Start observation** 1200 **End observation** 1440

Start construction 1349 **End construction** 1407

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 5 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program
Marine Mammal Observation Data
Data sheet

Page ______ of ______

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
1200	Start observation						
1224	Sighting (Lady H)	H.S.		Swimming	165°	1300m	
1407	End const.						
1440	Depart						

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 24/03/2012
(dd/mm/yyyy)

ORPC Reference # pile # 6, # 8 hole

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: N/A **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N ___°___.___ x W ___°___.___ Birch Point - Pembroke

Observer names: — (inward) (500 ft exclusion zone) — (outward) (Out to 1 nm)

Recorder's name: Nathan Spear (vessel captain and radio operator)

Time (24 hrs): **Start observation** 12:30 **End observation** 14:40

Start construction 13:49 **End construction** 13:57

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 5-10 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: Observations used to 2.5 mile range

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/25/12
(dd/mm/yyyy)

ORPC Reference # pile #6, #8 hole

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Miss Behavin **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 66 x W 67 ° 3 . 002

Observer names: Nathan Spear (inward) (500 ft exclusion zone) Lee Leddy (outward) (Out to 1 nm)

Recorder's name: Darius Neptune (vessel captain and radio operator)

Time (24 hrs):
Start observation 1300 **End observation** 15:00
Start construction 14:00 **End construction** 1421

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: North° 5-10 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: 1:40 visibility reduced to 2nm due to snow / incresed cloud cover to 90%

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Darius Neptune

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3 / 25 / 2012
(dd/mm/yyyy)

ORPC Reference # pile #6, #8 hole

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Lady H downstream vessel / upstream vessel (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 546 x **W** 067 ° 02 . 580

Observer names: Cecil Oates (inward) (500 ft exclusion zone)   Royce ~~R~~ Richards (outward) (Out to 1 nm)

Recorder's name: Matt Lacase (vessel captain and radio operator)

Time (24 hrs): **Start observation** 1300   **End observation** 1500

Start construction ______   **End construction** 1430

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 5 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: ______

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form) ______

Recorder's signature at end of event: [signature]

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
1213	On site						
1213	Sighting	H.S.		sv E-W @ 1000'	210°	400'	East
				from site			
	Sighting	H.S.		2000'	150°	250'	NW
1242	On Mooring						
1242	Snow						
1246	Sighting	H.S.			110°	300'	
1254	Sighting	H.S			124°	250'	155°
1300	Start Alt. ob.						
1324	Sighting	H.S.			132°	250'	
1340	Visibility <2NM				160°	½ M	
1405	Sighting	H.S.			140°	300'	170°
1410	Sighting	H.S.			250°	250'	
1430	End const.						
1500	Depart						

ORPC
OCEAN RENEWABLE POWER COMPANY

Vessel Name: Lacy H
PSO: Craig Gates
Recorder/Captain: Matt Lacroix

Vessel Location: Shackford Head Side
Date: 3/25/12
Time: 12:25

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3 / 29 / 2012
(dd/mm/yyyy)

ORPC Reference # Steve #3 Cancelled

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Shackford Head **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N ____ ° ____ . ____ x W ____ ° ____ . ____

Observer names: Steve Erwin (inward) (500 ft exclusion zone) ____ (outward) (Out to 1 nm)

Recorder's name: Steve Erwin (vessel captain and radio operator)

Time (24 hrs):

Start observation 16.00 **End observation** 16:45

Start construction n/a **End construction** n/a

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NNE ° 5 mph ~~(knots)~~

Visibility: 0nm 1nm 2nm 3nm **unlimited** (circle one)

Weather: clear **haze** **cloudy** light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: <10% 10-50% 50-90% **>90%** (circle one)

Beaufort Sea State: 0 **1** 2 3 4 5 (circle one)

Comments: ____

Photographs or video collected: Yes **No** (circle one)

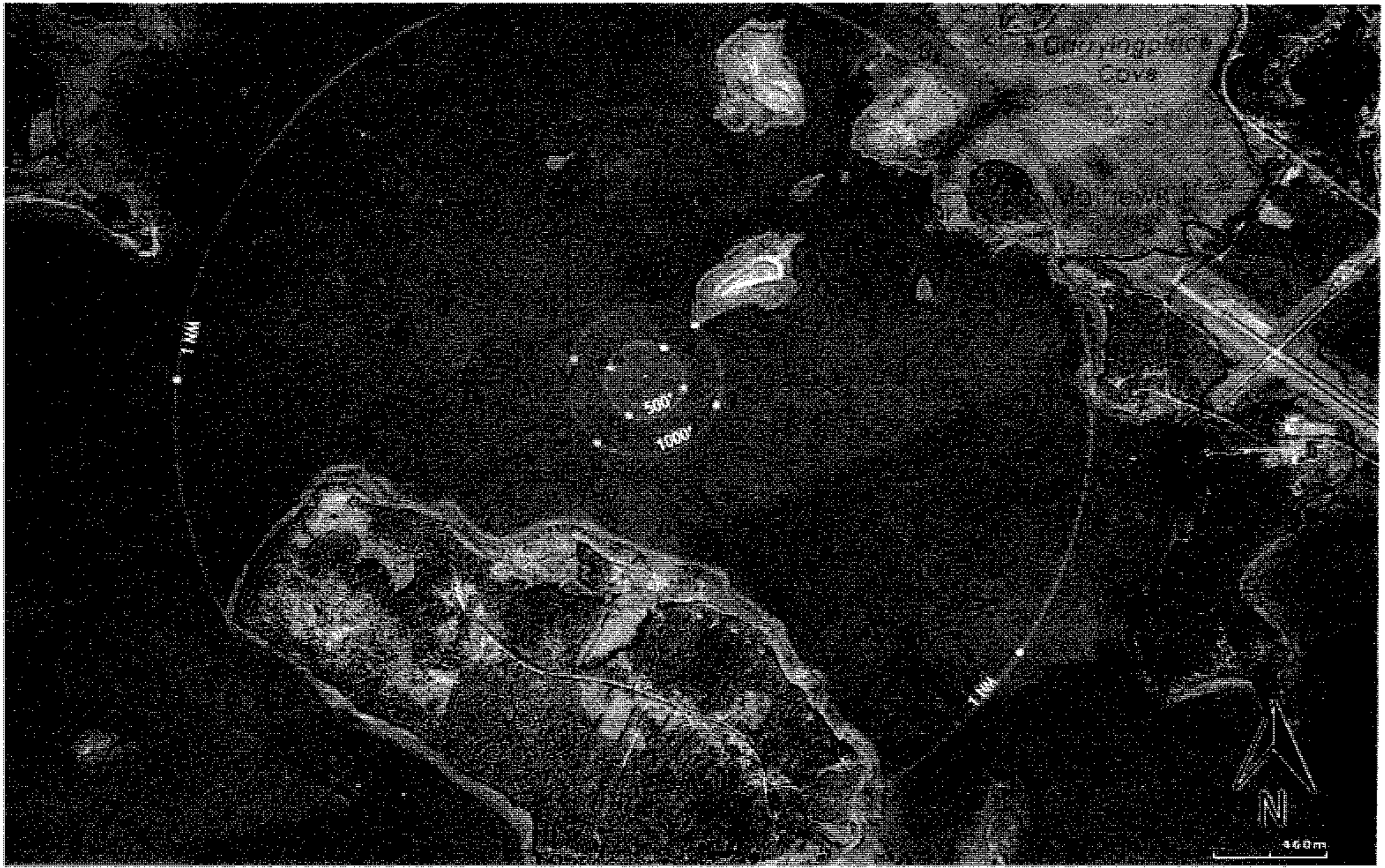
Were there incidents involving endangered or protected species? Yes **No** (circle one)

Which species? (complete incident form) ____

Recorder's signature at end of event: [signature]

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
16:40	Harbor Seal			Normal		750 yards	NNW



ORPC
OCEAN RENEWABLE POWER COMPANY

Vessel Name: Shackford Head
PSO: Steve Erwin
Recorder/Captain: N/a

Vessel Location:
Date: 3-29-12
Time: 4:00

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 03/29/2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #3 Cancelled

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Miss Behavin **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 **°** 54 **.** 655 **x W** 067 **°** 03 **.** 001

Observer names: Tessa Florek (inward) (500 ft exclusion zone) Leah Lebby (outward) (Out to 1 nm)

Recorder's name: James Smith (vessel captain and radio operator)

Time (24 hrs): **Start observation** 1600 **End observation** 1647

Start construction______ **End construction**______

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 5 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:______

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)______

Recorder's signature at end of event: James E. Smith

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/29/12
(dd/mm/yyyy)

ORPC Reference # Sleeve #3 Cancelled

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Birch point **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N ____ ° ____ . ____ x **W** ____ ° ____ . ____

Observer names: Nathan Spear (inward) ________ (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Nathan Spear (vessel captain and radio operator)

Time (24 hrs): **Start observation** 4:30 **End observation** 4:44

Start construction n/a **End construction** n/a

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NE ° 1 (knots)

Visibility: 0nm 1nm 2nm 3nm unlimited (circle one)

Weather: clear haze cloudy light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: <10% 10-50% 50-90% >90% (circle one)

Beaufort Sea State: 0 1 2 3 4 5 (circle one)

Comments: Alot of birds

Photographs or video collected: Yes No (circle one)

Were there incidents involving endangered or protected species? Yes No (circle one)

Which species? (complete incident form) ________

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 03/29/12
(dd/mm/yyyy)

ORPC Reference # Sleeve #3 Cancelled

ORPC Environmental Manager: Nate Jones

Observer Vessel name: Lady H **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): N ____ ° ____ . ____ x **W** ____ ° ____ . ____

Observer names: Ralph DeWitt (inward) (500 ft exclusion zone) Darius Neptune (outward) (Out to 1 nm)

Recorder's name: Cecil Cates (vessel captain and radio operator)

Time (24 hrs): **Start observation** 16:00 **End observation** 17:00

Start construction n/a **End construction** n/a

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: North 0° ~5 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: ______

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form) ______

Recorder's signature at end of event: Cecil Cates

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (^{o})	Distance to animal	Animal heading (^{o})
12:00	Harbor seal			at surface	250°	150 ft	

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 03 / 29 / 2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #5

ORPC Environmental Manager: Nathan Johnson

LAND
~~Observer Vessel name~~: Shackford Head **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N____ **°** ____ . ____ **x W** ____ **°** ____ . ____

Observer names: Royce Richards (inward) " " (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: ________ (vessel captain and radio operator)

Time (24 hrs): **Start observation** 09:30 **End observation** 1110

Start construction 1038 **End construction** 1039

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NE **°** 10-15 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:________

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)________

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3 / 29 / 2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #5

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Lady H **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 515 x W 067 ° 02 . 513

Observer names: Tess Florek (inward) (500 ft exclusion zone) Steve Erwin (outward) (Out to 1 nm)

Recorder's name: Matt Laasse (vessel captain and radio operator)

Time (24 hrs):
Start observation 0930 **End observation** 1110
Start construction 1032 **End construction** 1039

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NE ° 10-15 (knots)

Visibility: **0nm 1nm 2nm 3nm unlimited** (circle one)

Weather: **clear haze cloudy light rain rain snow patchy fog fog** (circle all that apply)

Cloud cover: **<10% 10-50% 50-90% >90%** (circle one)

Beaufort Sea State: **0 1 2 3 4 5** (circle one)

Comments:

Photographs or video collected: **Yes No** (circle one)

Were there incidents involving endangered or protected species? Yes No (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Matt Laasse

11:10

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 29/03/2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #5

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Miss Behavin **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 652 x W 067 ° 02 . 978

Observer names: Alethea Leone (inward) Darius Neptune (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Ralph DeWitt (vessel captain and radio operator)

Time (24 hrs): **Start observation** 0930 **End observation** 11:30

Start construction 1032 **End construction** 1039

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NE ° 10-15 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** Test **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Ralph DeWitt

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/29/12
(dd/mm/yyyy)

ORPC Reference # Sleeve #5

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Birch Point **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N ____ ° ____.____ x **W** ____ ° ____.____

Observer names: Nathan Spear (inward) (500 ft exclusion zone) ________ (outward) (Out to 1 nm)

Recorder's name: Nathan Spear (vessel captain and radio operator)

Time (24 hrs): **Start observation** 9:30 **End observation** 11:10

Start construction 1032 **End construction** 1039

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NE ° 1 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: ________

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form) ________

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/31/12
(dd/mm/yyyy)

ORPC Reference # piles 3,4,5 to refusal

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Miss Behavin downstream vessel / upstream vessel (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 656 x W 067 ° 02 . 993

Observer names: Lee Leddy (inward) (500 ft exclusion zone) Steve Irvin (outward) (Out to 1 nm)

Recorder's name: Darius Neptune (vessel captain and radio operator)

Time (24 hrs):
Start observation 1715 End observation 1905
Start construction 1814 End construction 1833

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: S ° 5-10 (knots)

Visibility: 0nm 1nm 2nm 3nm unlimited (circle one)

Weather: clear haze cloudy light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: <10% 10-50% 50-90% >90% (circle one)

Beaufort Sea State: 0 1 2 3 4 5 (circle one)

Comments:

Photographs or video collected: Yes No (circle one)

Were there incidents involving endangered or protected species? Yes No (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Darius Neptune

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3 / 31 / 2012 (P-1)
(dd/mm/yyyy)

ORPC Reference # piles 3&5 to refusal

ORPC Environmental Manager: Nate ~~Thompson~~ Johnson

Observer Vessel name: Lady H **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): **N** 44 ° 54 . 564 x **W** 067 ° 02 . 580

Observer names: Tess Pocock (inward) Royce Ritchie (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Matt Lacasse (vessel captain and radio operator)

Time (24 hrs): **Start observation** 1715 **End observation** 1905

Start construction 1814 **End construction** 1833

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: W ° <5 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Matt Lacasse

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/31/12
(dd/mm/yyyy)

ORPC Reference # Sleeve #3

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Miss Bethany downstream vessel upstream vessel (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 646 x W 067 ° 02 . 949

Observer names: Jamie Mitchell (inward) (500 ft exclusion zone) Nathan Speer (outward) (Out to 1 nm)

Recorder's name: Darius Neptune (vessel captain and radio operator)

Time (24 hrs):

Start observation 11:30 **End observation** 12:45

Start construction 12:10 **End construction** 12:16

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NE ° ≤5 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: Cloud Cover increased At 12:15 to 10-50%

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Darius Neptune

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 31/03/2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #3

ORPC Environmental Manager: Nathan Johnson

~~Observer Vessel name~~: Shackford Head **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N ____ ° ____ . ____ x W ____ ° ____ . ____

Observer names: Steve Erwin (inward) ____ (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Steve Erwin (vessel captain and radio operator)

Time (24 hrs): **Start observation** 11:30 AM **End observation** 12:45

Start construction 12:10 **End construction** 12:16

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: Calm / ° 3 mph NNE (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 7 / 31 / 2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #3

ORPC Environmental Manager: Nate ~~Thompson~~ Johnson

Observer Vessel name: ______ downstream vessel / upstream vessel (circle one)

Observer Vessel location (lat/long): Birch Point. N ___° ___.___ x W ___° ___.___

Observer names: Matt Larrabee (inward) (500 ft exclusion zone) ______ (outward) (Out to 1 nm)

Recorder's name: Matt Larrabee (vessel captain and radio operator)

Time (24 hrs): Start observation 1130 End observation 1245

Start construction 12:10 End construction 12:16

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: W ° <5 (knots)

Visibility: 0nm 1nm 2nm 3nm unlimited (circle one)

Weather: clear haze cloudy light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: <10% 10-50% 50-90% >90% (circle one)

Beaufort Sea State: 0 1 2 3 4 5 (circle one)

Comments: ______

Photographs or video collected: Yes No (circle one)

Were there incidents involving endangered or protected species? Yes No (circle one)

Which species? (complete incident form) ______

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 3/31/12
(dd/mm/yyyy)

ORPC Reference # Sleeve #3

ORPC Environmental Manager: Nate ~~Jones~~ Johnson

Observer Vessel name: Lady H — **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 .666 x W 067 ° 02 .526

Observer names: Tess Fortee (inward) (500 ft exclusion zone) Lee Leddy (outward) (Out to 1 nm)

Recorder's name: Cecil Cates (vessel captain and radio operator)

Time (24 hrs):
Start observation 11:28 **End observation** 12:45
Start construction 12:10 **End construction** 12:16

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: Calm ° <1 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** 1 2 3 4 5 (circle one)

Comments: glass smooth surface

Photographs or video collected: Yes No (circle one)

Were there incidents involving endangered or protected species? Yes No (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Cecil Cates

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

7:15
5:45

Date: 01 / 04 / 2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #1

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Miss B **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 044 **°** 54 **.** 052 **x W** 067 **°** 02 **.** 998

Observer names: Drew (inward) Matt (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Ralph DeWitt (vessel captain and radio operator)

Time (24 hrs): **Start observation** 05:45 **End observation** 0715

Start construction 0630 **End construction** 0645

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: North ° Light (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Ralph DeWitt

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4 / 01 / 12
(dd/mm/yyyy)

ORPC Reference # Sleeve #1

ORPC Environmental Manager: Nate ~~Jones~~ Johnson

Observer Vessel name: Lady H **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): **N** 44 ° 54 . 564 x **W** 067 ° 02 . 580

Observer names: Lee Leddy (inward) Jessie Smith (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Cecil Cates (vessel captain and radio operator)

Time (24 hrs): **Start observation** 05:45 **End observation** 7:15

Start construction 6:38 **End construction** 6:45

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: calm ° <1 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Cecil Cates

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4/1/12 (dd/mm/yyyy)

ORPC Reference # Sleeve #7

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Miss be Havin **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): **N** 44 ° 54 . 650 x **W** 067 ° 02 . 950

Observer names: Jesse Smith (inward) (500 ft exclusion zone) Nathan Spear (outward) (Out to 1 nm)

Recorder's name: Darins Neptum (vessel captain and radio operator)

Time (24 hrs): **Start observation** 12.20 **End observation** 1350

Start construction 1302 **End construction** 1310

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: S ° <5-10 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: Wind Increased At 1300 to Se 5-10

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Darin Neptun

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4 / 1 / 2012 (PM Aft)
(dd/mm/yyyy)

ORPC Reference # Sleeve #7

ORPC Environmental Manager: Nate ~~Thompson~~ Johnson

Observer Vessel name: Lady H downstream vessel / upstream vessel (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 524 x W 067 ° 02 . 319

Observer names: Tess Ftorek (inward) Royce Ritchie (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Matt Lerner (vessel captain and radio operator)

Time (24 hrs): Start observation 1220 End observation 1350

Start construction 1302 End construction 1320

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: E ° <5 (knots)

Visibility: 0nm 1nm 2nm 3nm unlimited (circle one)

Weather: clear haze cloudy light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: <10% 10-50% 50-90% >90% (circle one)

Beaufort Sea State: 0 1 2 3 4 5 (circle one)

Comments:

Photographs or video collected: Yes No (circle one)

Were there incidents involving endangered or protected species? Yes No (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Matt Lerner

Donna
Tess
Royce

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 02/ 04/ 2019
(dd/mm/yyyy)

ORPC Reference # Sleeve #9

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Lady H **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): **N** 44 ° 54 . 555 **x W** 067 ° 02 . 604

Observer names: Tess Ftorek (inward) (500 ft exclusion zone) Royce Richards (outward) (Out to 1 nm)

Recorder's name: Ralph DeWitt (vessel captain and radio operator)

Time (24 hrs): **Start observation** 0615 **End observation** 0520

Start construction 0739 **End construction** 0750

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 5-10 mph (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one) 652 [illegible]

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form) Harbor Seal

Recorder's signature at end of event: Ralph DeWitt

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (^{o})	Distance to animal	Animal heading (^{o})
652		H, S,	1		210°	200'	300°
7:08		H, S,	1		265°	100'	30°
7:20		H, S,	1		130	150'	—
7:39		H, S	1		264	50'	—

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4 / 2 / 2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #9

ORPC Environmental Manager: Nate ~~Jones~~ Johnson

Observer Vessel name: Miss Behavin' **downstream vessel** **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 652 x **W** 067 ° 02 . 978

Observer names: James Smith (inward) Leah Leddy (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Cecil Cates (vessel captain and radio operator)

Time (24 hrs): **Start observation** 06:40 **End observation** 08:20
Start construction 7:39 **End construction** 07:50

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: 300 ° ≤1 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Cecil Cates

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
7:07	Harbor Seal				127°	1650 ft	
7:26	〃			Bottling	250°	298 ft	270°
8:11	〃			at surface	315°	525 ft	45°
8:18	〃			〃	90°	470 ft	

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4 / 2 / 12
(dd/mm/yyyy)

ORPC Reference # Sleeve #6

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Lady H **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): **N** 44 ° 54 . 527 **x W** 067 ° 02 . 499

Observer names: Nathan Spear (inward) (500 ft exclusion zone) Lee Leddy (outward) (Out to 1 nm)

Recorder's name: Darius Nephew (vessel captain and radio operator)

Time (24 hrs):
Start observation 1315 **End observation** 1445
Start construction 1403 **End construction** 1413

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: SE ° 5 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Darius Nephew

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 9 / 3 / 12
(dd/mm/yyyy)

ORPC Reference # Sleeve #4

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Lady H **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 559 x W 067 ° 02 . 596

Observer names: Nathan Spear (inward) (500 ft exclusion zone) John Turner (outward) (Out to 1 nm)

Recorder's name: Dorian Nepton (vessel captain and radio operator)

Time (24 hrs): **Start observation** 0745 **End observation** 9:30

Start construction 08:47 **End construction** 8:56

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NE ° 5-10 7 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: Increase wind 15-20 knots

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Dorian Nepton

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
9:05 am	Seal	Harb			135	250 ft out	

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4 / 4 / 2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #4

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Miss Behavin' **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 • 54 . 652 x **W** 067 • 02 . 978

Observer names: Steve Erwin (inward) Lee Leady (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Matt Carasse (vessel captain and radio operator)

Time (24 hrs): **Start observation** 0745 **End observation** 0930
Start construction 0847 **End construction** 0856

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NE ° 5-10 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Matt Carasse

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4 / 4 / 17
(dd/mm/yyyy)

ORPC Reference # Sleeve #2

ORPC Environmental Manager: Nathan Johnson

Observer Vessel name: Miss Behavin **downstream vessel / upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 656 x W 067 ° 03 . 000

Observer names: Tess Frolek (inward) (500 ft exclusion zone) Jesse Smith (outward) (Out to 1 nm)

Recorder's name: Darius Neptune (vessel captain and radio operator)

Time (24 hrs): **Start observation** 0834 **End observation** 1030

Start construction 0953 **End construction** 1000

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 10-15 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: Wind reduce to Five-10 knots at 0950

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Darius Neptune

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
10:25	seal	Harbor	1	normal	200°	200 ft	150°

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4 / 4 / 2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #2

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Lady H — downstream vessel / upstream vessel (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 364 x W 067 ° 02 . 580

Observer names: Royce Ritchie (inward) (500 ft exclusion zone) — Steve Erwin (outward) (Out to 1 nm)

Recorder's name: Matt Lacasse (vessel captain and radio operator)

Time (24 hrs):

Start observation 0830 — **End observation** 1030

Start construction 0953 — **End construction** 1000

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 5-10 (knots)

Visibility: 0nm 1nm 2nm 3nm unlimited (circle one)

Weather: clear haze cloudy light rain rain snow patchy fog fog (circle all that apply)

Cloud cover: <10% 10-50% 50-90% >90% (circle one)

Beaufort Sea State: 0 1 2 3 4 5 (circle one)

Comments: Coffee got cold.

Photographs or video collected: Yes No (circle one)

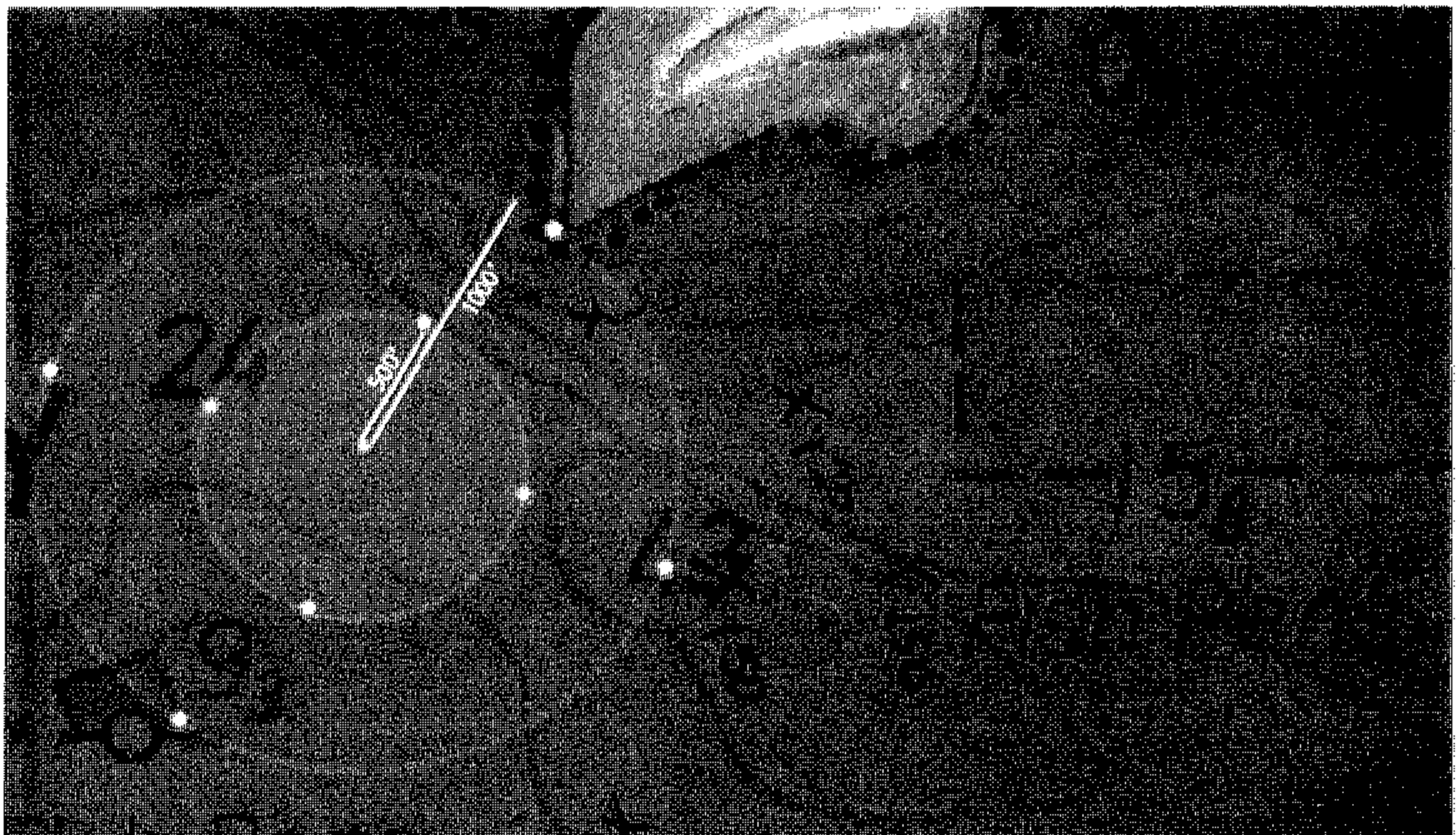
Were there incidents involving endangered or protected species? Yes No (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Matt Lacasse

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)
0805	Depart Bal						
0829	On site						
0830	Start ob						
0837	Moored						
0838	Seal #1	H.S.		Bottle	55°	200'	
	#1	H.S			35°	50'	N
	#2				45°	200'	N
0900	#1			Bottle	110°	900'	
0924	Clearing 15-50 cc.						
0927		H.S.			230°	70'	W
0939		H.S.		Bottle	180°	300'	
0946		H.S.		Bottle	110°	400'	
0953	Start const.						
1000	Stop const.						
1000	Sunny						
1030	Depart						



Vessel Name: Lady H

PSO: Stephen Ervin

Recorder/Captain: [illegible]

Vessel Location: [illegible]

Date: 4-4-2012

Time: 08:30 – 10:30

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4 / 4 / 2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #10

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Miss Behavin' **downstream vessel** **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 645 x **W** 067 ° 02 . 950

Observer names: Royce Richards (inward) (500 ft exclusion zone) Steve Erwin (outward) (Out to 1 nm)

Recorder's name: Matt (vessel captain and radio operator)

Time (24 hrs): **Start observation** 1510 **End observation** 1647
Start construction 1611 **End construction** 1617

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: NW ° 5-10 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: [signature]

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 4/4/2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #10

ORPC Environmental Manager: Nate Johnson

Observer Vessel name: Lady H. **downstream vessel** / **upstream vessel** (circle one)

Observer Vessel location (lat/long): **N** 44 ° 54 . 529 **x W** 067 ° 02 . 502

Observer names: Lee Leddy (inward) Tessa Ftorek (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: James Smith (vessel captain and radio operator)

Time (24 hrs): **Start observation** 3:10 pm **End observation** 4:47 pm
Start construction 4:11 pm **End construction** 4:17 pm

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: N ° 10-15 (knots)
gust to 20

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments:

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: James E. Smith

ORPC Cobscook Bay Protected Species Observer Program

Marine Mammal Observation Data
(Cover sheet)

Date: 04/02/2012
(dd/mm/yyyy)

ORPC Reference # Sleeve #6

ORPC Environmental Manager: Nate Jones

Observer Vessel name: Miss Behavin' **downstream vessel** **upstream vessel** (circle one)

Observer Vessel location (lat/long): N 44 ° 54 . 652 x W 067 ° 02 . 978

Observer names: Tess Florek (inward) Matt Lacasse (outward)
(500 ft exclusion zone) (Out to 1 nm)

Recorder's name: Cecil Cates (vessel captain and radio operator)

Time (24 hrs): **Start observation** 13:15 **End observation** 14:45
Start construction 14:03 **End construction** 14:13

Environmental Conditions: (record at start of observation period, record changes to env. conditions on data sheet)

Wind Direction and Speed: 280° ° 3 (knots)

Visibility: **0nm** **1nm** **2nm** **3nm** **unlimited** (circle one)

Weather: **clear** **haze** **cloudy** **light rain** **rain** **snow** **patchy fog** **fog** (circle all that apply)

Cloud cover: **<10%** **10-50%** **50-90%** **>90%** (circle one)

Beaufort Sea State: **0** **1** **2** **3** **4** **5** (circle one)

Comments: Mixed rain clouds + clear sky

Photographs or video collected: **Yes** **No** (circle one)

Were there incidents involving endangered or protected species? **Yes** **No** (circle one)

Which species? (complete incident form)

Recorder's signature at end of event: Cecil Cates

Data sheet

Time	Description	Species	No.	Behavior	Bearing to animal (°)	Distance to animal	Animal heading (°)

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Appendix G

SSI Presentation to NMFS, April 2, 2012

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SCIENTIFIC SOLUTIONS, INC.
INNOVATIVE RESEARCH AND ENGINEERING

TidGen™ Pile Driving Preliminary Near-Field Sound Level Results

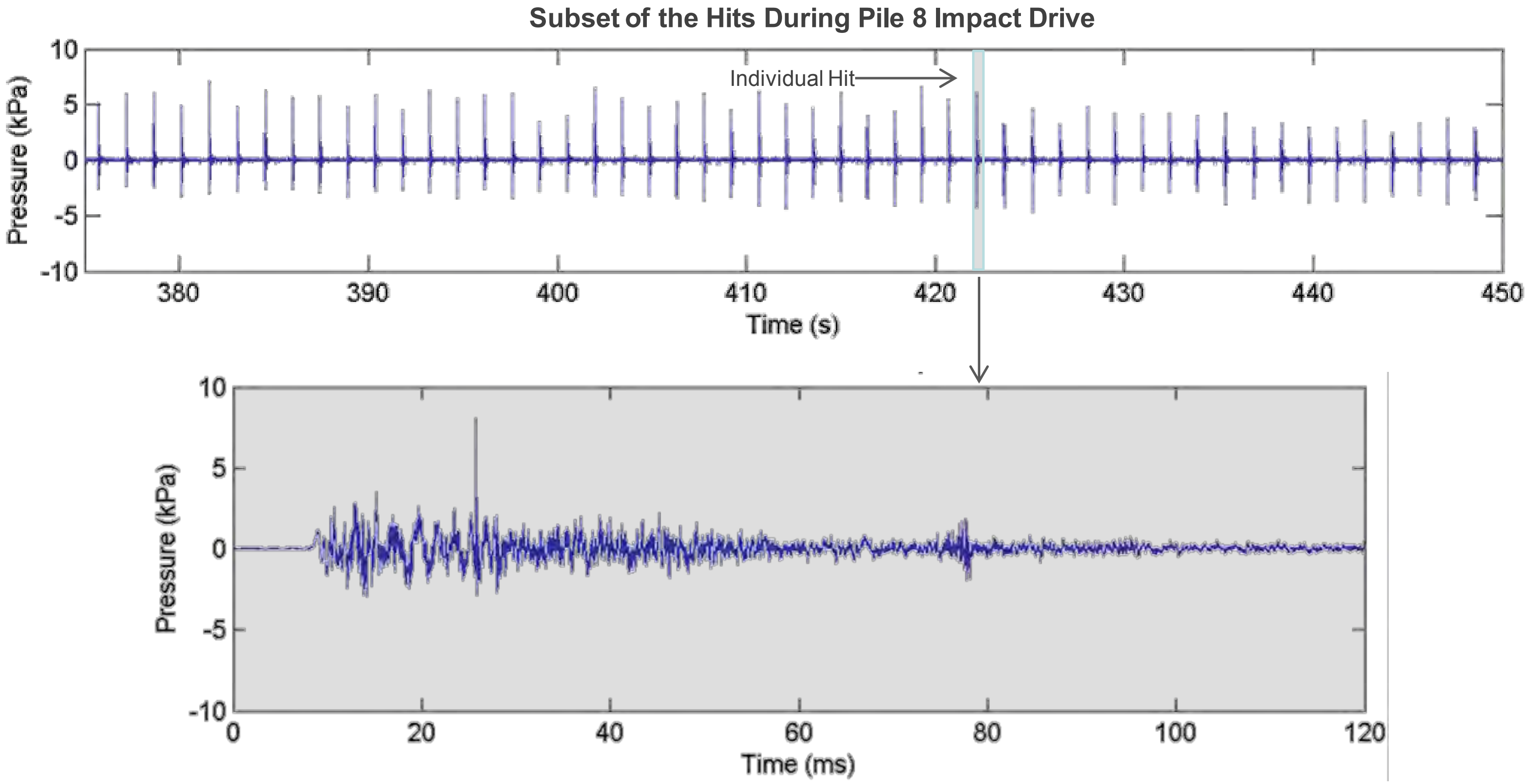
April 02, 2012

Measurement Overview

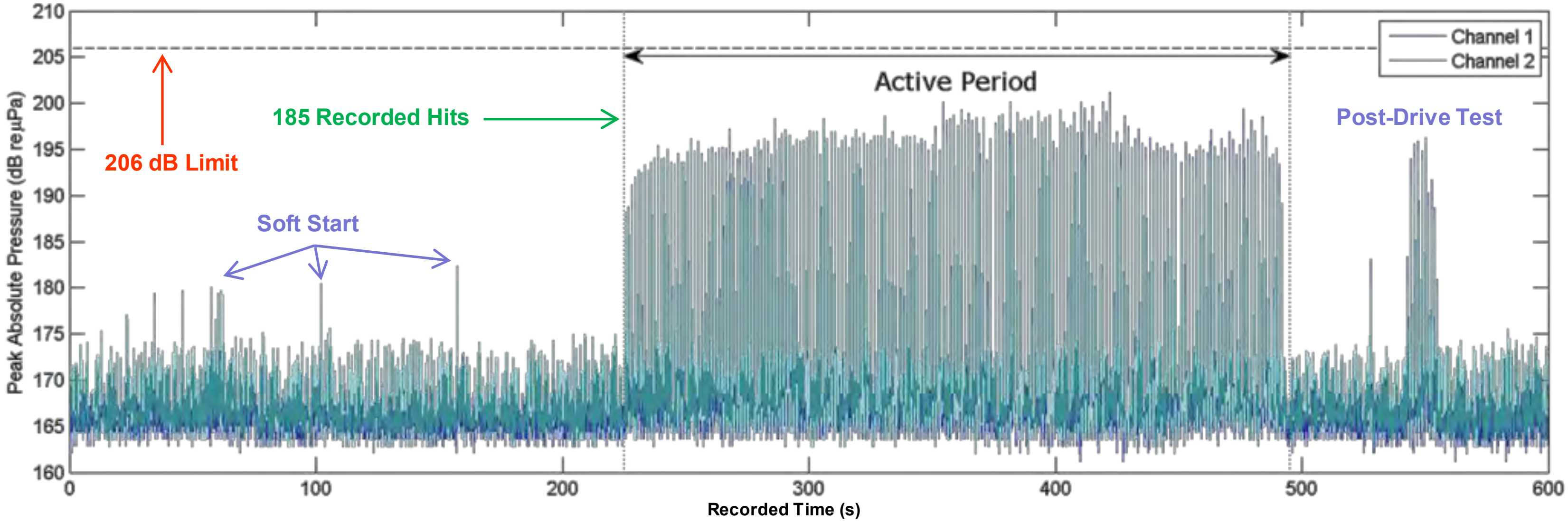
- Objective is to measure sound pressure levels on the barge (approximately 10 meters from pile)
  - During impact and vibratory hammer driving
  - Determine peak absolute pressures at 10 m
  - Determine sound exposure level (SEL) at 10 m
- Testing has shown that ORPC
  - Does not exceed the 206 dB peak pressure limit using impact or vibratory
  - Does not exceed the 187 dB SEL limit using impact
  - Has not exceeded the SEL limit using vibratory since improving hammer-follower and follower-piling connections
    - Note that a mitigation strategy exists for remaining below the threshold even under the initial conditions that led to high SEL levels

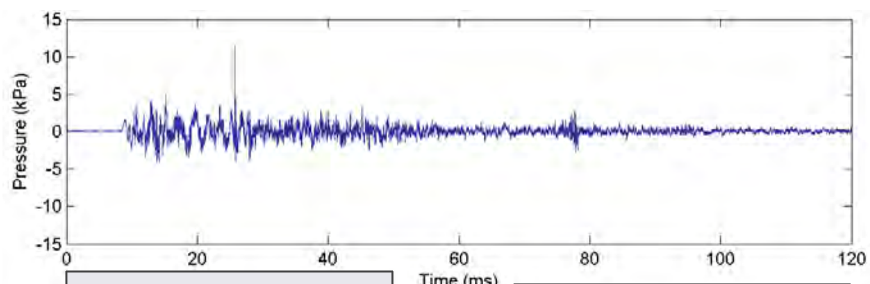
Near-Field Impact Hammer

- The impact hammer involves a series of discrete hits
  - Measure the peak pressure among each individual hit
  - Measure the SEL among each individual hit



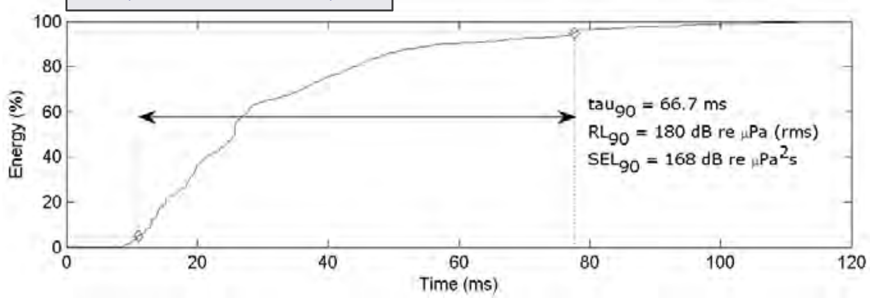
Near-Field Impact Hammer Example – Pile 8





Impact at 422.16 seconds
Peak Pressure 202 dB re µPa
(**63% of 206 dB Limit**)

SEL calculated in 90% relative cumulative energy window [1]



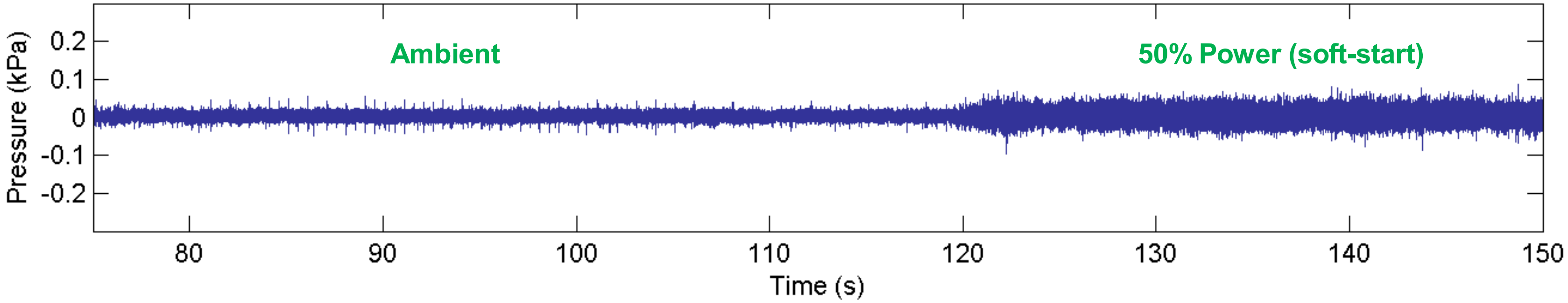
Event Summary	
Distance Driven	15 ft
Duration	5 min 17 sec
Largest (Peak) Individual Impact	
Peak Pressure	202 dB re µPa **(63% of 206 dB limit)**
RMS_{90} Pressure	180 dB re µPa
SEL_{90}	168 dB re µPa^{2}s **(1% of 187 dB limit)**
Ensemble	
Number of Impacts	185
Mean Peak Pressure	~197 dB re µPa

[1] Madsen, P.T., Marine mammals and noise: problems with root mean square sound pressure for transients, *J. Acoust. Soc. Am, 117, pp. 3952-3957, 2005.*

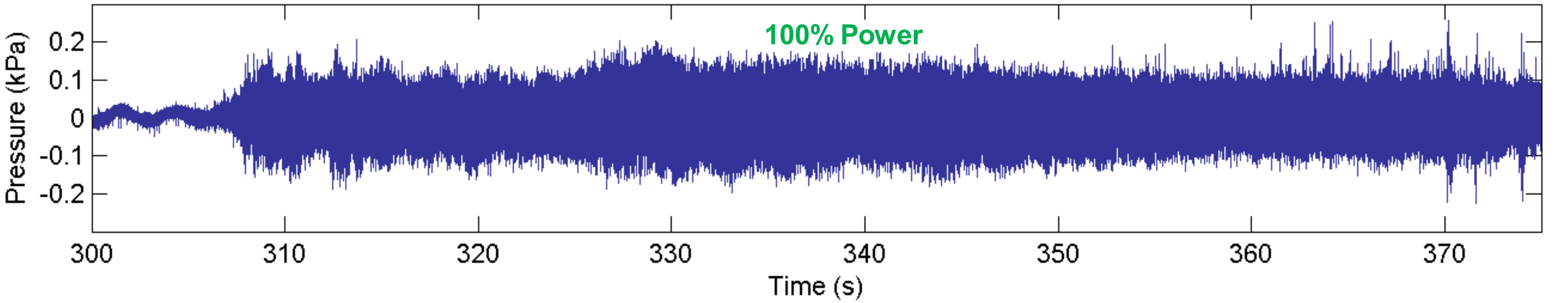
Near-Field Vibratory Hammer

- The vibratory hammer is a continuous source
  - Measure the peak pressure during entire drive
  - Measure SEL at 10 m after soft-start

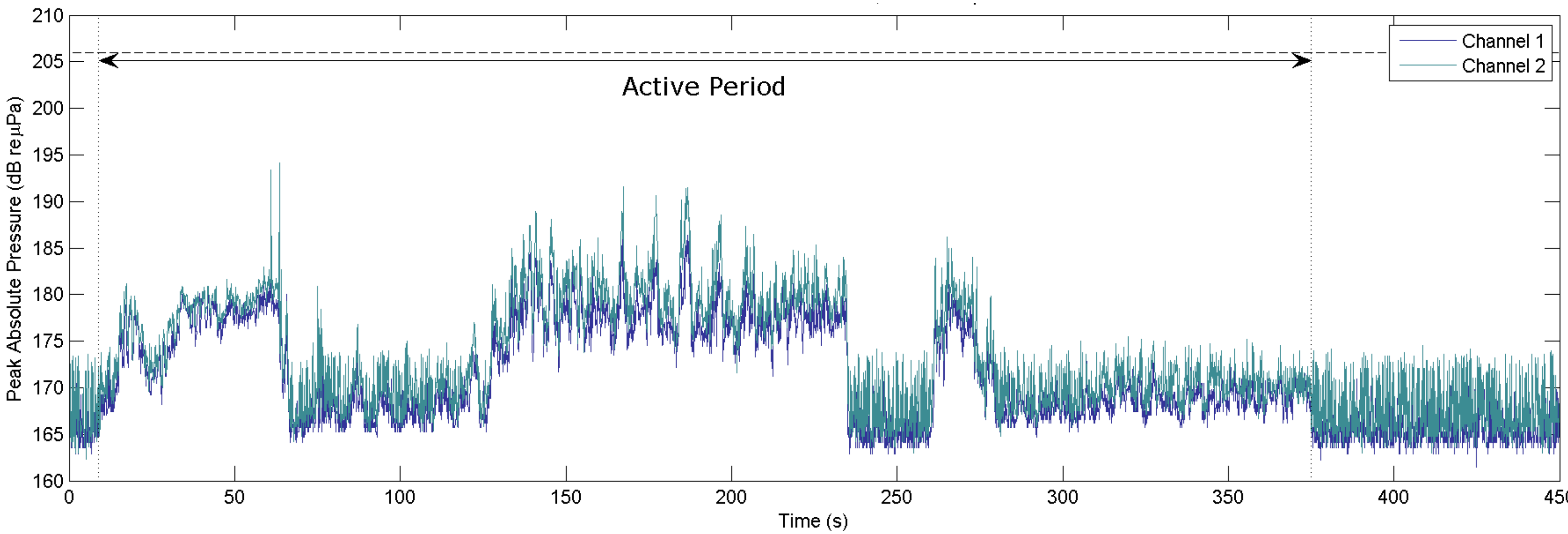
Subset of the Hammer Activity During Pile 1 Vibratory Drive

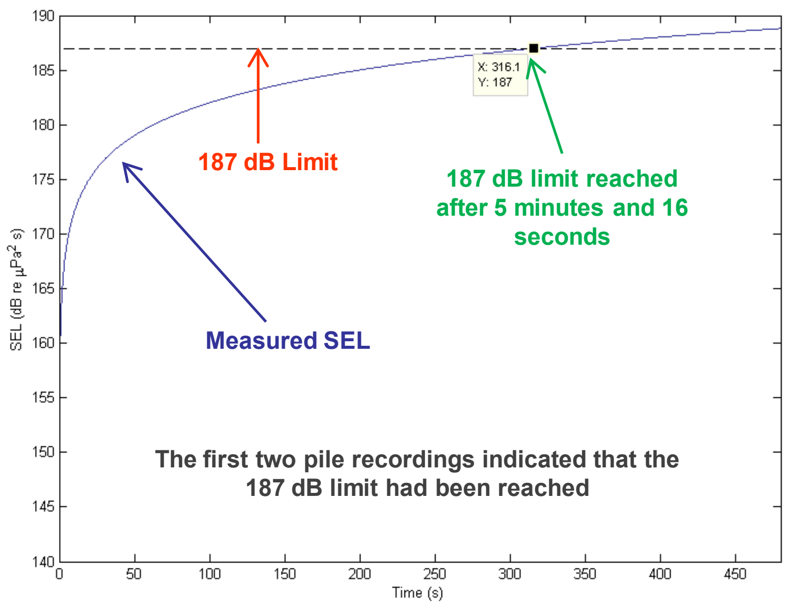


Note that there is a minimum 1 minute break between the final soft-start and full power



Near-Field Vibratory Hammer Pile 8



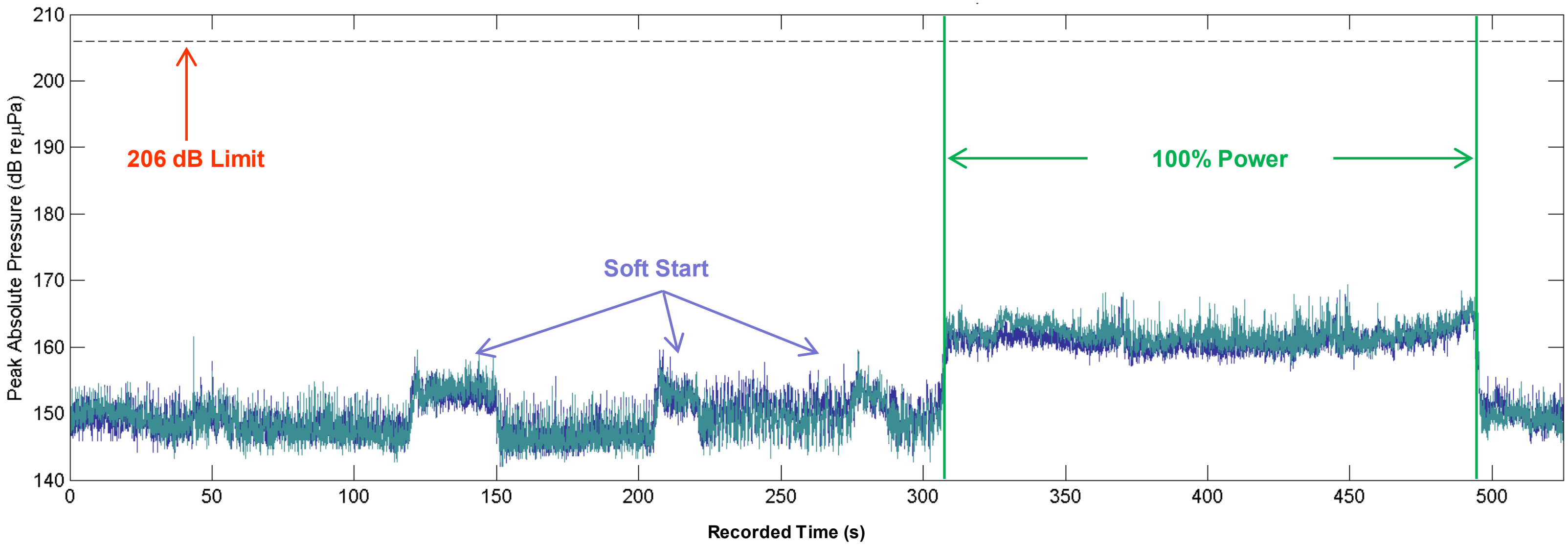


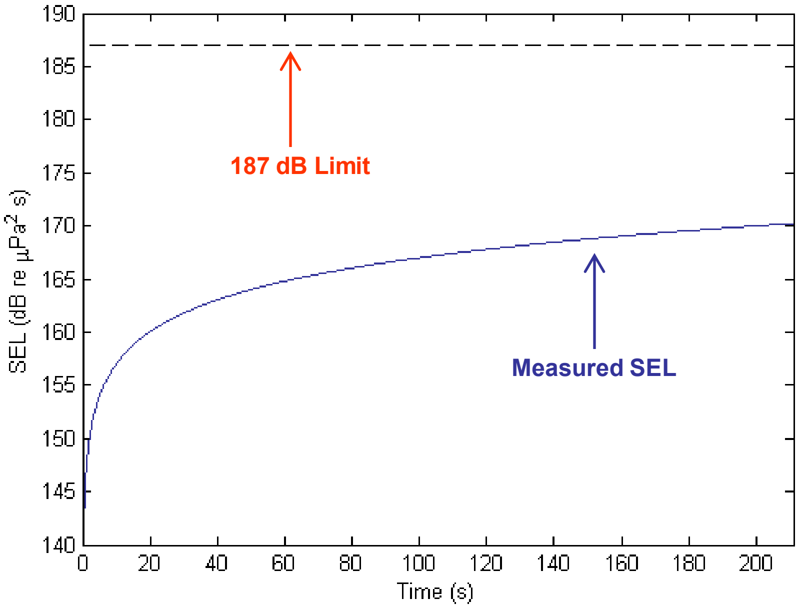
Event Summary	
Distance Driven	32 ft
Duration	8 min
Pressure	
Peak Pressure	195dB re µPa **(29% of 206 dB limit)**
RMS Pressure	161 dB re µPa
Sound Exposure Level	
SEL	188 dB re µPa^{2}s **(25 % *over* 187 dB limit)**
Duration$_{SEL@187}$	5 min 16 sec

Factors Possibly Affecting Initial SEL Threshold

- The first two piles showed SEL levels in excess of the 187 dB threshold
- Issues were noted during the driving regarding the connection of the hammer to the follower and follower to pile
- Three piles have been driven and recorded after improving the connections
  - Root mean square (rms) pressure levels and associated sound exposure levels are significantly lower

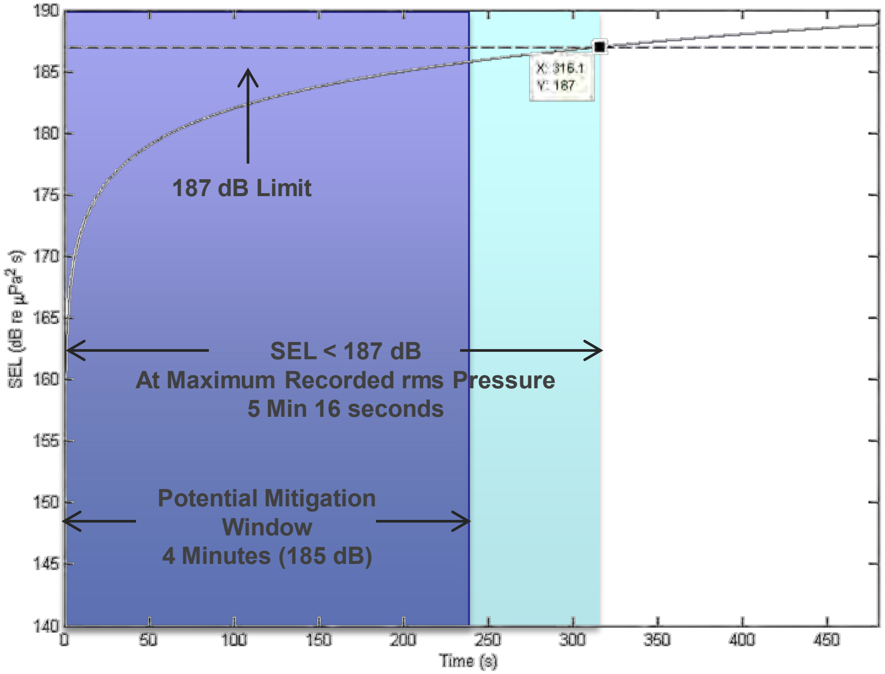
Near-Field Vibratory Hammer Pile 1 – After Improved Cnxn





Event Summary	
Distance Driven	29 ft
Duration	3 min 31 sec
Pressure	
Peak Pressure	170 dB re µPa **(2% of 206 dB limit)**
RMS Pressure	147 dB re µPa
Sound Exposure Level	
SEL	171 dB re µPa^{2}s **(16 % of 187 dB limit)**
$\text{Duration}_{\text{SEL@187}}$	> 2 hours

Vibratory Hammer Mitigation Strategy



- Sound exposure level is a function of the root mean square (rms) pressure and hammer activity duration
  - High rms pressures during the first two drives allowed the SEL to reach the 187 dB threshold before the activity was complete
- A conservative strategy is to limit vibratory hammer operations to a duration based on the highest measured rms pressure during vibratory activity
- A limit of the duration to 4 minutes would meet the requirement
  - This is well under the 5 min 16 second duration for an SEL of 187 dB at the highest recorded rms pressure levels
  - It allows for rms pressures 25% higher than any value recorded and still not exceed the 187 dB threshold

Near-Field Summary

Sleeve	Type	Drive Depth (ft)	Duration (min)	Peak Pressure dB re µPa (206 dB Threshold for Injury)	SEL re $\mu Pa^2 s$ (187 dB Threshold for Injury)
8	Vibratory	32	7:30	195	188 (25% over limit)
8	Impact	15	5:17	202	168
5	Vibratory	38	8:09*	184	188 (25% over limit)
3	Vibratory	36	8:30**	177	180
3	Impact	0	3:00	200	170
5	Impact	0	1:00	198	169
1	Vibratory	29	7:31**	170	171
7	Vibratory	48.5	13:30**	171	178

*Includes soft start period of 2 minutes at 50% energy
**Includes soft start period of 4 minutes at 0% (off) and 50% energy

- ORPC is below the peak pressure limit and can stay below the sound exposure limit through mitigation
  - Impact hammer has not exceeded the peak sound pressure level or the sound exposure level limits
  - Vibratory hammer has not exceeded the peak sound pressure level
  - The vibratory hammer initially exceeded the SEL limit, but subsequently has been well within limits
    - Likely difference is improved connections with hammer and follower
    - Limiting vibratory hammer operations to 4 minutes at 100% energy would not have exceeded for the first two piles the SEL threshold for injury of 187 dB re $\mu Pa^2 s$

Appendix B

Adaptive Management Plan, Cobscook Bay Tidal Energy Project, May 21, 2012
Adaptive Management Team Meeting Minutes, July 24, 2012
Adaptive Management Team Meeting Minutes, March 12, 2013

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ORPC
OCEAN RENEWABLE
POWER COMPANY

ADAPTIVE MANAGEMENT PLAN

COBSCOOK BAY TIDAL ENERGY PROJECT
FERC PROJECT NO. P-12711

May 21, 2012

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Contents

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PART 1. INTRODUCTION TO ADAPTIVE MANAGEMENT

A. Purpose

This Adaptive Management Plan (AMP) was developed as a requirement for a Federal Energy Regulatory Commission (FERC) pilot project license (P-12711, Article 404) for ORPC Maine's Cobscook Bay Tidal Energy Project (Project). The AMP is an integral part of ORPC Maine's implementation of the Project and provides a strategy for achieving the Project's objectives. As required by Article 404 of our FERC Pilot License, the AMP was drafted in consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Coast Guard, Maine Department of Environmental Protection, and Maine Department of Marine Resources. ORPC Maine also consulted with technical advisors, who have been involved with the development of each of the elements of this project. The resulting AMP reflects the collaborative approach that has been an integral part of the Project since its beginning.

The collaborative approach that was adopted for this AMP was first utilized for the 2009 memorandum of understanding (MOU) between the State of Maine and FERC, that included a working structure to develop and permit Maine's first hydrokinetic power project. An important component of the MOU was to develop appropriate and cost effective environmental studies and monitoring plans. It was clear from the onset that knowledge of the eco-system and its many facets potentially affected by this new hydrokinetic power project would require new methods of inquiry to collect, monitor and evaluate environmental data. Many of the new scientific methods that have been developed for the Project have become a new basis for learning, and the scientific community has begun modifying approaches to environmental studies using these new methodologies in other programs. This learning has helped to bring the agencies and industry to a point where they have more tools to confidently address the needs of permitting of a commercial development. ORPC's AMP has been designed to utilize not only the environmental studies at the Project site, but also environmental studies from other hydrokinetic projects and related studies from around the world.

ORPC's AMP recognizes that many scientific uncertainties exist and that environmental conditions constantly change. The AMP, therefore, is designed to be modified within the project time line and acknowledges that elements such as key environmental uncertainties, applied studies and institutional structure may evolve over time. We would also like to acknowledge that the plan, as laid out here, has worked well for the agencies, the stakeholders, and ORPC as the project evolved from a concept to the first pilot deployment.

Part 1 of the AMP gives the rationale for utilizing adaptive management for ORPC's Project. Part 2 describes the monitoring plans, which laid the foundation for adaptive management. This work was used to develop a data collection approach based on monitoring, applied scientific studies, and management targets that will provide data for management response. Part 3 describes ORPC's organizational structure and protocols by which Project managers, regulatory agencies, scientists, and stakeholders will work together for effective adaptive management decision-making. The comprehensiveness of this approach will provide direction for the Project based on the best current information. Part 4 includes references that were consulted in preparation of the AMP.

B. Project Background

ORPC Maine, LLC, a wholly-owned subsidiary of Ocean Renewable Power Company, LLC, (collectively, ORPC), is a Maine-based developer of hydrokinetic power systems and eco-conscious projects that harness the power of oceans and rivers to generate clean, predictable renewable energy. In partnership with coastal and river communities, ORPC works to create and sustain local jobs while promoting energy independence and protecting the environment.

In March 2012, ORPC began construction of the Project off the coast of Eastport and Lubec, Maine (Figure 1). This is the first grid-connected installation of ORPC's TidGen™ Power System, for which we received a FERC pilot project license on February 27, 2012.

Figure 1. Cobscook Bay Tidal Energy Project location map

The Project will be carried out in two separate phases over an expected eight-year pilot license term. In Phase 1, ORPC will build, deploy, monitor and operate a single-device TidGen™ Power System for one year (Figures 2 and 3). In Phase 2, ORPC will add four additional TidGen™ devices to the power system, for a total of five. ORPC will also deploy environmental monitoring equipment within the project boundary. Electricity generated by the pilot project will be delivered by an underwater power cable to the on-shore station in Lubec, Maine, where it will be power-conditioned and connected to the Bangor Hydro Electric Company power grid.

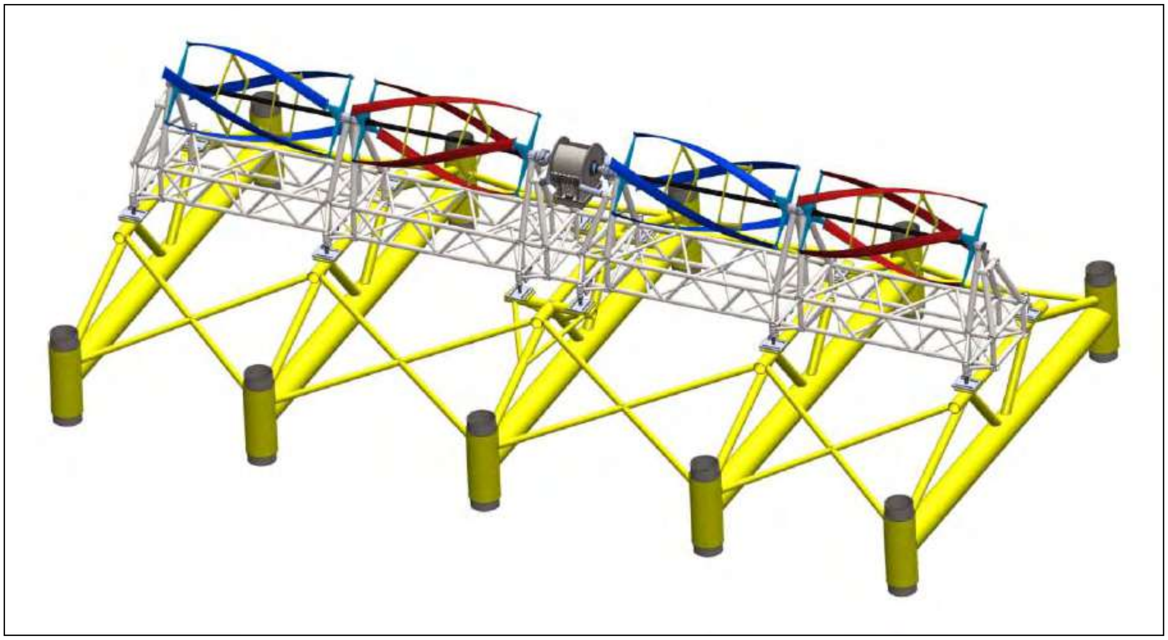

Figure 2. TidGen™ device

Figure 3. Deployment of the bottom support frame, March 2012

C. Evolution of ORPC's Adaptive Management Process

ORPC has been committed to the adaptive management process since the inception of the Project and has collaborated with local communities and key stakeholders at every step of the development process. ORPC has worked to pioneer a new regulatory standard for the industry and has been cited by the Governor of Maine's Ocean Energy Task Force as a model ocean energy developer in 2009.[i]

<u>2008 Ocean Energy Task Force</u>

In 2008, ORPC worked with Governor Baldacci's Ocean Energy Task Force to develop strategies for success in the tidal and offshore wind industries.[ii] The Task Force endorsed tidal energy development in Maine by aligning the state's General Permit for test sites with the FERC pilot project process, simplifying the submerged lands lease fee program for pilot projects and recognizing ORPC's development expertise as a state model. The Task Force's recommendations were approved and signed into law by Maine's 124th Legislature in 2008.

<u>2009 Memorandum of Understanding</u>

In 2009, the state of Maine and FERC also signed an MOU outlining their collaborative approach to state and federal regulatory consistency, with a goal of ensuring sustainable development of tidal energy resources and the commercialization of new technologies.[iii] Agencies from Maine's Departments of Conservation, Environmental Protection, Inland Fisheries and Wildlife, and Marine Resources, State Planning Office, and the Governor's Office of Energy Independence and Security and FERC came to together to create a coordinated process to review tidal energy projects with the pilot license process. Maine's Department of Environmental Protection was designated as the lead agency for Maine. Key aspects of the MOU, relevant to this AMP are noted here:

> *G.1.* The Parties agree that the pilot licensing process may be appropriate as a short-term means of allowing hydrokinetic tidal energy projects to proceed on a pilot (demonstration) basis while additional economic, environmental, and technical data concerning the effects and operation of such projects are gathered. The Parties also agree to share and make publicly available in accordance with applicable law and regulations all economic, environmental, and technical data gathered on these pilot projects. The Parties also agree that any shorter licensing approach established must incorporate appropriate safeguards, limitations, and monitoring to ensure that there are no significant adverse environmental, economic, or social impacts.
>
> *G.2.* Maine and the Commission agree that any required pre-and post-licensing studies for these pilot (demonstration) projects should be reasonable in scope, commensurate with the limited size and duration of the projects, and designed to provide information that will be relevant to the evaluation of the impacts of any proposed commercial-scale projects.
>
> *G. 7.* Maine and the Commission agree that they will work to coordinate their environmental reviews of any proposed hydrokinetic tidal energy project to be located in Maine state waters, or in federal waters where the project affects coastal resources or coastal uses in Maine's designated coastal area, and subject to the

> Commission's licensing jurisdiction, so that documents prepared by the Commission for review under NEPA may be used by Maine agencies to satisfy the requirements of Section 401 of the Clean Water Act and the Maine Waterway Development and Conservation Act, the Maine Endangered Species Act, Mandatory Shoreland Zoning Act, and other similar requirements that are enforceable policies of Maine's approved Coastal Zone Management Program under the CZMA, or any other required actions to be taken by Maine. The Parties also agree to consult with stakeholders, including the project developers, concerning the design of studies and environmental measures, including adaptive management measures, for hydrokinetic tidal energy projects in Maine state waters, or in federal waters where the projects affect coastal resources or coastal uses in Maine's designated coastal area.

This MOU has been extremely important for ORPC and has helped facilitate inter-agency discussion and review of the Project. It has, in effect, created the model for the development of the FERC pilot license application which was started in 2010 and the adaptive management process that ORPC has subsequently adopted.

<u>FERC Pilot License Application</u>
During the development of the FERC pilot license application, ORPC consulted with federal and state resource agencies and stakeholders, including native tribes, to develop a comprehensive set of environmental study plans to monitor the TidGen™ Power System and the surrounding environment. ORPC drafted environmental monitoring plans, held workshops and conference calls with the resource agencies and stakeholders to discuss and resolve comments on the plans. Subsequently, these study plans were modified significantly from those originally submitted in the draft pilot license application and are now based on pre-deployment data, agency concerns and carefully designed study plans that address critical interaction issues during initial operation. The study plans, most importantly, include a commitment by ORPC to present this data and reports with recommendations on modifications of the methods to improve the scientific knowledge on all impacts of the project during the first Phase of deployment.

This process of stakeholder and regulatory consultation and scientific innovation has resulted in the development of the following study plans, included in Appendix C of the FERC pilot license application:

- Acoustic Monitoring Plan
- Benthic and Biofouling Monitoring Plan
- Fisheries and Marine Life Interaction Monitoring Plans
- Hydraulic Monitoring Plan
- Marine Mammal Observation Plan
- Bird Observation Plan

Concurrently with the submittal of the FERC pilot license application and the Maine General Permit application, ORPC also consulted with the Maine Department of Conservation Bureau of Parks and Lands to identify the requirements for obtaining a submerged lands lease for the Deployment Area. ORPC has received a submerged lands lease, with a term concurrent with the Maine Department of Environmental Protection General Permit.

D. Adaptive Management Defined

Given the collaborative approach that has evolved over several years in developing ORPC's tidal energy Project, adaptive management is defined here as *a collaborative, consultative process among ORPC management, state and federal agencies, and stakeholders that monitors and reviews the results of policies, Project actions and environmental data, and integrates this new learning into policy and management actions, adapting as necessary*. In this approach, policy and management actions are viewed as scientific experiments that are conducted among scientists, managers, and other stakeholders on key policy decisions. This concept is important because the environmental outcomes of management policies are often uncertain. To be effective, decision-making processes are flexible and are designed to be adjusted in the face of uncertainties as outcomes from management actions and other events are better understood.

E. Adaptive Management Plan Objectives

ORPC's AMP is structured in a manner that is consistent with the processes and relationships that the company has developed with regulatory agencies and project stakeholders throughout the permitting efforts.

The objectives of ORPC's Adaptive Management Plan are:

- To generate science-based information for managers, agencies, and stakeholders
- To establish a mechanism to assess the effectiveness of environmental studies and monitoring plans included in the FERC pilot project license
- To provide guidance on changes to monitoring requirements, including scope, frequency, and targets
- To effectively communicate ORPC and agency recommendations for changes to the FERC pilot project license
- To convert information into effective management decisions
- To involve the public to help provide management direction
- To store and organize information for use by management and the public
- To include the results of environmental studies associated with hydrokinetic projects from around the world

PART 2. PLANNING PHASE: Monitoring Plans

During the planning phase of the pilot license application, ORPC worked with federal and state agencies, scientists and local stakeholders to lay the groundwork for adaptive management during the Project's implementation and operation. Environmental studies and monitoring plans were subsequently prepared based on these consultations and included data collection approaches, monitoring and applied studies from the scientific community. The development of these plans laid the foundation for an adaptive management approach to hydrokinetic monitoring and is now incorporated in ORPC's FERC pilot license application (Appendix C); the monitoring plans' objectives are repeated here:

A. Acoustic Monitoring Plan

The primary goals of the Acoustic Monitoring Plan are to identify and characterize the noise radiated by the TidGen™ Power System in the high-velocity environment of the Project site, by gathering acoustic data under various environmental and mechanical conditions both prior to and during Project deployment. This will be accomplished by: 1) conducting ambient noise measurements at the Deployment Area prior to the deployment of a single-device TidGen™ Power System; 2) conducting noise measurements on the Beta TGU to gather preliminary data and gain experience with the equipment and methodologies; 3) conducting noise measurements on the single-device TidGen™ Power System after its Phase I deployment; and 4) conducting noise measurements on the five-device TidGen™ Power System after its Phase II deployment. The equipment and methodologies used will gather noise data and help determine the origins of the noise. The Acoustic Monitoring Plan will use this data to characterize the TidGen™ Power System's acoustic footprint, in accordance with the requirements of the FERC pilot license.

Additional information on potential marine life interaction with the turbine will be monitored as outlined in the University of Maine Fisheries Monitoring Plan and the ORPC Marine Life Interaction Monitoring Plan. The presence of marine mammal species in the vicinity of the Project is addressed in the Marine Mammal Observation Plan. Separate from these study plans, ORPC, in conjunction with Scientific Solutions Inc., is developing monitoring technology and methods to deploy an active acoustic monitoring system (Figure 4). The ultimate goal of this system under development is to monitor marine life automatically and in real time.

Figure 4. Scientific Solutions conducting noise measurements

B. Benthic and Biofouling Monitoring Plan

Figure 5. Lower intertidal sampling in the cable crossing area. Photo: MER Assessment Corporation.

The primary goals of the Benthic and Biofouling Monitoring Plan are to evaluate the benthic community during the Project and to study whether the structures introduced into the marine system have the potential to allow biofouling accumulation that may alter the habitat within the Deployment Area. These goals will be accomplished by: 1) characterizing the existing benthic community (pre-deployment), (Figure 5); 2) examining the recovery of the benthic resources disturbed during the installation of the subsea cable; 3) examining the benthic community near the deployed TidGen™ devices; and 4) examining the presence and relative extent of coverage of biofouling organisms on the deployed TidGen™ devices. The Benthic and Biofouling Monitoring Plan will use the data gathered to evaluate the potential Project effects on the benthic community in accordance with the requirements of the FERC pilot license process.

Additional information regarding the monitoring of the hydraulic flow fields and sediment transport in the Deployment Area is included in the Hydraulic Monitoring Plan.

C. Fisheries and Marine Life Interaction Monitoring Plans

The goal of the Fisheries Monitoring Plan is to collect pre-deployment and post-deployment information to provide an initial description of fish distribution and relative abundance within Cobscook Bay to supplement existing information for the general Passamaquoddy Bay area. Specific objectives include:

Figure 6. Dr. Gayle Zydlewski, Assistant Research Professor, University of Maine School of Marine Sciences, completing fisheries monitoring aboard ORPC's research vessel, the *Energy Tide 2*.

- Characterize fish presence and vertical distribution in Cobscook Bay with acoustic technologies
- Conduct stratified sampling to evaluate tidal cycle, diel, and seasonal trends
- Characterize fish distribution, species, and relative abundance and summer seasonal occurrence with multiple netting efforts in open-water pelagic and benthic areas, near-shore sub-tidal areas, and intertidal areas of outer, middle, and inner bays within Cobscook Bay
- Use data gathered to develop a preliminary assessment of the potential effects of the Project on fish populations in the Deployment Area and to the extent possible in Cobscook Bay
- Monitor indirect fish interactions with the TidGen™ devices(s) to evaluate potential Project effects (Figure 6)
- Evaluate potential cumulative effects of the Project based on this comprehensive data set and the direct interaction monitoring data collected (Section 3 of this plan).

D. Hydraulic Monitoring Plan

The primary goal of the Hydraulic Monitoring Plan is to characterize the hydrological zone of influence for the Project. This will be accomplished by: 1) conducting measurements of the pre- and post-deployment flow fields in the deployment area; 2) providing experimental inputs into a large-scale computational circulation model for the estimation of far field impacts; and 3) monitoring for scouring, or sediment transport processes, within the deployment area. The Hydraulic Monitoring Plan will use the data gathered to characterize the hydrological zone of influence of the Project in Cobscook Bay and the effects (if any) of the TidGen™ Power System on flow and sediment transport, in accordance with the requirements of the FERC pilot license process.

Additional information regarding the monitoring of the benthic community in the deployment area is included in the Benthic and Biofouling Monitoring Plan.

E. Marine Mammal Observation Plan

The primary goal of the Marine Mammal Monitoring Plan is to identify the species, number of animals and their behavior to characterize changes in marine mammal use in and around the deployment area (Figure 1) due to the deployment of hydrokinetic devices. This will be accomplished by ORPC personnel and contractors: 1) conducting multi-season marine mammal observations to characterize the species presence, relative frequency of occurrence, and habitat use prior to the deployment of a single-device TidGen™ Power System; 2) conducting multi-season marine mammal observations around the single-device TidGen™ Power System after its Phase I deployment; and 3) conducting multi-season marine mammal observations on the five-device TidGen™ Power System after its Phase II deployment. In addition, dedicated and trained marine mammal observers will 4) conduct marine mammal watch prior to and during major deployment, maintenance and retrieval activities (Figure 7). The Marine Mammal Monitoring Plan will use the data gathered to characterize marine mammal presence in Cobscook Bay and the effects (if any) of the TidGen™ Power System on marine mammals, in accordance with the requirements of the FERC pilot license process.

Since marine mammals are known to utilize the Cobscook Bay area, ORPC will provide a dedicated marine mammal watch, by qualified personnel, before and during major on-water deployment, maintenance and/or retrieval activities. This service will provide ORPC and its contractors with advance notification of the approach, presence and all-clear for marine mammals. ORPC will take all precautions to minimize harassment of and/or contact with marine mammals during these periods of higher risk.

Figure 7. Harbor Seal in Cobscook Bay

Additional information on potential direct interactions between marine mammals and the TidGen™ Power System will be monitored as outlined in the Fisheries and Marine Life Interaction Monitoring Plans. The effect of noise produced by the installation and operation of the TidGen™ Power System on marine mammals is addressed in the Acoustic Monitoring Plan. Separate from these study plans, ORPC is working with Scientific Solutions, Inc. under a grant from the U.S. Department of Energy to develop an active acoustic monitoring system, a real-time, automated system capable of tracking the movements of fish and mammals in the vicinity of the TidGen™ Power System.

ORPC will apply for an incidental harassment authorization (IHA) with the National Oceanic and Atmospheric Association (NOAA)/National Marine Fisheries Service (NMFS) as required by the Marine Mammal Protection Act, if activities or operations may result in the harassment of marine mammals. Furthermore, ORPC will consult with NOAA/NMFS regarding the credentials of the persons to be assigned to this task. ORPC will also follow procedures to assure minimal harassment and risk to marine mammals. The IHA will be modified based on findings of previous work.

F. Bird Observation Plan

The primary goal of the Bird Monitoring Plan is to determine the species, number, and time of peak use of sea and shore birds in the Deployment Area, the onshore landing site where the under P&D cables of the TidGen™ Power System will come ashore, and the waters immediately off the landing site. Information about the behavior of these birds within these areas will be gathered as well. This will be accomplished by: 1) conducting multi-season bird observations to characterize the species presence, relative frequency of occurrence, and habitat use in these areas prior to the deployment of a single-device TidGen™ Power System (Figure 8); 2) conducting multi-season bird observations in these areas after the Phase I deployment of the single-device TidGen™ Power System; and 3) conducting multi-season bird observations in these areas after the Phase II the five-device TidGen™ Power System deployment. The Bird Monitoring Plan will use the data gathered to characterize bird presence in Cobscook Bay and the apparent effects (if any) of the TidGen™ Power System on sea and shore bird behavior, in accordance with the requirements of the FERC pilot license process.

Figure 8. Shorebirds at Cobscook Bay. Photo: Bill Silliker, Jr.

PART 3. ORGANIZATIONAL STRUCTURE AND PROTOCOLS

A. FERC License Article 404

ORPC's adaptive management is a formal process and incorporates the requirements included in the FERC pilot project license (P-12711, Article 404), which specifically requires an AMP and proscribes what the plan should include:

> *Article 404.* *Adaptive Management Plan. Within 3 months of license issuance, the licensee shall file with the Commission for approval an Adaptive Management Plan that has been developed in consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Coast Guard, Maine Department of Environmental Protection, and Maine Department of Marine Resources.*
>
> *The plan shall include: 1) protocols for consultation with federal and state agencies on preliminary results of monitoring studies and any necessary modifications, with documentation of consultation and any recommended or proposed modification included in each environmental monitoring plan report filed with the Commission; 2) the allowance for minor modifications (i.e. location, frequency) to the monitoring plans without prior Commission approval in cases where all consulted entities are in agreement, with modifications and the record of consultation included in the required reports of the affected monitoring plans; 3) the allowance for major modifications (i.e. termination of monitoring, change in reporting schedule) to the monitoring plans upon Commission approval; and 4) a provision for consultation and Commission approval on the effectiveness of the monitoring and the operation of the project in Phase 1 prior to commencing with Phase 2 deployment.*
>
> *Prior to filing the plan with the Commission, the licensee shall submit the plan to the agencies identified above and allow them a minimum of 45 days to review and comment on the plan. The final plan shall include copies of any comments received and the licensee shall address all comments and recommendations received from the agencies. If the licensee does not adopt a recommendation, the plan shall include the licensee's reasons based on project-specific information.*

In response to the requirements of Article 404, ORPC has completed the following tasks:

- ORPC has developed an AMP in consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Coast Guard, Maine Department of Environmental Protection, and Maine Department of Marine Resources.
- The AMP includes the four protocols, allowances and provisions listed in the above excerpt.
- The AMP has been submitted to the above agencies for review and comment on March 30, 2012, within the minimum of 45 days prior to submission to FERC.
- ORPC also sent the AMP to other stakeholder entities whose comments were incorporated as appropriate.

- The AMP addresses agencies comments and recommendations, and when appropriate the rationale based on project-specific information for not adopting a recommendation based on Project-specific information (Attachment 1).
- The AMP has been filed for approval with FERC within three months of license issuance.

B. Organization

An Adaptive Management Team has been created to implement the AMP. The 2012 Adaptive Management Team is identified in Table 1.

Chair

The Chair of the Adaptive Management Team will be an individual who is acceptable to federal and state agencies, is knowledgeable in environmental regulation and monitoring, has an interest in and knowledge of tidal energy, and is independent of federal and state regulatory agencies.

Agencies

The Adaptive Management Team will have representation from federal and state agencies, reflecting those agencies with which FERC has required consultation in Article 404:

- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- U.S. Coast Guard
- Maine Department of Environmental Protection
- Maine Department of Marine Resources

In addition, the team will also have standing members from the following agencies:

- U.S. Army Corps of Engineers
- NOAA Office of Protected Species

ORPC Staff

The Adaptive Management Team will also include representatives from ORPC staff.

Project Stakeholders

The Adaptive Management Team will identify key project stakeholders who may include representatives from the following:

- First Nations
- Commercial Fishing Associations
- Local Resource Agencies
- City and Town officials

The Adaptive Management Team will have the ability to add or remove members as it sees appropriate.

Table 1. *2012 Adaptive Management Team*

NAME	ORGANIZATION	ROLE	RESPONSIBILITY
To be Determined	Unaffiliated	Chair	Chairs meetings
Herbert Scribner	ORPC	Project Developer	Communication
Laury Zicari	U.S. Fish & Wildlife Service	Government Regulator	Compliance with established regulations
Sean McDermott	National Marine Fisheries Service	Government Regulator	Compliance with established regulations
Dan Tierney or Jeff Murphy	National Marine Fisheries Service	Government Regulator	Compliance with established regulations
Linda Mercer	Maine Department of Marine Resources	Government Regulator	Compliance with established regulations
Ron Beck	U.S. Coast Guard	Government Regulator	Compliance with established regulations
Jim Beyer	Maine Department of Environmental Protection	Government Regulator	Compliance with established regulations
Michelle Magliocca	NOAA Office of Protected Resources	Government Regulator	Marine Mammals
ADVISORY			
Nathan Johnson	ORPC	Project Developer	Advisory
Gayle Zydlewski	University of Maine	Technical Advisor	Fisheries Monitoring
Moira Brown	New England Aquarium	Technical Advisor	Marine Mammal Monitoring
Jay Clement	U.S. Army Corps of Engineers	Government Regulator	Advisory
To be determined by Adaptive Management Team	International Academia	Technical Advisor	Marine Hydrokinetic Project Experience

C. Communications

ORPC is responsible for disseminating information to the Adaptive Management Team, agencies, stakeholders and the public at large via the appropriate delivery systems (at the Adaptive Management Team direction).

D. Consultation Protocols

Article 404 of ORPC's FERC license requires the AMP to include protocols for consultation:

Protocols for consultation with federal and state agencies on preliminary results of monitoring studies and any necessary modifications, with documentation of consultation and any recommended or proposed modification included in each environmental monitoring plan report filed with the Commission

Protocols for consultation include the following:

- The Adaptive Management Team, whose membership is described above, will meet bi-annually at a minimum. Additional details of meeting content and frequency will be determined by the Adaptive Management Team.
- The purpose of Adaptive Management Team meetings is to consult on the results of the environmental monitoring plans, and scientifically based recommendations from ORPC, advisors and agencies.
- The Adaptive Management Team will support the common goal of delivering a sound and effective environmental monitoring assessment of ORPC's Project.
- The Adaptive Management Team will be copied on all relevant communication regarding the monitoring outputs and program results.
- ORPC, based on scientist input and consultation with the jurisdictional regulator, will make recommendations on necessary modifications to the environmental monitoring plans to the Adaptive Management Team for concurrence or comment. This activity is not limited to the biannual meeting. The modification process shall be utilized by ORPC in response to unforeseen or unanticipated actions or results during the operation of the Pilot Project.
- ORPC will document the consultations and modifications and disseminate among the Team.
- ORPC will file the Adaptive Management Team consultations and modifications with FERC following each bi-annual meeting and disseminate to stakeholders.
- The Adaptive Management Team will evaluate or adopt an annual report, similar to ORPC's FERC annual report that summarizes data and recommended or approved changes, and will distribute that report to the public.
- The public report will include inputs from the fishing community, information from meetings that ORPC and University of Maine hold throughout the year, as well as other stakeholder inputs.
- Additional membership to the Adaptive Management Team will be the decision of all members of the Adaptive Management Team before permission is granted.

E. Minor Modification Allowances

Article 404 of ORPC's FERC pilot project license allows minor modifications in the AMP:

The allowance for minor modifications (i.e. location, frequency) to the monitoring plans without prior Commission approval in cases where all consulted entities are in agreement, with modifications and the record of consultation included in the required reports of the affected monitoring plans

ORPC will utilize the following protocols to make minor modifications to monitoring plan methods, schedules, parameters without prior Commission approval based on the following:

- All Adaptive Management Team are in agreement (documented) by consensus.
- Description of all modifications and the record of consultation are documented in the required reports of the affected monitoring plans.
- Communication of intent and scope will be made with FERC's Compliance Division as the situation develops that may require a minor license modification.

F. Major Modification Allowances

Article 404 of ORPC's FERC pilot project license allows major modifications in the AMP:

> *The allowance for major modifications (i.e. termination of monitoring, change in reporting schedule) to the monitoring plans upon Commission approval*

Because there is a potential for public review and comments, major modifications will require the following prior to seeking Commission approval:

- Major modifications will require all consulting agencies review and comment and then the Adaptive Management Team will submit the proposed changes to FERC so that the 30 day comment period can be published and comments can be considered prior to the Major modification.
- Scientifically based tools to substantiate the changes
- Data based
- Scientifically proven acceptance

G. Tools for Evaluating Monitoring Results

The Adaptive Management Team will identify and evaluate tools that might be used to rank the importance, potential risks and relevance of the modifications given the size of the project. Potential innovative tools and approaches may include the following:

- Weight of evidence models for risk assessment
- Ecosystem management approaches - integrated, holistic focus
- Integrated, multi-modal, GIS-centric monitoring programs with a life-of-the-field perspective
- Geospatial, behavior-based movement modeling tools
- Alternative monitoring technologies
- Additional evaluation tools to be identified by Adaptive Management Team

H. Consultation and Commission Approval

Article 404 of ORPC's FERC pilot project license requires a provision for consultation and Commission approval on the effectiveness of the monitoring and the operation of the project in Phase 1 prior to commencing with Phase 2 deployment:

> *A provision for consultation and Commission approval on the effectiveness of the monitoring and the operation of the project in Phase 1 prior to commencing with Phase 2 deployment*

Since the inception of the Cobscook Bay Tidal Energy Project ORPC has worked collaboratively and in consultation with state and federal regulatory agencies, scientists and stakeholders. ORPC has confidence in this group to provide sound and effective environmental monitoring assessments and will apply this same structure for consultation on the effectiveness of the Project's Phase 1 monitoring and operation when seeking Commission approval to proceed to Phase 2.

The process for determining a decision to commence Phase 2 will include the following:

- The Adaptive Management Team will first make the recommendation to proceed/not proceed to Phase 2.
- Agencies with standing membership on the Adaptive Management Team will have a vote.
- Other agencies will provide input.
- The Adaptive Management Team decision will be unanimous.
- The Adaptive Management Team will submit a report to FERC with their recommendation.
- The Adaptive Management Team report will reflect the need for adaptability to the Project's next phase of operation, which will include new challenges.

I. Dispute Resolution

The Adaptive Management Team will decide at its first meeting how it will seek dispute resolution. The working relationships ORPC has developed to date through the pilot license application process and as facilitated through the FERC MOU with the State of Maine has been very effective. ORPC, therefore, expects agencies with jurisdiction pertaining to specific environmental aspects of the project will continue to have final approval of any modifications to the monitoring programs.

PART 4. REFERENCES

The following references were consulted in the preparation of this AMP:

SeaGen Marine Current Turbine Project, *Science Group Terms of Reference.*

Fundy Ocean Renewable Center for Energy (FORCE), Fundy Tidal Energy Demonstration Project, *Environmental Monitoring Advisory Committee (EMAC), Terms of Reference*, November 23, 2011.

Reedsport OPT Wave Park Settlement Agreement, *Exhibit B – Adaptive Management Process Overview.*

Williams, B.K., R.C. Szaro, and C.D. Shapiro. 2009. *Adaptive Management: The US Department of the Interior Technical Guide.* Adaptive Management Working Group, US Department of the Interior, Washington, DC. Available online at: http://www.doi.gov/initiatives/

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[i] Maine Coastal Program, Maine State Planning Office (2009). Final Report of the Ocean Energy Task Force to Governor John E. Baldacci. Appendix 13.

[ii] Executive Order 20 FY 08/09, November 7, 2008. See http://www.maine.gov/spo/specialprojects/OETF/index.htm

[iii] Maine State Planning Office (2009). Final Report of the Ocean Energy Task Force to Governor John E. Baldacci.

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Cobscook Bay Tidal Energy Pilot Project

Adaptive Management Meeting

Project:	Cobscook Bay Tidal Energy Pilot Project (FERC 12711)	**Date:**	7/24/12
Meeting	Adaptive Management Workshop	**Location:**	ORPC Eastport Office

Workshop Objective: To discuss how adaptive management works in a regulatory setting and the roles that members and advisors and other stakeholders play in that process.

Workshop Outcome: The Adaptive Management Team, advisors and outside resources established the framework to advance the evaluation and decision making process for environmental monitoring from tidal energy pilot projects towards commercialization.

Discussion

1. Workshop participant introductions
   - Attendees discussed their position and role in the adaptive management process. Attendees are listed in Table 1.

2. Remarks by Ann Miles, FERC
   - Adaptive management has been used in different applications for many years, developing an approach specific to marine hydrokinetics is key.
   - Global goal of consolidating and making existing information available is important. Ocean Energy Systems (OES) Annex IV is compiling an international database for marine hydrokinetic environmental effects : (http://www.ocean-energy-systems.org/about_oes/work_programme/annex_iv/)
   - Collaboration by all entities involved in the Cobscook Bay Tidal Energy Project (CBTEP) adaptive management process is essential.

3. Development of the AMP (FERC MOU process) – Herb Scribner, ORPC
   - Adaptive management has many objectives; the overarching goal is to effectively facilitate project decisions and a path forward without all the data normally available
   - ORPC's adaptive management plan was developed as an extension of the process used during the pilot license application.

- Adaptive management is an opportunity to consider monitoring frequency over time based on scientific results.
- Providing solid knowledge and quality scientific data gives regulatory agencies a means of support and makes the project easier to sell to the public/community.
- To advance from pilot to commercial projects the industry needs to determine the most efficient pathway, including the collection and evaluation of accurate data and the interpretation of that data.
- The Department of Energy, and those involved in the Canadian industry, are interested in the adaptive management process proposed by ORPC
- Estuaries and Coasts, a recognized scientific journal plans to publish an edition by the end of this year focusing on marine hydrokinetics. Gayle Zydlewski (University of Maine), Anna Redden (Acadia University) and Andrea Copping (PNNL) have contributed to the journal, which will feature several articles pertaining to ORPC's Cobscook Bay Project.

4. Structure of Plan and Team – Nate Johnson, ORPC
   - Members of the Team were dictated by FERC in License Article 404. ORPC added additional members to the team who played key roles throughout the pilot license application process and will continue to do so as the project progresses.
   - ORPC technical advisors play a key role in environmental monitoring and the adaptive management process.
     - Technical advisors are well respected in the scientific community and provide independent data collection and analysis
   - Need for independent chair (and approaches to dispute resolution)
     - An independent chair with broad experience can bring value, including a philosophical perspective (Graham Daborn)
     - ORPC should keep the idea of an independent chair open, especially someone from academia or who has experience in ocean energy licensing. (Sean McDermott)
     - A facilitator could help avoiding wasted time (Jim Beyers)
     - Final resolution in regard to monitoring modifications should be by FERC (Sean McDermott)
     - FERC is willing to help resolve internal disputes through its dispute resolution service. FERC's preference is for the AMT to come to a resolution on their own if possible. Secondly they recommended intervention by FERC staff and finally the dispute resolution service if necessary. This becomes especially important when the Team cannot achieve a consensus on monitoring modifications. (Ann Miles)
     - FERC offers both formal and informal dispute resolution (Emily Carter)

     FERC Dispute Resolution Service: http://www.ferc.gov/legal/adr/drs.asp

       - Based on the discussion, ORPC suggested that determining an independent chair at this time is not essential and can be revisited as necessary.

5. Adaptive Management Team member comments on process
    - In the case of a unique adaptive management plan it is critical to scrutinize what adaptive management means to that particular project and ensure that everyone is on the same page. (Ann Miles)
    - During the initial process keep the ultimate goal of commercialization in mind, ORPC is blazing the trail. (Ann Miles)
    - In order to prevent lots of small amendments write flexibility into the plan (Rachel Price)
    - Keeping a running list of amendments is helpful for future applications (Ann Miles)
    - Consensus may not be necessary for monitoring modifications (in reference to page 17 of the AMP). (Steve Shepard).
    - Unanimity on modifications is not always required. FERC wants to allow greater flexibility when making small changes and only become involved when necessary (Rachel Price)
    - How you will be sure the entire team is involved in decision-making in case they cannot be at a meeting, for example. (Gayle Zydlewski)
        - The decision making process will involve iterative communication between ORPC and the AMT. The AMT will need to determine how many times they are requested to receive input before ORPC pursues other options

6. Adaptive Management Case Study: Phase I Pile Driving - Nate Johnson ORPC
    - Pile installation successful despite seasonal weather difficulties and the challenge of meeting the required time window for completion
    - Environmental monitoring methods and techniques were successful.
    - Best management practices were established and implemented based on monitoring and operations in the field.
    - Recommendations for Phase II installations were developed
    - Demonstrated efficient process of license modification working with agencies and FERC Compliance
    - ORPC's Final IHA Report will be posted on NOAA's website following review and also available from ORPC upon request.

7. License Modification Process - Team Discussion
    - Most minor modifications can be done via email. FERC does not intend to have direct involvement with minor modifications (Rachel Price)
    - Refer to guidance in each license article for the minimum requirement when making changes to a particular plan (Ann Miles)
    - Modifications will be posted to the FERC website
    - It is important to be aware of who has jurisdiction when making modifications
    - It is important to be aware of the distinction between minor and major modifications. – Major modifications will involve FERC review and concurrence.

8. Evaluation of Monitoring Results - Team Discussion

- Risk assessment. The Weight-of-Evidence (WOE) approach to Risk Assessment may provide a useful framework to balance the needs of regulatory agencies and ORPC in making best use of existing data, designing an efficient operational monitoring program, and for managing impacts.
    - Bringing a risk assessment specialist early on in the process could help to define questions (Moira Brown, Gayle Zydlewski and Sean McDermott).
    - Important for risk assessment to be conducted by an independent entity(Gayle Zydlewski)
    - Risk assessment could be a tool to increase confidence in decision making. It fills in the gaps where information is not available, probabilities are derived from research (Gayle Zydlewski)
    - A model is like a bikini – what it reveals is interesting but what it conceals is vital. There is nothing magical about it; it can appear to be mystical until you have somebody explain what it is based on (Graham Daborn)
    - Regulatory agencies will need to be educated on how risk assessment can be used for MHK projects (Ann Miles, Jim Beyer, Sean McDermott)
- ORPC will continue to evaluate technologies to collected environmental data.

9. Reporting and Public Dissemination of Results - Team Discussion
    - Public meetings have been very effective for communicating information to the Eastport and Lubec communities
    - UMaine has been conducting social science studies that have also include community meetings and are evaluating perceptions and interactions of community members (particular fishermen) with tidal power development in the region.
    - It is important to engage communities and ask how they want to receive information
    - ORPC is looking into ways to share environmental studies and monitoring data through its website.
        - Email notification would be helpful when new data is posted (Jim Beyer)

Summary of Key Points and Action Items:

- Final resolution in regard to monitoring modifications should be by FERC.
- FERC offers both formal and informal dispute resolution.
- ORPC suggests that determining an independent chair at this time is not essential and can be revisited as necessary.
- In order to prevent the potential for numerous small amendments, the Plan should be written with flexibility in mind.
- Keeping a running list of amendments is helpful for future applications.
- Consensus may not be necessary for monitoring modifications.
- Unanimity on modifications is not always required. FERC wants to allow greater flexibility when making small changes and only become involved when necessary.
- Bringing a risk assessment specialist early on in the process could help to define questions.
- ORPC to gather information on the use of risk assessment for MHK for distribution and feedback from the Team.
- ORPC to investigate options for web-based sharing of environmental studies.

- Email notification would be helpful when new data or monitoring studies are posted.

Figure 1. ORPC Adaptive Management Workshop, July 24, 2012

Table 1. ORPC Adaptive Management Workshop Attendee List

ADAPTIVE MANAGEMENT TEAM				
NAME	ORGANIZATION	ROLE	RESPONSIBILITY	July 24th Attendance
Herbert Scribner	ORPC	Project Developer	Communication	✓
Steve Shepard	U.S. Fish & Wildlife Service	Government Regulator	Compliance with established regulations	✓
Sean McDermott	National Marine Fisheries Service	Government Regulator	Compliance with established regulations	✓
Dan Tierney or Jeff Murphy	National Marine Fisheries Service	Government Regulator	Compliance with established regulations	Unable to attend
Linda Mercer	Maine Department of Marine Resources	Government Regulator	Compliance with established regulations	Unable to attend
Ron Beck	U.S. Coast Guard	Government Regulator	Compliance with established regulations	Unable to attend
Jim Beyer	Maine Department of Environmental Protection	Government Regulator	Compliance with established regulations	✓
Michelle Magliocca	NOAA Office of Protected Resources	Government Regulator	Marine Mammals	✓

ADVISORY				
Nathan Johnson	ORPC	Project Developer	Advisory	✓
Gayle Zydlewski	University of Maine	Technical Advisor	Fisheries Monitoring	✓
Moira Brown	New England Aquarium	Technical Advisor	Marine Mammal Monitoring	✓
Jay Clement	U.S. Army Corps of Engineers	Government Regulator	Advisory	Unable to attend

OTHER RESOURCES				
Ann Miles	FERC			✓
Emily Carter	FERC			✓
Rachel Price	FERC			✓
Ryan Sun Chee Fore	DOE			✓
Whitney Blanchard	DOE			✓
Graham Daborn	Acadia University			✓
Glen Marquis	ORPC	Project Developer	Workshop Facilitator	✓

Ocean Renewable Power Company
Cobscook Bay Tidal Energy Project (P-12711)
Adaptive Management Team Meeting Minutes
March 12, 2013

Location: Maine Department of Environmental Protection, Eastern Maine Regional Office

Attendees (in-person):
Nathan Johnson, ORPC
Herb Scribner, ORPC
John Ferland, ORPC
Glen Marquis, ORPC
Jim Beyer, Maine DEP
Jessica Jansujwicz, University of Maine
Gayle Zydlewski, University of Maine
Jeff Murphy, NOAA NMFS
Sean McDermott, NOAA NMFS
Steve Shepard, USF&W
Linda Mercer, Maine DMR

Attendees (by phone):
Michele DesAutels, USCG
Dan Hubbard, USCG
Lt. Megan Drewniak, USCG
Andrea Claros, FERC
Michael Watts, FERC
Whitney Blanchard, DOE
Meghan Massaua, DOE
Courtney Smith, DOE
Graham Daborn, Acadia University

Welcome and Introductions (Glen Marquis)
Glen Marquis of Ocean Renewable Power Company (ORPC) opened the meeting at 10:05 am. He welcomed attendees and conference call participants. Everyone introduced themselves and their affiliations. Glen reviewed the agenda and asked for any input on changes. No changes were made in the agenda and Glen proceeded to review the meeting objectives:

- Review adaptive management's role in Project
- Summarize 2012 activities and lessons learned
- Explain environmental monitoring results
- Discuss recommended modifications and finalize necessary changes
- Provide briefing on overall Maine Tidal Energy Project

Nathan Johnson of ORPC provided an overview of the environmental reporting and review process:

Reporting Task	Proposed Date
Complete annual monitoring	December 31, 2012
Submit Annual Environmental Monitoring Report draft to agencies for review (start 30-day review period)	February 12, 2013
Adaptive Management Team meeting	**March 12, 2013**
End 30-day agency review period	March 15, 2013
Submit Annual Environmental Monitoring Report to FERC	April 1, 2013

ORPC's Adaptive Management Experience (John Ferland)

John Ferland of ORPC said the Adaptive Management Plan experience had been positive for the company. He stated the plan's beginnings were rooted in feedback from the resource agencies who advised ORPC that the company and the agencies should work together on the plan much like they had collaborated on the project's pre- and post-deployment study plans. John indicated that inquiries have come to ORPC from all over the world seeking guidance on how to mirror the Cobscook Bay Tidal Energy Project's (CBTEP's) Adaptive Management Plan process and expressing interest in the environmental findings. He said the work of the Adaptive Management Committee would help create a new generation of environmental literature about marine hydrokinetic projects and that the information will have global impact. John thanked the committee for their interest in continued collaboration and for providing ORPC with good guidance.

2012 Lessons Learned (Herb Scribner)

Herb Scribner described ORPC's lessons learned in 2012 from the CBTEP. He emphasized how important it was to move the project from a planning concept to an actual deployment, and that in terms of data collection, lessons learned and implementing plan adjustments, there was no substitute for actual in-water experience. In order to advance its technology and help increase knowledge about tidal energy projects, ORPC felt it needed to act quickly on resolving any issues and moving forward based on lessons learned. He explained the project's experience with electronics glitches and acoustic interference issues, and noted that ORPC has retrieved and redeployed several times as ORPC resolved operational matters. He emphasized that ORPC viewed its experience as consistent with the purposes of the FERC pilot license. Herb said ORPC has sought to apply lessons learned while remaining consistent with the monitoring methodologies, results and challenges, which are explained in the draft 2012 Environmental Monitoring Report.

2012 Environmental Monitoring Results (Nathan Johnson)

Monitoring methodologies, results and challenges

Nathan Johnson of ORPC explained ORPC's monitoring methodologies and provided an overview of the monitoring results and challenges.

- *Acoustic*
  ORPC implemented acoustic monitoring to determine source levels and isopleths ranges during Phase I pile driving activities in March and April 2013. This was accomplished using the same Drifting Noise Measurement System (DNMS) that was used for pre-deployment surveys and met the requirements of an Incidental Harassment Authorization (IHA) provided by NOAA. ORPC was able to demonstrate that pile driving activities remained within noise thresholds by developing best management practices. This report was presented as a case study during the Adaptive Management Team Workshop held July 24, 2012. ORPC will be conducting Phase 1 operational monitoring in early April 2013. Nate noted the complexity of scheduling within the confines of the FERC license, which is very time and date specific. While the license state's that ORPC would conduct this monitoring within 6 months of initial deployment, ORPC was not operating at that time frame. ORPC hopes to work with FERC to adopt different licensing language that is more in keeping with the realities of operating a first hydrokinetic project.

- *Jim Beyer of the Maine Department of Environmental Protection (MDEP) recommended revising proposed Phase I acoustic monitoring date in Report (page 17 of 81) from "late February or early March 2013" to "early April 2013" based on most recent schedule.*

- *Benthic and Biofouling*

  Nate explained how ORPC installed the transmission and data cable using a shear plow, including stapling (bent rebar) sections of the cable where sufficient penetration was not achieved. He explained the methodology for conducting the benthic survey of the cable. ORPC and the benthic consultant, MER Associates (Chris Heinig) are evaluating improvements to data collection. The as-built location differs from the plan location because of areas of hard bottom and the realities of working with large equipment in deep water. While the two locations are proximate when mapped, divers are challenged in following the exact line of the cable because of the current speed and low light conditions. Nonetheless, results reported by MER indicate minimal benthic disturbance observed from exposed cable and that the use of staples has restricted cable movement. The buried sections of the cable are stationary and not expected to cause impacts. Nate said a second survey was conducted in February and ORPC only recently received the consultant's report. This will be provided as a supplemental report but is not expected to change the original analysis.

  Nate also explained that biofouling had been minimal. The bottom support frame is at a depth that minimizes phototropic activity. Some growth occurred on the generator in the fall of 2012 and was removed by power washing during on-shore maintenance. ORPC will continue to monitor the potential for biofouling, including an experimental test patch of anti-fouling coating applied to the generator. ORPC will also collect samples of marine growth prior to pressure washing in during future TGU removals.

- *Fisheries and Marine Life Interaction*

  Nate introduced Gayle Zydlewski from the University of Maine. Gayle discussed the methods results and challenges of the fisheries and marine life interaction studies. Nate discussed the issues with current meters and acoustic interference with the Simrad and ORPC's plan to modify operations through free-wheeling to collect pertinent interaction data.

- *Jeff Murphy of NOAA/NMFS suggested adding the turbine location (depth in water column) to the University of Maine's relative fish density figure (Slide 19/Figure 20 in Report).*
- *Regarding Slide 21/Figure 23 in Report, target strength distribution. Gayle Z clarified that -50 dB target strength corresponds to herring, alewife, or larger mackerel. Gayle also suggested that decreasing target strength threshold to -50 dB may improve some of the clutter on the far side of the turbine; however returns from smaller fish would be lost.*
- *For Slide 22/Figure 25 in Report, distribution of horizontal direction of fish movement, Steve Shepard of the U.S. Fish and Wildlife Service asked if there were any indications of fish attraction to the device . Gayle Gayle responded that it is too early to conclude. Herb also asked if this figure could be separated by fish size.*

- *Regarding Slide 23. Jeff Murphy inquired if turbine rpm's is the same if free-wheeling vs. generating. (Subsequent conversations with ORPC's Engineering team indicate that rpm's during free-wheeling are approximately 50% higher (60 rpm peak) than when generating (40 rpm peak). However, these numbers do not differ from ORPC's estimated operations rpm of 40 to 60 rpm peak.)*
- *Gayle Z mentioned research proposed in collaboration with Argonne National Laboratory to collect more detailed information on fish distribution around the turbine. This is currently proposed for 2013.*

- *Hydraulic*

  The hydraulic plan is comprised of 2 major components; hydraulics (near and far-field) and sediment transport. Sandia National Laboratories generated a hydraulic model of Cobscook Bay that has contributed to the assessment of far field effects of five TidGen™ devices. For scour monitoring, ORPC has marked the pilings securing the bottom support frame to be able to document changes at the seabed. Results to date indicate minimal change in seabed elevation around the foundation piles, except where the bottom support frame skirt was embedded upon deployment. For current measurements ORPC will deploy Acoustic Doppler Current Profilers (ADCPs) at multiple locations in 2013. In addition, the Northwest National Marine Renewable Energy Center (NNMREC) has proposed conducting wake measurements at the project in September, 2013.

- *Marine Mammals*
  ORPC developed a marine mammal observation program with guidance from Dr. Moira Brown of the New England Aquarium. She prepared and led an observer training program that resulted in more than 20 people, including local community residents and ORPC employees, being trained in marine mammal sightings, identification and recording. ORPC has used dedicated observers during pile driving activities and when the TGU has been deployed and retrieved. Nate referenced the IHA report that is part of the appendix of the draft 2012 Annual Environmental Report. Results to date indicate no changes to marine mammal presence in the area of thee project and no evidence of strike.

- *Sea and Shorebirds*
  The sea and shorebird monitoring program utilizes the services of Peter Vickery of the Center for Ecological Research, Chris Bartlett of the UMaine Sea Grant program and local volunteers. Nate reported that results show that the winter 2011/2012 surveys show the same general number of seabirds as the two previous winters and that preliminary results for 2012/2013 mirror previous results.

Recommended Monitoring Modifications (Nathan Johnson)
ORPC described recommended modifications to monitoring based on results to date and lessons learned. We will be concurrently working with FERC's D2SI office to modify our Inspection and Maintenance Plan. ORPC discussed a Supplemental Information Document that will be provided to the Team (submitted on March 13, 2013) that includes further clarification on recommended license modifications. ORPC's will revise the Recommended License Modification Table in the Final Report to

FERC to include the Supplemental Information Document as well as any feedback from the Adaptive Management Team.

- *Several members of the team asked for more time to review the Supplemental Information Document but an overall extension of the April 1 deadline to FERC did not appear warranted. Comments are anticipated by close of business on Tuesday, March 19, 2013.*
- *Benthic Plan. ORPC indicated that due to the installation schedule, the benthic survey planned for July 2012 (following the first growing season after the deployment of a single TidGen™) is now scheduled for July 2013.*
- *The question of seasonality was raised in relation to the benthic surveys of the cable route. The group felt that quarterly inspections would appropriate to indicate any changes related to seasonality.*
- *Sean McDermott inquired if Michelle Magliocca, NOAA NMFS, was aware of the recommended modifications to marine mammal observations since she was not in attendance. Michelle was included in the distribution of the Draft Report and subsequent conversations occurred after the AMT Meeting to ensure these recommendations were conveyed.*

Maine Tidal Energy Project Update (Glen Marquis)

Glen Marquis provided an overview of the overall Maine Tidal Energy Project, of which the CBTEP is part. The CBTEP will include Phase I and Phase 2 activities and then ORPC will be seeking to expand capacity through licensing of the Western Passage Tidal Energy Project. Glen explained that the Maine Tidal Energy Project was the first tidal project connected to the grid under a FERC pilot license and the first in the country to have a long-term (20-year) power purchase agreement. A growing supply chain has been formed to provide services. He said that this year ORPC will focus on operations and environmental monitoring for the Cobscook Bay Phase 1, and designing engineering improvements, which would be incorporated into Phase 2. The company's projected schedule is to deploy a second but improved TidGen™ TGU in the spring of 2014. For the company's third deployment later that year, ORPC is proposing an OcGen™ TGU. This would represent the next evolution of ORPC's technology development and provide time for the company to properly work with a single unit before deploying stacked devices in Western Passage. ORPC is responding to both investor guidance and input from the national laboratories encouraging ORPC to accelerate its efforts to engineer the OcGen™ and obtain in-water operation experience. This is seen as critical for successful, future commercialization and for also facilitating a successful Western Passage project. ORPC is having on-going consultations about deploying OcGen™ in Cobscook Bay with FERC (regarding potential license modifications) and DOE (regarding DOE funding and program management). ORPC will engage the Adaptive Management Team in further consultation on the OcGen™ in Cobscook Bay when engineering design is more substantial. ORPC anticipates deployment in Western Passage to begin in 2015. ORPC will need an extension to its existing Western Passage preliminary permit for the area and has begun consultation with FERC about this process. Herb Scribner noted that it will be important for ORPC to receive the concurrence of the resource agencies (who also comprise CBTEP's Adaptive Management Team) in support of ORPC's schedule change for Western Passage. ORPC continues to advance its pre-deployment activities in Western Passage, with plans this spring for continued resource assessment, and environmental monitoring related to marine mammals and seabirds.

Reporting and Public Dissemination of Results (Nathan Johnson)

Nate Johnson conveyed that the Final 2012 Environmental Monitoring Report will be made available on ORPC's website. Members of the AMT provided feedback regarding additional and alternative methods of public dissemination.

- *The group discussed ORPC developing a brief summary of 2012 environmental monitoring results for public distribution. In addition, full copies of the Final Report will be made available to the communities of Eastport and Lubec.*
- *Maine DEP and USF&W requested paper copies of the final report.*
- *Meghan Massaua suggested that the Final Report also be available on the Tethys website.*
- *ORPC encouraged members of the Adaptive Management Team to visit the Project site in Eastport and Lubec.*

Action Items and Assignments (Nathan Johnson)

- *ORPC will distribute Supplemental Information Document to the Adaptive Management Team (submitted on March 13, 2013)*
- *ORPC will distribute draft meeting minutes for review*

Appendix C

Underwater noise measurements of a proposed tidal generator site in Cobscook Bay using a drifting noise measurement buoy, including ambient noise and estimates of tidal generator noise impact,
Scientific Solutions Inc., July 2011

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Underwater noise measurements of a proposed tidal generator site in Cobscook Bay using a drifting noise measurement buoy, including ambient noise and estimates of tidal generator noise impact

Cobscook Bay, Maine

July 17, 2011 – July 21, 2011

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Executive Summary

The goals of the work conducted were to

a) Demonstrate successful measurement of underwater noise in a high-current environment using a drifting noise measurement (DNM) buoy.

b) Establish the ambient noise levels in the deployment area for the ORPC TidGen™ units in Cobscook Bay prior to installation of the proposed hydrokinetic system, and

c) Estimate the noise impact of the TidGen™ units to be deployed by measuring the noise impact of the ORPC Beta unit and extrapolating the results to the TidGen™ deployment. By using the actual noise levels of the ORPC Beta system, a prediction of the acoustic impacts of the proposed FERC Cobscook Bay Tidal Energy pilot project can be included in the BA (biological assessment) of the ORPC application.

Ambient noise measurements, and radiated noise measurements of the ORPC turbine generator unit (TGU) beta version deployed off a barge in Cobscook Bay, were made at the location of the proposed TidGen™ at several tidal stages. The measurements were made using a drifting noise measurement buoy consisting of two suspended hydrophones, GPS, data acquisition system, and power system all contained in a stable spar buoy.

The buoy with its associated hydrophones was released well upstream of the barge by a support boat. The support boat engine was then turned off after release so as not to contaminate the measurement. The buoy was allowed to autonomously drift by the barge with the turbine deployed and then recovered downstream of the barge.

This was repeated for a variety of conditions including different current speeds, different operating conditions of the surface electrical gear, and with and without the barge present. This method was deemed the best way to overcome the noise contamination issues with a fixed measurement system in very strong currents. The quality of the data set indicates this measurement method was very successful.

Ambient Noise

Figure 1 shows the ambient spectral levels measured during one of the lowest current periods along with spectral levels measured close to the operating TGU during one of the highest current (and turbine rotational) periods. Ambient noise levels are equivalent to a sea state 1 condition and were measured a large distance from the barge when the TGU is effectively not rotating (0.2 RPM or less). This is essentially the slack tide condition and represents some of the lowest ambient levels measured. The peak increase in noise when as close as 68 m from the TGU is approximately 35 dB (at 105Hz), although the difference across the spectrum is generally less than 20 dB.

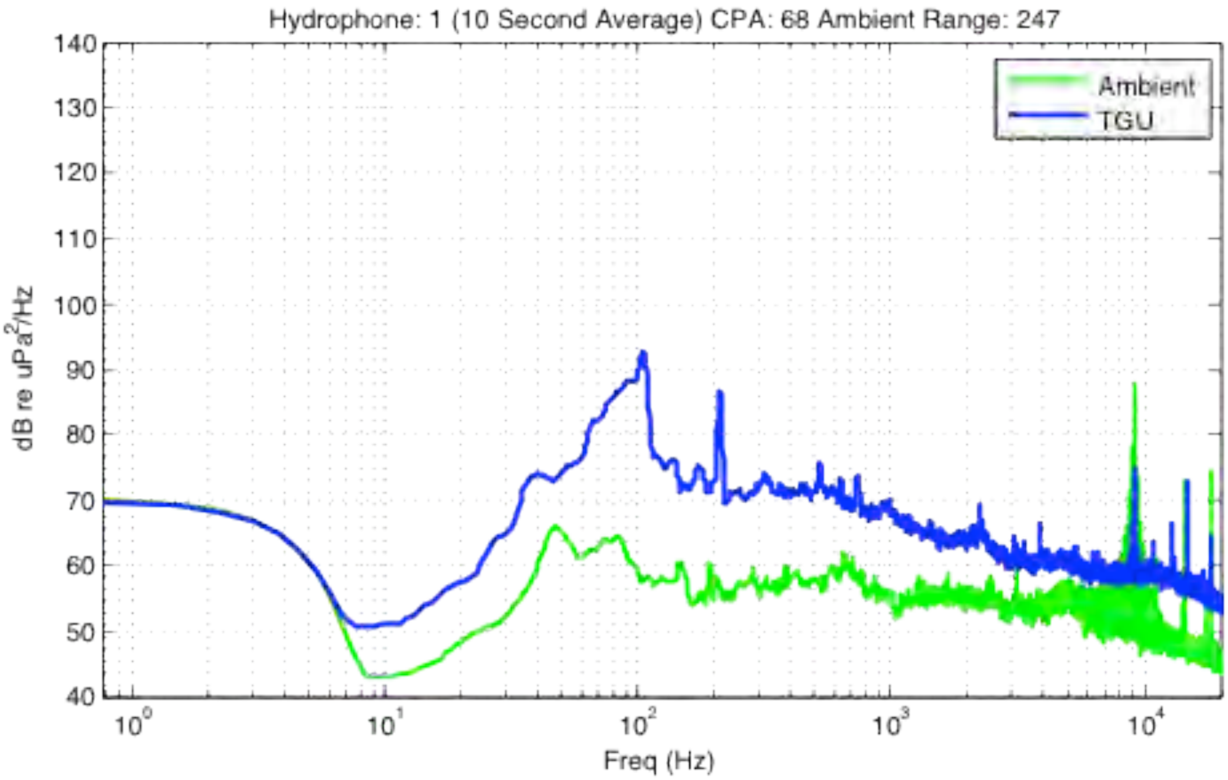

Figure 1: Ambient noise levels vs. TGU noise levels at 22.4RPM. Ambient noise levels are measured approximately 250m from the location of the barge/TGU while the TGU is nearly stationary (0.2RPM) and the tides are essentially slack. TGU noise levels are measured 68m from the barge. Some of the broadband noise increase is likely due to the increase in ambient noise with current speed. The tonals above 8 kHz are measurement system related. The tonals below 8 kHz are the TGU and can be heard in a playback of the data recording.

Turbine Generator Radiated Noise

At the closest points of approach during the drifts, which are as low as 10 m from the barge, measured radiated noise levels are less than 100 dB re µPa^2/Hz with most of the energy in a 50 Hz band around 200 Hz. Approximate RMS levels are less than 112 dB re µPa^2 at 68m from the TGU. By roughly 200-500 m from the barge the noise from the turbine itself is undetectable above the ambient levels.

Table 1 presents the TGU noise levels 68m from the barge, as well as ambient levels across a variety of current conditions, as third-octave band levels. From this data it is clear that broadband ambient noise levels can change significantly with current conditions. Under similar current conditions (*e.g.*, 2.9 knots), the difference in noise levels between ambient conditions and the TGU radiated noise is generally less than 15 dB at 68 m.

The planned TidGen™ deployment consists of 5 generators with each generator powered by 2 turbines. Each turbine is the same size as the beta unit. Thus one can conservatively assume there will be 10 times the number of turbines as in the beta unit contributing to the noise. If we assume the measured noise results for 1 turbine and wish to extrapolate to a proposed TidGen™ installation that is the equivalent of 10 of the beta units, one can assume that the combined noise would sum incoherently, or increase by 10log10 dB, or 10 dB. This gives a maximum predicted RMS noise level of 122 dB re µPa^2 at ranges up to about 68 m from the installation. These levels are only measured very close to the TGU (ranges less than 100 m) and are essentially at or well below the threshold for a level B harassment. Thus an incidental harassment authorization is not deemed necessary.

		dB re µPa^2/Hz						
		Ambient						TGU
Current (Knots)		1.5	2.2	2.9	3.3	3.0	1.1	2.9
Third Octave Band (Hz)	80	54.8	58.3	64.6	76.9	66.7	65.3	65.5
	100	59.5	64.7	69.7	81.5	72.0	67.7	71.7
	125	64.7	69.2	77.4	82.9	75.4	76.7	78.7
	160	70.4	81.2	80.6	85.2	78.3	86.0	85.2
	200	70.0	76.8	80.4	87.8	80.7	89.6	85.3
	250	72.2	81.5	80.9	87.1	85.7	94.3	95.0
	315	70.8	85.4	90.1	96.2	85.9	94.3	102.5
	400	70.1	85.6	91.0	91.8	87.2	98.7	104.8
	500	71.4	83.2	90.9	91.6	91.5	101.8	94.6
	630	72.7	84.8	98.6	97.8	88.5	95.4	92.6
	800	77.1	83.8	89.1	95.3	88.7	95.9	98.0
	1000	76.1	85.0	91.3	96.5	80.6	98.9	93.1
	1250	76.8	87.6	89.2	92.4	81.6	104.9	92.8

Table 1: Ambient noise measurements in varying current conditions versus typical TGU measurement. These results show that at most the TGU increases the noise levels by 15 dB and only very close to the TGU (ranges under 100 m).

A single accelerometer located on the barge showed a similar spectral pattern as the radiated noise data. It is clear that longer-term monitoring can be accomplished with accelerometers attached to the TidGen™ unit. Once installed, taking a baseline measurement with the DNM buoy, and then monitoring with the accelerometers to measure any increases will be adequate to determine that the noise has not increased, along with alerting the operators as to any mechanical faults.

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1 Overview

This document provides the ambient noise levels measured in Cobscook Bay at different stages of the tidal cycle, a measurement of radiated noise levels from the ORPC beta unit deployed off the Energy Tide 2 barge, and an estimate of the noise impact of the proposed TidGen™ installation in Cobscook Bay. These measurements were made using a Drifting Noise Measurement (DNM) buoy that was used to mitigate the difficulties of making a quality noise measurement in a high current region. Subsequent sections of this document will briefly describe the testing procedure (additional measurement details provided in Appendix 3), provide analysis of ambient noise levels, describe the measured noise of the ORPC ET2 TGU, and discuss the extrapolation to the planned TidGen™ deployment and the noise mitigation plan following deployment.

The results presented in this report were gathered using the Drift Noise Measurement buoy developed for ORPC by SSI. The buoy drifted within in the current flow thereby effectively removing any induced flow noise or biases into the ambient noise measurements. Through a combination of sensitive receive electronics and accurate GPS tracking of the DNM Buoy, a successful series of noise measurements were made with and without the TGU that identified its contribution to the overall acoustic noise structure found in this region.

		dB re $\mu Pa^2/Hz$						
		Ambient						TGU
Current (Knots)		1.5	2.2	2.9	3.3	3.0	1.1	2.9
Third Octave Band (Hz)	80	54.8	58.3	64.6	76.9	66.7	65.3	65.5
	100	59.5	64.7	69.7	81.5	72.0	67.7	71.7
	125	64.7	69.2	77.4	82.9	75.4	76.7	78.7
	160	70.4	81.2	80.6	85.2	78.3	86.0	85.2
	200	70.0	76.8	80.4	87.8	80.7	89.6	85.3
	250	72.2	81.5	80.9	87.1	85.7	94.3	95.0
	315	70.8	85.4	90.1	96.2	85.9	94.3	102.5
	400	70.1	85.6	91.0	91.8	87.2	98.7	104.8
	500	71.4	83.2	90.9	91.6	91.5	101.8	94.6
	630	72.7	84.8	98.6	97.8	88.5	95.4	92.6
	800	77.1	83.8	89.1	95.3	88.7	95.9	98.0
	1000	76.1	85.0	91.3	96.5	80.6	98.9	93.1
	1250	76.8	87.6	89.2	92.4	81.6	104.9	92.8

Table 2: Ambient noise measurements in varying current conditions versus typical TGU measurement. These results show that at most the TGU increases the noise levels by 15 dB and only very close to the TGU (ranges under 100 m).

To provide a sense of the relative magnitude of the ambient noise under varying current conditions and TGU radiated noise under operational conditions, Table 2 shows the third-octave band levels in key bands where the TGU was identified to measurably alter the noise level. Although in general there is a trend towards higher ambient noise levels as the current increases, there is significant variability in the noise levels relative to current changes. Comparing ambient noise levels to TGU noise levels under similar current conditions (see 2.9 knots in Table 2) rather than ambient levels during slack tide shows the difference in noise levels is generally less than 15 dB (at 68 m) in the bands where an increase in noise was measured.

2 Measurement Procedure

The procedure for noise level testing was completed in two stages. The first stage was to conduct a series of drift measurements that started several hundred meters upstream of the barge where the DNM buoy entered the water from a drifting vessel. Deploying from a moving vessel placed the buoy in the same inertial frame of reference as the surrounding water allowing for a safe install of the hardware with minimal stress on the components. Once released, the buoy drifted free of the vessel with a 100m polypropylene recovery line following behind but introducing no drag to the buoy.

In the second stage, a baseline environment noise level measurement with the TGU positioned out of the water and the barge removed from the site was performed. During these trials the same drift measurements were conducted where the buoy drifted nominally along the same paths as with the TGU positioned in the water in normal operating conditions.

All trials used a small boat with an outboard engine and the DNM buoy hardware described in Appendix 3. In addition to the buoy's GPS tracking system, the onboard battery powered hardware consisted of dual low noise amplifiers and a two coincident hydrophones. Damage in shipping affected the overall sensitivity of one hydrophone such that its results were suspect and is not provided in this report. The remaining hydrophone's performance was verified on-site and in the laboratory following the experiment.

3 Results

The length of each data set varies based on the duration required for the buoy to traverse the measurement area. The buoy's relative range from the barge is used to guide the data processing window and generally set at ±200m relative to the buoy's closest point of approach (CPA) to the barge.

The data for a given trial is presented in up to three forms:

- Spectrograms (*e.g.,* Figure 4) show the complete spectral analysis. Spectral level is shown as a function of elapsed transit time and frequency.
- A spectral splice at the CPA (*e.g.,* Figure 5) is taken from the spectrogram to provide additional detail of spectral level at the CPA for that trial.
- The buoy position relative to the barge to provide a perspective on the buoy's drift pattern from deployment to recovery.

A summary of each trial with annotations specific to each run is available in Appendix 1. All trial results including spectral content and buoy drift patterns are presented in Appendix 2. Note that all tones above approximately 8 kHz are an artifact of the data acquisition hardware in the buoy and are not real noise data.

3.1 Ambient Noise Results

The ambient noise that this study acquired was measured during a relatively quiet period where there was no significant commercial or pleasure vessel activity. Sea conditions were generally benign with wave heights less than 1ft. Wind speeds did not generate significant white caps whose constant breaking would add bubble collapse structures to the water column and increase the minimum background noise ambient artificially. The ambient noise background was not further contaminated weather such as rail or hail, but instead was taken during relatively calm conditions and should be considered as a good baseline for the region.

The original objective of the ambient noise measurements involved making measurements in the same area as the barge/TGU after the barge had been removed from the site. Although data was collected after the barge was removed, the data collection appears to have coincided with the operation of a pump system at a nearby fish farm.

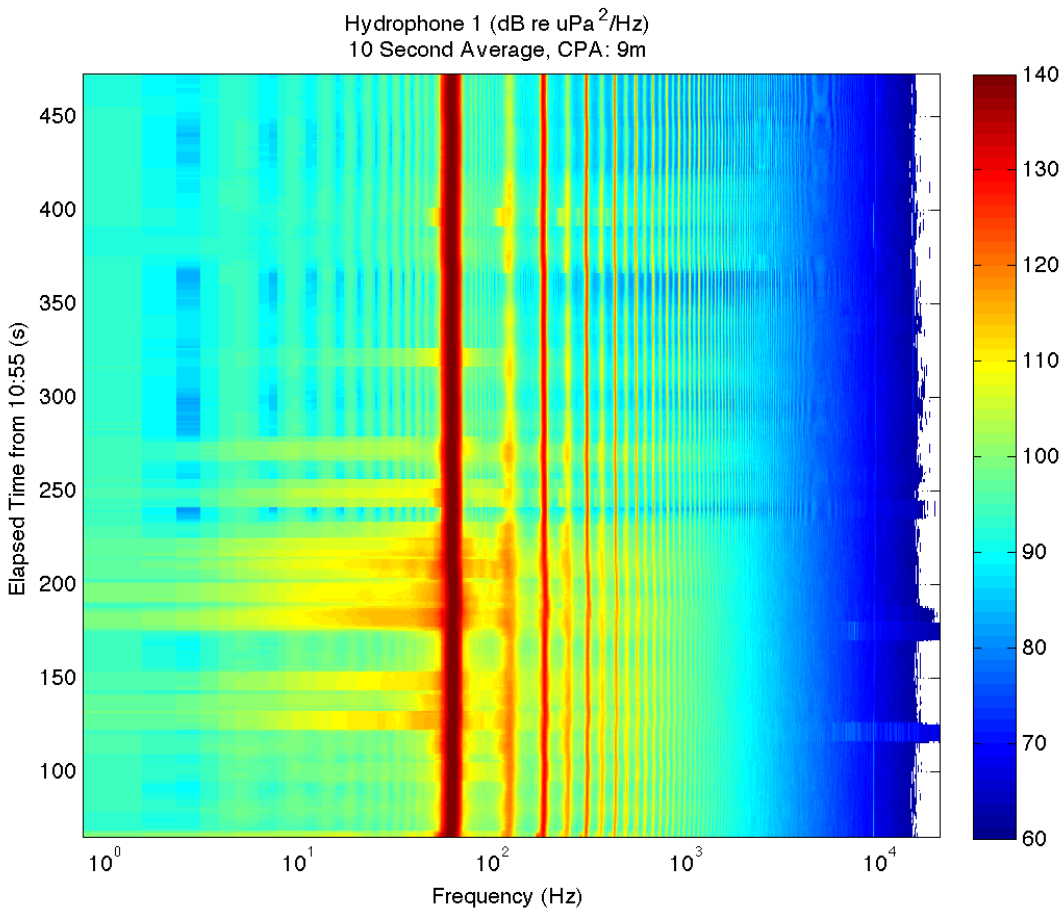

Figure 2: Spectrogram of noise measurements with the barge/TGU removed. During this time the pump system for a nearby (< 2km) fish far was audibly active. The primary tone is at 60Hz with obervable harmonics (data from trial 9).

Observations of higher broadband noise levels as well as a primary tone at 60Hz with associated harmonics in the data coincide with audible indications of the pump operation noted during data collection. Figure 2 is a spectrogram of the ambient noise with the barge removed during operation of the fish farm system. The primary tone at 60Hz and resulting harmonics are quite prominent and can also be seen in the slice shown in Figure 3.

Due to the contamination of the ambient noise measurements with the barge removed as seen in Figure 3, ambient noise levels were based on data taken 250 meters or greater from the barge (see Table 2). We note that when listening to the data, the TGU was not heard when more than 200 m from the barge. In addition, the primary ambient noise level considered (previously shown in Figure 1) were taken when the TGU was effectively stationary (operating in minimal current 0.2 RPM or less), currents were the lowest in the data set (< 1.5 knots), and the sea state conditions were as quite as possible.

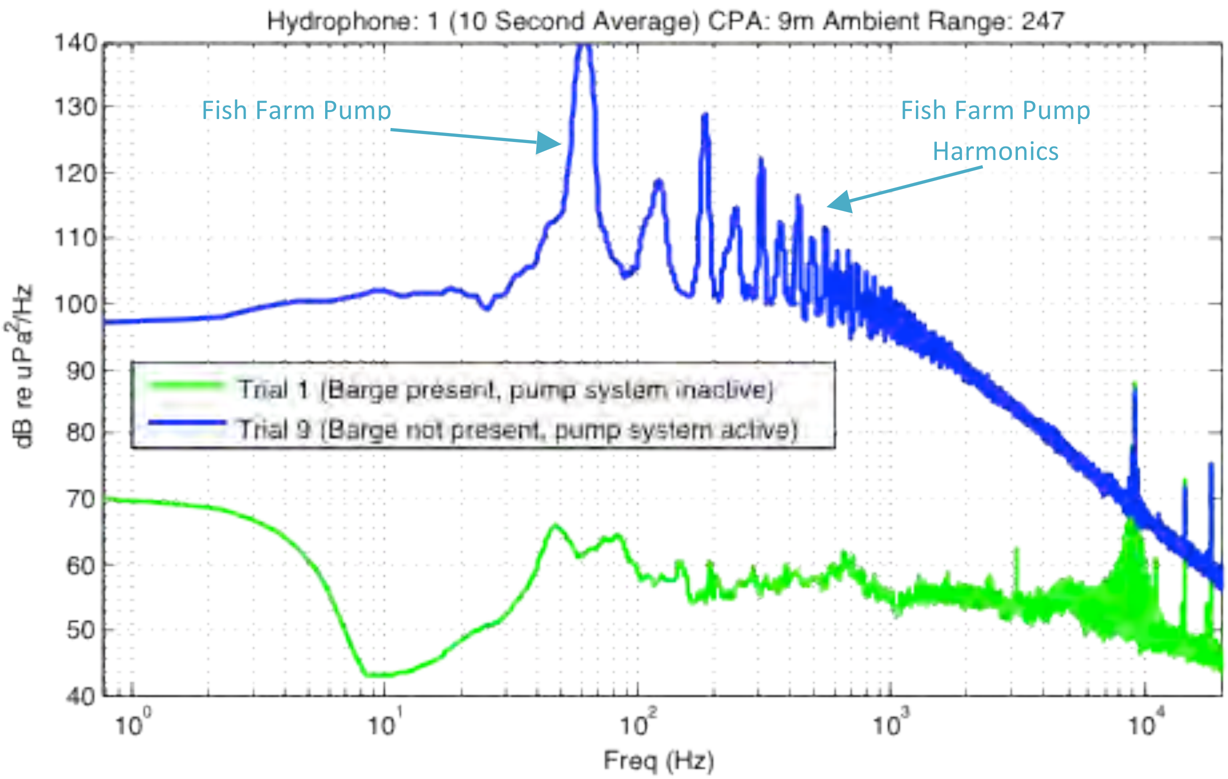

Figure 3: Slice of the spectrogram in **Figure 2** (blue) with the barge/TGU absent when the buoy was closest to the location of the barge/TGU before it was removed. The green line shows the ambient noise level measured 250m from the barge with the barge/TGU in place, but nearly stationary (0.2 RPM).

As seen in Table 2, there is significant variation in the ambient noise levels based on current speed and likely other conditions. As such there is no single spectrum level function that defines the ambient noise level. The ambient spectrum shown in Figure 1 and used as a baseline to determine the radiated noise the TGU represents some of the lowest levels seen across the trials.

3.2 Turbine Generator Radiated Noise

The TGU noise levels defined here are based on the levels in a ten second window when the measurement buoy is closest to the TGU/barge. The spectrograms in this section and in Appendix 2 confirm that the highest levels of tones due to the TGU occur during this window.

All of the trials contain features that are the result of a number of factors, such as the fish farm pump system discussed earlier. Additional factors include the load bank/inverters on the barge that are not a part of the actual TGU, depth sounders on the buoy deployment boat, deployment boat noise, and intermittent surrounding boat traffic. These factors can be significant when evaluating the spectrograms and spectral level splices in Appendix 2. In this section those features will be highlighted as a part of identifying the noise attributed to the TGU.

Figure 4 shows the spectrogram of the TGU operating at nominally its highest revolutions per minute (RPM) for this series of tests (trial 4, 22.4 RPM). As can be seen more clearly in the spectral level slice in Figure 5, there is a rise in the level at 105 Hz and 210 Hz at the CPA with a maximum level of 92.5 dB re $\mu Pa^2/Hz$ at 105 Hz.

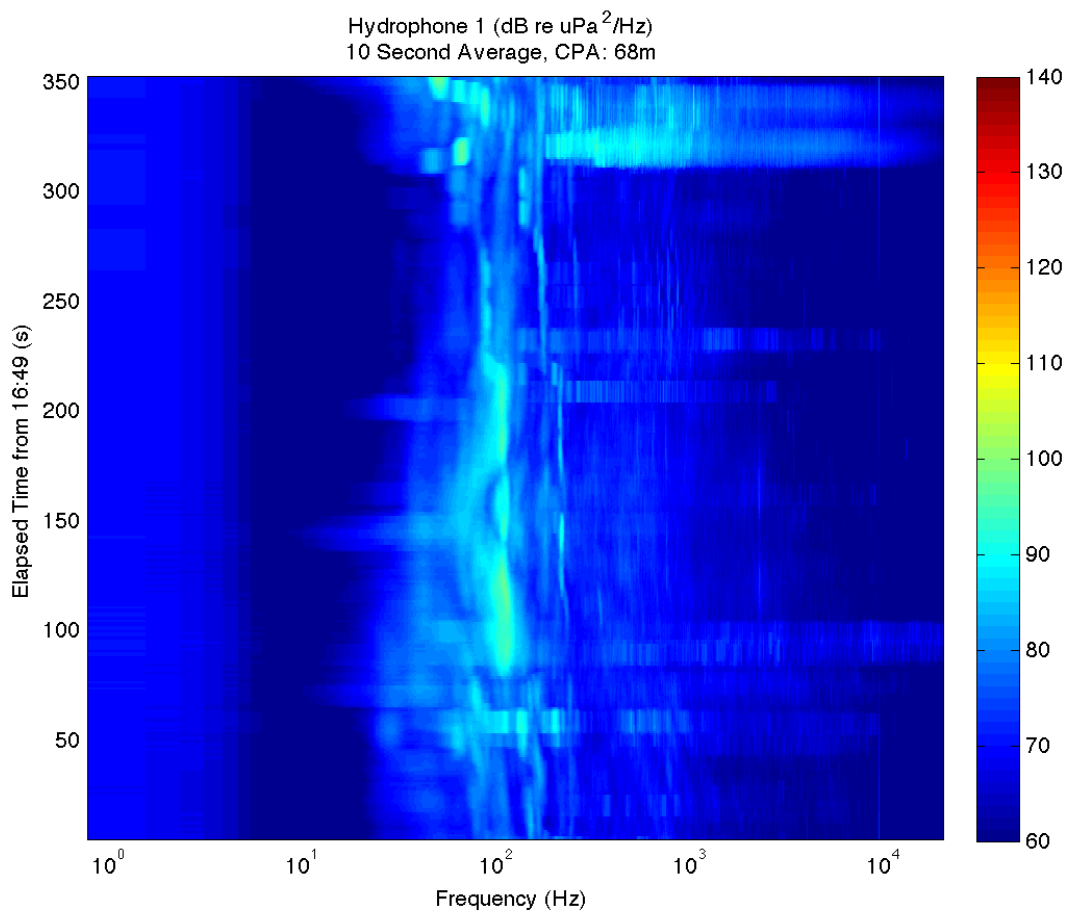

Figure 4: Spectrogram of trial 4.

Figure 6 is a spectrogram of the TGU operating at near its highest RPM for this series of tests (trial 5, 21.9 RPM) with the load. Although there is some light boat activity in the distance, the TGU related noise is clearly seen in the region of 100 Hz. The tone at 1050 Hz and associated harmonics are believed to be due to the barge's load banks/inverters. A comparison of data taken where the load banks were turned off vs. on, and where they were turned on during a run would appear to indicate that they are the source of the tone.

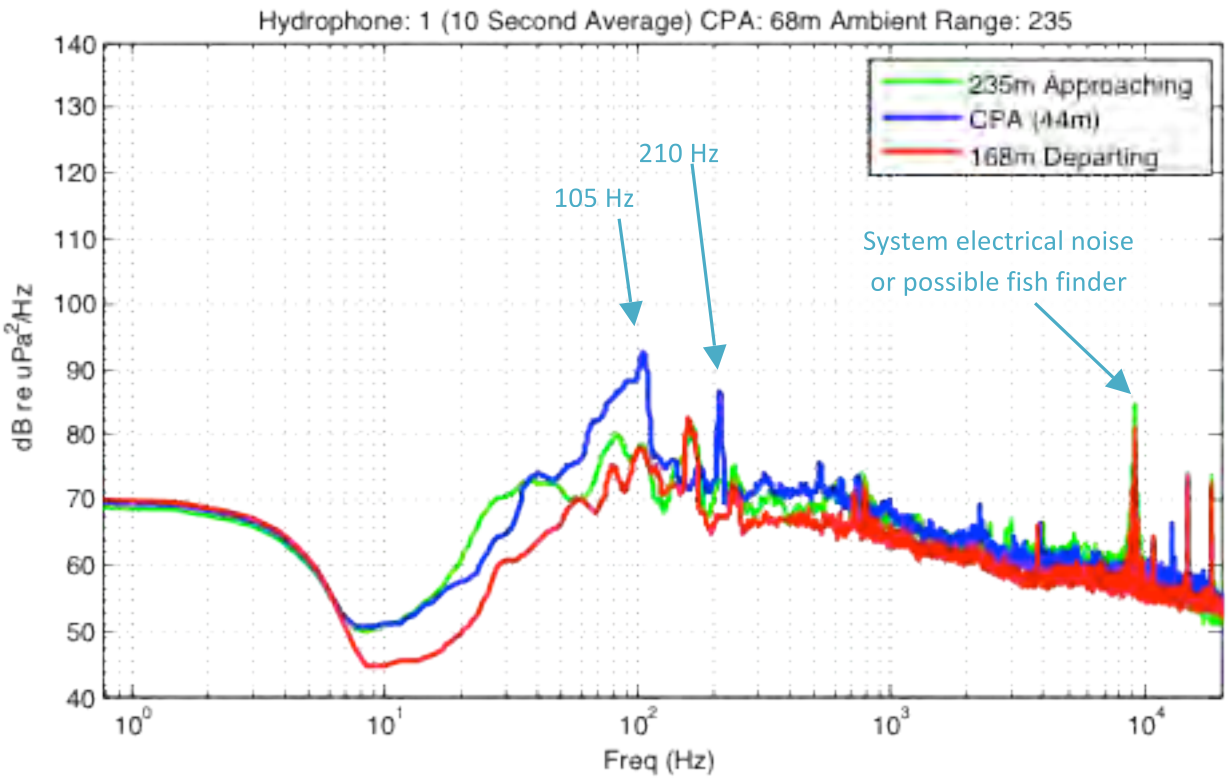

Figure 5: Spectral time slices for trial 4. The three slices show the power levels as the buoy is approaching the TGU at 235m (green), at the CPA (blue), and as the buoy is drifting away from the TGU at 168 m (red). At the CPA there are peaks at 105 Hz and 210 Hz. The peak at 160 Hz in both the approaching and departing data (approaching obscured by departing) is not present at the CPA.

Figure 7 shows the spectral level at the CPA, with the maximum spectral level nominally 90 dB re $\mu Pa^2/Hz$. As the load banks are part of the barge support system and not part of the TGU itself, it should be recognized that they would not be a contributing noise source to the final TidGen™ deployment[1]. The tone at 85 Hz is similar to the tone seen from the fish farm pump system at 60 Hz in Figure 3.

[1] However, even the level generated by the load banks has a peak level of ~110 dB re $\mu Pa^2/Hz$ and below the 120 dB re $\mu Pa^2/Hz$ marine harassment level.

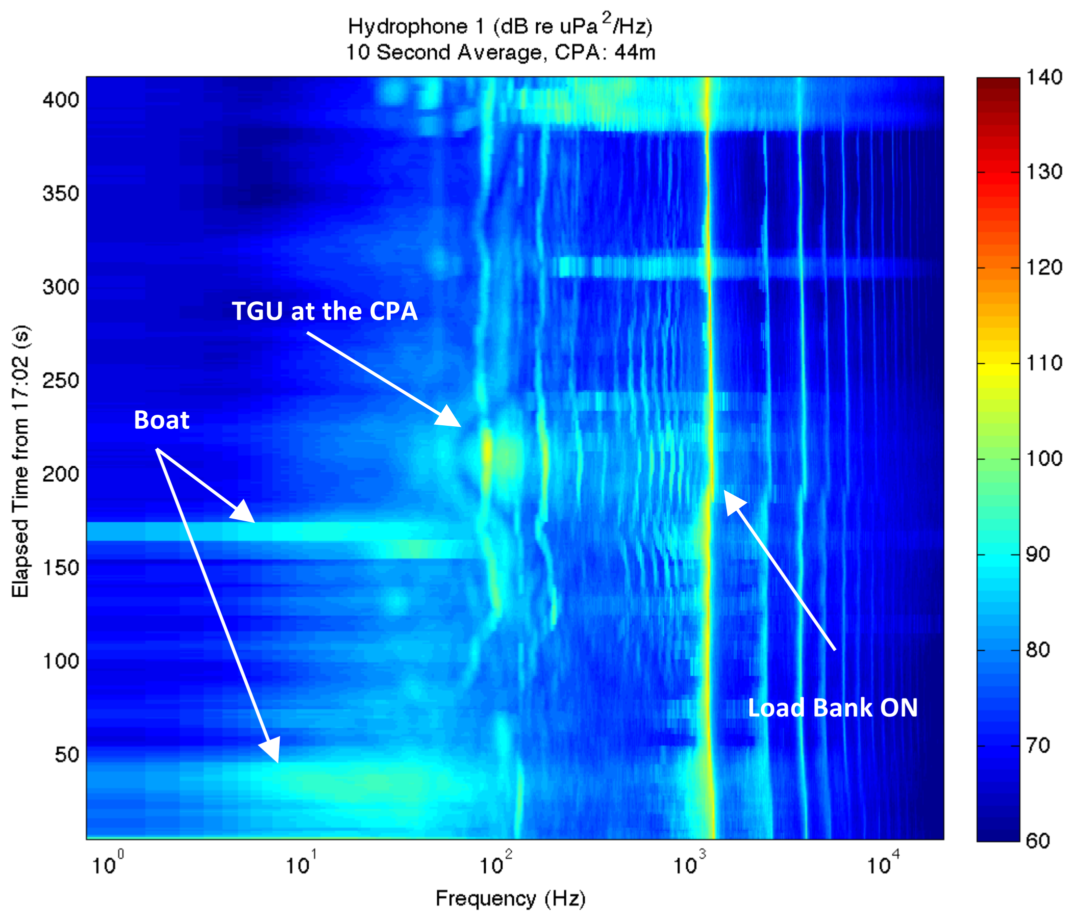

Figure 6: Spectrogram of trial 5. In addition to TGU noise the load bank and associated harmonics and intermittent use of the boat are visible.

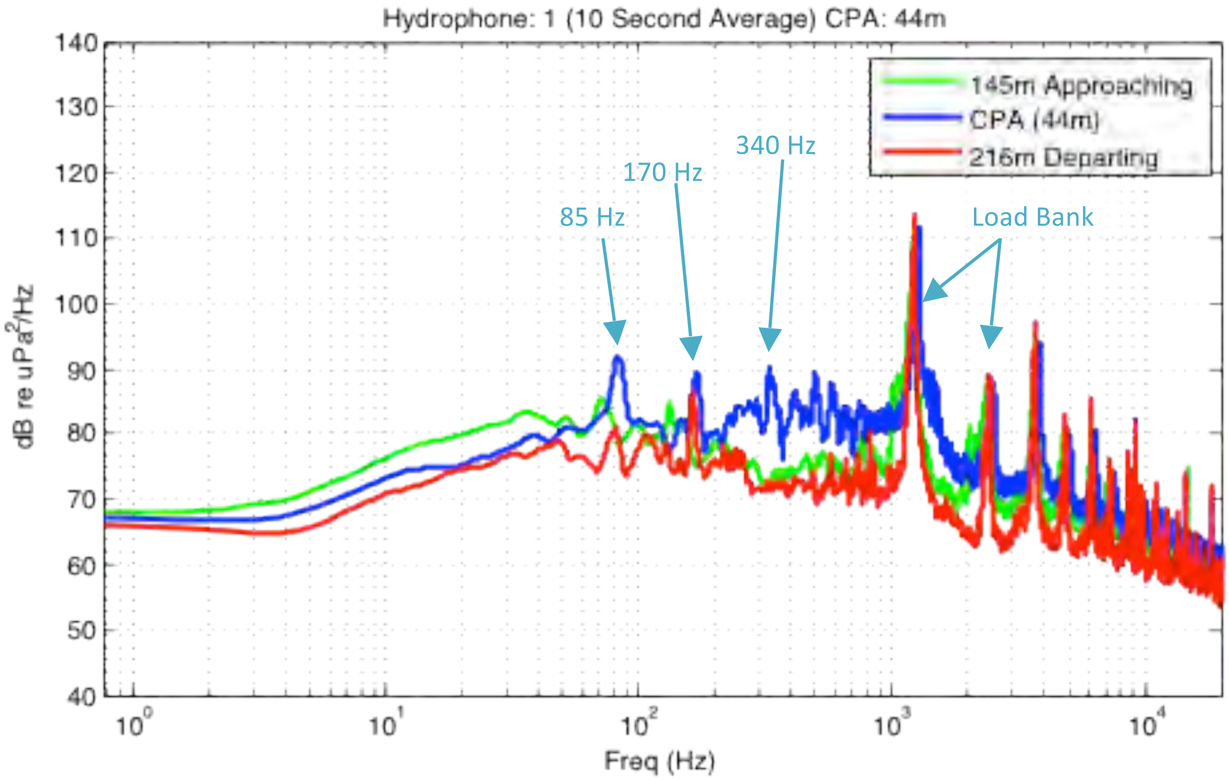

Figure 7: Spectral time slices for trial 5. The three slices show the power levels as the buoy is approaching the TGU at 154 m (green), at the CPA (blue), and as the buoy is drifting away from the TGU at 216 m (red). There is a clear increase in the tone at 85 Hz (~90 dB re $\mu Pa^2/Hz$) with accompanying harmonics, as well as a broadband increase between 200 Hz and 500 Hz.

Figure 8 shows spectral time slices for trial 3. Similar to the data with the fish pump system active, there is a response at approximately 60 Hz, however the level is much lower. This may be attributable to the bilge pump on the barge. Although trial 3 does include increased levels around 105 Hz and 210 HZ, similar to trial 4 (Figure 9), the response is somewhat different. There are also peaks between around 150 Hz not seen in trial 4 at the CPA, however a similar peak existed around 155 Hz in the approaching and departing spectral content for trial 4.

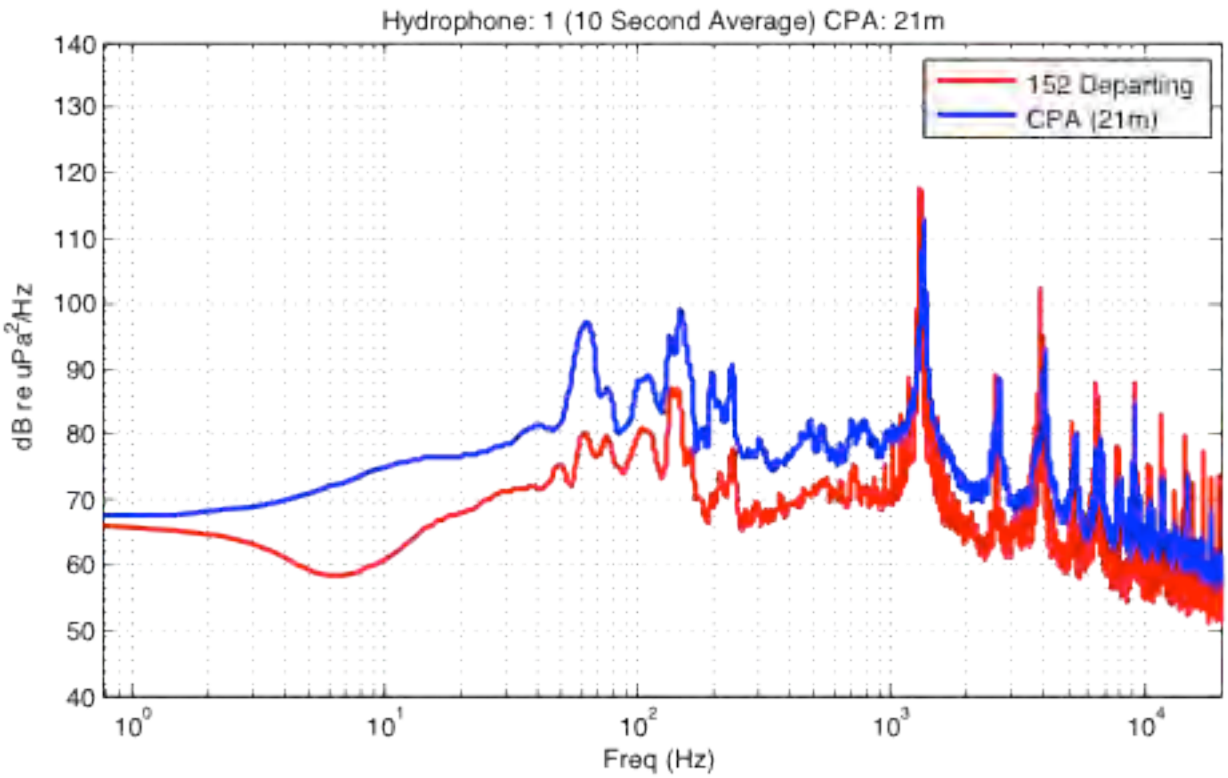

Figure 8: Spectral time slice for trial 3. The two slices show the power levels at the CPA (blue), and as the buoy is drifting away from the TGU at 216 m (red). Boat activity prior to the CPA prevented comparison with approach ambient levels. The strong tones above 1 kHz are due to the load bank inverter being on.

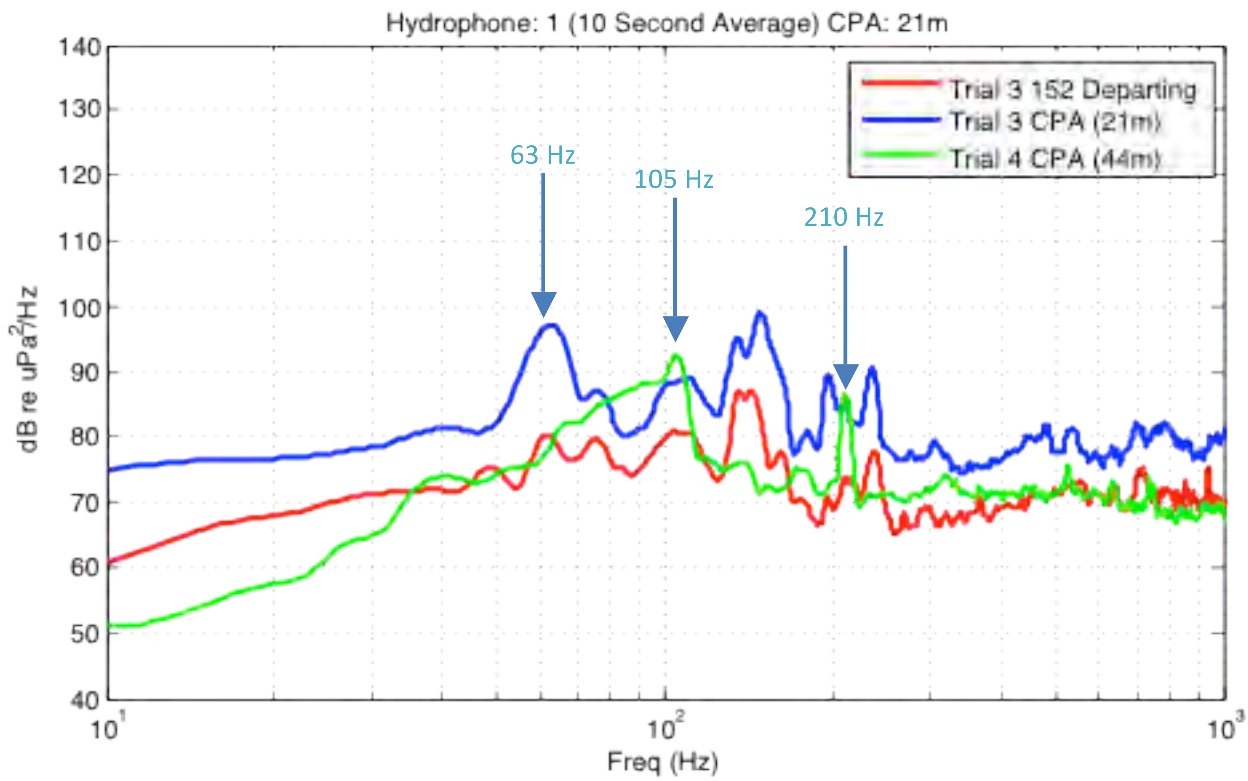

Figure 9: Spectral time slice for trial 3 and trial 4 between 10 Hz and 1000Hz.

4 Conclusions

The results from this noise measurement test confirm that the TGU does produce a noise signature that is above the background ambient noise, but only at ranges less than roughly 100 m to the unit. Although there is some variation in the noise signature across trials, any signature that is present is consistently below 100 dB re μPa^2/Hz and more typically below 90 dB re μPa^2/Hz. Therefore up to the maximum current velocity/TGU rotational speed measured, the spectral noise level is well below what is considered to be a harassment level to local marine life.

4.1 Full Deployment Radiated Noise

From this measurement of from a single TGU it is possible to extrapolate this to multiple TGUs. As they will all operate independently, their generated noise will add incoherently in the water such that the addition of N TGUs will increase the spectral levels presented here by a factor equal to 10Log(N).

The planned TidGen^{TM} deployment consists of 5 generators with each generator powered by 2 turbines. Each turbine is the same size as the beta unit. Thus one can conservatively assume there will be 10 times the number of turbines as in the beta unit. Thus for 5 TGUs, the expected increase in noise level will be 10dB, or a maximum radiated noise level of 110dB re μPa^2/Hz, or 122dB re μPa^2/Hz based on RMS levels.

4.2 Mitigation Plan

The measurement described in this document will be repeated following the deployment of the first TidGen™ unit. The measurement will also be repeated following any expansion (additional TGUs) of the installation. In addition, accelerometers located on the TGUs will be monitored for any increase in vibration – an indicator of mechanical failure or other changes that may result in increase noise levels.

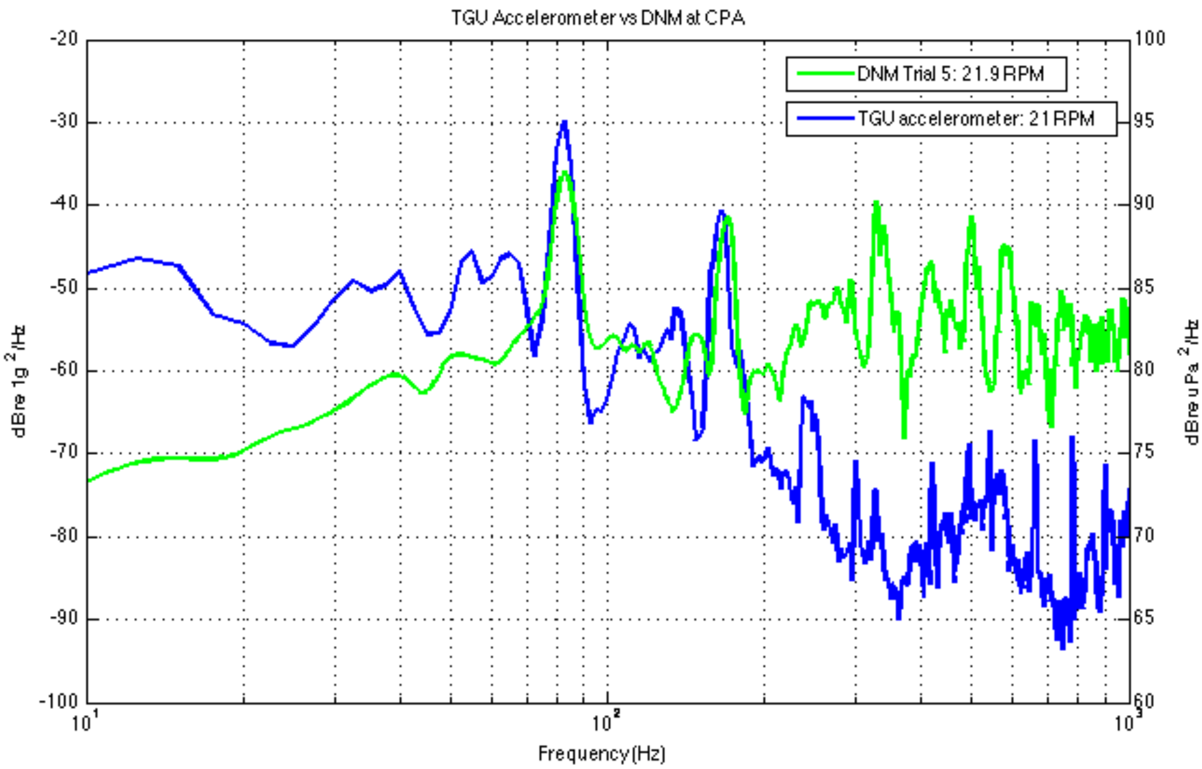

Figure 10: Comparison of data from an accelerometer on the TGU to DNM data (trial 5). In both cases the turbine is rotating at approximately 21-22 RPM.

Figure 10 is a comparison of data from an accelerometer on the TGU to DNM data (trial 5). In both cases the turbine is rotating at approximately 21-22 RPM. Although the prominent signature in this case largely resembles the data seen from the fish farm pump system, it is clear that accelerometers on the TGU and TidGen™ units should allow for the monitoring of changes in the system that may result in changes in the radiated noise level.

5 Appendix 1: Trial Summary

The following tables characterize each of the trials. Trials fall into one of three categories

- Noise measurements with the TGU in the water (afternoon)
- Noise measurements with the TGU in the water (morning)
- Noise measurements with the barge removed from mooring

The following measurement characteristics were constant for all tests

- Hydrophone Sensitivity = 201dB//µPa
- Signal Gain = 60dB
- Per Channel Sampling Rate = 100kHz

5.1 TGU Operational Noise Measurements (Afternoon)

During each of these trials the TGU was in the water and operational in a west to east current flow on July 19, 2011.

Trial	Start Time	Wind (knots)/ Heading (deg)	Water Velocity (knots)	TGU RPM	Notes
1	1548	5.3/154	1.5	0.2	Depth finder turned off, SatCon off, Load Bank initially off but activated ~350 secs into the trial. Drift past TGU starting in front of bow on SB side. Boat approaching at 1555 from East at CPA. Deployment boat turned on from 1556-1557.
2	1615	3.7/191	2.2	17.5	State: Depth finder turned off, SatCon on, Load Bank off. Drift past TGU starting in front of bow on SB side.
3	1633	---	2.7	18.5	State: Depth finder turned on, SatCon on, Load Bank off. Drift past TGU starting in front of bow on SB side. Buoy dragged by boat at ~1635 to avoid hitting barge and produced two CPAs. Boat shutdown at 1636. Very close pass to barge
4	1648	3.6/166	2.9	22.4	State: Depth finder turned off, SatCon on, Load Bank off (but turned on very briefly at 4:51). Drift past TGU starting at barge on

					SB side. Boat active at 1707 for ~20 secs. No boat activity in the area.
5	1702	-----	3.3	21.9	State: Depth finder turned off, SatCon on, Load Bank on. Drift past TGU starting at barge on SB side. No boat activity in the area.

Table 3: TGU Operational Noise Measurements (Afternoon)

- SatCon is the Barge's satellite communication system.
- Load Bank is the barge's battery charging system, which includes an inverter system for producing AC power on the barge.
- CPA = Closest Point of Approach of the DNM buoy relative to the barge position

5.2 TGU Operational Noise Measurements (Morning)

During each of these trials the TGU was in the water and operational in a west to east current flow on July 20, 2011.

Trial	Start Time	Wind (knots)/ Heading (deg)	Water Velocity (knots)	TGU RPM	Notes
6	0828	4.5/283	3.0	17.4	State: Depth finder turned off, SatCon on, Load Bank on.
7	0849	3.7/286	2.3	18.5	State: Depth finder turned off, SatCon on, Load Bank on Drift past TGU starting in front of bow on SB side. Nearby (<2km) salmon farm has a pump system running that is clearly audible at the barge. Deployment boat in idle for the 1st 2 minutes of deployment.
8	0917	2.2/155	1.1	7.3	State: Depth finder turned off, SatCon on, Load Bank on (initially) but secured approximately 2 mins into the drift test. Drift past TGU starting in front of bow on SB side. Deployment boat active at ~0920 for 10 secs. No pump noise heard (audible) from the salmon farm. Boat activity to the east at 0925 as DNM approached CPA. Tug boat approaching at

					end of run

Table 4: TGU Operational Noise Measurements (Afternoon)

5.3 Morning Noise Measurements Following Barge Removal

During each of these trials the barge had been removed from the mooring and transported out of the area. Wind speed and direction measurements were estimated on-site. Current flow was east to west and increasing following slack tide that occurred at approximately 9:30A. Measurements were taken on July 20, 2011.

Trial	Start Time	Wind (knots)/ Heading (deg)	Water Velocity (knots)	TGU RPM	Notes:
9	1056	4/270	----	N/A	Nearby (<2km) salmon farm has a pump system running that is clearly audible at the barge. Water velocity is increasing. Deployment boat active for 2 mins at the start of the run.
10	1111	4/270	-----	N/A	Nearby (<2km) salmon farm has a pump system running that is clearly audible at the barge. No boat activity

Table 5: Morning Noise Measurements Following Barge Removal

6 Appendix 2: Comprehensive Trial Results

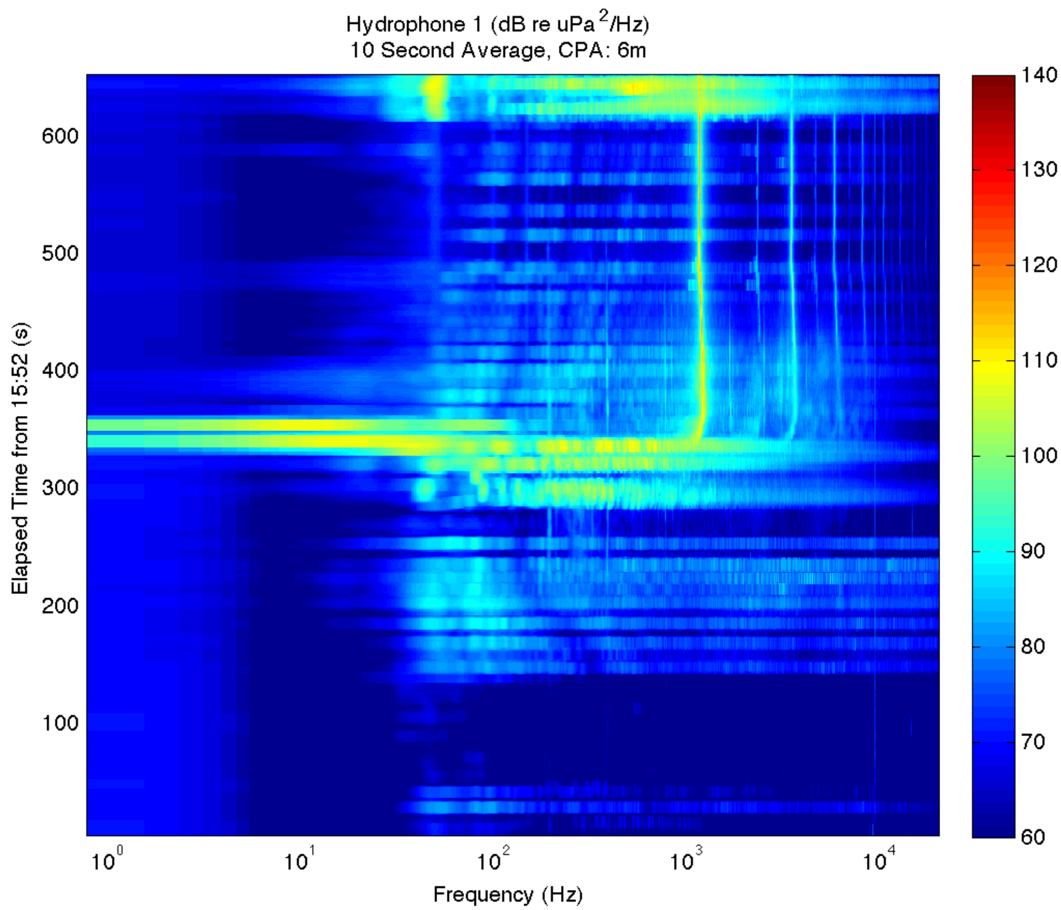

Figure 11: Spectrogram of Trial 1

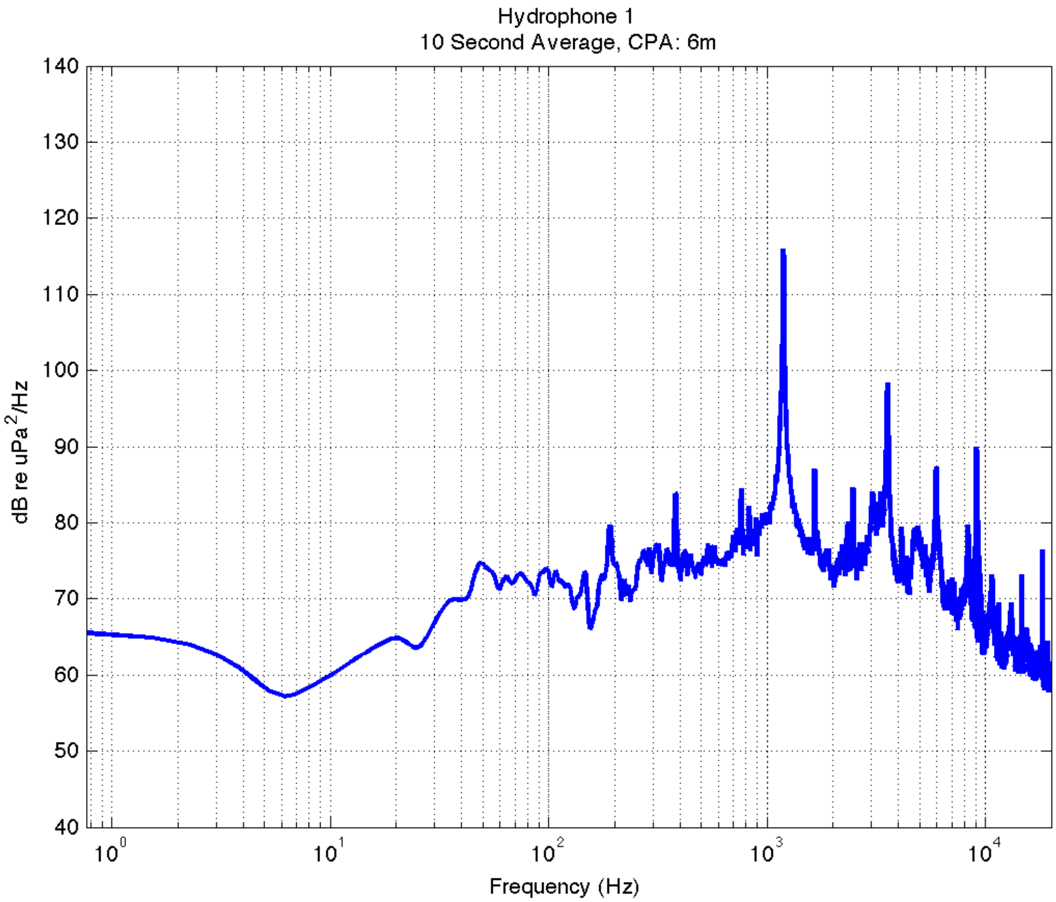

Figure 12: Spectral Time Slice at CPA for Trial 1

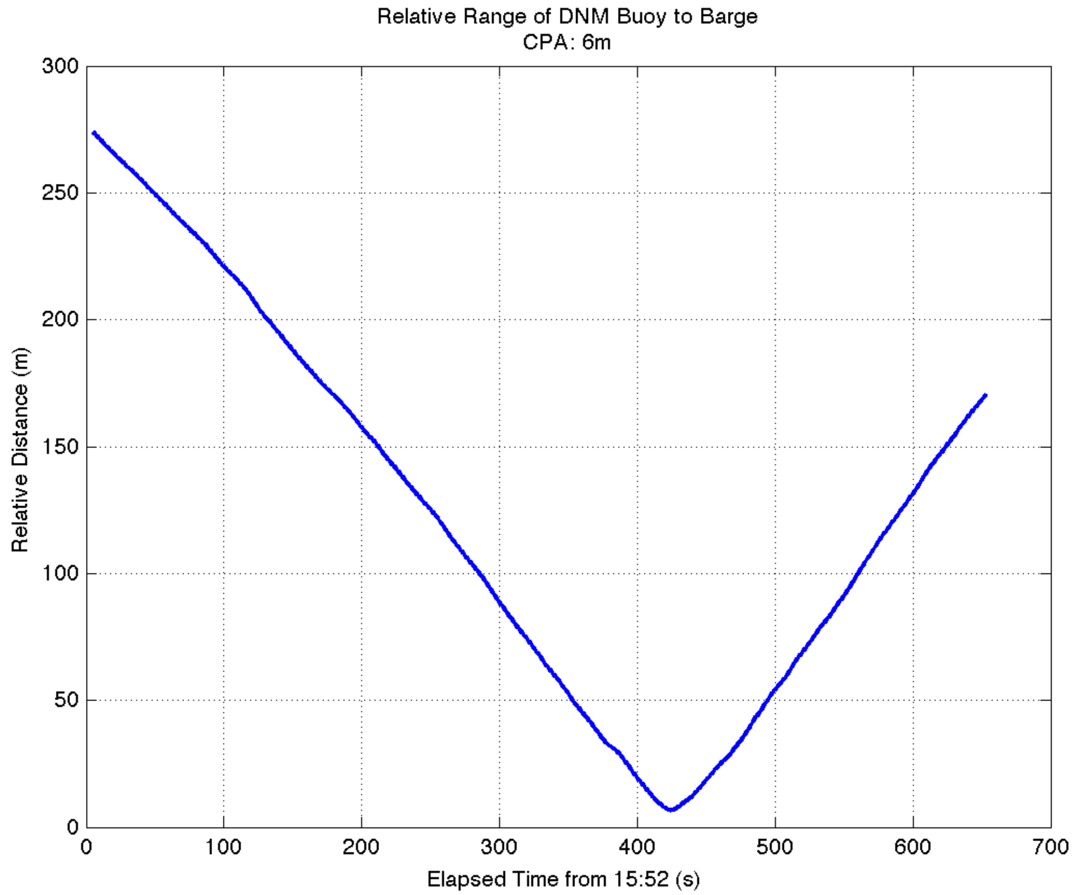

Figure 13: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 1

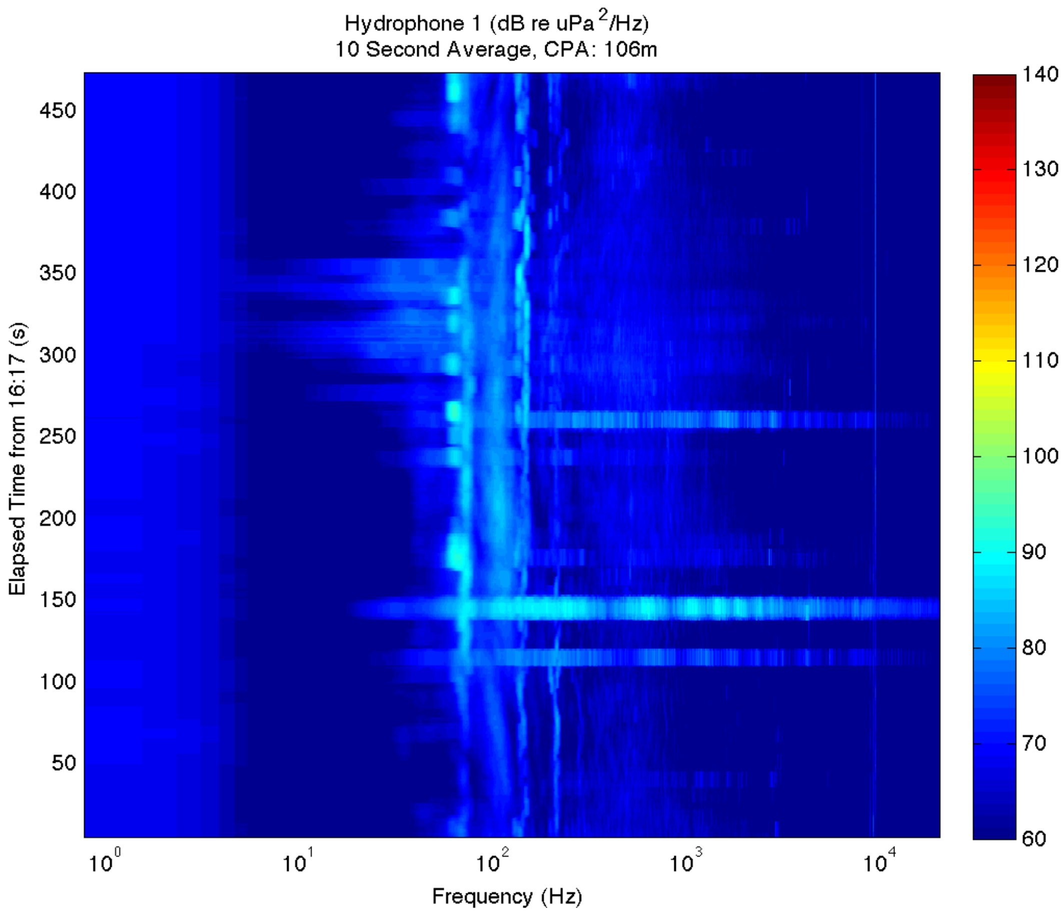

Figure 14: Spectrogram of Trial 2

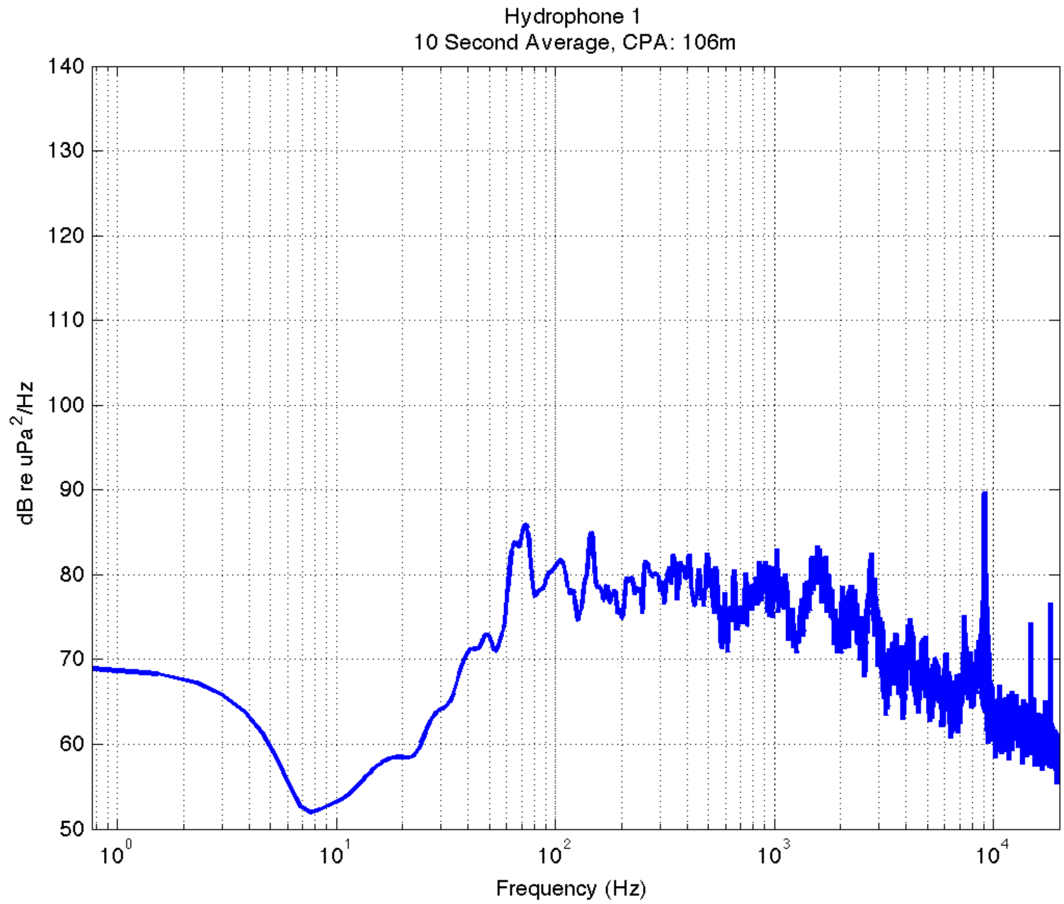

Figure 15: Spectral Time Slice at CPA for Trial 2

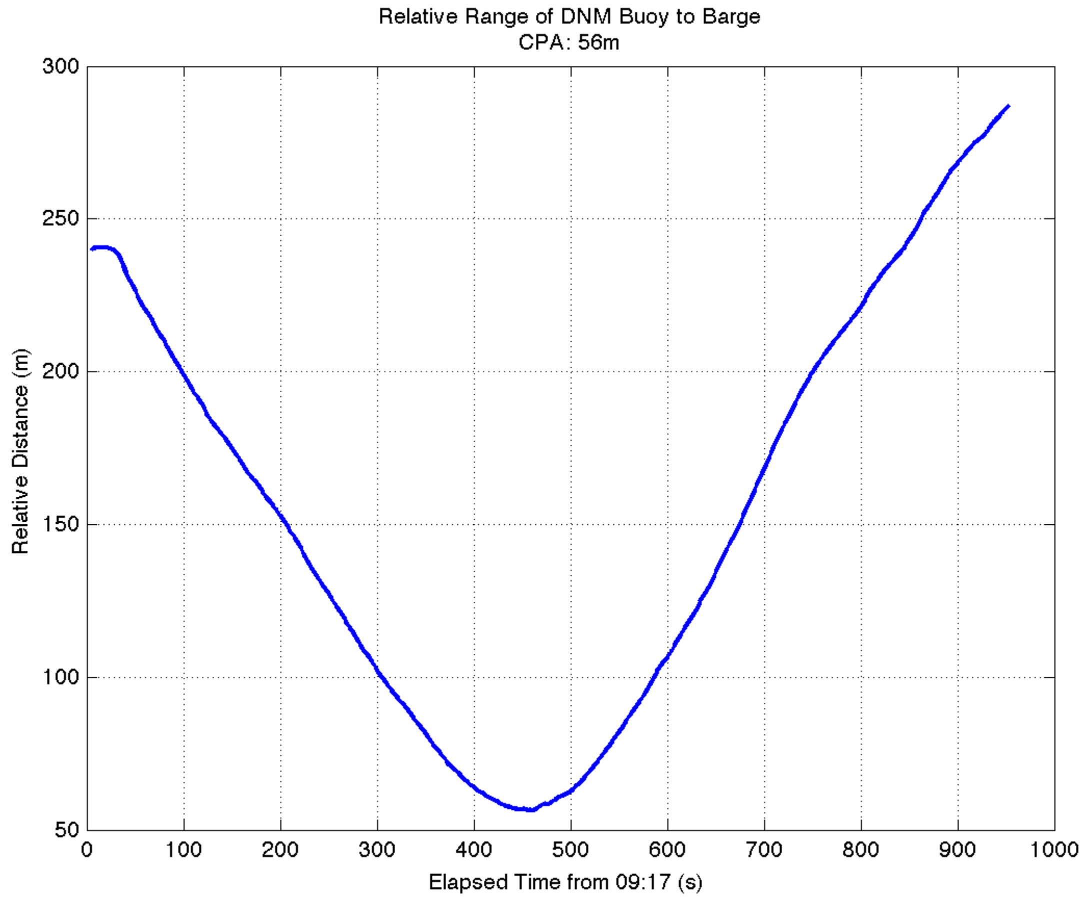

Figure 16: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 2

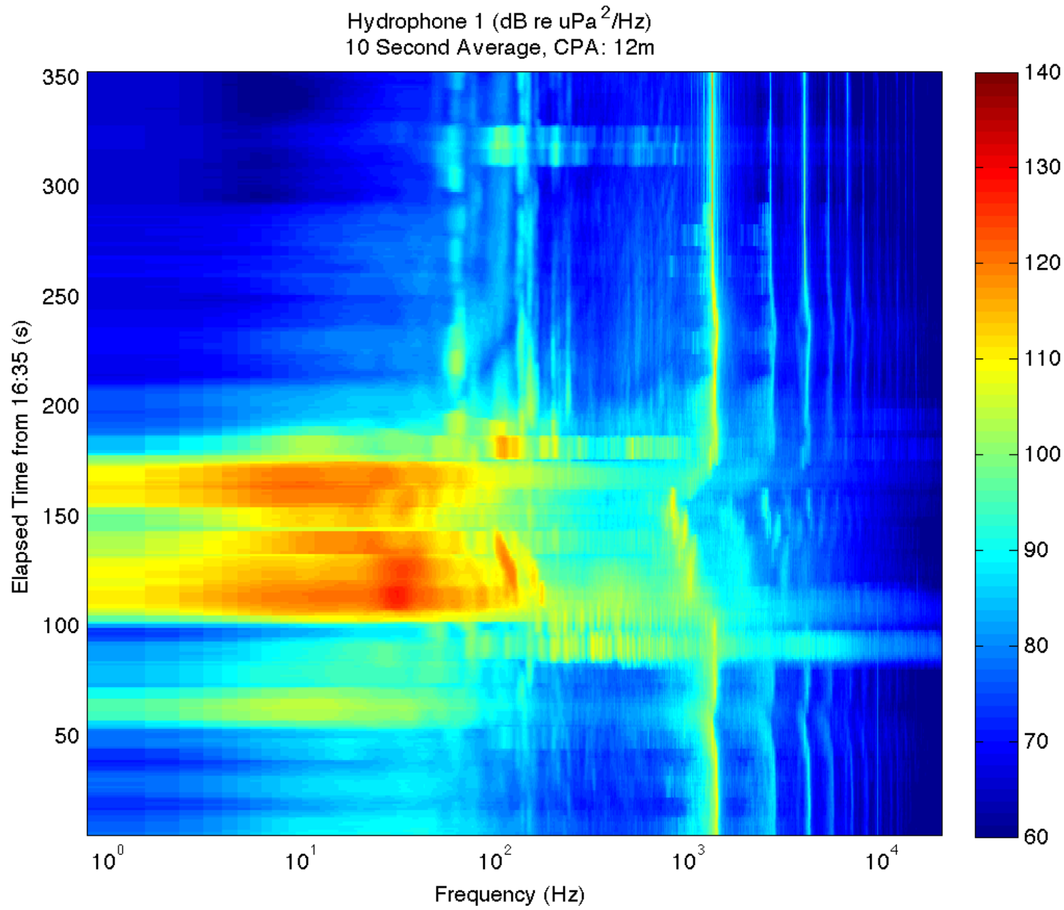

Figure 17: Spectrogram of Trial 3

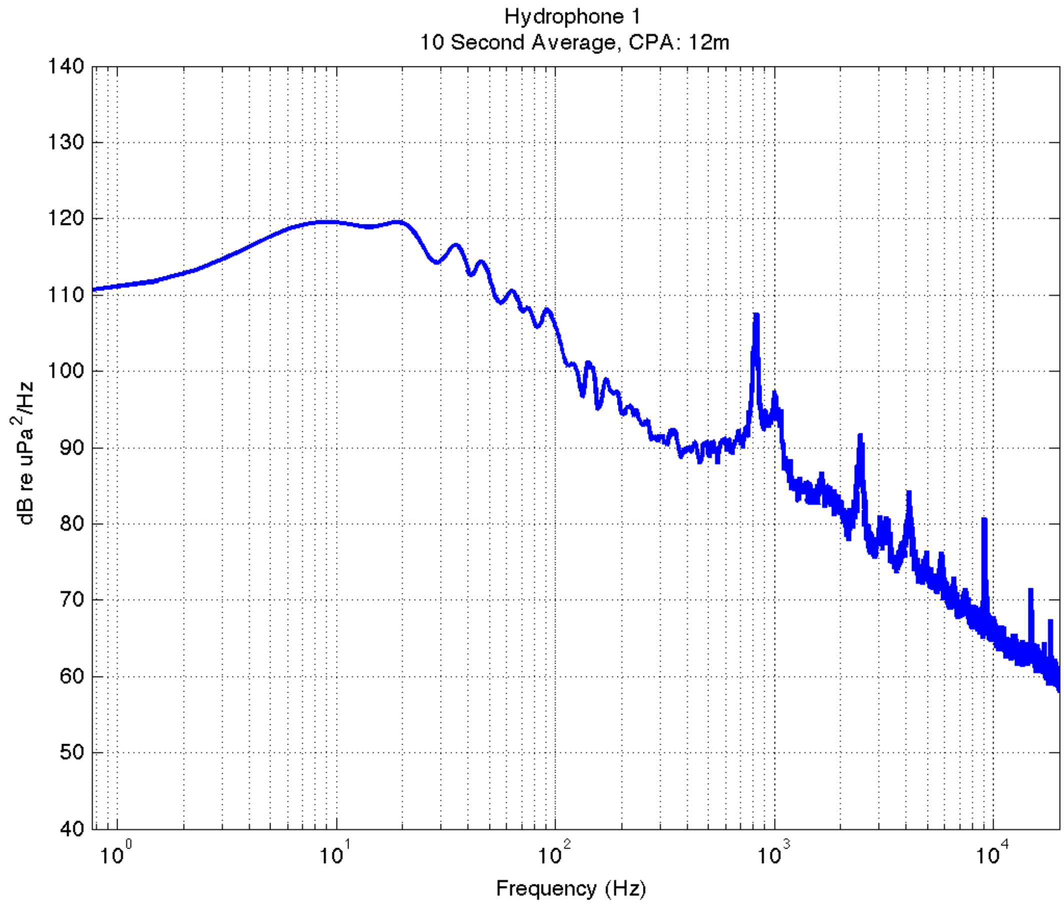

Figure 18: Spectral Time Slice at CPA for Trial 3

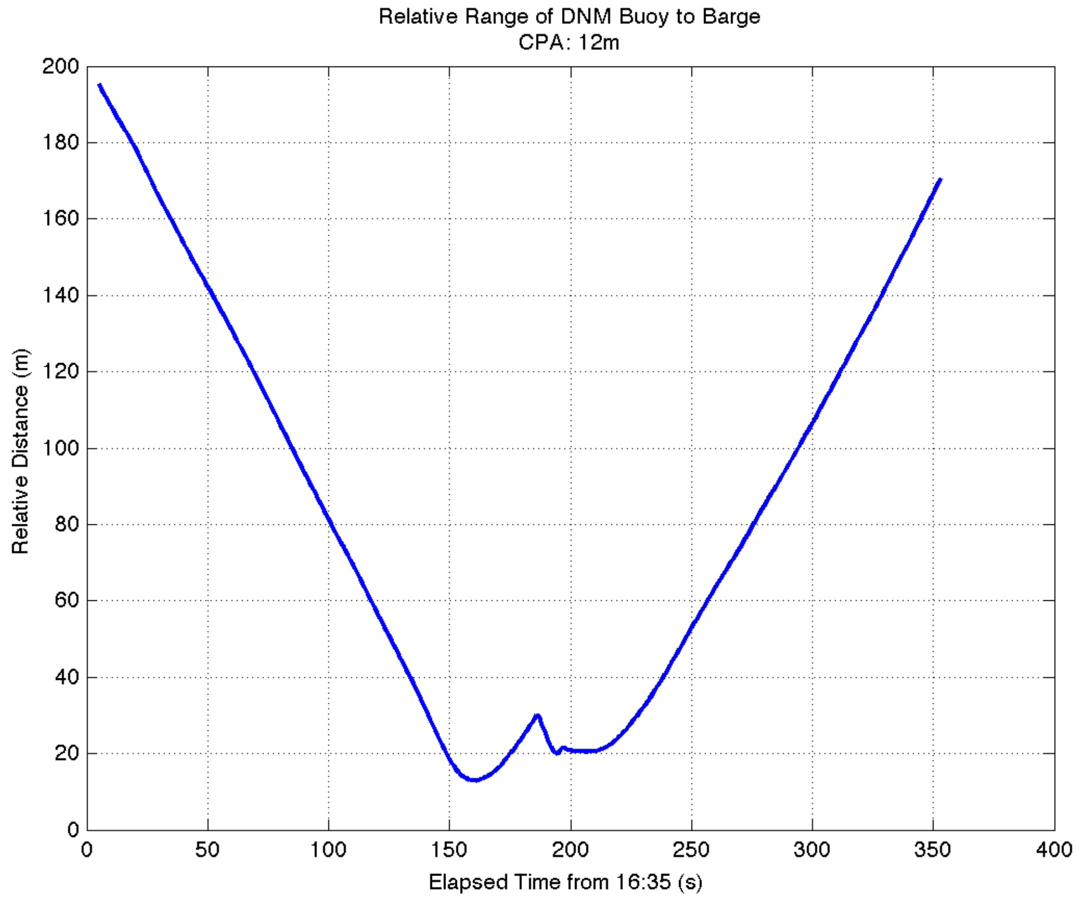

Figure 19: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 3

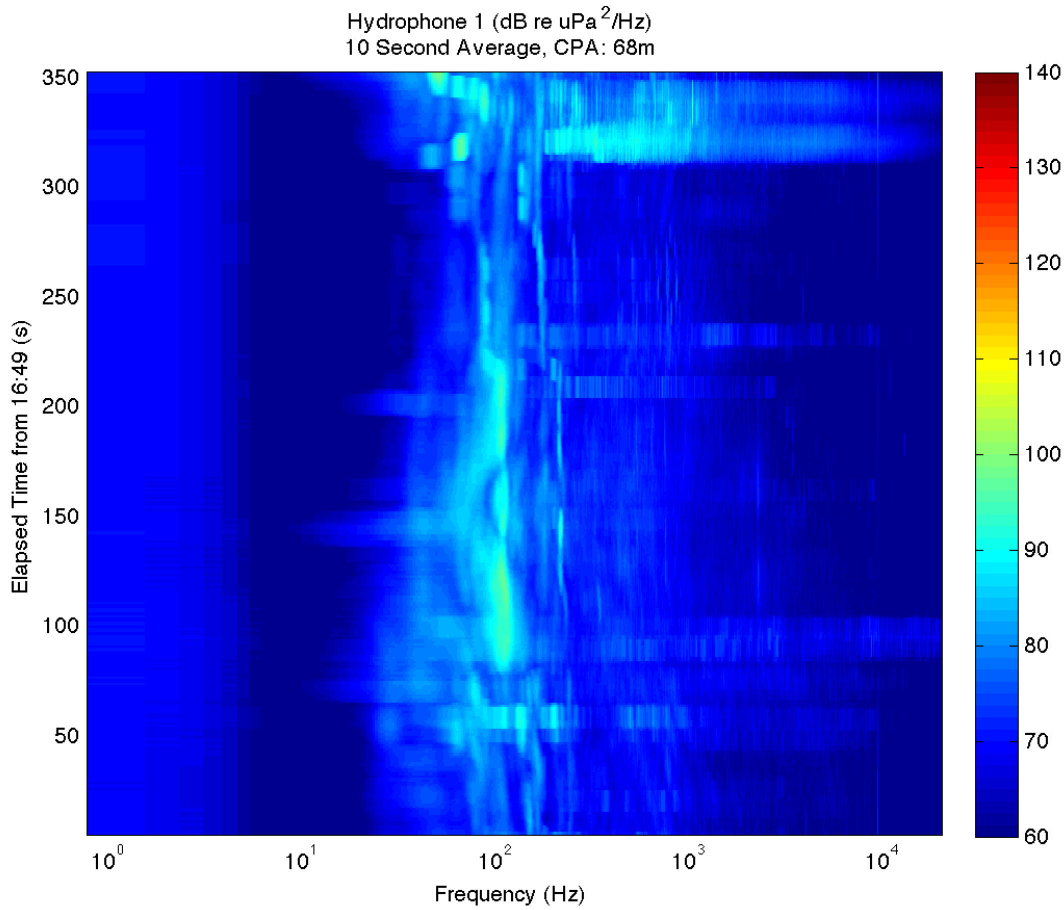

Figure 20: Spectrogram of Trial 4

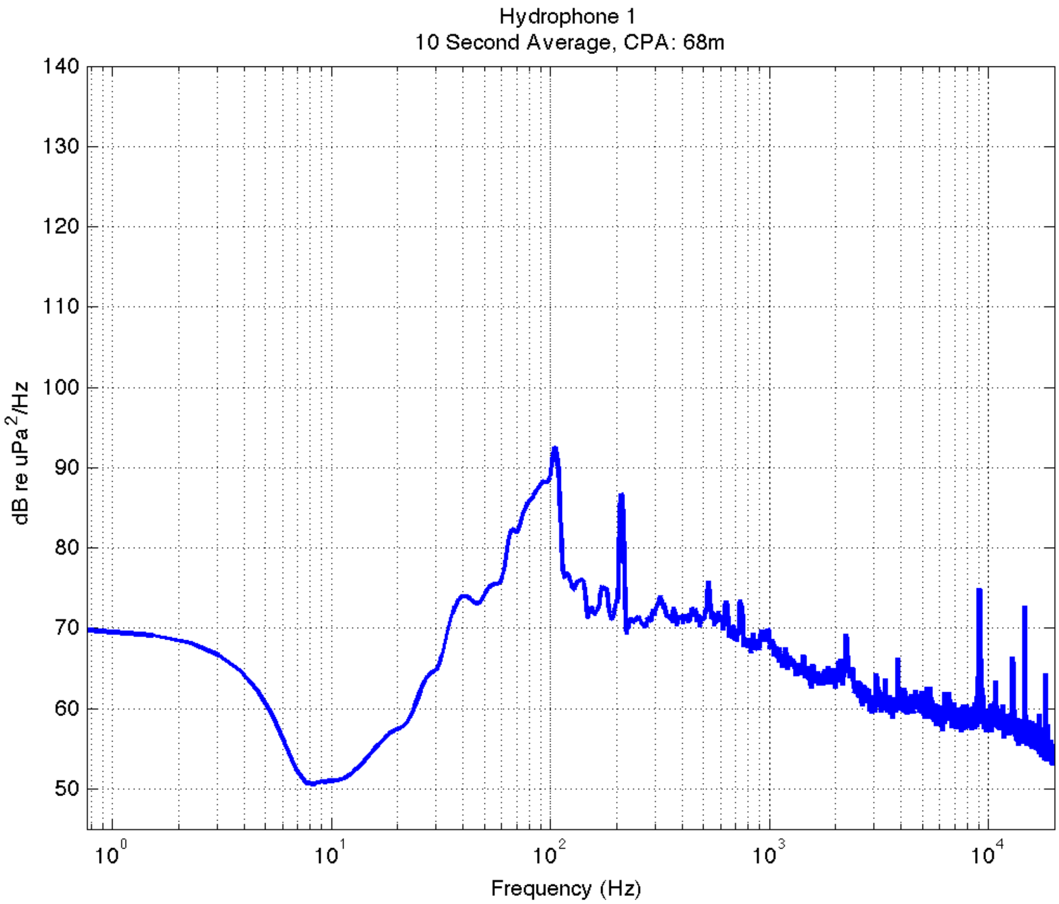

Figure 21: Spectral Time Slice at CPA for Trial 4

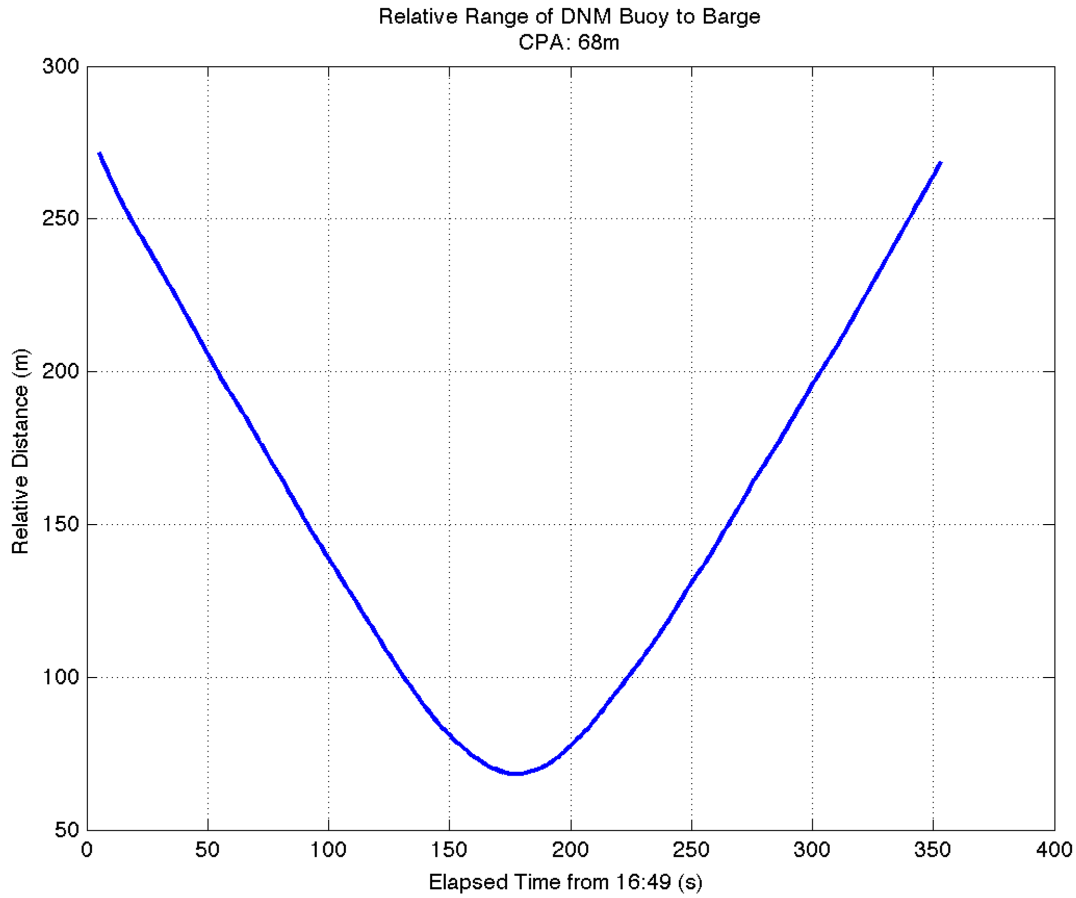

Figure 22: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 4

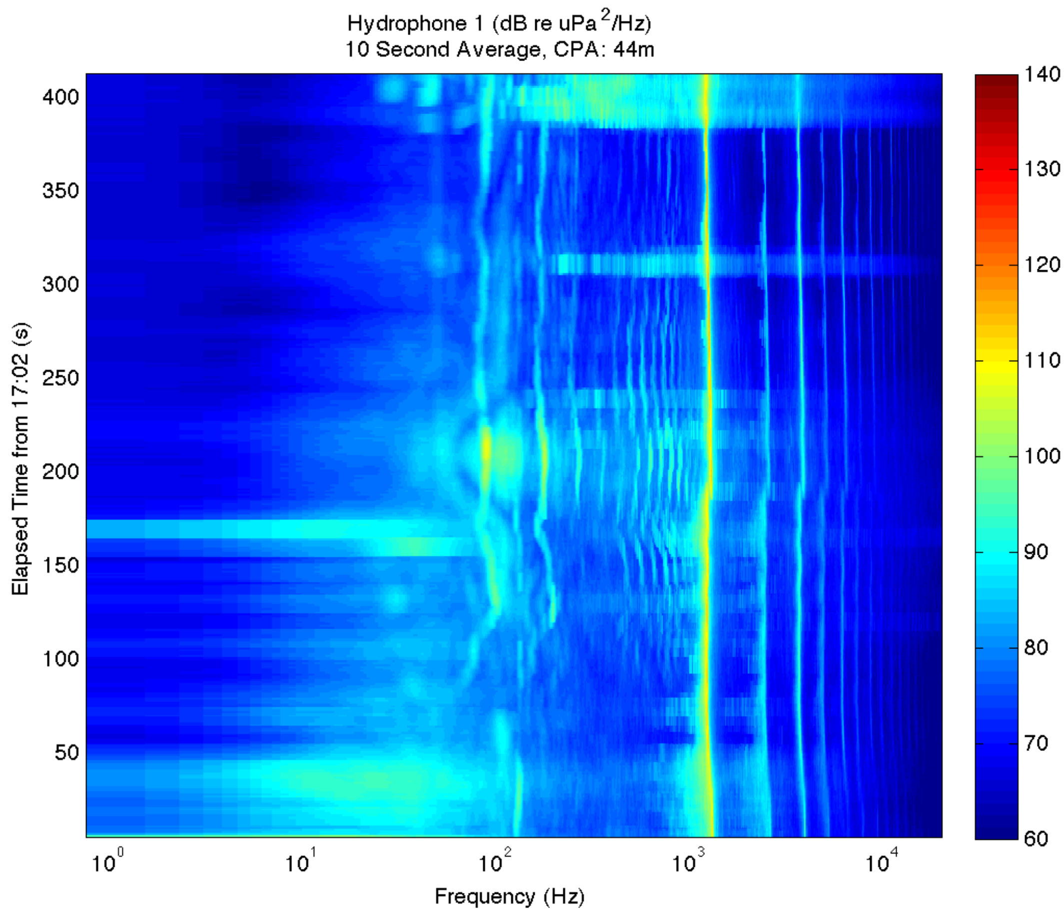

Figure 23: Spectrogram of Trial 5

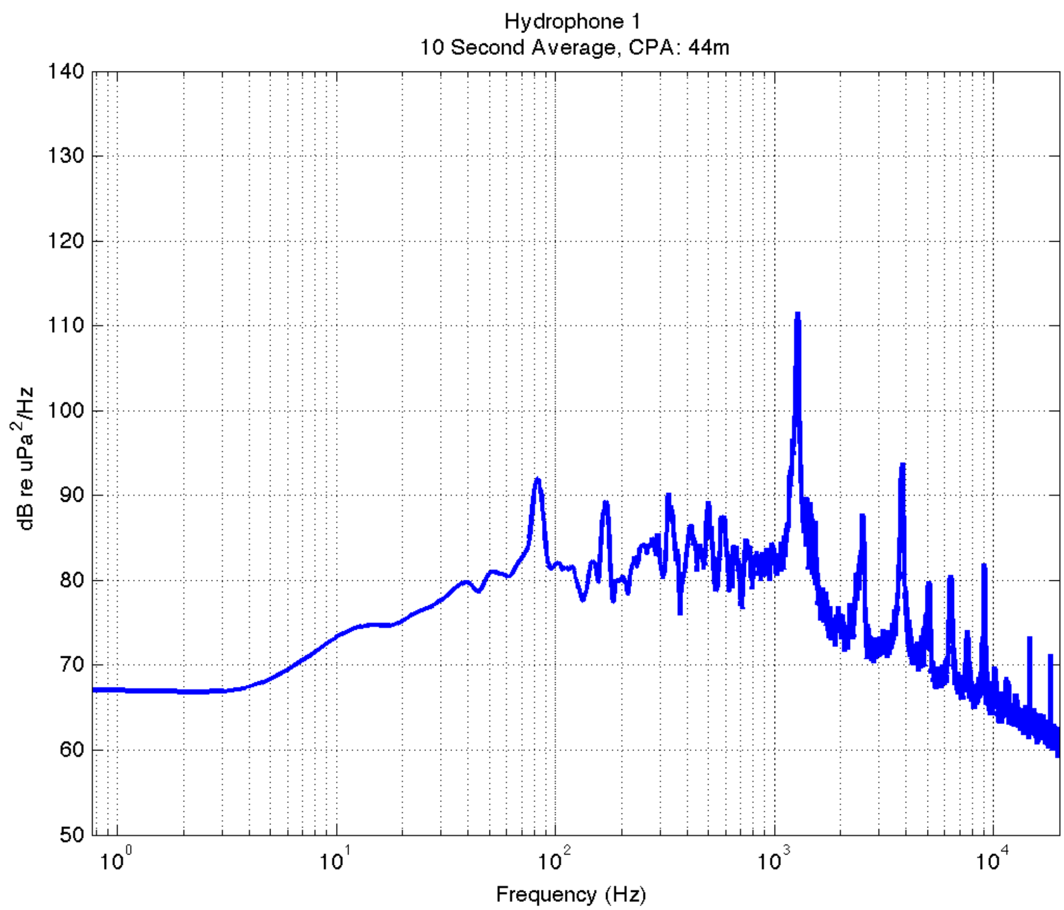

Figure 24: Spectral Time Slice at CPA for Trial 5

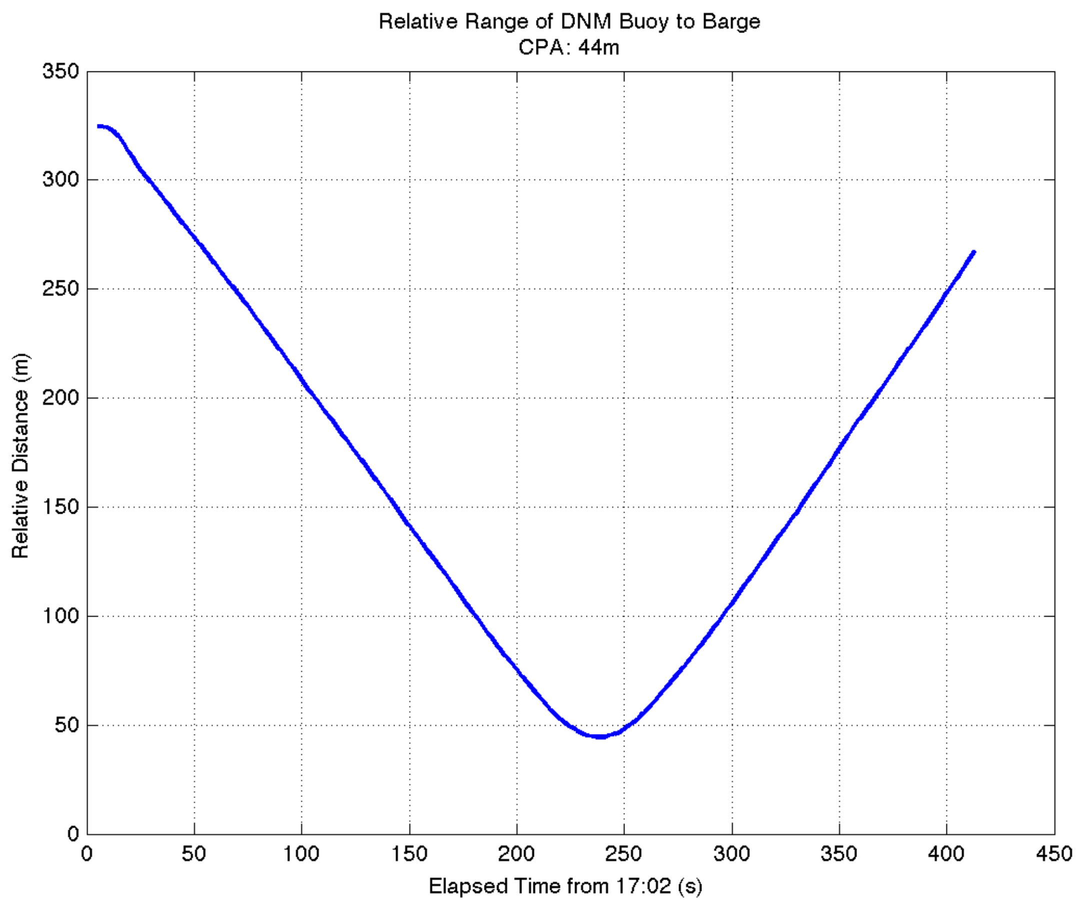

Figure 25: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 5

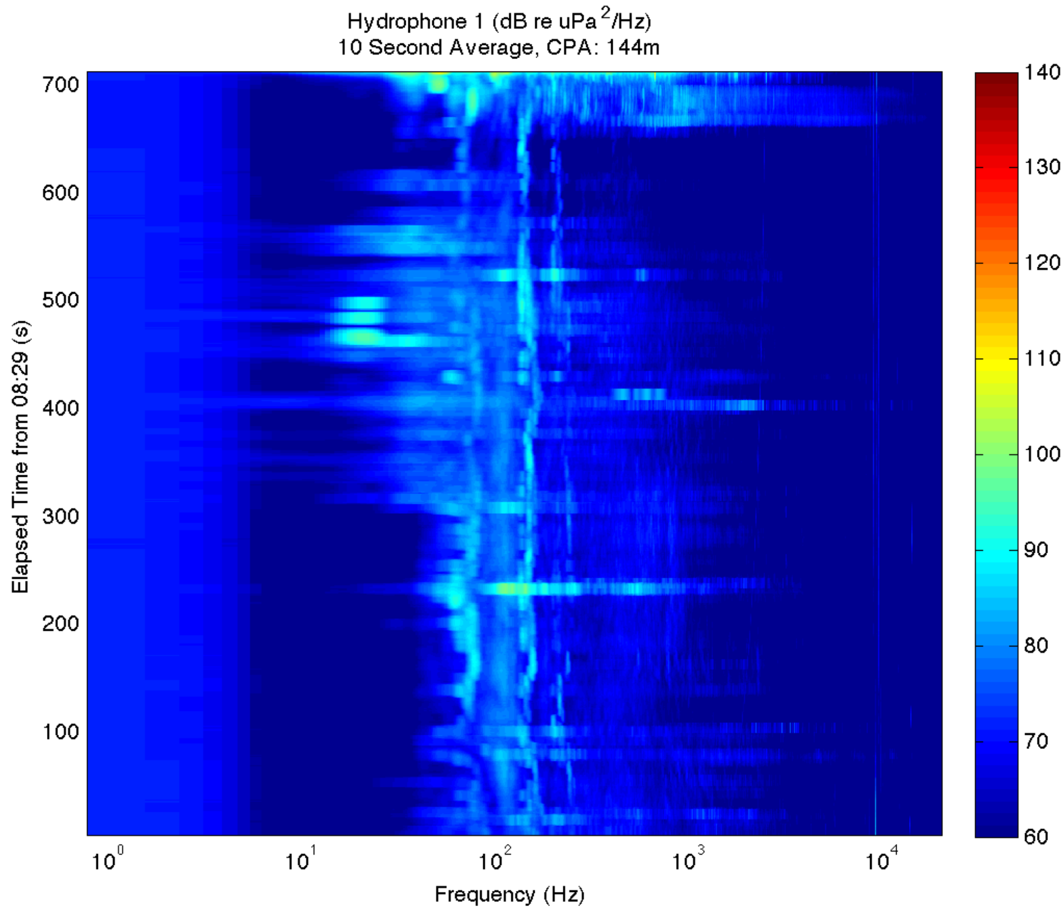

Figure 26: Spectrogram of Trial 6

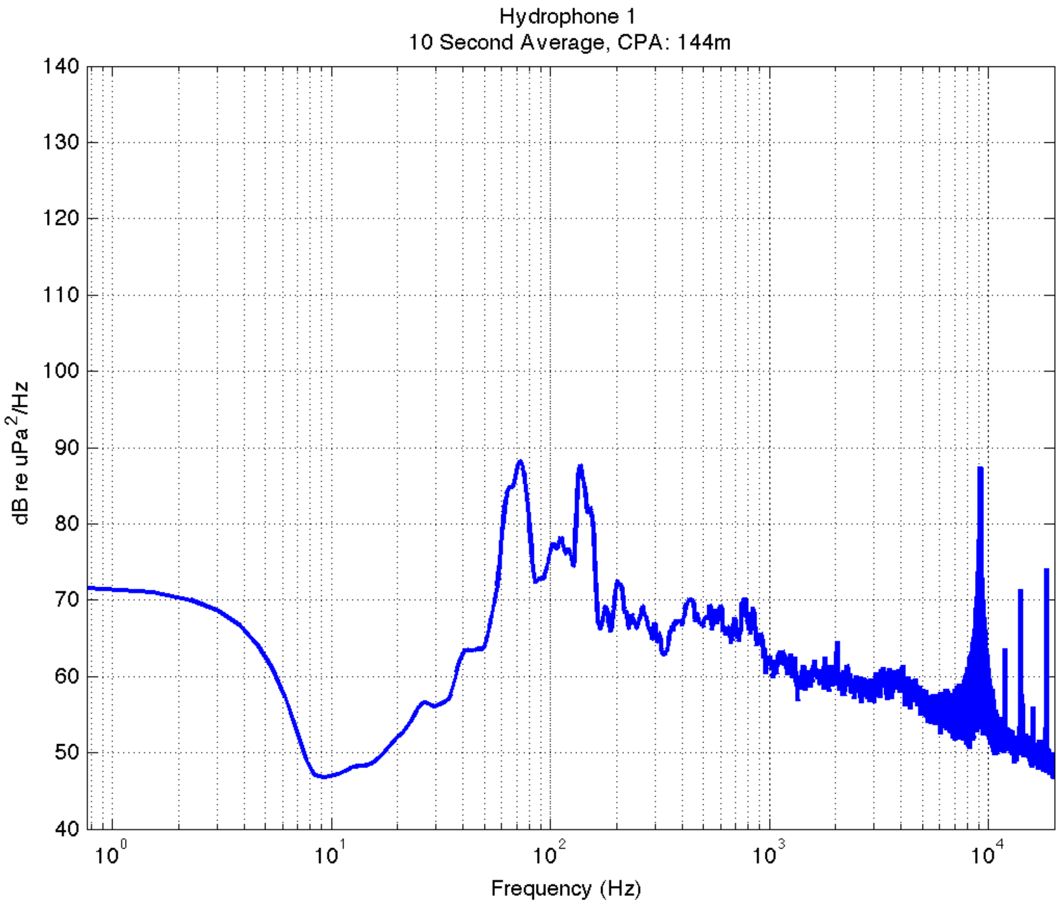

Figure 27: Spectral Time Slice at CPA for Trial 6

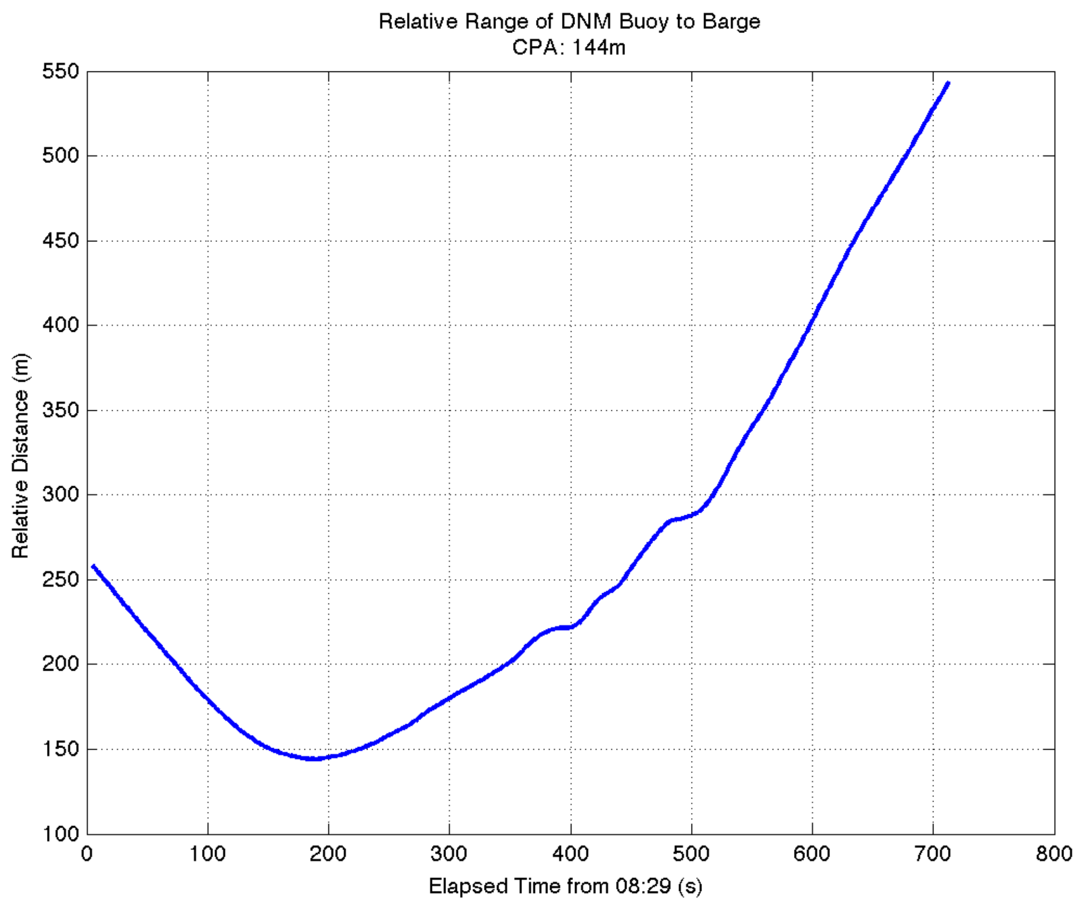

Figure 28: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 6

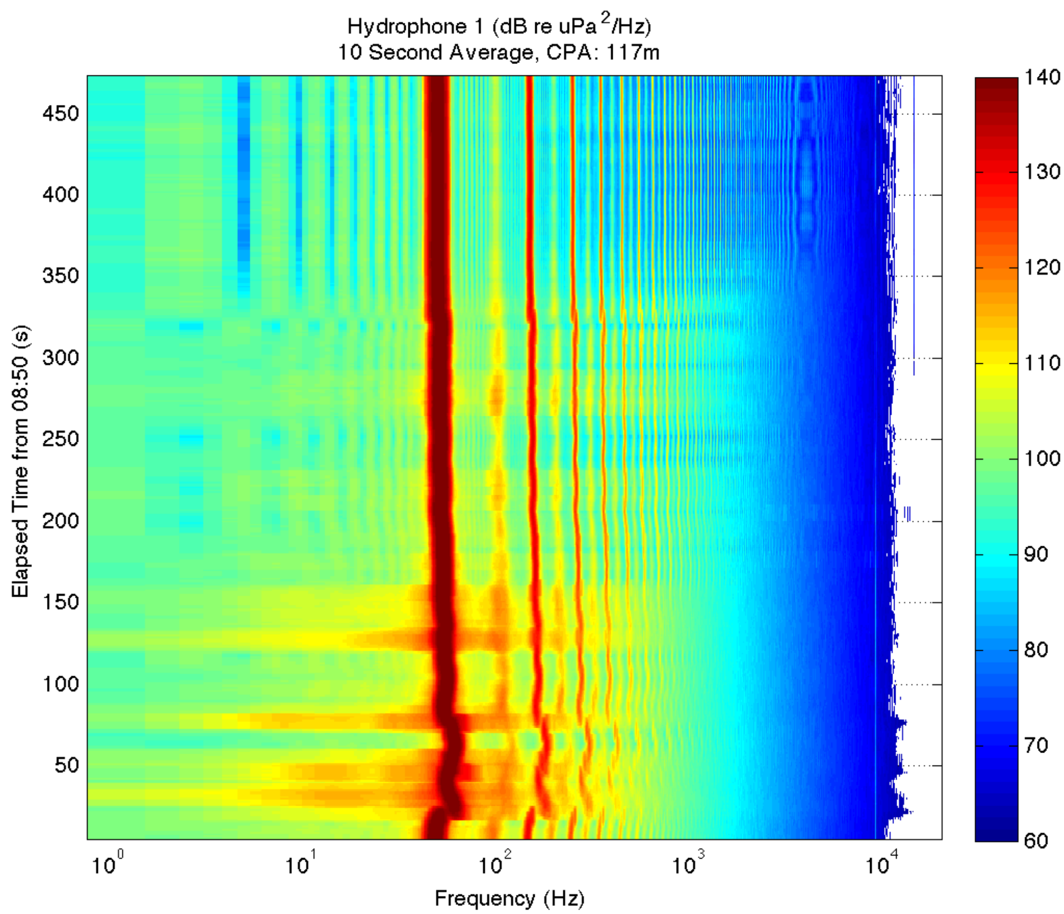

Figure 29: Spectrogram of Trial 7

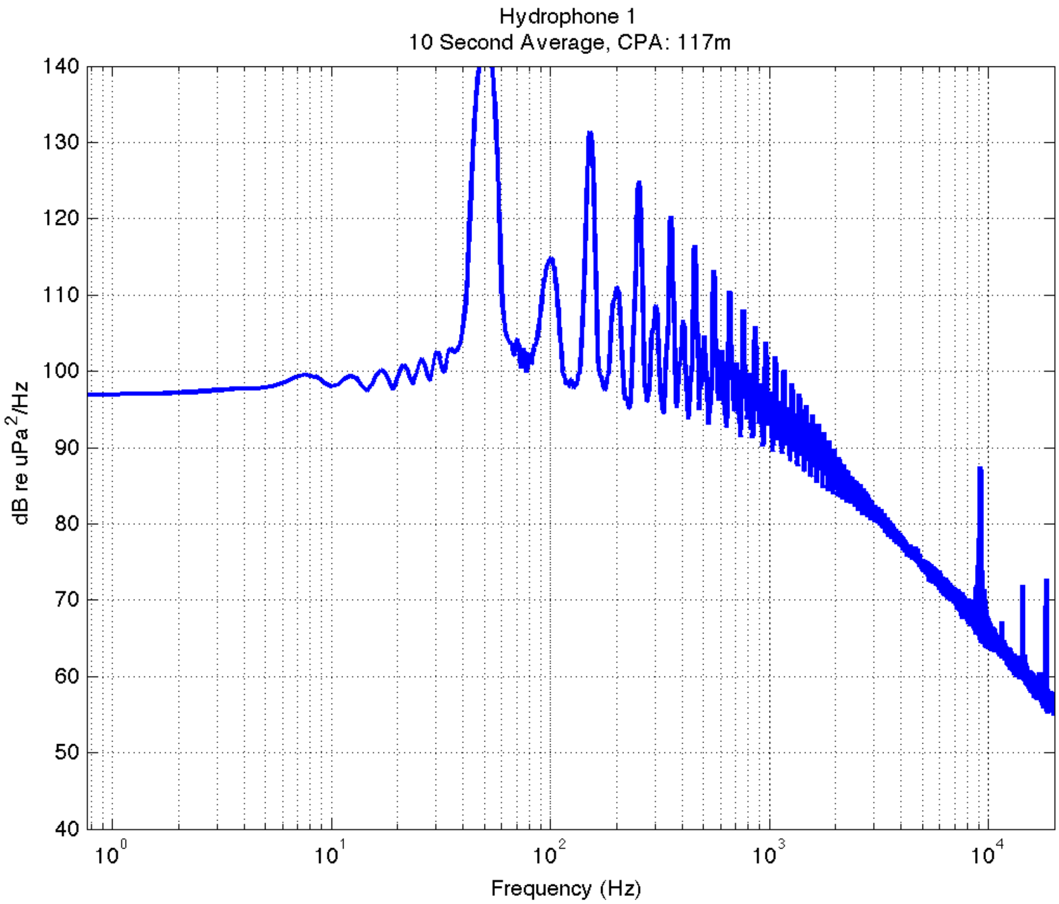

Figure 30: Spectral Time Slice at CPA for Trial 7

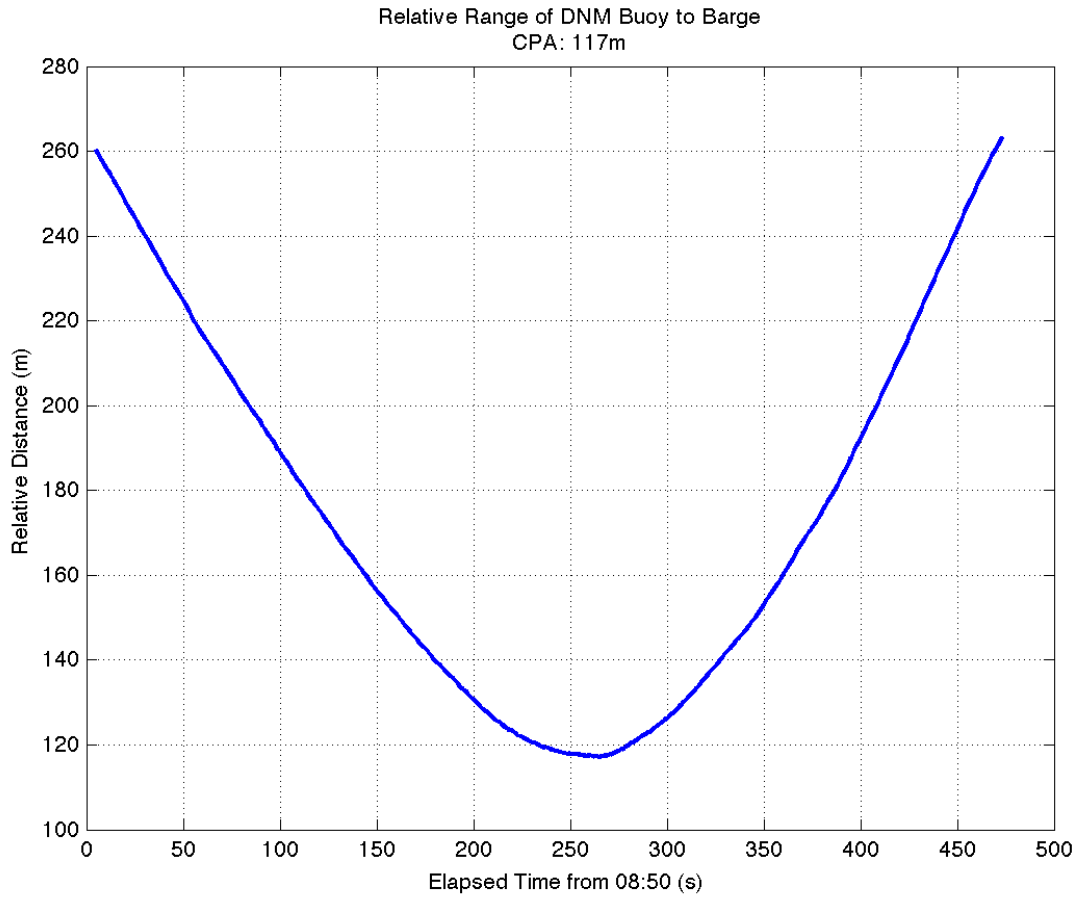

Figure 31: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 7

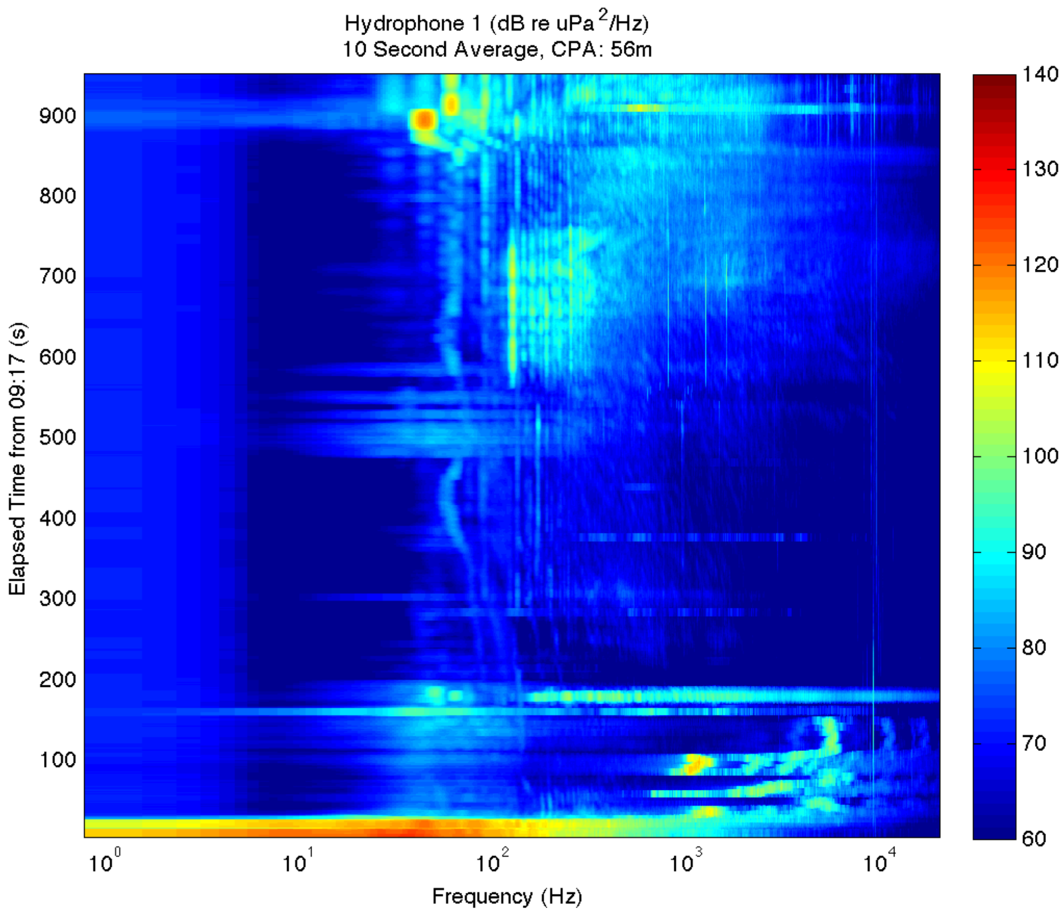

Figure 32: Spectrogram of Trial 8

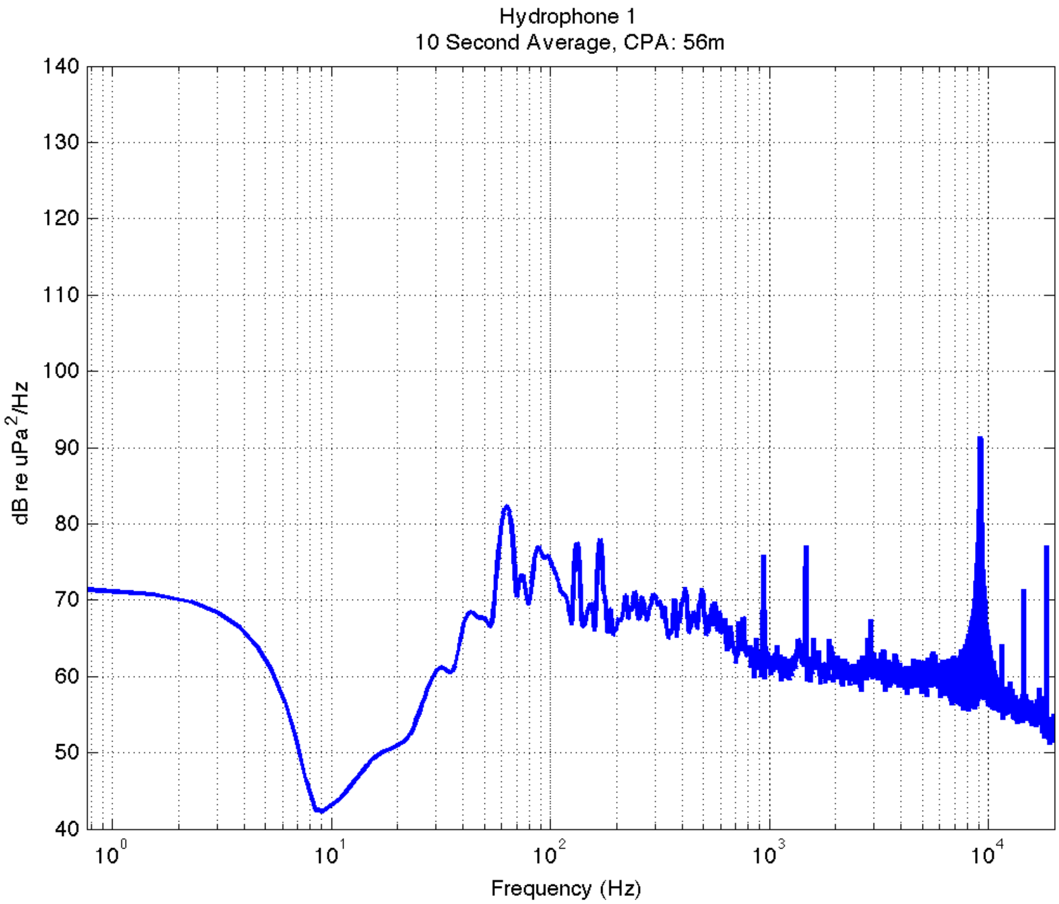

Figure 33: Spectral Time Slice at CPA for Trial 8

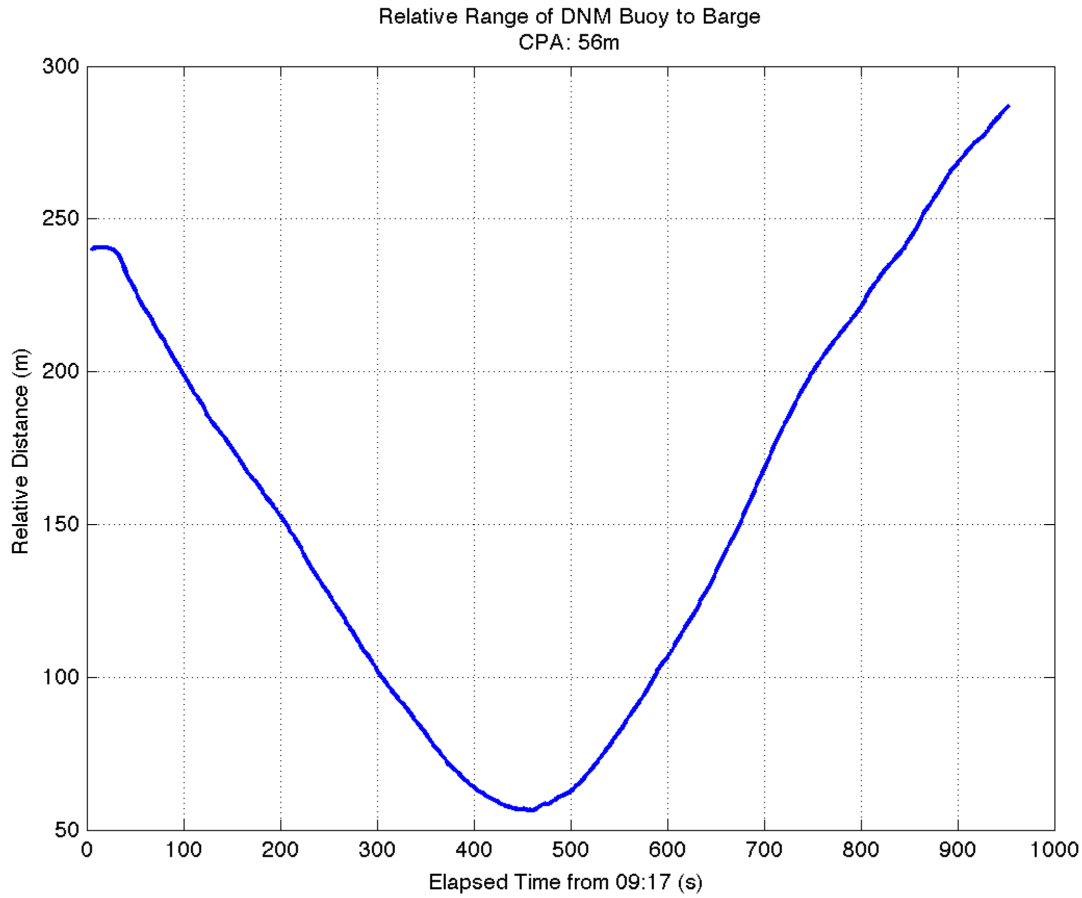

Figure 34: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 8

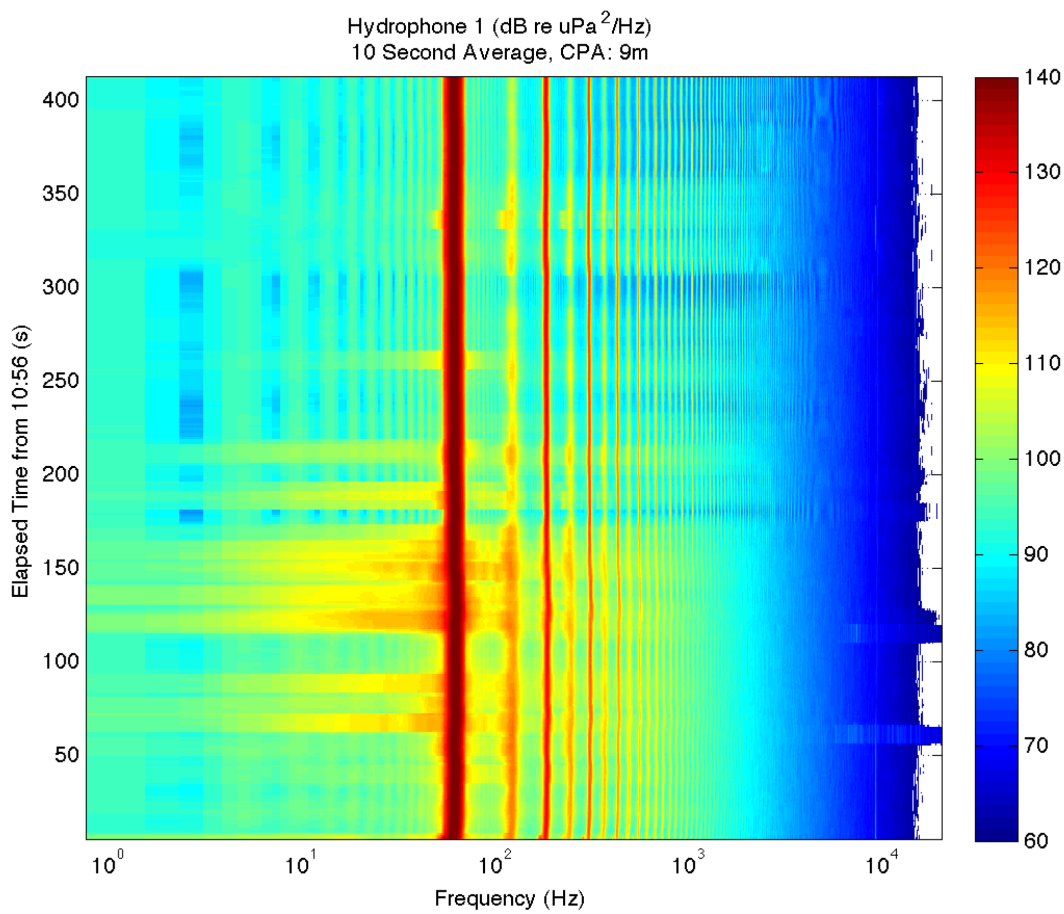

Figure 35: Spectrogram of Trial 9

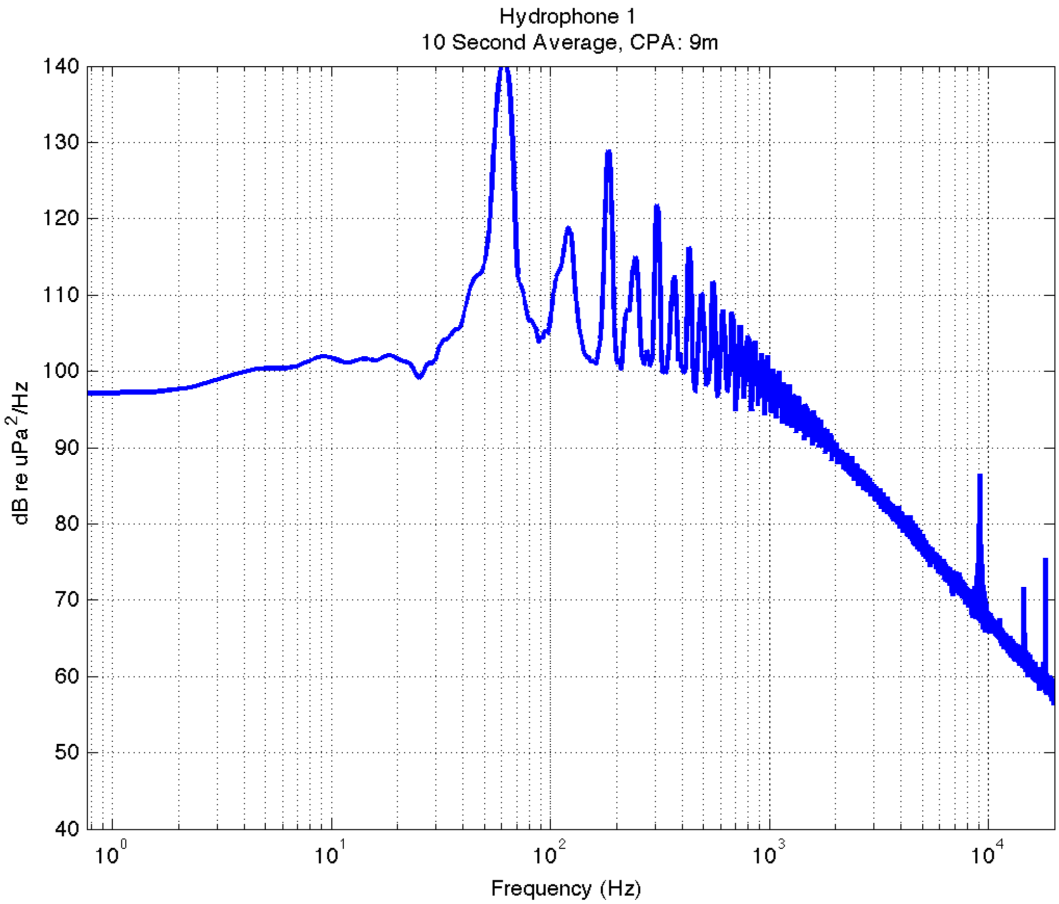

Figure 36: Spectral Time Slice at CPA for Trial 9

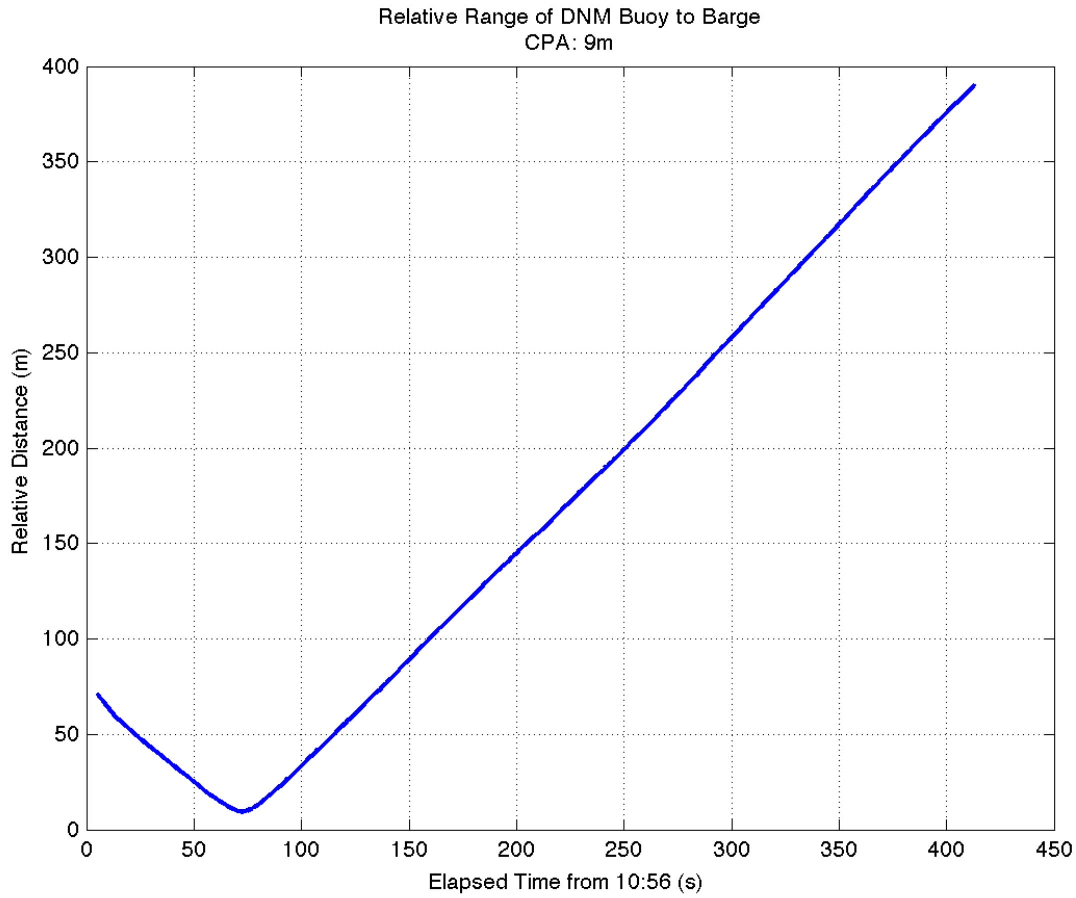

Figure 37: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 9

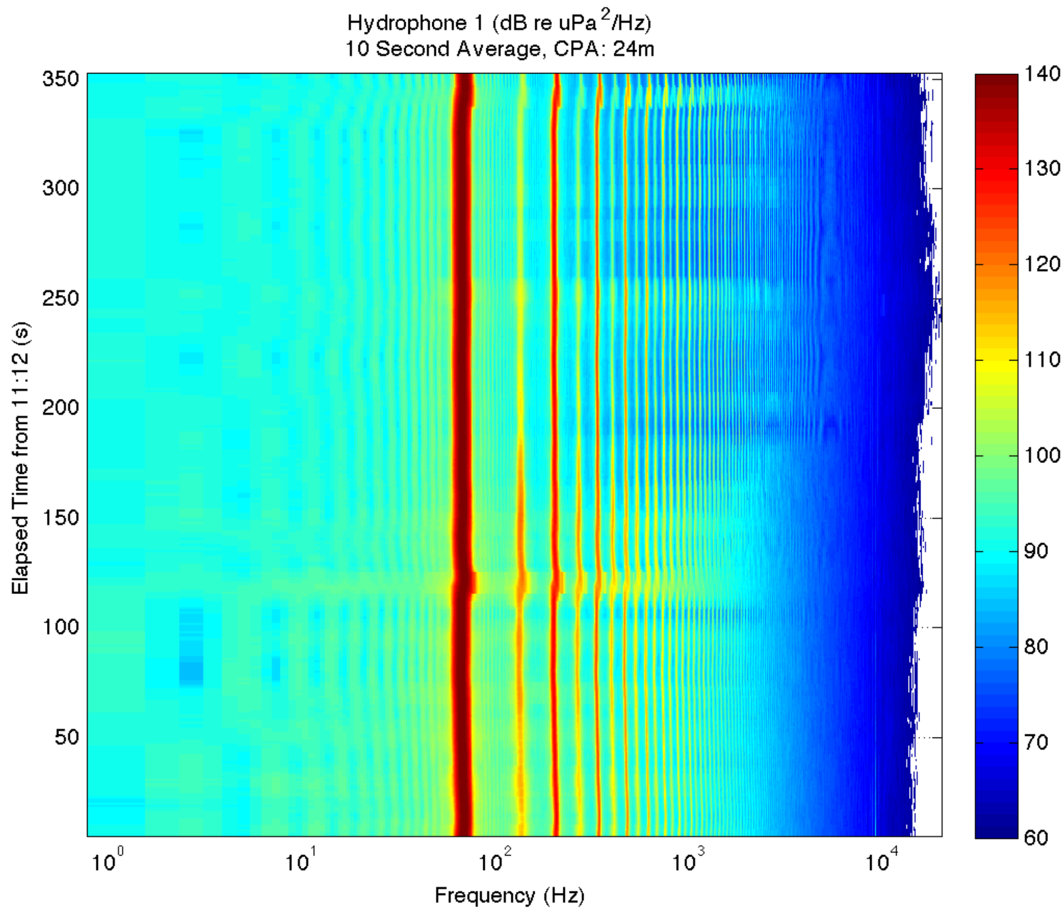

Figure 38: Spectrogram of Trial 10

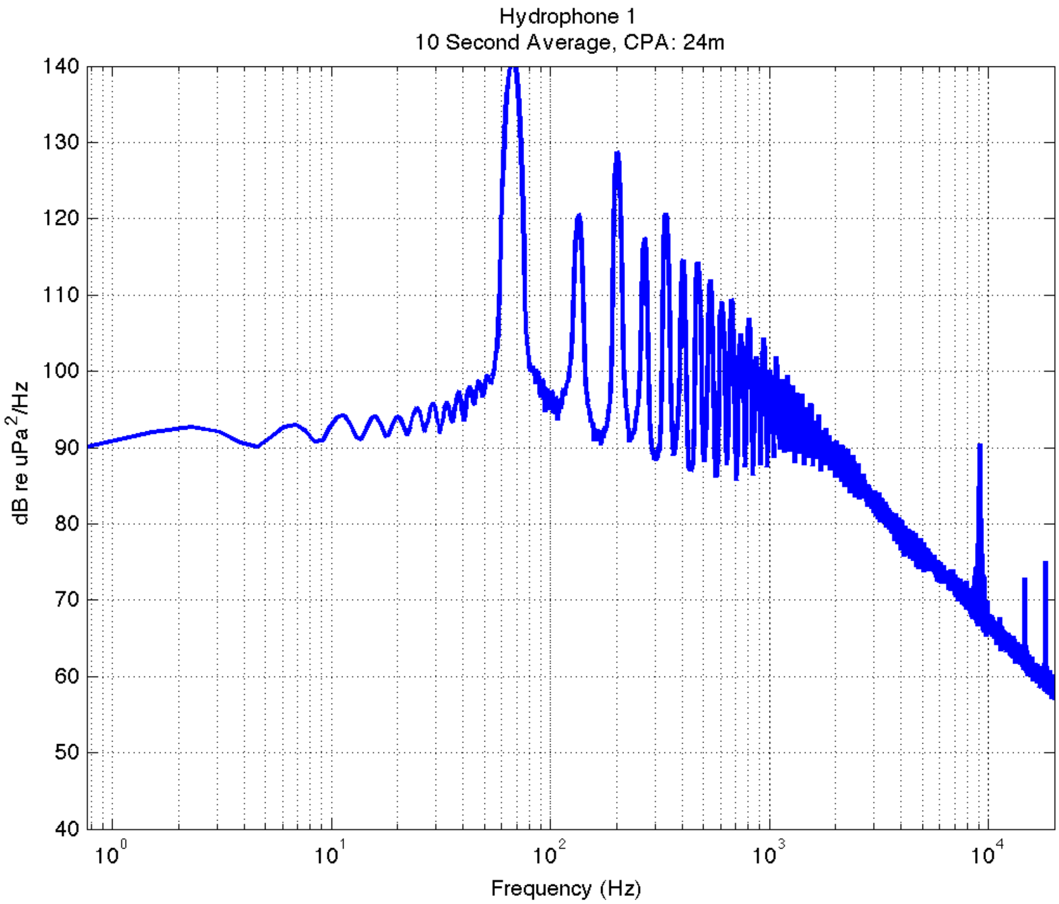

Figure 39: Spectral Time Slice at CPA for Trial 10

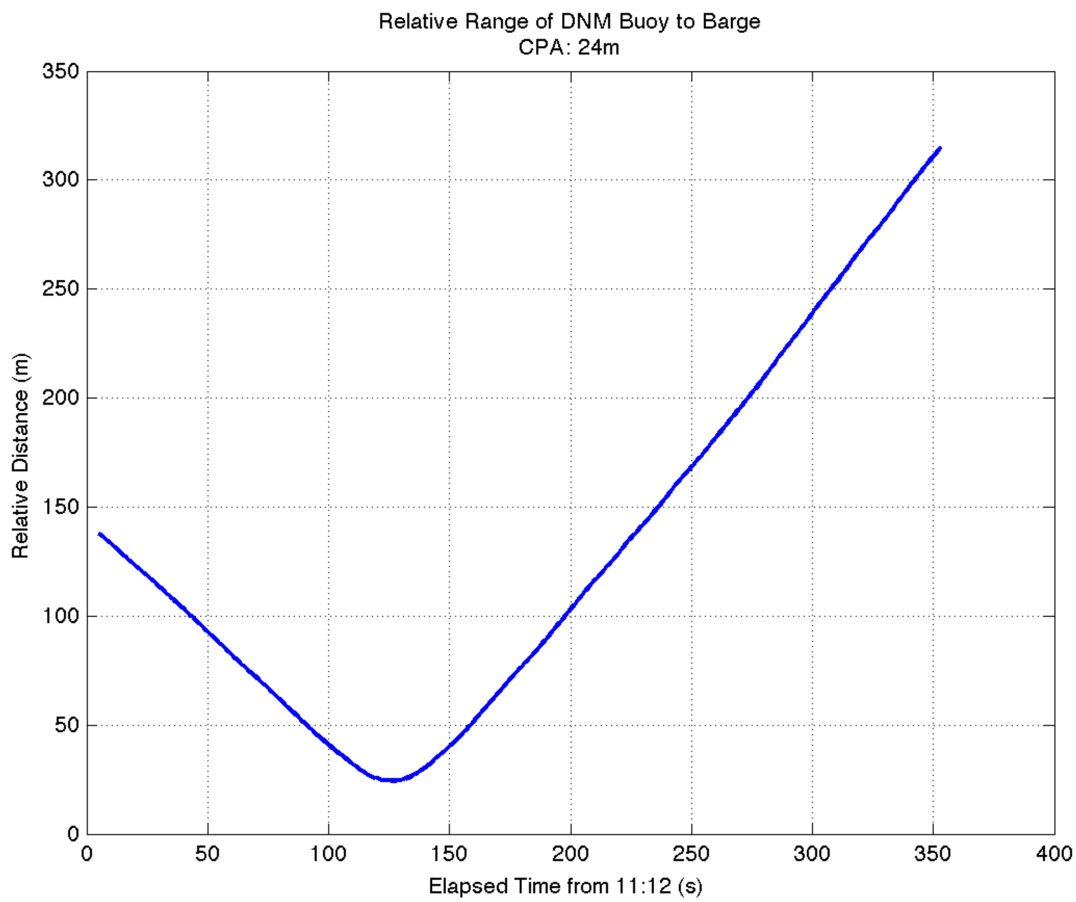

Figure 40: DNM Buoy Drift Pattern (Relative to the TGU Barge) for Trial 10

7 Appendix 3: DMN Hardware and Test Procedure Details

7.1 Hardware Setup

The general in-water setup is shown in figure 1. It consists of two ITC-1042 hydrophones, which are connected to a wire support rope that ran between the DNM buoy and a small 5kg mushroom anchor. The sensors are placed at a depth of 7m from the water's surface. The mushroom anchor served to stabilize the drifting system and also protect the hydrophones from themselves becoming an anchor should the system drift into shallow water.

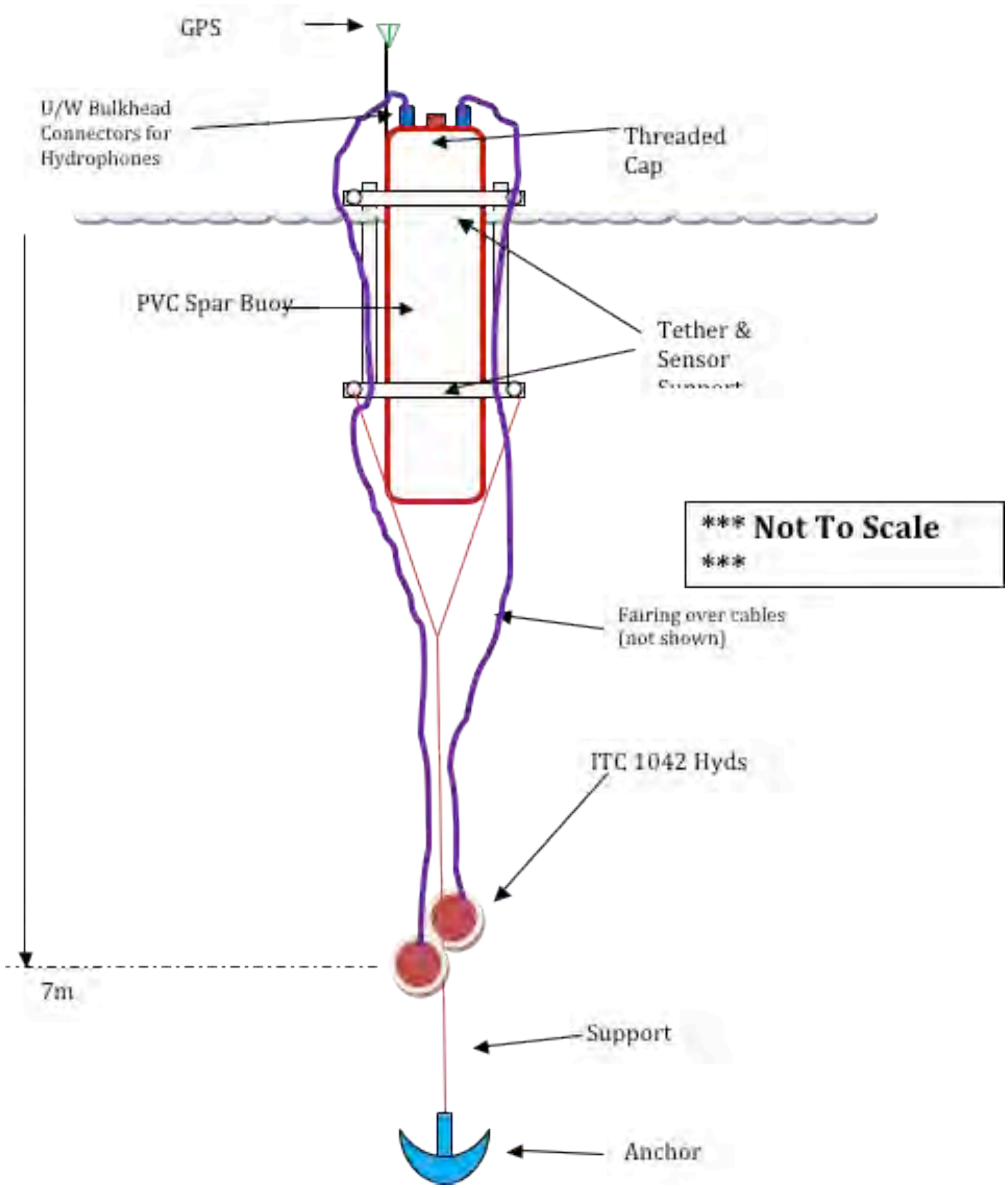

Figure 41: General In-Water hydrophone test setup

The buoy's electronic suite (figure 2) consisted of two 12v batteries, an analog data logger, a serial data logger for GPS, analog matching transformers and a custom dual channel low noise amplifier. The ITC-1042 hydrophones are connected to approximately 10m of DSS3 hydrophone cable. The individual sensors' sensitivity is 201dB//µPa//(Hz)$^{1/2}$ from 10Hz to 40kHz. The hydrophone signals passed through the underwater connectors into one of two custom SSI low noise amplifiers. These amplifiers have a nominal electrical noise floor -167db//(Hz)$^{1/2}$ and a signal gain of 60dB and a low pass filter roll-off of 2.7Hz. The gain setting was increased from 40 to 60dB early in the measurement to maximize the signal strength while maintaining sufficient dynamic range to prevent the amplifiers from saturating. The amplifiers are designed with a flat wide band frequency response so as to add high signal gain with less than 0.1% harmonic distortion. Figure 2 depicts the amplifier response at a gain of 40dB. A spectral analysis of the ambient noise data was performed in real time using an HP3562 Dynamic Spectral Analyzer which confirmed that the increase in gain to 60dB did not alter the response shown in figure 2.

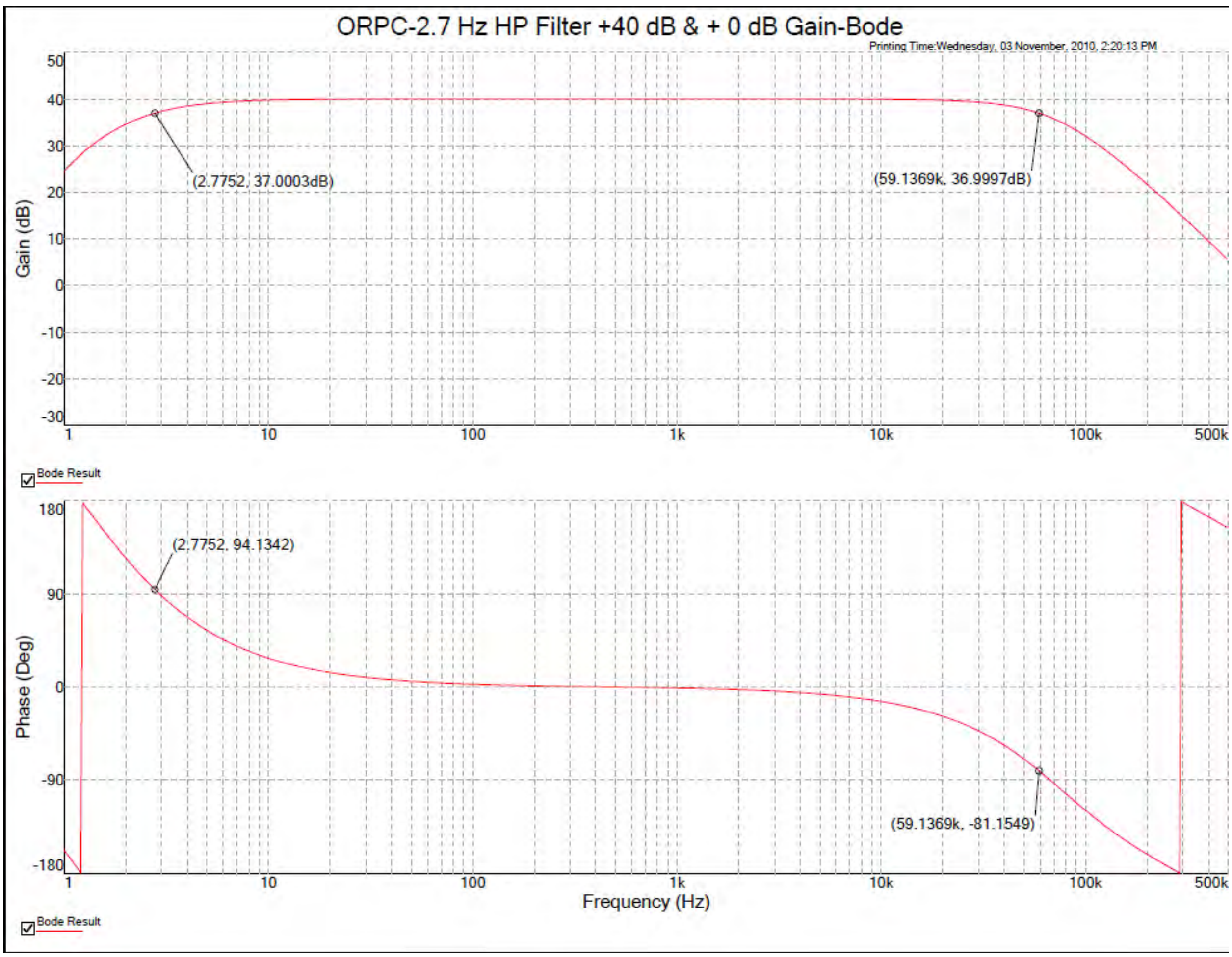

Figure 42: Amplifier Transfer Characteristics

The electrical noise floor sets the lower limit of the input signal range. When combined with the hydrophone sensitivity, the electrical noise floor translates to a minimum measureable sound pressure level (SPL) of 34dB//µPa //(Hz)$^{1/2}$. The term "(Hz)$^{1/2}$" signifies that these levels were measured in a signal bandwidth of 1Hz. As ambient noise is considered as uncorrelated noise, a 1Hz result can be corrected to any desired signal bandwidth by adding 10*log(bandwidth). The electronics' suite is secured to a PVC tray and mounted within a cutout of a 6" diameter PVC pipe (figure 3).

The amplified signal is routed through an isolation transformer to a Measurement Computing analog data logger, which sampled each of the two channels at a rate of 100KSamples/sec with a 40kHz anti-aliasing filter. The sampled data is stored internal to the analog data logger on a Secure Digital (SD) card in a NTFS data format for easy retrieval via the unit's USB port and Windows' Explorer. The Garmin LVC-PC GPS antenna is also the GPS receiver and is mounted externally on a 1m PVC pole connected to the Buoy's Top Cap. The unit outputs a RS232 data stream that is stored onto a Databridge SDR2-CF (hidden under the PVC arch) using a Compact Flash card. Both data recorders are connected to the Top Cap via USB cables that allows their data to be offloaded with having to open the unit.

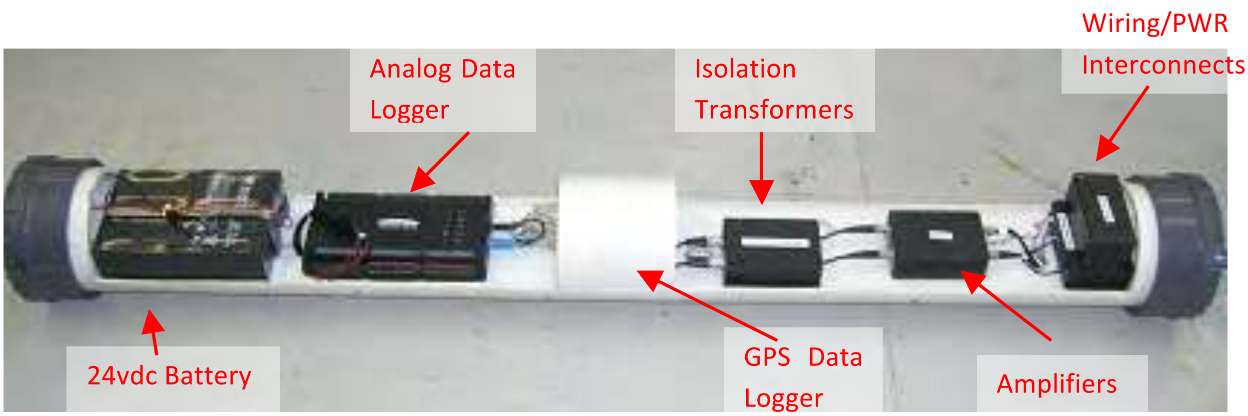

Figure 43: DNM Buoy Electronic Suite

The completed electronics suite is slid into a 2m PVC pipe (figure 4) where it is sealed inside to eliminate water intrusion. All Top Cap mounted connectors are from the SubConn circular underwater mateable family and allows direct access to not only the data loggers but also the batteries for power initialization and charging. The Top Cap itself consists of two Schedule 80 flanges that sandwich an internal gasket between them to create a watertight seal when bolted together. A cylindrical PVC pipe was chosen for this design to create a "spar buoy" that would drift with the current but produce minimal vertical oscillations as it is passed through the waves. Wave induced oscillations will introduce extremely strong low frequency pressure variations that will saturate sensitive acoustic amplifiers such that they can no longer react to any other stimuli. In figure 4, the completed assembly is shown with the external connectors for the two hydrophones, data access ports to offload the GPS and analog data and a small PVC pipe to support the GPS antenna. A secondary Garmin GPS unit (not shown) was placed on the buoy that logged positional data as a back up to the primary system.

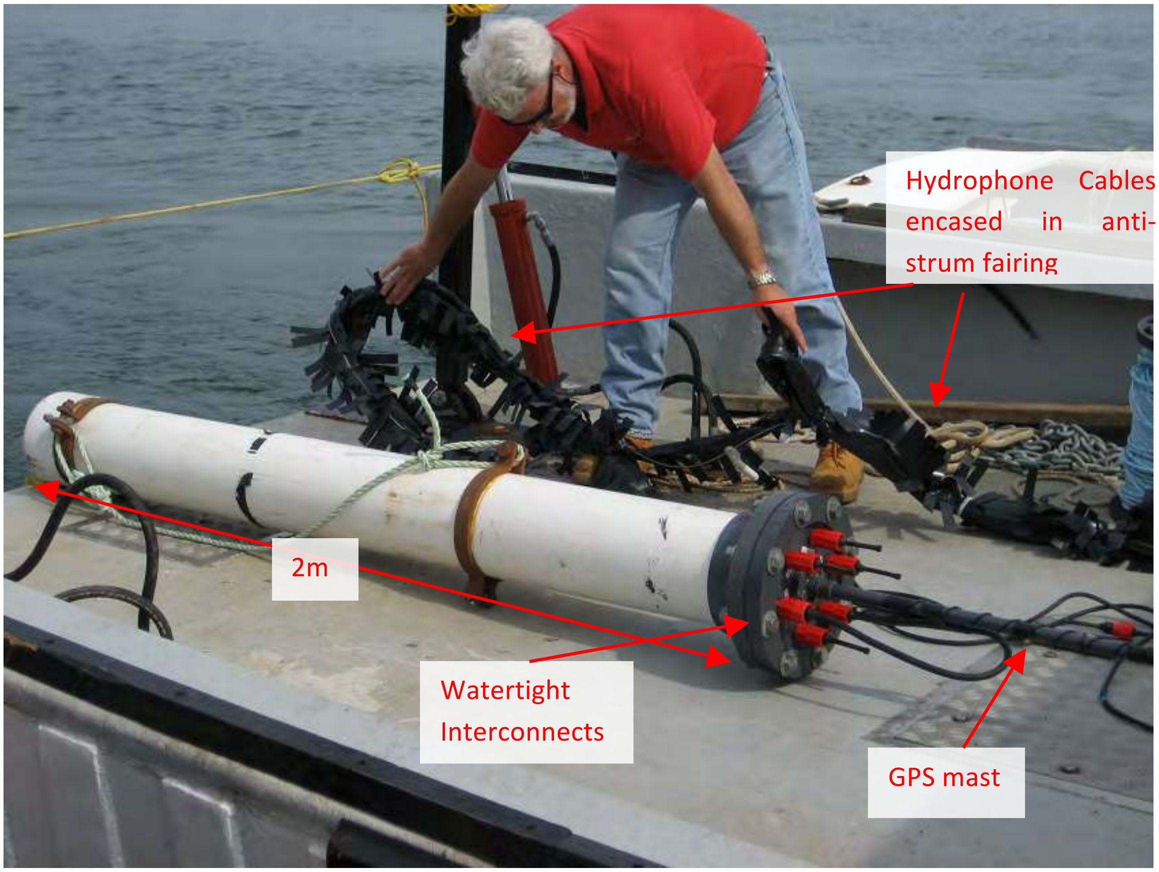

Figure 44: Completed DNM Buoy Assembly

7.2 Trial Setup

For each noise measurement, the DNM buoy was taken by small boat to a location 400m minimum up current from the TGU barge to allow for deployment time and so when the buoy is released, it will drift in a line that will bring it as close as possible to the TGU. Once at the mark, the vessel secured all engines and systems to allow it to drift with the current and decrease the relative velocity seen by the buoy upon its release. This allowed the buoy to be placed into the water with minimal drag forces acting upon it making for a safer deployment.

Prior to deployment, a red power plug is inserted into the battery activation connector that energizes all on board systems. The analog data logger is synchronized to a PC clock that had earlier been synchronized to GPS. Accuracy of this process is within a few seconds of the actual time. The application of power automatically brings all systems on-line. As the GPS systems were allowed to become acclimated to the region prior to this measurement period, it took only a few moments for both systems to acquire a stable position prior to launch of the buoy, figure 5. Once in the water, the buoy quickly righted itself and drifted with the current. Trailing behind the buoy is the length of polypropylene line and a small float to aid in recovery and to provide a surface marker should the buoy get snagged and pulled under by the high currents, figure 6.

Figure 45: Launch of DNM Buoy

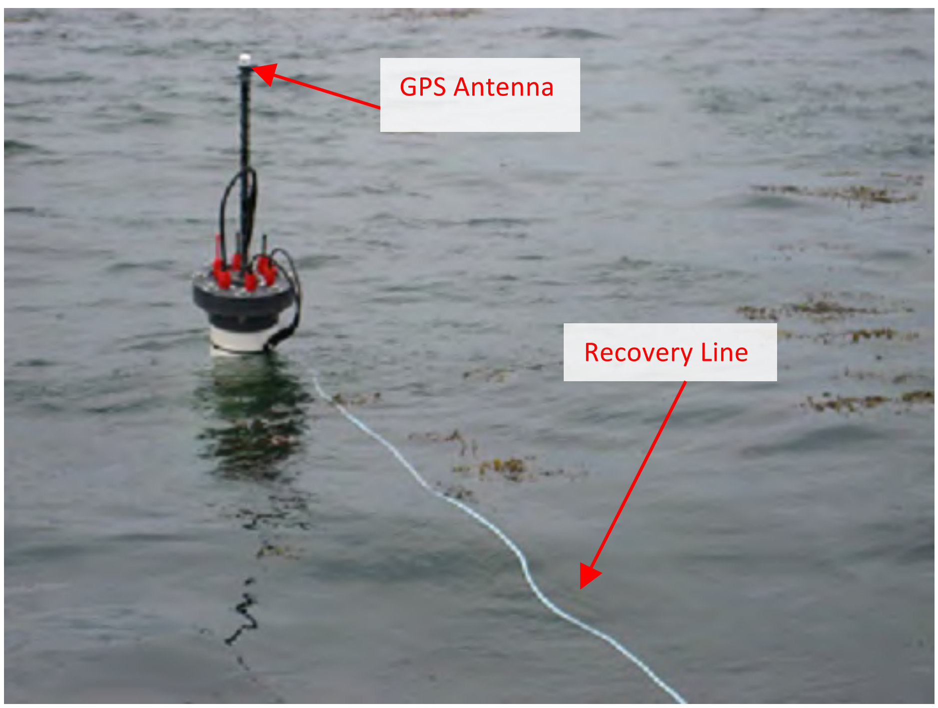

Figure 46: DNM Buoy Adrift Following Launch

Appendix D

Benthic Cable Survey Report, Review of video recording of November 9, 2012, MER Associates, January 31, 2013

Benthic Cable Survey Report, Review of video recording of February 2, 2013 MER Associates, March 11, 2013

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Review of video recording of November 9, 2012
Ocean Renewable Power Company Maine (ORPC)
Upper Cobscook Bay

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January 31, 2013

Introduction

Ocean Renewable Power Company Maine (ORPC) conducted an inspection of the power and data cable route associated with its Upper Cobscook Bay TidGen^{TM} tidal power generation unit (TGU) on November 9, 2012. The inspection covered sections of the cable route running from the TGU deployment area to the shoreline landing in Gove Cove on Seward Neck in Lubec, Maine.

The final "As-built" cable route does not coincide exactly with the area covered by the July 2011 baseline survey over much of the route, as shown in Figure 1. The change in route was required for two principal reasons: 1) a shift in the TGU deployment location to avoid shallow bedrock and allow proper penetration of the piling supports for the TGU and 2) to avoid shallow to bedrock areas along the cable route that would have prevented cable penetration (Jarlath McEntee, ORPC email correspondence).

The inspection included video recordings to document the condition of the cable as well as the benthic habitat along the cable route. MER Assessment Corporation (MER) did not participate in the planning or execution of the cable inspection effort. MER was requested to review the video recordings to assess the condition of the benthic habitat and associated epibenthic fauna. This report summarizes observations made during the review and provides comments and recommendations on the video recording methods used.

Review

Video recordings were made by Braden's Future, Inc. SCUBA divers using Go Pro hand-held cameras and single spot lighting. Videos were provided to MER as mp4 files and were reviewed using Quick Time Player (Apple, Inc.) on a 22" monitor.

GoPro 11 9 12A (from dogleg toward TGU) Times are minutes on video recording

The seafloor habitat begins as silt covered cobble with heavy relic mussel shells and transitions to gravel covered with a layer of relic mussel shells. Toward the end of the transect the seafloor becomes covered with rocks, stones and small boulders. The cable is first located at 02:11 when epifauna observed include green sea urchin, *Strongylocentrotus droebachiensis*, and sea potatoes, *Boltenia ovifera*. Urchins and sea potatoes continue to be seen between 03:00 and 08:54 but much of the video is difficult to review due to narrow field of view, limited light and the motion of the image making determination of epifauna density difficult. The cable is reacquired at 08:54 but appears to soon after become buried in the relic shell-covered gravel bottom. From this point through 12:00 the seafloor appears to remain similar and epifauna include sea potatoes, possible sea stars (unidentifiable), northern red anemones, *Urticina felina*, and green sea urchins. Between 12:00 and 15:00 the bottom is covered with relic shell and sea potatoes are common. Other epifauna along this segment include red (blood) sea star, *Henricia* sp., urchins, purple sunstar, *Solaster endeca*, palmate sponge, *Isodictya* sp., scallops, *Placopecten magellanicus*, and northern red anemones. Between 15:00 and 18:00 the diver drags a weight and line along the bottom. The diver's location and route relative to the cable is unclear but limited forward progress is made. Throughout this segment the bottom remains relic

Figure 1. July baseline survey video locations and As-built cable route (Source: ORPC/Google Earth)

mussel shell and gravel and only limited epifauna are visible. The bottom remains similar between 18:00 and 22:30 as do the epifauna consisting of sea potatoes which continue to be common, sea scallops, rock crab, *Cancer irroratus*, small northern red anemones, urchins and palmate sponge. Again, abundance is difficult to determine from the limited field of view. At 22:30 rocks begin to appear along the relic mussel shell bottom, some increasing in size to small boulders, and the number increases to become a rock field by 23:30. Sea potatoes are common along the bottom and abundant on rocks, as is crumb-of-bread sponge, *Halichondria panicea*; northern red anemones are also abundant through 24:00. The diver begins his ascent at 24:23.

GoPro 11 9 12B (from TGU toward dogleg) Times are minutes on video recording

The video recording begins at the shore cable termination anchor (SCTA) near the TGU, at 01:39; the diver follows the cable to 02:05 when it becomes buried in the bottom but is reacquired at 09:39. Through this segment the bottom remains similar as cobble with a fine layer of silt, gravel, occasional rocks and small boulders with relic shell that increases at about 03:30. Sea potatoes are common to abundant, at times creating a "*Boltenia* meadow" across the bottom; sea urchins are also common to abundant. Other epifauna include crumb-of-bread sponge common on rocks and cobble, and northern red anemone, scallop, northern sea cucumber, *Cucumaria frondosa*, bulbous sponge, *Cliona celata*, palmate sponge, sea stars, presumed to be *Asterias* spp., Stimpson's whelk, *Colus stimpsoni*, spiny sunstar, *Crossaster papposus*, all of which are common to rare.

After reacquiring the cable at 09:39 the diver locates the guide rope a short distance from the cable and between 09:50 and 10:36 drags the line weights toward the cable to bring the guide rope in closer proximity. At times during this procedure the camera is set down on the bottom and shows the bottom as primarily relic shell with sea potatoes and urchins. The cable is seen stapled to the bottom with metal "U"-bar at 10:45 and again at 11:00. Recording of the cable and bottom resumes at 10:46 until interrupted between 11:06 and 11:46 when diver again realigns the guide rope to the cable. The bottom through this section is gravel covered with relic mussel shell and epifauna remain primarily sea potatoes and urchins with a rare to occasional scallop based on the limited field of view. Video recording resumes at approximately 12:00 over a similar bottom consisting of gravel and relic mussel shells with the cable partially buried in the bottom. Sea potatoes and urchins are common to abundant; urchins are seen covering the cable and sea potatoes are seen within very close proximity (few inches) of the cable. The bottom remains similar with abundant urchins, sea potatoes commonly observed and occasional or rare observations of northern sea cucumber, northern red anemones, hermit crab, *Pagurus* sp., and Jonah crab, *Cancer borealis*. The camera is set on the bottom at 13:44 and the cable is seen slightly off the bottom; camera is briefly picked up at 14:00 but set down again at 14:14 through 14:42 for guideline realignment; cable is seen stapled to the bottom at 14:54. Bottom remains similar as do the epifauna.

From 15:00 through 16:00 the bottom is primarily gravel with relic shells; urchins remain abundant with sea potatoes and northern red anemones occasionally seen. The guide line is again dragged toward the cable between 16:00 and 16:15 during which a scallop and northern red anemone are observed. The cable becomes buried at 16:34 in a gravel and relic shell bottom.

Between 17:00 and 20:00 the diver pans the bottom searching for the cable making observations of the bottom difficult. The bottom initially appears to remain primarily gravel and relic shell, but rocks begin to appear at 18:25; epifauna continue to be dominated by urchins, sea potatoes and northern red anemones increase in abundance; other epifauna include sea scallops and finger sponge, *Haliclona oculata*. The diver again begins dragging the guideline and weights at approximately 20:00 and reacquires the cable at 22:09; the bottom is gravel with rocks and visible epifauna remain urchins, northern red anemones and an occasional scallop. Dive ends at 20:10.

GoPro 11 9 12C (from dogleg toward shore) Times are minutes on video recording

The diver reaches the seafloor at 01:50 where a double cable with orange guideline is acquired; bottom is relic shell. The video light beam is narrow, limiting the field of view and epifauna are difficult to see.

From the video start through 05:00 the bottom remains primarily relic mussel shell over gravel and the cable(s) are stapled to the bottom (first staple observed at 02:38) with little indication of movement. Epifauna are predominantly urchins which are present all along the bottom as well as on the cable. Other fauna include sea potatoes, sea star, rock crab, *Cancer irroratus*, or Jonah crab, purple sunstar, scallop, waved whelk, *Buccinum undatum*, seen on the cable at 04:25, and possibly northern red anemone and sea peach, *Halocynthia pyriformis*.

Between 05:00 and 07:45 when the cable becomes buried in the seafloor, the bottom remains initially relic shell transitioning to gravel, sand and silt. Epifauna continue to consist of urchins which are abundant, sea potatoes, northern red anemones which become progressively more common to abundant; scallop, spiny sunstar, and rock or Jonah crab are only rarely seen. When the cable becomes buried at 07:45, the diver digs to expose the cable just below the surface at 08:19. The double cable again emerges from the bottom at 08:25 and is shown stapled to the bottom at 08:31. Epifauna remain similar with northern red anemones becoming more numerous and waved whelks more frequent.

At 09:00 the bottom remains gravel with the cable on the surface until it becomes buried at 10:59. Urchins remain common or abundant and sea potatoes are occasionally seen while northern red anemones continue to increase in abundance and scallops become more frequent. Other epifauna observed are sea stars, *Asterias* spp. and possibly *Leptasterias* sp., purple sunstar and sea peaches.

The seafloor remains gravel at 11:00 where it then begins to transition to coralline algae-covered cobble, gravel, clay and rocks, some large, toward the end of the dive at 16:51. The cable remains buried throughout the remainder of the video recording. A line appears in the clay along the bottom at 14:09 that may represent the cable route, although this is not clear. A chain is encountered at 14:23, presumably associated with the salmon farm previously located in the vicinity. The diver follows this to a large mooring stone (14:48). Northern red anemones remain abundant on the harder cobble substrate throughout this segment and urchins also remain common to abundant, covering the occasional large rocks and small boulders. Sea potatoes are still occasionally seen but at a substantially lower frequency than in the deeper water at the start of the video. Other epifauna observed over the segment include Jonah crab, scallops, crumb-of-bread sponge on hard substrate, sea stars and sea peaches, the latter of which increase in frequency toward shallower water. The video recording ends at 16:51.

Discussion

The quality of the Go Pro video image on the surface is remarkably good. However, definition seems to be lost once at depth under artificial lighting conditions. This lack of definition is particularly problematic when reviewing the video and attempting to identify organisms along the bottom; identification was therefore only possible based on observable shape and, in some cases, color, although this, too, was not always clear. Additionally, the narrow-beam lighting provided by the spot light(s) used during recording only allows a narrow field-of-view, making determination of abundance difficult other than in cases where substantial numbers of a particular organism are seen. The generally erratic motion of the camera further complicates review of the videos due to the blurring of the image, particularly when the video is paused during review.

The offset between the baseline survey cable route and the “As-built” cable route clearly makes direct comparisons between the two impossible. Furthermore, although the location of the start of the dive and video recordings is generally known, it is unclear exactly where the starting point is with exception of video segment 11 9 12B which starts at the SCTA, an image of which is included on the recording. Without visible markers along the path recorded and the uncertainty of the point at which the dive and recordings end, it is unclear where along the recording the diver is at any given time. Similarly, it is difficult to determine proximity to the cable route other than when the cable is visible.

Despite the difficulties encountered with the video review and the inability to directly compare the November 9, 2012 videos to those of the July 2011 baseline, certain general statements can be made. The bottom sediments seen in videos 11 9 12A and 11 9 12B, recorded along the deeper portion of the cable route between the TGU and the dogleg toward shore, appear to be generally consistent with the sediment description for Transect 2 of the baseline survey conducted in July 2011 that covered the deeper areas of the cable route (refer to Table 1). The first portion of video 11 9 12A, reported as starting at the “dogleg” and heading southeast toward the TGU, covers an area that was not covered during the baseline survey due to the cable route shift. Sediments shown on the later portion of the video are consistent with those observed at the northeast end of the July 2011 Transect 2 video, specifically rocks, coarse sand and relic mussel shell. This is also similar to the sediment description of Station 9 of the July 2011 baseline survey (the sampling station at the end of Transect 2) where the sediments are described as cobble, relic mussel shells and shell hash. Sediments observed along the path of video 11 9 12B begin as cobble with a fine layer of silt, gravel, occasional rocks, small boulders and relic shell and transition to gravel and rocks at the end of the recording; these are also generally consistent with the sediment descriptions of the baseline Transect 2 video which begins over cobble, stones and relic shell and transitions to rocks, coarse sand, shell hash, clay and relic mussel shell. The epifauna seen on videos 11 9 12A and 11 9 12B are also consistent with those previously observed, specifically a predominance of sea potatoes and green sea urchin and sea cucumbers, northern red anemones and scallops occasionally or rarely seen.

The sediment and epifauna composition seen on video 11 9 12C appear generally consistent with those previously seen along Transect 1 of the July 2011 baseline. Specifically, the sediment transitions from predominantly relic mussel shell in the deeper area at the northeast end to cobble, gravel and clay in the shallower area at the southwest. The epifauna are dominated by urchins throughout much of the recording with sea potatoes observed in the deeper area; northern red anemones become more numerous attached to hard substrate in the shallower area where sea peaches begin to appear. Several scallops are seen but their broader abundance is difficult to determine. Nevertheless, their abundance appears to be reduced compared to along Transect 1 of the July 2011 baseline survey when they were commonly seen.

The laying and burial of the cable was completed in July 2012 using a vessel-towed sled and plow. Most of the video recordings taken on November 9, 2012 focus on a narrow area immediately surrounding the exposed or buried cable, but some panning of the broader surrounding area does occur. During these pans, no obvious evidence of the passage of the sled, such as furrowing or mounding of the bottom, is seen.

The cable is buried for some portion of the recording in all three videos and, where it is not visible, the divers appear to have difficulty determining its exact route although they are able to reacquire exposed sections further along the route. Given the uncertainty of the video recordings' proximity to the buried cable, it is difficult to assess whether any disturbance effect exists. Where exposed, the cable is stapled into the bottom with steel "U"-shaped bar set at relatively frequent intervals. These exposed, stapled sections of the cable show little sign of movement and little, if any, evidence of scouring of the bottom. In certain areas, urchins, northern red anemones and waved whelks are frequently seen attached to the cable; in others sea potatoes, sea cucumbers and scallops are seen occurring immediately adjacent to the cable.

Based on these observations, it appears that the exposed sections of the cable are causing minimal disturbance to the seabed and are not adversely impacting the surrounding habitat or benthic epifauna. The buried portion of the cable is stationary and would not be expected to cause any disturbance impacts.

The quality of the video recordings will need to improve if they are to be useful in a continuing effort to assess benthic impacts. MER met with ORPC and its dive consultant on December 14, 2012 to discuss improved data collection methods during cable surveys. Steps to be taken include improvement of the field of view through additional lighting; correction of the "hot spot" effect through the use of a light diffuser over the spot light lens; and reduction or elimination of the erratic motion of the recording. More precise location information needs to be provided, including, at a minimum, geographic coordinates for the start and end of each recording. Additional comments on the video quality and recommendations for improving the quality are included in Attachment I. MER and ORPC have been in discussions to address these issues and steps are being taken to implement the recommendations.

Table 1. July 2011 Upper Cobscook Bay baseline video transect and benthic sampling station coordinates, sediment type, and predominant organism(s)

UCB	Latitude	Longitude	Sediment	Predominant organism(s)/relative abundance*
Video T1 Start (NE T1)	44 54.590	-67 2.960	relic mussel shell, cobble, stones	sea potatoes (A), sea stars (C), sea cucumbers (C), anemones (C), sea scallops (C)
Video T1 End (SW T1)	44 54.264	-67 3.217	sand, clay, relic shell	green sea urchin (A), whelks (A), sea peaches (O/C)
Video Sta 9 to St 8 Start	44 54.620	-67 2.870	gravel/sand/shell hash/boulders	sea potatoes (A), anemones (C/A), sponges (C)
Video Sta 9 to St 8 End	44 54.590	-67 2.960	relic shell, cobble, stones	sea potatoes (A), anemones (C/A), sponges (C)
Video T2 Start (SE T2)	44 54.580	-67 2.740	cobble, stones, relic shell, shell hash	sea potatoes (A), anemones (C/A), sea stars (C), sea cucumbers (C), sea urchins (C), sea scallops (O)
Video T2 End (NW T2)	44 54.620	-67 2.870	rocks/coarse sand/shell hash/clay/mussel shell	sea potatoes (A), sea stars (C), sea cucumbers (C), sea urchins (C), sea scallops (O), hermit crab (R)
Station 1 (T1)	44 54.264	-67 3.217	sand, clay, relic shell	sea urchins (A), sea cucumbers (C), waved whelk (C)
Station 2 (T1)	44 54.300	-67 3.160	sand, clay, relic shell, shell hash	sea urchins (A), sea cucumbers (C), waved whelk (C), sea peaches (C)
Station 3 (T1)	44 54.347	-67 3.128	gravel, shell hash, sand, hard-pan clay	sea urchins (A), sea peaches (A), sea cucumbers (C), sea scallops (C)
Station 4 (T1)	44 54.396	-67 3.094	cobble, sand, mussel shell hash, rocks, clay base	sea urchins (A), sea peaches (A), sea cucumbers (C), sea scallops (C)
Station 5 (T1)	44 54.444	-67 3.060	cobble, gravel, sand, mussel shell hash	sea urchins (A), sea stars (C), sea scallops (C), sea potatoes (C/A), sea peaches (C)
Station 6 (T1)	44 54.493	-67 3.027	cobble, gravel, relic mussel shell	sea scallops (C/A), sea cucumbers (C), anemones (C); hermit crab (R); lobster (R),
Station 7 (T1)	44 54.541	-67 2.994	relic mussel shells, cobble	sea scallops (C/A), sea cucumbers (C), anemones (C)
Station 8 (T1)	44 54.590	-67 2.960	relic mussel shell, cobble, stones, boulders	sea potatoes (A), sea cucumbers (C), anemones (C)
Station 9 (T2)	44 54.620	-67 2.870	cobble, relic mussel shell, shell hash	sea potatoes (A), sea cucumbers (C), sea urchins (C), sea scallops (O)
Station 10 (T2)	44 54.601	-67 2.809	cobble, relic mussel shell, shell hash	sea potatoes (A), sea stars (C), sea cucumbers (C), sea urchins (C), sea scallops (O)
Station 11 (T2)	44 54.580	-67 2.740	cobble, relic mussel shell, shell hash	sea potatoes (A), anemones (C/A), sea stars (C), sea cucumbers (C), sea urchins (C), sea scallops (O)

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Attachment I

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ORPC Benthic Monitoring Survey
12/14/12

Review of 11/9/2012 cable inspection video using Go Pro camera

Critique:

1. Field of view (FOV) is very narrow – too narrow for proper benthic community review and analysis;
2. "Hot spot" in lighting makes viewing very difficult and makes relative abundance estimates impossible;
3. Lighting and excessive motion of camera makes organism identification difficult to impossible;
4. "Jerking" motion blurs image and makes review of benthic community impossible; light appears to be fixed/mounted to camera (or vice versa) – type of light?
5. When cable is showing we know we are on the route, but when cable is buried it is difficult to know where the cable is and how far away the diver/camera is from the cable. In certain videos the guide-rope (orange rope/line) is off-set from the cable but by a varying and unknown distance.
6. Camera appears to be fixed-focused on far-field – when close or resting on the bottom the near-field is out of focus.

Need to:

1. Increase field of view with more light – a doubling of field of view would be good. Field of view can be expanded primarily laterally (horizontally) rather than vertically – this can be achieved with additional lighting;
2. Eliminate the "hot spot" by installing light diffusers on the lights; frosted glass may help although two layers may be required – even with two layers, hot spot may still not be fully eliminated. Ampibico has a diffuser about 3¼" in diameter – costs about $63US if I recall correctly – contact: Joe Bendahan @ Aquatica, Montreal Quebec CA – 514-737-9481, joe@aquatica.ca ; see: http://www.amphibico.com
3. Need to slow down rate of swim and rate of motion of camera during pans across the bottom; rate should be at least have of what diver "believes" a proper rate should be… rate needs to be consciously slowed; see video GoPro 11912C 0:10:00 to 0:10:30 and 0:12:30 to 0:13:30 as examples of acceptable footage.
4. Filming needs to be done at a consistent distance off the bottom; 2-3 feet is usually fine but depends on lighting – more light with greater field of view, further diver can be off bottom; narrower the FOV is, the closer diver needs to be, but the closer he is to the bottom, the slower he needs to swim to avoid a "blur";
5. Avoid "Startrek" effect when particulates in the water cause refraction of light by steepening the angle to the bottom; may need to be nearly perpendicular under very turbid conditions, but if so, rate of swim needs to be slowed as above in 4.;
6. Need to be able to reference video location along route
7. Is "Auto-focus" an option of on the GoPro camera… likely not.

Next steps:

1. On next video run (December 2012/Jan 2013) modify existing equipment to improve usefulness of video – add another light and have lights overlap at center of FOV;
2. Slow swim rate and panning rate to improve video quality;
3. On next-following video run (Jan/Feb 2013) use MER diver held Amphibico video equipment ;
4. Investigate use of remote "drop" camera with GPS tracking embedded on video – MER has equipment but if decided as choice, new equipment will be necessary – MER-ORPC can discuss shared cost, fee, etc. to avoid duplication of equipment.

Review of video recording of February 2, 2013
Ocean Renewable Power Company Maine (ORPC)
Upper Cobscook Bay

Prepared for

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March 11, 2013

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Introduction

Ocean Renewable Power Company Maine (ORPC) conducted an inspection of the power and data cable route associated with its Upper Cobscook Bay TidGen™ tidal power generation unit (TGU) on February 2, 2013. The inspection covered the entire cable route, running from the nearshore area (previous Station 1) in Gove Cove on Seward Neck in Lubec, Maine to the TGU deployment area to the shoreline landing.

The inspection included video recordings to document the condition of the cable as well as the benthic habitat along the cable route. MER Assessment Corporation (MER) did participate in the planning of the cable inspection effort but did not participate in the actual execution. MER was requested to review the video recordings to assess the condition of the benthic habitat and associated epibenthic fauna. This report summarizes observations made during the review and provides comments on the video recording methods used.

Methods

A video transect line was deployed along the bottom using Tide Tracker and a Hemisphere VS101 GPS positioning unit. The transect line was made up of four (4) 900 ft lines and one (1) 400 ft line for a total of 4,000 ft. The video transect lines was held in place by weights dropped at specific distances as shown in Table 1 following a course shown in Figures 1 and 2.

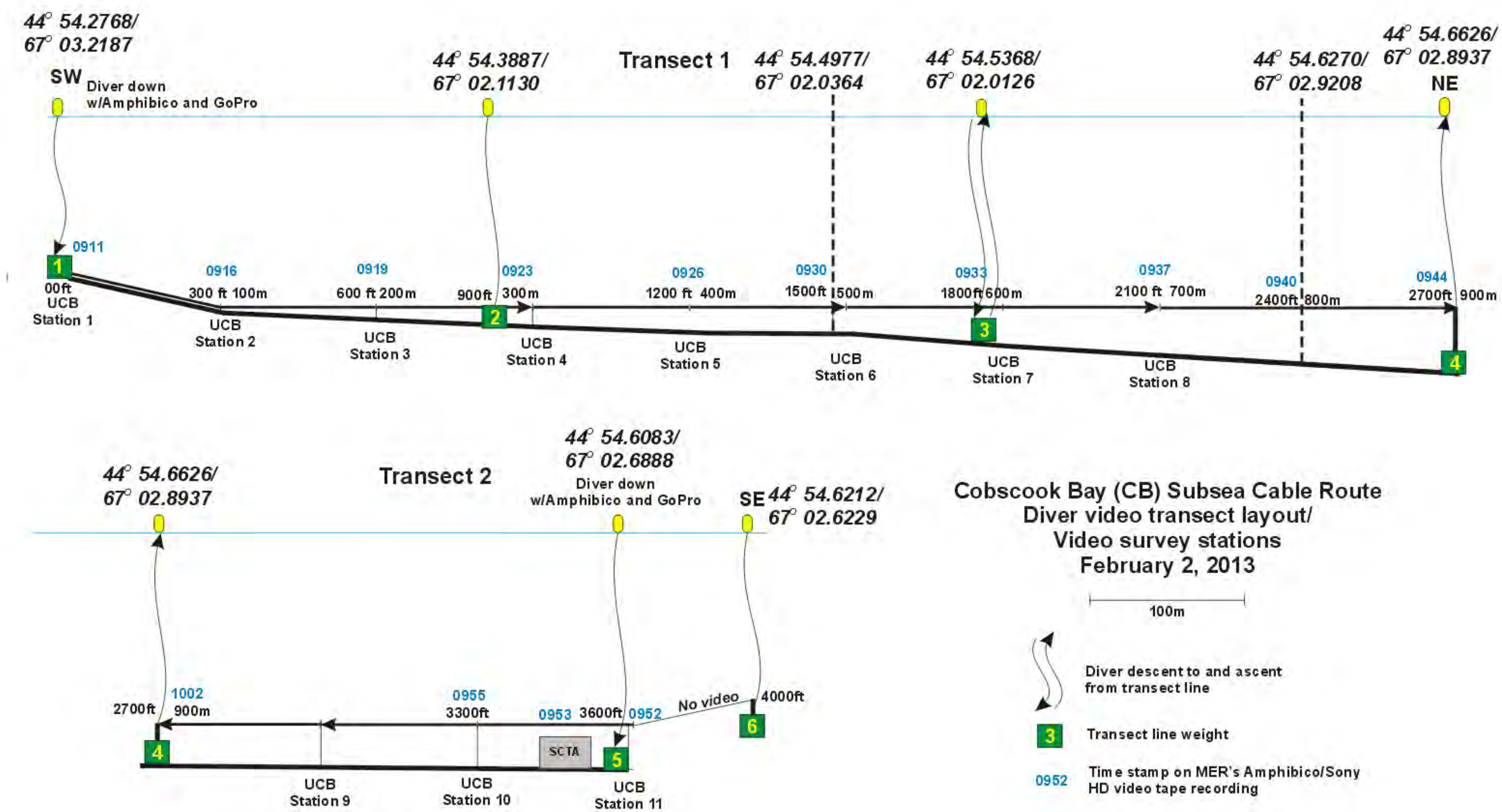
Table 1. Video transect line distances, weight locations (Lat/Long) and depths in meters (Source: ORPC)

Distance (ft)	Latitude	Longitude	Depth (m)
0	44°54.2768	67°03.2187	1.0
900	44°54.3887	67°03.1130	12.3
1500	44°54.4977	67°03.0364	19.5
1800	44°54.5368	67°03.0126	23.9
2400	44°54.6270	67°02.9208	25.1
2700	44°54.6626	67°02.8937	25.6
3300	44°54.6159	67°02.7593	26.0
3600	44°54.6083	67°02.6888	25.9
4000	44°54.6212	67°02.6229	28.2

Video recordings were made by Braden's Future, Inc. SCUBA divers using MER's Amphibico VHHCEL57/Sony HDR-HC9 high definition digital video camera and Amphibico VLDIG3AL 35W/50W switchable underwater arc lamp lighting package. Video was simultaneously recorded using a light-mounted Go Pro camera; lighting was the same as that for the Amphibico housed Sony camera. Videos were provided to MER as HD tapes from the Sony camera and mp4 files from the Go Pro cameras. The taped recordings were uploaded to a Panasonic DMR T3040 HDD Recorder/Burner and reviewed on a Sony Trinitron screen; the Go Pro recordings were uploaded to a HP Desktop and reviewed using Quick Time Player (Apple, Inc.) on a 22" monitor. The Sony captured videos were reviewed for purposes of benthic disturbance/recovery assessment; the Go Pro recordings were reviewed to determine their suitability for benthic monitoring purposes in addition to cable inspection.

Figure 1. February 2, 2013 survey video route locations and (Source: David Turner, ORPC)

Figure 2. February 2, 2013 survey video route locations and (Source: David Turner, ORPC)



Results:

Table 2, below, summarizes the sediment composition and predominant species and their relative abundance based on the review of the video recordings.

Table 2. Video survey times, distances and observed sediment types and species/relative abundance

Start time	Interim time	Distance (ft/m)	Weight No.	Sediment Type	Species/Abundance
0911	0915	300/100	1	Soft silt with epilithic diatoms	Urchins (A), unidentifiable worm tubes (A), hermit crabs (C)
0915	0919	600/200		Silt covered gravel	Urchins (A), hermit crabs (C), sea scallops (C)
0919	0923	900/300	2	Pink coral covered cobble	Urchins (A), Northern red anemone (A), sea scallops (A), sea peach (C), sea potatoes (C) , hermit crab (C), star fish (C)
0923	0926	1200/400		Pink coral covered cobble	Urchins (A), Northern red anemone (A), sea scallops (A), star fish (A), sea peach (C), sea potatoes (C), hermit crab (C)
0926	0930	1500/500		Cobble/heavy relic shells	Urchins (A), Northern red anemone (A), sea scallops (A), sea potatoes (C)
0930	0933	1800/600	3	Cobble/heavy relic shells	Urchins, sea potatoes, (A), Northern red anemone (C), sea scallops (C), hermit crabs (C)
0933	0937	2100/700		Cobble/heavy relic shells	Urchins (C), sea potatoes (C), Northern red anemone (C), sea scallops (C)
0937	0940	2400/800		Boulders, cobble/heavy relic shells	Urchins (C), sea potatoes (C), Northern red anemone (C)
0940	0944	2700/900	4	Cobble/heavy relic shells	Urchins (C), sea potatoes (C), Northern red anemone (C), sea scallops (C), hermit crabs (C) (diver up)
0952	0955	300/100	5	Cobble/gravel/heavy relic shells	Sea potatoes (A), urchins (C), Northern red anemone (C), hermit crabs (C) SCTA reached and in view at 0953
0955	1002	600/200	4	Cobble/gravel/heavy relic shells	Urchins (A), Northern red anemone(C), hermit crabs (C), star fish (C)
					Other species found in limited number (rare): Kelp, rockweed, crumb of bread sponge, fig sponge, palmate sponge, purple sun star, large northern sea cucumber, burrowing anemone, Stimpson's whelk, waved whelk, bushy backed

Discussion

The quality of the video recorded with the MER camera/housing/light package is very good over the entire cable route from the shallows to the deeper deployment area and allows clear observation of the seafloor composition and epibenthic community. The GoPro video recordings are similarly good and substantially better than the previous recordings of November 9, 2012 in the shallow to moderate depths (<70-75 feet) where the ambient light is enhanced by the artificial lighting provided by MER's Amphibico VLDIG3AL 35W/50W lighting package; any lighting system providing similar temperature and intensity light would be expected to provide similar results. However, again, some loss of definition seems to occur with the GoPro camera at depth under artificial lighting conditions making identification and relative abundance estimates difficult. This might be alleviated with a slower swim rate; however, given the depth in excess of 25 meters along much of the cable route and the short recording time allowed by the brief "slack" water period, this may prove impractical. The transect line is marked with distance markers (orange tape making 300-ft intervals) and the divers were occasionally able to show the marker and distance quite clearly but, on other occasions the writing on the tape marker was not readable due to a lighting "hot spot" or the diver simply moving past too quickly; these can, nevertheless be counted as long as the diver makes certain to capture an image of the marker as he passes it. The image also has a slight skip even when the file being viewed is saved to the computer's drive rather than being viewed off of a DVD. This is not caused by erratic motion of the camera by the diver but appears to be a momentary delay during image saving by the camera onto the Scan Disk. The frequent skipping combined with the blurring of the artificially lighted image in the darkness at depth continues to complicate review of the videos recorded in the deeper portions of the cable route.

As shown in Figure 1, the February 2, 2013 transect line is offset from the baseline survey cable route and the *As-built* cable route over much of video recorded course although the offset between the video transect line and the *As built* route is relatively small (5-6 meters) between Weights #2 and #3. The transect line crosses the *As built* route just before Weight #2 and approximately 50 meters before Weight #4. The cable is also seen for several meters from the shore cable termination anchor (SCTA) until it becomes buried in the bottom. Clearly, as before, where the video transect is offset by considerable distance from the *As built* cable route, direct comparisons between the two is impossible. However, where the cable is visible on the surface, the cable is seen firmly stapled to the bottom and there is no evidence of scouring or disturbance to the bottom caused by cable(s). Epifauna, including green sea urchins, *Strongylocentrotus droebachiensis*, Northern red anemones, *Urticina felina*, sea peaches, *Halocynthia pyriformis*, sea potatoes, *Boltenia ovifera*, waved whelks, *Buccinum undatum*, sea scallops, *Placopecten magellanicus*, and hermit crabs, *Pagurus* sp., are seen adjacent to and, in some cases attached to, the cable(s). Based on these observations, it does not appear that the cable is causing any adverse impacts to the substrate or the associated epifauna. The sediment composition and predominant epifauna observed at the eleven sampling stations (shown in Figures 1 and 2) during the baseline survey in July 2011 are listed in Table 2 for comparative purposes.

Table 3. July 2011 Upper Cobscook Bay baseline video transect and benthic sampling station coordinates, sediment type, and predominant organism(s)

UCB	Latitude	Longitude	Sediment	Predominant organism(s)/relative abundance*
Station 1 (T1)	44 54.264	-67 3.217	sand, clay, relic shell	sea urchins (A), sea cucumbers (C), waved whelk (C)
Station 2 (T1)	44 54.300	-67 3.160	sand, clay, relic shell, shell hash	sea urchins (A), sea cucumbers (C), waved whelk (C), sea peaches (C)
Station 3 (T1)	44 54.347	-67 3.128	gravel, shell hash, sand, hard-pan clay	sea urchins (A), sea peaches (A), sea cucumbers (C), sea scallops (C)
Station 4 (T1)	44 54.396	-67 3.094	cobble, sand, mussel shell hash, rocks, clay base	sea urchins (A), sea peaches (A), sea cucumbers (C), sea scallops (C)
Station 5 (T1)	44 54.444	-67 3.060	cobble, gravel, sand, mussel shell hash	sea urchins (A), sea stars (C), sea scallops (C), sea potatoes (C/A), sea peaches (C)
Station 6 (T1)	44 54.493	-67 3.027	cobble, gravel, relic mussel shell	sea scallops (C/A), sea cucumbers (C), anemones (C); hermit crab (R); lobster (R),
Station 7 (T1)	44 54.541	-67 2.994	relic mussel shells, cobble	sea scallops (C/A), sea cucumbers (C), anemones (C)
Station 8 (T1)	44 54.590	-67 2.960	relic mussel shell, cobble, stones, boulders	sea potatoes (A), sea cucumbers (C), anemones (C)
Station 9 (T2)	44 54.620	-67 2.870	cobble, relic mussel shell, shell hash	sea potatoes (A), sea cucumbers (C), sea urchins (C), sea scallops (O)
Station 10 (T2)	44 54.601	-67 2.809	cobble, relic mussel shell, shell hash	sea potatoes (A), sea stars (C), sea cucumbers (C), sea urchins (C), sea scallops (O)
Station 11 (T2)	44 54.580	-67 2.740	cobble, relic mussel shell, shell hash	sea potatoes (A), anemones (C/A), sea stars (C), sea cucumbers (C), sea urchins (C), sea scallops (O)

Conclusions/recommendations

This video recording effort represents substantial improvement in both the recording technique and quality of the image produced, excepting as mentioned above for the GoPro cameras at depths estimated to be > 75 feet. However, improvement still needs to be made in properly imaging the distance markers attached to the transect line to allow the video reviewers to properly track the diver's progress along the transect line and to locate the image being reviewed along the cable route; it is vitally important that the distance marker tags be clearly visible to the reviewer. We would recommend that each time a red tag (not necessarily a mark, e.g. black-painted mark) with distance is encountered the diver make a momentary stop to clearly record the distance; failure to do this, particularly if a tag is missed altogether, leads to guessing on the part of the reviewer as to the location of the diver and the image being recorded. We would recommend that the divers meet with the MER video reviewers to review the videos or portions of them to gain a better understanding of what might be done during filming to assist the review process.

Although the GoPro camera images are substantially improved when good lighting is provided, the image is still difficult to use for biological monitoring purposes. MER will therefore continue to make its video and lighting equipment available for future survey efforts.

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Revised Table 2. Proposed Monitoring Schedule of the Fisheries Monitoring Plan for Cobscook Bay

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Fisheries and Marine Life Interaction Monitoring Plans Annual Report
March 2013

University of Maine, School of Marine Sciences
Haley Viehman, Garrett Staines, Gayle Zydlewski

1.0 Introduction

1.1 Study Context and Purpose

Ocean Renewable Power Company, LLC (ORPC) has deployed a TidGen™ Power System in outer Cobscook Bay, Maine, as the first stage of the Cobscook Bay Tidal Energy Project (Figure 1). This installation requires monitoring to assess potential effects of the TidGen™ Power System on the marine environment. ORPC's monitoring plan regarding marine life has two parts: 1) Fisheries Monitoring Plan and 2) Marine Life Interaction Monitoring Plan.

1.2 Study Design

1.2.1 Fisheries monitoring plan

The Fisheries Monitoring Plan is a continuation of research started by the University of Maine's School of Marine Science researchers in 2009. The study was designed to capture tidal, seasonal and spatial variability in the presence of fish in the area of interest (near the TidGen™ deployment site). The design involves down-looking hydroacoustic surveys during several months of the year, and examines the vertical distribution and relative abundance of fish at the project and control site (for relative comparison). Pre-deployment data were collected in 2010, 2011, and early 2012, and will be compared to post-deployment data to quantify changes in fish presence, biomass, and vertical distribution associated with the installation of the TidGen™ power system. Surveys are planned through the year 2017.

1.2.2 Marine life interaction monitoring plan

The Marine Life Interaction Monitoring Plan uses side-looking hydroacoustics collected by ORPC at the TidGen™ project site to assess the interaction of marine life (fish, mammals, and diving birds) with the TidGen™ device. This monitoring focuses on the behavior of marine life (primarily fish) as they approach or depart from the region of the turbine, and will attempt to quantify changes in behavior in response to the TidGen™ unit. Side-looking hydroacoustic data will be collected for three years after the deployment of the TidGen™ Power System.

Figure 1. Cobscook Bay Tidal Energy Project location map and TidGen™ device drawing (CBTEP Fisheries and Marine Life Interaction Plan, 2012). The yellow icon represents the present location of a TidGen™ device. The grey icons represent potential TGU locations to complete an array in the future.

1.3 In This Report

This first report details: (1) approach to date; (2) preliminary results; and (3) challenges to date, how they are being addressed, and future work.

2.0 Approach

2.1 Fisheries Monitoring Plan (down-looking hydroacoustic surveys)

2.1.1 Study design

To compare the relative abundance and vertical distribution of fish at the project site and a control site nearby, both before and after turbine deployment, down-looking hydroacoustic surveys are conducted from a research vessel for one 24-hour period several times per year at each site (Table 1). Locations during pre-deployment sampling include one site at the project location (CB1) and one control site (CB2), approximately 1.6 km seaward of the project site (Figure 2). During post-deployment, three sites were sampled: two at the project location (CB1a, beside the turbine, and CB1b, in line with the turbine) and one at the same control site (CB2) (Figure 2). Sampling locations at the project sites in 2012 varied geographically because of construction activity and related safety concerns around the TidGen™. January and March were pre-deployment surveys, so only CB1b and CB2 were sampled. CB1b in March was only sampled for 12 hours due to extreme weather. There was no November sample because the TGU was removed for maintenance.

The down-looking surveys are carried out using a single-beam Simrad ES60 commercial fisheries echosounder, with a wide-angle (31° half-power beam angle), dual-frequency (38 and 200 kHz) circular transducer. In May 2012, a Simrad EK60 200 kHz split beam echosounder was added to the previous sampling protocol. The transducers are mounted over the side of the research vessel 1.8 meters below the surface, and they ensonify (alternately, every 0.5 seconds) an approximately conical volume of water extending to the sea floor. A 600 kHz Workhorse Sentinel Acoustic Doppler Current Profiler (ADCP) is set to record mean current speed in 1 meter bins to the sea floor every 30 minutes during the survey. ADCP data are used to determine slack tide periods during sampling.

Table 1. Months sampled for Fisheries Monitoring Plan (down-looking hydroacoustics). 1 and 2 indicate sampling at CB1 and CB2, respectively; 1a, 1b, and 2 indicate sampling at CB1a, CB1b, and CB2, respectively. Light gray indicates presence of TidGen™ bottom frame only; dark gray indicates presence of complete TidGen™.

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
2010					1, 2			1, 2	1, 2	1, 2	1, 2	
2011			1, 2		1, 2	1,2		1, 2	1, 2		1, 2	
2012	1, 2		1, 2		1a, 1b, 2	2		1a, 1b, 2	1a, 1b, 2			

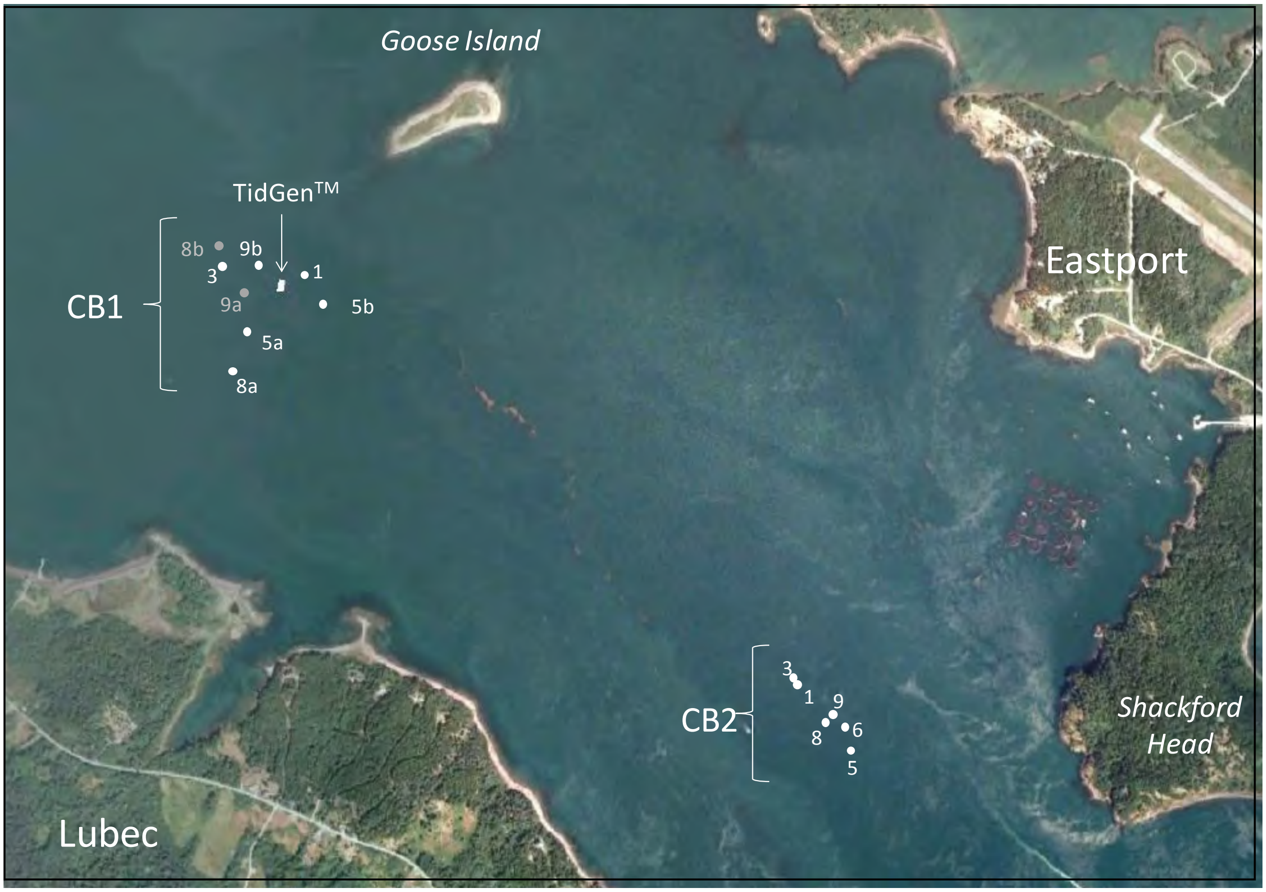


Figure 2. Fisheries Monitoring Plan study area and down-looking hydroacoustic survey locations for 2012. Each point represents the mooring location for one 24-hour survey. Numbers indicate the month of each survey; a and b indicate CB1a or CB1b, if applicable. Darker points (8b and 9a at CB1) are approximate due to GPS error.

The single-beam transducer, used for relative comparison to baseline data collected in 2010 and 2011, does not provide information on an acoustic target's location within the ensonified beam cross-section. This lack of angular data prevents meaningful target strength (TS) data, and therefore estimates of absolute fish abundance, from being acquired. Instead, a relative hydroacoustic measure of fish biomass is used to examine changes in fish biomass over time. This relative measure is also used to assess vertical distribution of fish biomass in the water column.

Comparisons of fish biomass and vertical distribution are made among the control site and project site(s) and among different months at each site. Sampling before and after turbine deployment at the project as well as at a control site improves the ability to distinguish changes that may be related to the presence of the turbine from changes due to annual, seasonal, daily, and tidal variation. These methods are consistent with a before-after-control-impact (BACI) statistical design. In the future, split beam data will be used to provide accurate TS on single fish and potentially allow quantitative measures of fish movement.

2.1.2 Data processing

Hydroacoustic data are processed using Echoview® software (5.3, Myriax Pty. Ltd., Hobart, Australia), and statistical analyses are carried out in MATLAB (r2011b, The MathWorks, Inc., Natick, MA, USA). 200 kHz frequency data are used in analyses. Processing includes scrutinizing the data and removing areas of noise (e.g., from electrical interference, a passing boat's depth sounder, high boat motion). Hydroacoustic interference from entrained air is common in the upper 10 m of the water column; analyses are therefore limited to the lowest 15 m of the water column. Unwanted hydroacoustic signals (such as plankton, krill, and fish larvae) are excluded by eliminating backscatter from targets with TS less than -60 dB. Most fish have a TS between -60 dB and -20 dB but TS varies greatly with fish anatomy and orientation (Simmonds and MacLennan 2005). This variability, combined with the TS uncertainty inherent in single beam systems, means that some fish will be excluded from analyses. Fish presence is measured on a relative scale using volume backscatter (S_V), which is a measure of the sound scattered by a unit volume of water and is assumed proportional to biomass (Simmonds and MacLennan 2005). S_V is expressed in the logarithmic domain as decibels, dB re 1 m^{-1}. Area backscatter, s_a, is the summation of volume backscatter over a given depth range, and is also proportional to fish biomass (Simmonds and MacLennan 2005). s_a is expressed in the linear domain ($m^2 \cdot m^{-2}$) and is used for vertical distribution comparisons.

Because flowing tides are the focus of this study, hydroacoustic data during slack tides are not included in analyses. Slack tides span one hour, centered at the time of low or high water. Mean current speed is obtained for each half hour by averaging ADCP data from surface to seafloor. The recorded time with the lowest water flow value is deemed slack. The half hour before and after this time is then removed from hydroacoustics data processing and analyses.

Inspected hydroacoustic data are divided into 30-minute segments. Echoview is used to calculate the mean S_v of the water column for each 30-min interval. For each interval, s_a is calculated for 1-m layers within the water column. By calculating the proportion of total water column s_a that is contributed by each 1-m layer of water, the vertical distribution of fish is constructed for each 30-min time interval. Layers are measured upward from the sea floor, rather than downward from the surface, as the turbine is installed at a fixed distance above the bottom (top of turbine at 9.6 m above the sea floor). In the future, split beam data will be processed similarly to determine whether it can be used for comparison to previously collected single beam data. At minimum, split beam data will be used to (1) make meaningful comparisons of the vertical distribution of fish using s_a; (2) quantify the number of fish tracks observed in 1 m layers measured up from the sea floor; and (3) provide accurate TS for tracked fish. Analyses comparing S_v between the single and split beam systems are underway.

Statistical comparisons of overall fish biomass and vertical distribution can be conducted among survey dates using t-test and linear regression analyses, as in Viehman 2012. Briefly, mean water column S_v values for each entire 24 h survey can be compared to other 24 h surveys using t-tests (significance level = 0.05). Vertical distributions can be compared by linear regression of one distribution onto the other. Shape similarity is indicated by a significant fit (significance level of 0.05) and a positive slope. Negative slope or insignificant fit indicates dissimilar distributions. For a full description of single-beam data analyses methods used and results from pre-deployment data collected, see Viehman 2012.

2.2 Marine Life Interaction Monitoring Plan (side-looking hydroacoustics)

2.2.1 Study design

ORPC has mounted a Simrad EK60 split beam echosounder (200 kHz, 7° half-power beam width) to a steel frame located 44.5 m from the southern edge of the TidGen™ (Figure 3). This frame holds the transducer 3.4 m above the sea floor, with the transducer angled 9.6° above the horizontal with a heading of 23.3°. The echosounder samples an approximately conical volume of water extending for 100 m, directly seaward of the TidGen™ device (Figure 3). The actual sampled volume used in data analysis is smaller, extending to the far edge of the turbine (78.1 m) rather than beyond. This is because after that point, interference from sound reflection off the water's surface becomes too great to reliably detect fish. The sampled volume is upstream of the device during the flood tide and downstream of the device during the ebb tide. The echosounder is powered and controlled via undersea cables from the ORPC shore station in Lubec, where data files are stored on a server and collected periodically by the University.

The echosounder records data continuously (though to date, collection has been intermittent; see Sections 3.2.1 and 4.2). Continuous data collection at a fast sample rate (4 to 6 per second) allows each fish or other marine animal that passes through the beam to be detected several times, recording information on the echo strength and 3D location within the beam (Figure 4). These data are used to track fish movement during their approach to the turbine (flood tide) as well as during their departure (ebb tide) on a fine spatio-temporal scale. The sampled volume is divided into three zones: the turbine zone, where fish would be likely to encounter the turbine; above the turbine zone (A, Figure 3a); and beside the turbine zone (B, Figure 3a). Fish numbers and movement in each zone provide indicators of turbine avoidance. The total sampling volume to 78.1 m range (for a 7° cone) is 1,866 m^3, and of this, 607m^3 are within the turbine zone, 345 m^3 are beside the turbine zone, and 914 m^3 are above the turbine zone.

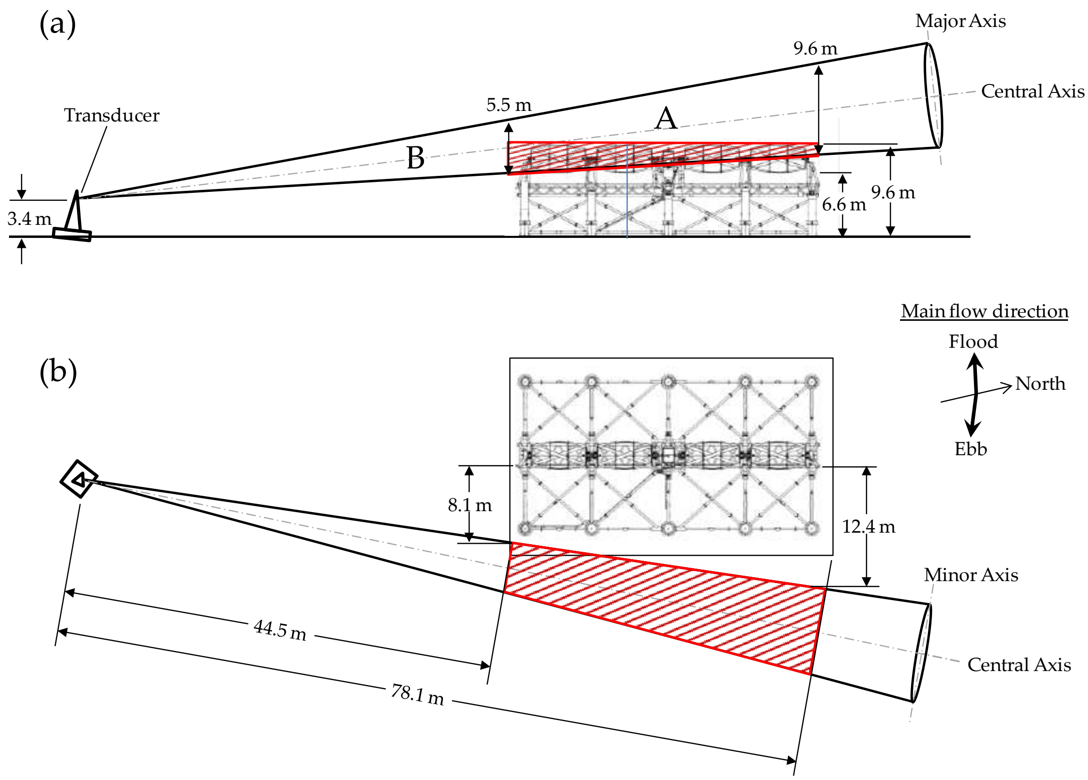


Figure 3. Marine Life Interaction Monitoring Plan setup. TidGen™ device and Simrad EK60 support structure shown from (a) the seaward side and (b) above. Hydroacoustic beam represented as 7° cone (half-power beam width) in solid black lines. Red hatched area indicates sampled volume within the turbine zone, A indicates the volume sampled above the turbine, and B indicates the volume sampled beside the turbine. Flow directions shown were provided by ORPC.

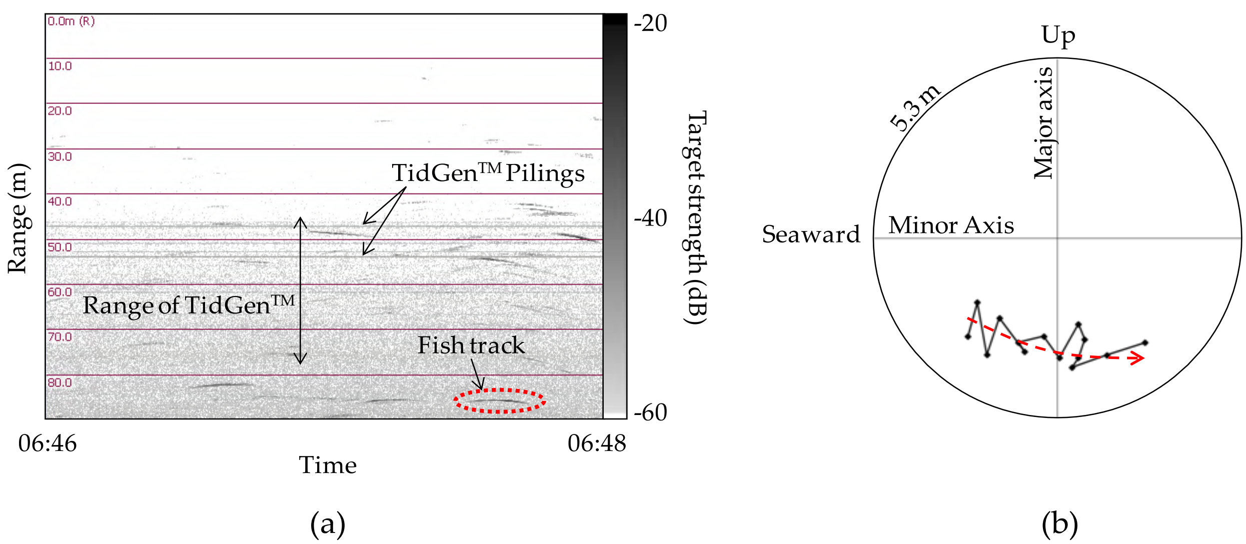


Figure 4. (a) Sample of side-looking hydroacoustic data from 9/30/2012 during the flood tide. (b) Fish in red dashed oval in (a) tracked through beam cross section. Outer circle represents 3.5° off-axis, or 5.3 m at this range. Each dot is a single detection of the fish. Red dashed arrow indicates direction of movement.

Other data collected (provided by ORPC) include current speed and direction, turbine movement in rotations per minute (RPM), and turbine operation state (generating or not). Current speed and direction are collected by a flow meter mounted to the TidGen™ support frame.

2.2.2 Data processing

Echoview is used to process raw side-looking split beam hydroacoustic data. Processing in Echoview begins with manually inspecting the data to identify and exclude unwanted noise (e.g., interference from depth sounders, entrained air from the surface, reflection from surface waves), and setting a TS threshold of -60 dB (consistent with down-looking approach) to exclude plankton and other small objects from analyses. Echoes from single targets are detected, excluding those more than 3.5° from the central axis of the beam or beyond 78.1 m from the transducer (due to the increase in surface noise interference). Single target detection parameters are summarized in Table 2. Echoview's fish tracking module is then used to trace the paths of individual fish through the sampled volume. Schools of fish are excluded from analyses. Fish track data are then exported from Echoview to be further analyzed using MATLAB. The data for each fish track include time of fish detection, location of the fish within the beam over time (range, depth, major and minor off-axis angles), fish TS, and fish swimming speed and direction. Data can then be grouped by month for further analyses.

Flood and ebb tide data are treated separately for all except overall summary data (e.g., total fish TS distribution and fish numbers). This is because a fish's approach to the turbine is sampled during the flood tide while its departure from the turbine is sampled during the ebb tide, and behaviors during each are assumed to differ (Viehman 2012; Viehman and Zydlewski submitted).

Table 2. Single target detection settings in Echoview.

Parameter	Value	Units
Target strength threshold	-60.00	dB
Pulse length determination level	6.00	dB
Minimum normalized pulse length	0.60	Unitless
Maximum normalized pulse length	1.50	Unitless
Beam compensation model	Simrad LOBE	
Maximum beam compensation	6.00	dB
Maximum standard deviation of minor-axis angles	1.000	Degrees
Maximum standard deviation of major-axis angles	1.000	Degrees

Target strength

Target strength (TS) is a point source measure and is the relative amount of acoustic energy reflected back toward the transducer by an object, represented in decibels (dB; Simmonds and MacLennan 2005). Though TS is dependent on several factors, including fish anatomy (e.g., swim bladder or none) and orientation relative to the transducer, it is generally proportional to fish size (Simmonds and MacLennan 2005). Depending on the species known to be in the area, TS may be used to identify with some probability the species of a detected fish and its size. The TS distribution is therefore extracted for each month of data in order to provide information on the size of fish sampled. The fish community of Cobscook Bay is also being assessed by UMaine (preliminary results from 2012 are included in the Appendix A), and results from that study will aid in identifying probable species represented by hydroacoustic targets.

Number and location of fish tracks

The total number of fish tracks detected by Echoview for each month of hydroacoustic data provides an index of the abundance of fish in the sampled volume over time.

The location of each fish in the sampled volume is used to place it in one of the three zones (in the turbine zone, beside the turbine zone, or above the turbine zone; Figure 3a). Density of fish in each zone is calculated for each ebb and flood tide by dividing the total number of fish detected in each zone by the volume sampled within the zone over the course of the tide. This volume is calculated by multiplying the area of the zone's vertical cross-section by the approximate linear distance of water to pass through it during the time sampled. The linear distance of water is the mean current speed multiplied by the sampling duration. In this way, fish counts were normalized for varying sample times and volumes, allowing the direct comparison of densities from different tidal stages. Densities obtained from each tidal stage are then grouped by month and can be compared to those from other months using a t-test (significance level = 0.05).

Fish swimming speed and direction of movement

The speed and direction of movement of each fish is compared to the current speed and direction at the time of fish detection (when data are available). Higher deviation from the current speed or direction within the turbine zone than in other zones may indicate avoidance behavior. For each month, the difference in fish speed and direction from current speed and direction in each zone is calculated for each tidal stage (flood or ebb) and can be compared to corresponding values from other months using t-tests (significance level = 0.05).

If current speed and direction information is not available (see section 3.2.1), the distributions of fish movement direction and speed and their variance can be used as indicators of avoidance. More variable movement directions are associated with avoidance reactions (e.g., diverting above, below, or to the side of the turbine, or reversing direction; Viehman 2012). Variance in speed and direction within each zone can be compared using one-way ANOVA tests (significance level of 0.05).

3.0 Results to Date

3.1 Fisheries monitoring plan (down-looking hydroacoustics)

Down-looking hydroacoustics data for the Fisheries Monitoring Plan have been collected as outlined in Section 2.1. Total water column fish biomass was determined at each site for each month (Figure 5). Vertical distribution of fish biomass by 1 meter depth layers (measured upward from the sea floor) was determined at each site for each month (Figure 6 and Appendices B and C). Pre-deployment data from 2010 and 2011 were analyzed previously and are not included here, but full analyses are available in Viehman 2012. March had the lowest biomass and May had the highest. As the summer months progressed, biomass decreased.

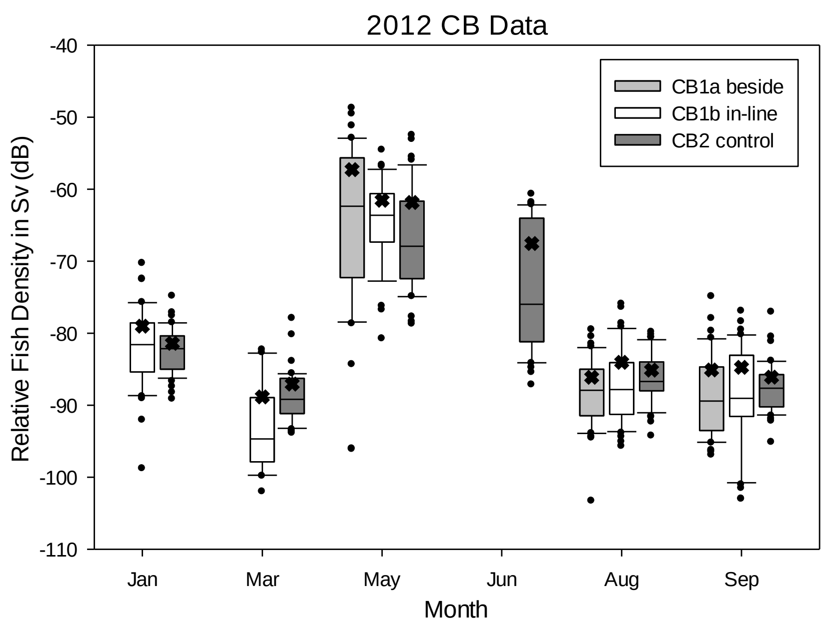


Figure 5. Total water column fish biomass recorded in Cobscook Bay at three sites in 2012. Sv (in dB) is displayed on the y-axis. Each site is represented for each month that data were collected. The box plot shows the 25th, 50th, and 75th percentiles. Each whisker represents the 10th and 90th percentile. The "x" on each is the overall mean. Dots outside the whiskers are outliers and display the variability in fish biomass over a 24 hour period.

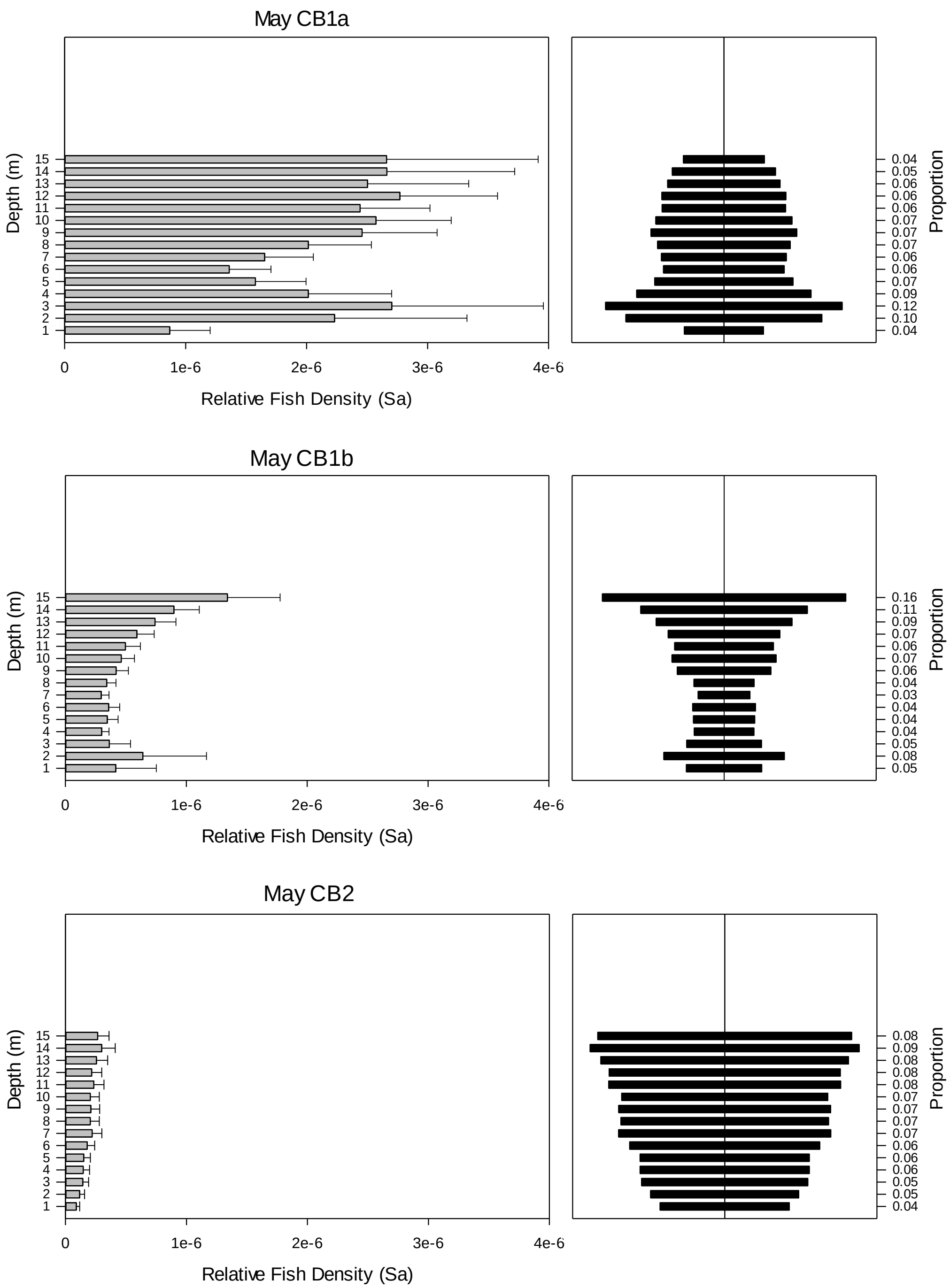


Figure 6. Relative fish densities (+ 1standard error) for Cobscook Bay in May 2012. S_a is an area-relative measure of biomass. Depth strata start at the ocean floor. Note the upper depth strata were not included due to changing tidal levels and entrained air in the upper water column close to the surface (<10 m). Graphs on right are for visual display of how fish are proportionally distributed in the water column. Depth strata are on the left y-axis and proportions of fish density are shown on the right y-axis. Data for January, March, June, August, and September are included in Appendices.

3.2 Marine life interaction monitoring plan (side-looking hydroacoustics)

3.2.1 Data availability

Data collection for the Marine Life Interaction Monitoring Plan began on August 29, 2012. The echosounder can be remotely accessed, acoustic data collection is automated, and data are stored on an ORPC server that is backed up periodically at the University. Due to various operational constraints since the start of data collection, collection has not been continuous (Figure 7). Gaps exist in the side-looking hydroacoustic data whenever the turbine or acoustic system was being repaired or adjusted, during periods of turbine deployment or removal, and whenever divers were present near the echosounder support structure. Additionally, hydroacoustic data have not yet been collected when the turbine was generating power, though collection has been possible while the turbine was free-spinning (moving but not generating power) or still (brake applied). This was because of electrical interference between the data and power transmission cables running together along the seabed to the shore station, and resulted in data gaps 3 to 5 hours in length on days when the turbine was generating. This issue is currently being addressed; however, to date, side-looking hydroacoustic data exist only for times when the turbine was free-spinning or still. As echosounder communication issues are resolved, data collection will become more continuous and reliable. For a discussion of these issues and remedial measures taken or planned, see Section 4.2.

Collection of water current speed and direction data has also been intermittent. For times when data are available, current direction is not reliable due to the alignment of the flow meter, and therefore was not used in the following analyses. Turbine RPM data were combined with power generation data to determine when the turbine was still, free-spinning, or spinning and generating power. Small gaps exist in all three of these data sets, and the first set of RPM data is not accurate due to a communication error that has since been corrected (Figure 7).

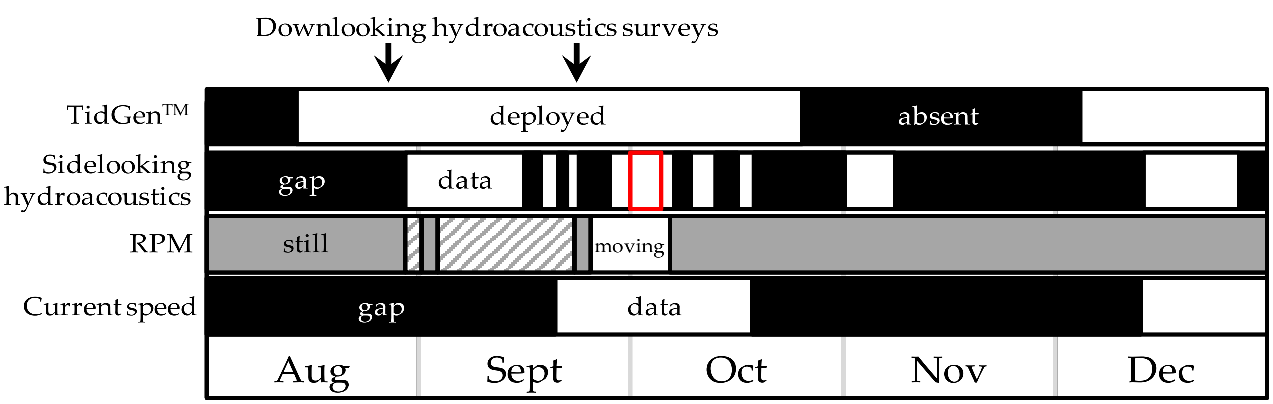


Figure 7. Summary of Marine Life Interaction Monitoring Plan data availability to date. Hatch lines represent revolutions per minute (RPM) data that are not accurate, but indicate that the turbine was free-spinning. Red box highlights data subset analyzed for this report.

Given these gaps in information, a subset of the data collected since August 2012 was analyzed for this report (Figure 8). This subset spans October 1st to October 5th, when the turbine was present and fully operating (that is, the brake was not applied, and the turbine would spin when sufficient current speeds were reached, sometimes generating power; Figure 8). Current speed, RPM, and power generation data are available for this time. The turbine was free-spinning for several tidal stages, resulting in approximately 13 hours of ebb tide data and 8 hours of flood tide data to analyze (Table 3).

As full months of data are not yet available, monthly comparisons have not been carried out as described in the methods section. The distribution of fish TS was created, and fish density was calculated for each zone during flood and ebb tide. The direction of fish movement was examined qualitatively. Sample size is low (4 ebb tides and 3 flood tides), so variances were large and statistical analyses were not carried out; however, this provides an example of future results.

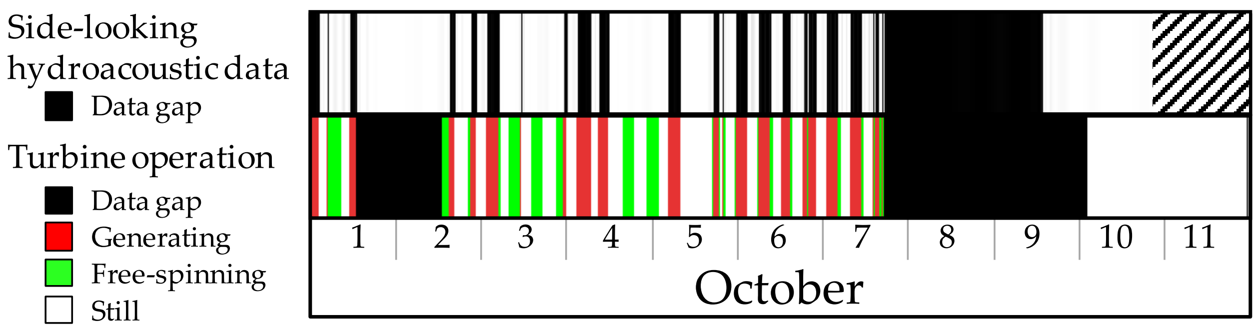


Figure 8. Turbine operational state and side-looking hydroacoustic data availability on dates analyzed for this report. Hatch lines represent hydroacoustic data that were available but could not be used due to interference from rough surface conditions. The green (free-spinning) segments in October 1-5 were analyzed for this report.

Table 3. Summary of data subset analyzed to date.

Fileset	Date	Start time	End time	Tidal stage	Mean current speed ($m \cdot s^{-1}$)	Duration (hrs)	Total fish tracked
1	10/1/2012	02:06	06:11	Ebb	1.26	4.08	2,538
2	10/2/2012	09:20	11:12	Flood	0.40	1.85	247
3	10/3/2012	03:19	06:27	Ebb	0.06	3.15	3,681
4	10/3/2012	09:47	12:36	Flood	0.31	2.82	1,300
5	10/3/2012	16:20	18:18	Ebb	0.41	1.97	1,873
6	10/4/2012	10:22	13:38	Flood	0.34	3.27	1,644
7	10/4/2012	16:47	20:27	Ebb	0.62	3.67	2,360

3.3.1 Results from subset analyzed

A total of 13,643 fish tracks were detected in the acoustic data subset. 3,191 of these were detected during flood tides, and 10,452 detected during ebb tides.

Target strength

The TS distribution of these fish is shown in Figure 9. The distribution is slightly bimodal, with peaks at -57 dB and -50 dB and most detections lying near these values.

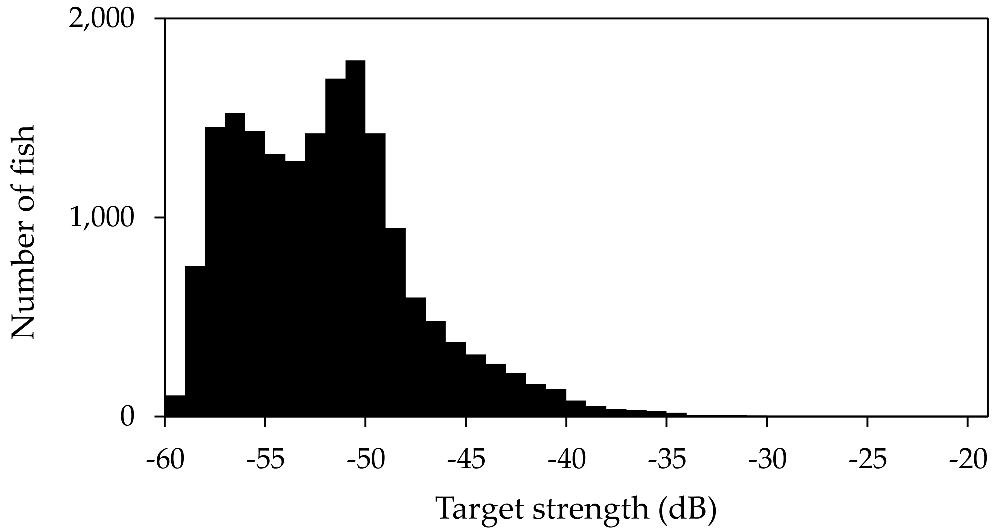


Figure 9. Target strength distribution of all fish detected in data subset.

Fish density

The mean density of fish in each sampling zone is shown in Figure 10. Density appeared to be greater beside and above the turbine than in the turbine zone, though no tests for statistical significance have been carried out due to the low sample size. At this point, densities in the zone beside the turbine may be disproportionately large compared to the densities above and in the turbine zone, possibly due to noise reducing the number of fish detected.

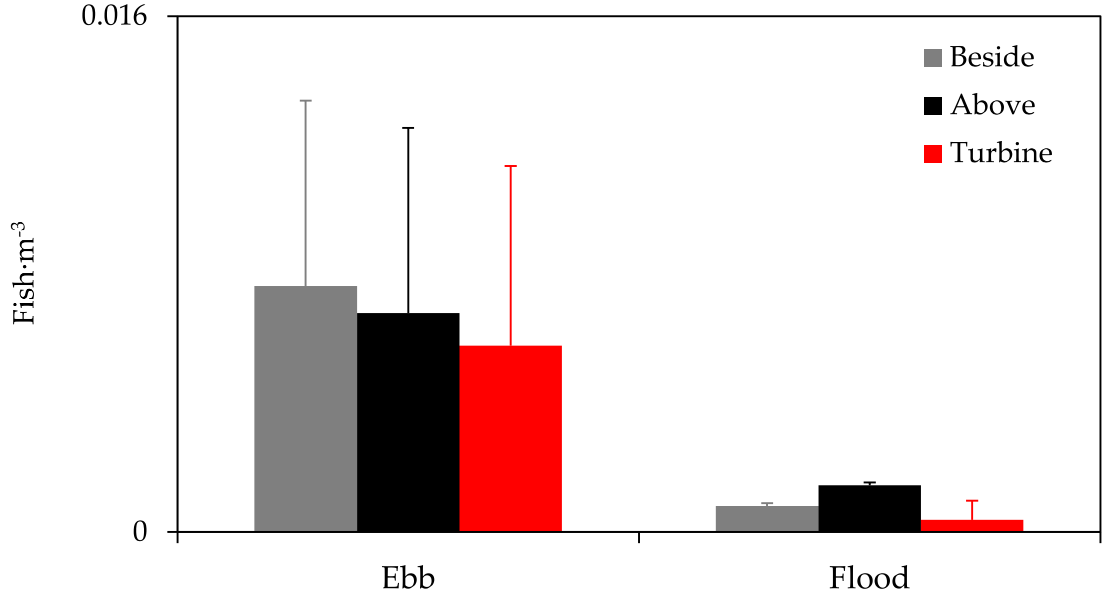
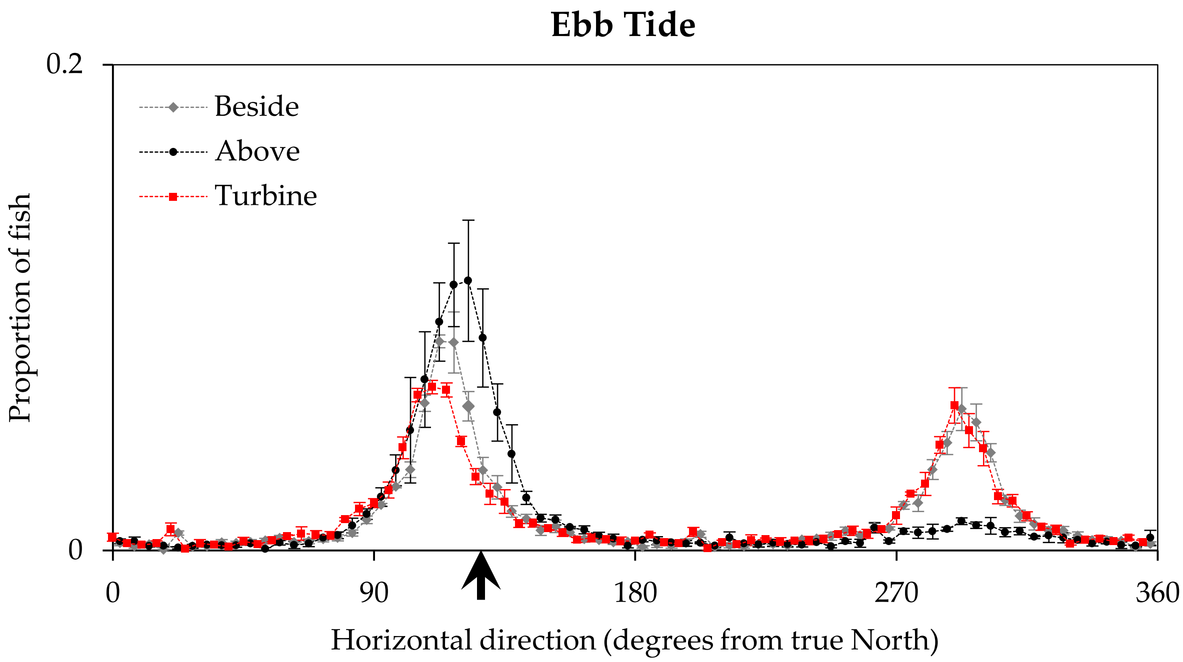


Figure 10. Mean fish density (+1 standard error) in each sampling zone during flood and ebb tide.

Direction of fish movement

The compass heading distribution for fish in each sampling zone was bimodal with peaks at the predominant current directions, indicating fish moving primarily with or against the prevailing current (Figure 11). Due to the small sample size, statistical significance was not tested. Against-current tracks were nearly as prevalent as with-current tracks in the region beside the turbine. Above the turbine, fish moved with the prevailing current almost exclusively. In the turbine zone during the flood tide, a greater proportion of fish were tracked moving against the current than with it. Overall, variance in direction of tracks above the turbine and in the turbine zone appeared greater during flood tides than during ebb tides. However, without current direction data, variation in fish track directions cannot be attributed to fish behavior alone.

The vertical direction distribution for fish beside the turbine peaked at 0°, indicating that most fish in this zone moved horizontally (Figure 12). There were no clear peaks in the distribution for fish in the turbine zone or above it, with vertical movement spread across all directions. Variance in vertical direction appeared greater during the flood tides than the ebb tides.



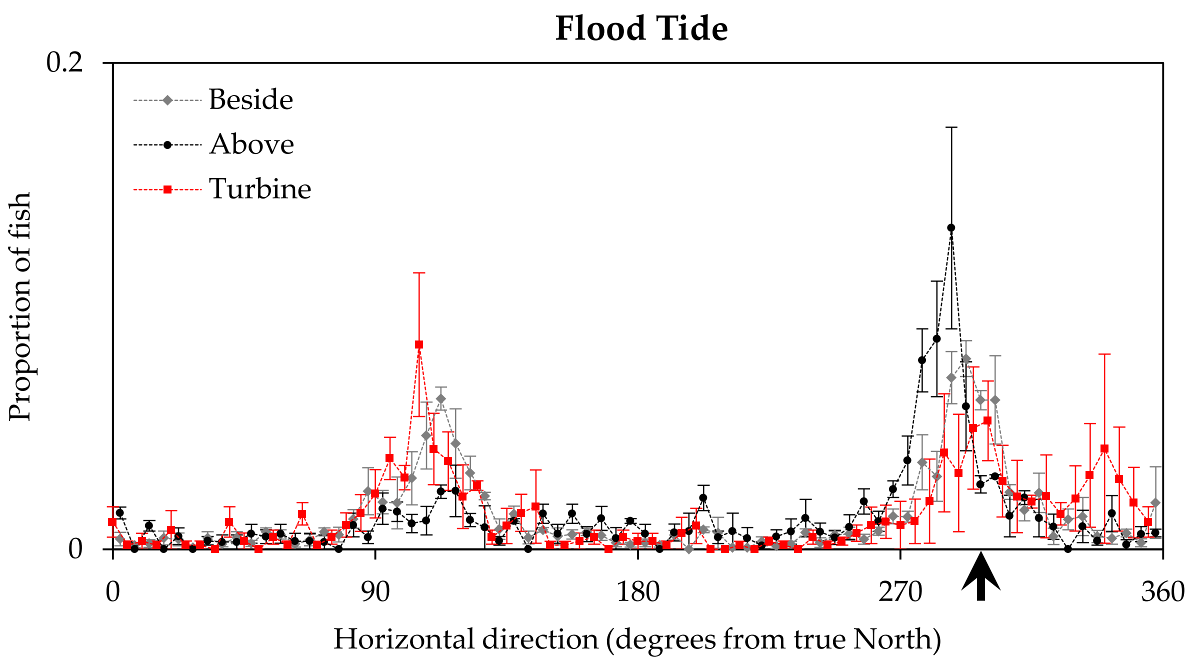
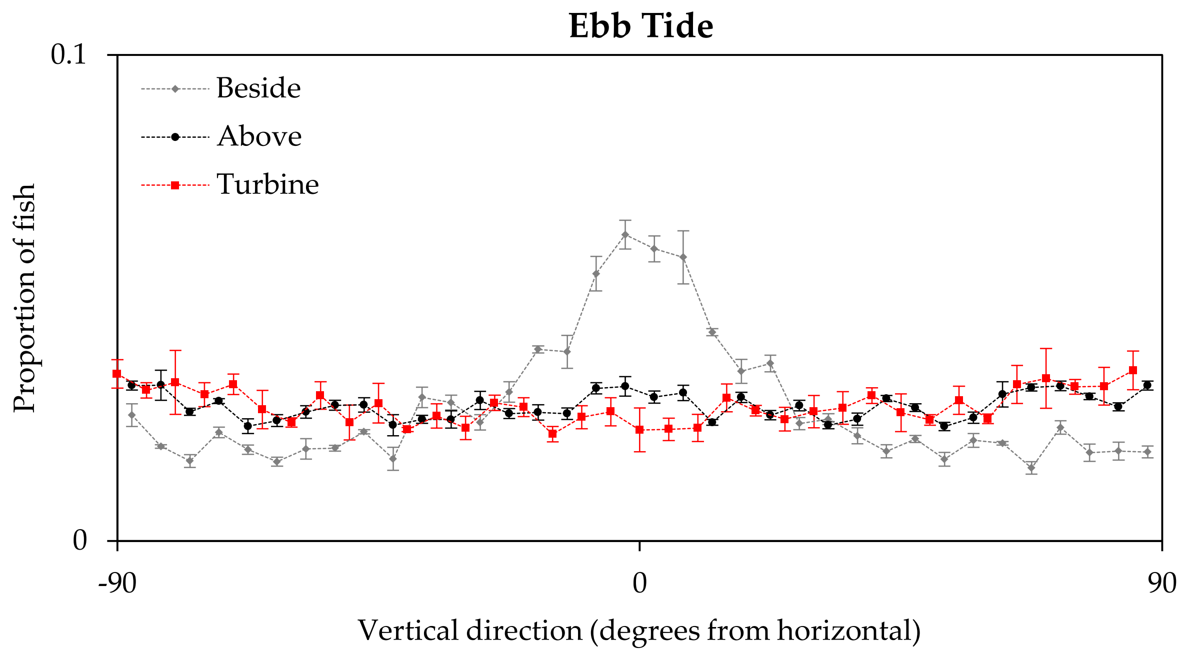


Figure 11. Distribution of horizontal direction of fish movement in each turbine zone for ebb and flood tides. 0°, 90°, 180°, and 270° are North, East, South, and West, respectively. Mean proportion of fish shown on vertical axis. Error bars represent ± 1 standard error. Arrows show predominant direction of tidal flow, obtained by ORPC.



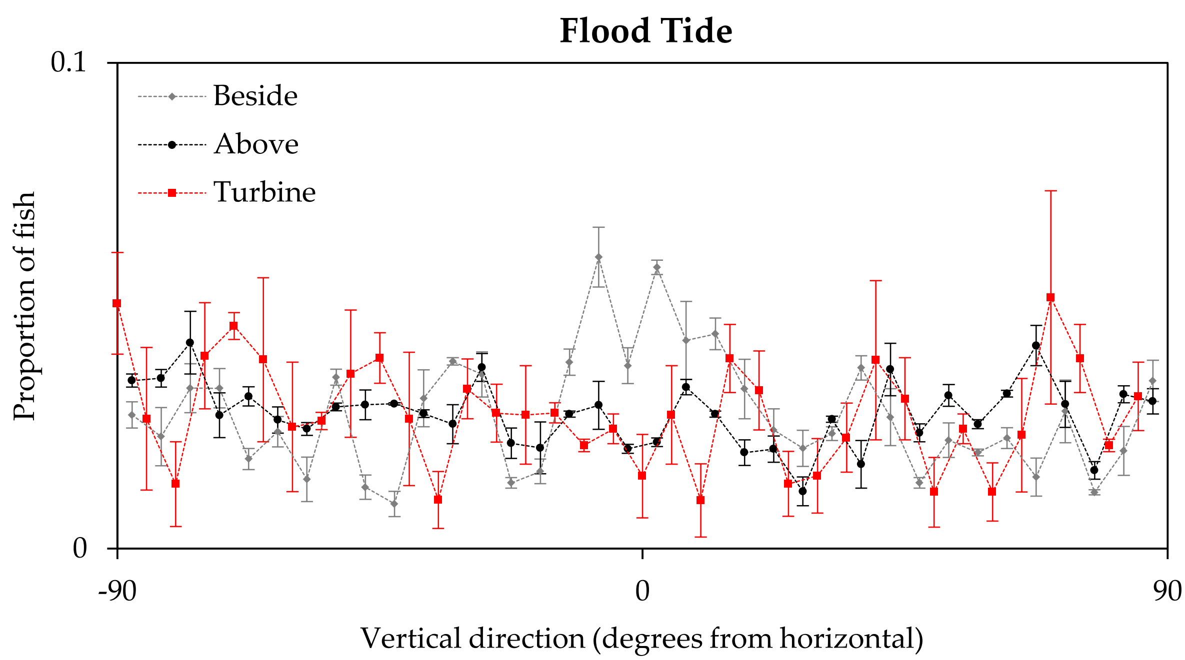


Figure 12. Distribution of vertical direction of fish movement in each turbine zone for ebb and flood tides. -90° degrees is downward, 90° is upward. Mean proportion of fish shown on vertical axis. Error bars represent ± 1 standard error.

4.0 Challenges & Future: Operational Constraints and Reconciliation

Ideal data collection is difficult under the best circumstances, and the highly dynamic environment of Cobscook Bay combined with construction activities associated with the TidGen™ project have affected data collection to date. Outlined below are the obstacles encountered within each monitoring plan and a discussion of how these have been or will be addressed as data collection continues.

4.1 Fisheries Monitoring Plan (down-looking hydroacoustic surveys)

As shown in Figure 2, sampling locations have so far been highly variable. Ideally, these locations would be consistent over time. This variability has been mainly due to construction activities surrounding the deployment, maintenance, and retrieval of the TidGen™ device, and the safety protocols involved (e.g., minimum safe distances for moorings). Additionally, November 2012 down-looking surveys were cancelled due to re-deployment of the turbine, causing sampling dates to deviate from the proposed schedule (CBTEP Fisheries and Marine Life Interaction Plan, 2012). Sampling locations and times will become more consistent with what was initially proposed as activity in the project area decreases. In addition, there has been a recent deployment of a large mooring block near the TGU that will be a permanent mooring for CB1b, minimizing spatial variation at that site. Site CB1a spatial variation will be decreased with the use of a more precise GPS unit.

4.2 Marine Life Interaction Monitoring Plan (side-looking hydroacoustics)

The goal of this plan is to collect and assess continuous data on the behavior of fish and other marine life in the vicinity of the turbine while it is operating. However, the operation of the side-looking echosounder at the turbine site is largely dependent on work carried out on the turbine. As discussed in Section 3.2.1, gaps exist in the hydroacoustic data collected to date which limit possible analyses. The largest gaps correspond to turbine operations (e.g., work on the undersea cables, retrieval or redeployment of the turbine). Smaller gaps occur when communication with the echosounder from shore is interrupted. These interruptions occur when the turbine is generating power, as the electric current in the undersea cables interferes with the neighboring data transmission cable of the echosounder. ORPC has taken several steps to remedy this issue and continues to work towards continuous data transfer. As construction activity in the area decreases and communication issues are resolved, the dataset will become more continuous and will be processed as described in this report.

Sound reflection off of turbine support structures and the surface may affect fish detection within the turbine zone, and the extent of this effect must be examined. Interference with the returned acoustic signal not only makes it difficult for Echoview to track fish, but also affects the calculation of fish track parameters such as TS and direction of movement. Additionally, clear gaps exist in the detected fish tracks at the range of each piling and even at the intervening crossbars of the TidGen™ support frame (visible as faint horizontal lines in Figure 4a). It is likely that the detection of fish echoes at these ranges is confounded by the sound reflected by the turbine support structure. To help determine the extent of this effect, the number of fish tracks obtained by Echoview must be compared with the number of fish tracks obtained by manually counting. Fish tracks may be obvious to the eye even when surrounded by interference that limits their detectability in Echoview. Comparing a manual count of fish tracks to the Echoview-generated count will determine if this is indeed an issue that must be addressed.

If so, there are several options available to explore:

1. Re-aim the transducer until reflection of sound from the turbine support frame no longer interferes with fish tracking. The disadvantage to this is that the beam would be even farther from the turbine face, and will therefore limit the usefulness of behavioral analyses. This method also does not help to reduce the effect of surface noise on the data at greater ranges.
2. Increase the threshold to -50 dB to eliminate most noise from the echogram altogether. This method will also result in the exclusion of fish with weaker acoustic signatures, such as mackerel or small herring. However, small fish are those that tend to interact with turbine blades (Viehman 2012), and most of the fish tracked so far have target strength less than -50 dB (Figure 9). Also, this option is not immune to the effects of surface noise and does not address the effect of very strong targets (such as the pilings) confounding Echoview's fish detection process.
3. Alter the method of fish detection. Image processing techniques may be useful when tracking fish in data with a low signal to noise ratio (e.g. Balk and Lindem 2000).

These options will be assessed as data collection and data quality continue to improve.

Current speed and direction are being collected by ORPC using a flow meter on the turbine support frame. While current speed data collected thus far have been accurate, direction data cannot be used due to the alignment of the flow meter. Once this is corrected, future data analyses will be carried out using both current speed and direction.

4.3 Final Remarks

Since the implementation of the Fisheries and Marine Life Interaction Monitoring Plans, great progress has been made in the setup and collection of data. New sampling locations and survey equipment have been integrated into the continuing down-looking acoustic surveys, and the side-looking Simrad echosounder has been successfully installed at the TidGen™ site and can be remotely operated from shore. Several obstacles remain to be addressed. For the Fisheries Monitoring Plan, these include achieving constant survey locations and further automation of data processing. Issues facing the Marine Life Interaction Plan include continuous data collection, noise reduction, processing automation, and full analyses of data collected to date. All of these concerns are currently being addressed, or will be, in the near future. Results presented here are preliminary analyses of a subset of data collected to date, and analyses in future reports will follow a similar approach. As data collection becomes more continuous and quality improves, we will continue to adopt and refine our analysis techniques.

5.0 References

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Appendix A : Report to the Maine Department of Marine Resources on Special License No. 2012-36-02 granted to the University of Maine to conduct fish capture research in Cobscook Bay.

2012 Annual Report: Special License Number ME 2012-36-02
University of Maine, School of Marine Sciences
Gayle Zydlewski, James McCleave, Jeffrey Vieser
16 November 2012

Introduction

The first objective of the project requiring the special license was to use midwater trawling to provide species verification to accompany acoustic assessment of pelagic fish abundance in Outer Cobscook Bay, near Eastport, Maine. The acoustic assessment was conducted independently of the special license. The acoustic assessment and midwater trawling are parts of an overall project to assess the seasonal, daily, and tidal abundance and distribution of pelagic fishes in locations proposed for deployment of electricity generating tidal turbines.

The second objective of the project requiring the special license was to use midwater trawling, benthic trawling, intertidal seining, and intertidal fyke netting to characterize the fish community of the entire Cobscook Bay. This study provides a wider ecosystem perspective against which to consider deployment of arrays of electricity generating tidal turbines.

Methods

Midwater and benthic trawling was done with the commercial fishing vessel *Pandalus* (147YV), owned and operated by Stephen W. Brown. The midwater net mouth dimensions were: headrope, footrope and breastlines 40 feet. Mesh sizes were: belly, square and side panels 4 inch, tapers 2 inch, and extensions and codend 1 inch. The benthic net mouth dimensions were: headrope 45 feet, footrope 35 feet, no breastlines. Stretch mesh sizes were: net body 2 inch, codend 1 inch. Tows were nominally 20 minutes, but sometimes varied, especially to shorter times because towable distance was too short in inner Cobscook Bay (Figure 1, Tables 1, 2).

Two 100 foot x 6 foot seines with 0.25-inch diamond mesh were used to sample shallow intertidal habitats including cobble fields, mud flats, rockweed patches, and sea grass beds (Figure 1, Table 3). Two fyke nets with 30 foot wings, 4 foot tall square hoops, and 1.5-inch stretch mesh were used to sample larger rockweed covered rock piles (Table 4). Sampling of intertidal habitats was conducted mostly in day time, with some night sampling.

Trawling and intertidal sampling were conducted during neap tides primarily in May, June, August and September, 2012. Forty midwater tows and 40 benthic tows were made over the four months, with 16 tows of each type being at night in central and outer Cobscook Bay (Tables 1, 2). One hundred eighty one seine hauls were made over the four months, with 36 hauls being at night (Table 3). Twenty five fyke net sets were made, with each set being two fyke nets nearby at the same location; 14 sets were at night (Table 4). Sixty additional seine hauls were made at a subset of locations in March, April, and November, with 13 being at night (Table 3).

Results

Benthic trawling and intertidal seining were quite successful in capturing a variety of fish species, but midwater trawling and fyke netting were less successful. More than 28,000 individual fish of 36 species were caught (all gears and dates combined) (Table 5).[1] Individuals of many species were primarily smaller (juvenile) specimens, but a few adult Atlantic herring (*Clupea harengus*) were caught in pelagic trawls (Table 6). Atlantic herring dominated the pelagic catch, and most were early juveniles. Winter flounder (*Pseudopleuronectes americanus*) juveniles dominated the catch in benthic trawls, but species richness was greatest among gears in the benthic trawls (26 species caught at least once) (Table 7).

Threespine stickleback (*Gasterosteus aculeatus*), Atlantic silverside (*Menidia menidia*), blackspotted stickleback (*Gasterosteus wheatlandi*), and alewife (*Alosa pseudoharemgus*) dominated the catches in intertidal seine tows, but in widely varying proportions in the four primary months of sampling (Table 8). Only six species represented by few individuals were caught in fyke nets (Table 9).

In both 2011 and 2012, four species comprised about 82% of the total catch. In 2012, these were, in rank order, threespine stickleback, Atlantic herring, Atlantic silverside, and winter flounder (Table 5), while in 2011, they were Atlantic herring, threespine stickleback, winter flounder, and rainbow smelt. Threespine sticklebacks were 10 times more abundant and blackspotted sticklebacks seven times more abundant in 2012 than 2011, but seining effort only increased threefold. Likewise, the 40-fold increased abundance of Atlantic silverside cannot be explained on increased seining effort. The decrease in abundance of winter flounder is probably real, as benthic trawling effort was similar in the two years.

Atlantic herring were abundant in both years, but those caught in May and June 2011 were mostly advanced larvae, while those caught in May and June 2012 were mostly juveniles. This may have been due to the mild winter of 2011-2012 and early warming in March 2012.

No Atlantic salmon (*Salmo salar*), shortnose sturgeon (*Acipenser brevirostrum*), or Atlantic sturgeon (*A. oxyrhynchus*) were captured in any gear. One harbor seal entered a fyke net on June 28, 2012, and drowned; it was reported through the proper channels. Excluder bars were installed in the mouths of the fyke nets before August and September sampling periods following a design suggested by NOAA.

Discussion

Visual observation, hook and line recreational fishing, acoustic fish finder records, and local fishers' knowledge indicates the presence of large numbers of Atlantic herring and Atlantic mackerel throughout the water column in the study area, especially in August and September. The inability of our gear to capture these highly mobile pelagic species in proportion to their probable abundance is a problem. We suspect that the ability of highly mobile fish to detect the presence of the trawls, through visual and other sensory clues, allows them to avoid it in most cases. When capture did occur, it was primarily at night, when visual

[1] Catch numbers in Tables 5-9 are provisional.

cues are restricted. Sampling effort at night with both midwater and benthic trawls was increased in 2012 compared with 2011.

It is expected that larger benthic species, e.g., spiny dogfish (*Squalus acanthius*), succeeded in avoiding capture, though there is less anecdotal evidence to support their presence in the bay. However, three were caught in one benthic trawl in 2012. A number of other species are probably under sampled as well in various gears, e.g., adult river herring (alewife and blueback herring), skates and flatfish species (other than winter flounder).

An application for an extension of our special license for 2013 will be forthcoming involving a few modest changes to our scope of work.

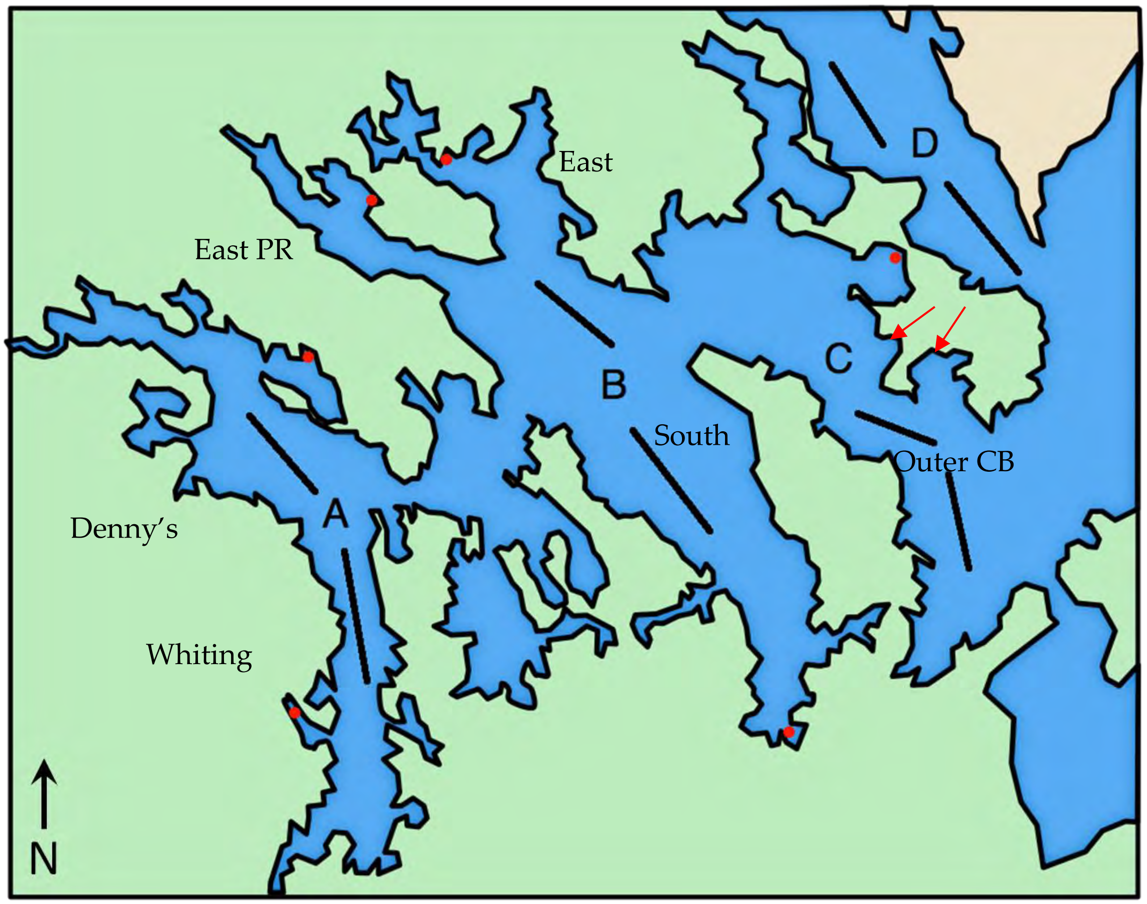


Figure 1. Map of Cobscook Bay and Western Passage of Passamaquoddy Bay showing mid-water and benthic trawl lines (black lines) fished in 2012 (Cobscook Bay) and planned for 2013 (all), as well as regular seine and fyke net sampling locations (red dots) and seining locations specifically for sticklebacks (red arrows). Both benthic and pelagic trawls occurred in the same location. Uppercase letters indicate the center of each of the three sub-bays of Cobscook Bay (A = inner; B = central; C = outer) and Western Passage in Passamaquoddy Bay (D). Smaller bays of each sub-bay are also named. PR is Pennamaquan River.

Table 1. Date and location of pelagic trawl samples in Cobscook Bay during May, June, August, and September, 2012. Tide is the tidal stage when nets were fished. GPS Begin and GPS End are latitude (N) and longitude (W) where nets were deployed and retrieved, respectively. Tow is tow number. Begin and End are times (EDT) when the trawls were deployed and retrieved, respectively. Night samples are highlighted in gray. CB is Cobscook Bay.

Month	Day	Bay	GPS Begin	GPS End	Tide	Tow	Begin	End
May	25	Outer CB	44°53.543′ 67°00.968′	44°53.943′ 67°01.712′	Low	P401	21:38	21:53
	25	Outer CB	44°55.837′ 67°01.371′	44°53.454′ 67°00.762′	Low	P402	22:06	22:26
	26	East	44°55.025′ 67°05.773	44°54.453 67°04.631	Low	P403	21:52	22:12
	26	South	44°53.744′ 67°04.827′	44°52.985′ 67°04.123′	Flood	P404	22:29	22:49
	27	Outer CB	44°53.950′ 67°01.470′	44°53.417′ 67°00.278	High	P405	16:02	16:22
	27	Outer CB	44°53.415′ 67°00.535′	44°53.925′ 67°01.628′	Ebb	P406	16:39	16:59
	28	Whiting	44°52.483′ 67°08.739′	44°51.029′ 67°08.599′	Flood	P407	16:47	17:08
	28	Dennys	44°53.388′ 67°09.843′	44°52.825′ 67°08.841′	Ebb	P408	18:30	18:46
	29	South	44°53.165′ 67°04.310′	44°54.061′ 67°05.209′	Low	P409	11:24	11:45
	29	East	44°54.518′ 67°05.121′	44°55.282′ 67°06.025′	Low	P410	12:00	12:23
June	24	Outer CB	44°53.767′ 67°01.407′	44°53.248′ 66°59.576′	Flood	P501	21:10	21:30
	24	Outer CB	44°53.356′ 67°00.484′	44°54.263′ 67°02.066′	Flood	P502	23:10	23:30
	25	East	44°55.208′ 67°05.936′	44°54.505′ 67°04.824′	Ebb	P503	21:25	21:50
	25	South	44°53.897′ 67°04.961′	44°53.118′ 67°04.251′	Low	P504	22:10	22:30
	26	Outer CB	44°53.370′ 67°00.313′	44°53.957′ 67°01.696′	High	P505	16:45	17:05
	26	Outer CB	44°53.762′ 67°01.321′	44°53.357′ 66°59.773	Ebb	P506	17:20	17:43
	27	South	44°53.004′ 67°03.985′	44°53.890′ 67°04.810′	Low	P507	11:20	11:41
	27	East	44°54.490′ 67°05.315′	44°55.456′ 67°06.109′	Low	P508	11:54	12:15
	28	Whiting	44°52.545′ 67°08.771′	44°51.288′ 67°08.576′	Low	P509	06:33	06:53

	28	Dennys	44°53.362′ 67°09.890′	44°52.715′ 67°08.794′	Ebb	P510	08:12	08:27
August	26	Outer CB	44°53.923′ 67°01.531′	44°53.333′ 66°59.941′	Ebb	P601	19:42	20:02
	26	Outer CB	44°53.694′ 67°01.347′	44°53.280′ 66°59.487′	Ebb	P602	20:30	20:50
	27	East	44°55.423′ 67°06.086′	44°54.395′ 67°04.881′	Ebb	P603	20:45	21:05
	27	South	44°52.901′ 67°04.005′	44°53.807′ 67°04.394	Ebb	P604	22:00	22:20
	28	Outer CB	44°53.337′ 66°59.895′	44°53.761′ 67°01.076′	High	P605	09:00	09:23
	28	Outer CB	44°53.736′ 67°01.410′	44°59.886 66°59.883′	Ebb	P606	09:35	09:55
	29	Whiting	44°52.113′ 67°08.655′	44°50.941′ 67°08.671′	Flood	P607	09:52	10:12
	29	Dennys	44°53.361′ 67°09.839′	44°52.771′ 68°08.832′	Ebb	P608	11:27	11:49
	30	South	44°53.490′ 67°04.709′	44°52.566′ 67°03.655′	Flood	P609	10:00	10:20
	30	East	44°55.376′ 67°06.265′	44°54.443′ 67°04.885′	Ebb	P610	11:45	12:10
September	23	Outer CB	44°54.081′ 67°01.827′	44°53.416′ 66°59.280′	Ebb	P701	10:14	10:35
	23	Outer CB	44°53.262′ 66°59.760′	44°53.816′ 67°01.311′	Flood	P702	12:19	12:39
	24	East	44°55.241′ 67°06.214′	44°54.463′ 67°05.039′	Low	P703	12:45	13:06
	24	South	44°53.711′ 67°04.768′	44°52.898′ 67°04.129′	Flood	P704	13:22	13:42
	25	Outer CB	44°53.335′ 67°00.201′	44°54.161′ 67°02.083′	Flood	P705	19:04	19:25
	25	Outer CB	44°53.956′ 67°01.661′	44°53.531′ 67°00.854′	Flood	P706	19:44	20:05
	26	Whiting	44°52.099′ 67°08.660′	44°50.946′ 67°08.680′	Flood	P707	08:30	08:56
	26	Dennys	44°53.179′ 67°09.323	44°52.771′ 67°08.626′	Ebb	P708	10:13	10:28
	26	East	44°54.712′ 67°05.550′	44°55.535′ 67°06.321′	Flood	P709	18:50	19:10
	26	South	44°52.903′ 67°04.045′	44°53.704′ 67°04.796′	High	P710	20:40	21:00

Table 2. Date and location of benthic trawl samples in Cobscook Bay during May, June, August, and September, 2012. Tide is the tidal stage when nets were fished. GPS Begin and GPS End are latitude (N) and longitude (W) where nets were deployed and retrieved, respectively. Tow is tow number. Begin and End are times (EDT) when the trawls were deployed and retrieved, respectively. Night samples are highlighted in gray. CB is Cobscook Bay.

Month	Day	Bay	GPS Begin	GPS End	Tide	Tow	Begin	End
May	25	Outer CB	44°53.030′ 67°00.337′	44°52.275′ 66°59.878′	Ebb	B401	20:22	20:44
	25	Outer CB	44°52.330′ 66°59.842′	44°53.190′ 67°00.359′	Ebb	B402	20:54	21:04
	26	East Bay	44°54.770′ 67°05.401′	44°55.400′ 67°06.111′	Ebb	B403	21:03	21:23
	26	South Bay	44°52.754′ 67°04.045′	44°53.587′ 67°04.893′	Flood	B404	23:03	23:23
	27	Outer CB	44°53.107′ 67°00.467′	44°52.347′ 66°59.939′	Flood	B405	14:50	15:10
	27	Outer CB	44°52.253′ 66°59.859′	44°53.080′ 67°00.123′	Flood	B406	15:21	15:41
	28	Whiting	44°51.104′ 67°08.602′	44°52.087′ 67°08.646	High	B407	17:25	17:47
	28	Dennys	44°52.899′ 67°08.966′	44°53.378′ 67°09.864′	High	B408	18:01	18:18
	29	South	44°53.917′ 67°04.891′	44°52.002′ 67°04.211′	Ebb	B409	10:50	11:10
	29	East	44°55.450′ 67°06.223′	44°54.665′ 67°05.334′	Flood	B410	12:32	12:53
June	24	Outer CB	44°52.961′ 67°00.207′	44°52.187′ 66°59.630′	Flood	B501	21:50	11:17
	24	Outer CB	44°52.401′ 66°59.834′	44°53.223′ 67°00.608′	Flood	B502	22:30	23:00
	25	East	44°54.721′ 67°05.387′	44°55.367′ 67°06.007′	Ebb	B503	20:50	21:10
	25	South	44°52.692′ 67°03.975′	44°53.444′ 67°04.637′	Flood	B504	22:50	23:10
	26	Outer CB	44°52.982′ 67°00.336′	44°52.241′ 66°59.870′	Flood	B505	15:30	15:50
	26	Outer CB	44°52.231′ 66°59.897′	44°53.019′ 67°00.173′	Flood	B506	16:08	16:28
	27	South	44°53.789′ 67°04.787′	44°53.145′ 67°03.959	Ebb	B507	10:42	11:02
	27	East	44°55.559′ 67°06.199′	44°54.747′ 67°05.348′	Flood	B508	12:28	12:49
	28	Whiting	44°51.147′ 67°08.580′	44°52.081′ 67°08.692′	High	B509	07:05	07:26

	28	Dennys	44°52.793′ 67°08.844′	44°53.327′ 67°09.787′	Ebb	B510	07:40	08:00
August	26	Outer CB	44°53.140′ 67°00.395′	44°52.112′ 66°59.759′	Ebb	B601	21:16	21:36
	26	Outer CB	44°52.077′ 66°59.705′	44°52.929′ 67°00.314′	Ebb	B602	21:51	22:12
	27	East	44°54.788′ 67°05.574′	44°55.505′ 67°06.260′	High	B603	20:05	20:25
	27	South	44°53.716′ 67°04.737′	44°52.917′ 67°03.788′	Ebb	B604	21:25	21:45
	28	Outer CB	44°52.863′ 67°00.195′	44°52.038′ 66°59.667′	Ebb	B605-B	10:35	10:55
	28	Outer CB	44°52.177′ 66°59.762′	44°53.020′ 67°00.337′	Ebb	B606	11:05	11:25
	29	Whiting	44°51.158′ 67°08.591′	44°52.051′ 67°08.668′	High	B607	10:27	10:47
	29	Dennys	44°52.970′ 67°09.093′	44°53.372′ 67°09.817′	Ebb	B608	11:00	11:20
	30	South	44°52.622′ 67°03.775′	44°53.453′ 67°04.545′	High	B609	10:32	10:54
	30	East	44°54.766′ 67°05.531′	44°55.455′ 67°06.139′	Ebb	B610	11:10	11:30
September	23	Outer CB	44°52.079′ 66°59.684′	44°52.950′ 67°00.285	Ebb	B701	11:00	11:20
	23	Outer CB	44°52.999′ 67°00.389′	44°52.187′ 66°59.811′	Low	B702	11:33	11:53
	24	East	44°54.648′ 67°05.501′	44°55.487′ 67°06.181′	Ebb	B703	12:06	12:26
	24	South	44°52.729′ 67°03.890′	44°53.514′ 67°04.642′	Flood	B704	13:54	14:15
	25	Outer CB	44°52.916′ 67°00.294′	44°52.148′ 66°59.731′	High	B705	20:22	20:43
	25	Outer CB	44°52.238′ 66°59.887′	44°53.110′ 67°00.446	Ebb	B706	20:55	21:15
	26	Whiting	44°51.204′ 67°08.578′	44°52.070′ 67°08.681′	Flood	B707	09:07	09:28
	26	Dennys	44°52.956′ 67°09.123′	44°53.344′ 67°09.840′	High	B708	09:44	09:59
	26	East	44°55.488′ 67°06.212′	44°54.705′ 67°05.507′	Flood	B709	19:20	19:40
	26	South	44°53.632′ 67°04.853′	44°52.835′ 67°04.034′	Flood	B710	20:00	20:20

Table 3. Date and location of regular intertidal seine samples in Cobscook Bay during May, June, August, and September, and additional seine samples at a subset of regular stations in March, April, and November, 2012. Tide is the tidal stage when nets were fished. Tow is tow number. Time is the time when each tow (EDT) began; each tow takes <10 minutes. Night samples are highlighted in gray. CB is Cobscook Bay.

Month	Day	Bay	Locale	Tide	Habitat	Tow	Time
March	8	Outer CB	Broad Cove	Ebb	Not recorded	W1	12:00
	8	Outer CB	Broad Cove	Ebb	Not recorded	W2	12:30
	8	Outer CB	Deep Cove	Ebb	Not recorded	W3	13:15
	8	Outer CB	Deep Cove	Ebb	Not recorded	W4	13:45
	8	Outer CB	Deep Cove	Ebb	Not recorded	W5	14:15
	9	East	Sipp Cove	High	Not recorded	W6	11:49
	9	East	Sipp Cove	Ebb	Not recorded	W7	11:55
	9	East	Sipp Cove	Ebb	Not recorded	W8	12:20
	9	Outer CB	Carrying Place Cove	Ebb	Not recorded	W9	13:25
	9	Outer CB	Carrying Place Cove	Ebb	Not recorded	W10	13:40
	9	Outer CB	Carrying Place Cove	Ebb	Not recorded	W11	13:55
	9	East	Sipp Cove	Ebb	Not recorded	W12	14:20
	9	East	Sipp Cove	Ebb	Not recorded	W13	14:55
	10	Pennamaquan	Hersey Cove	Ebb	Not recorded	W14	13:40
	10	Pennamaquan	Hersey Cove	Ebb	Not recorded	W15	13:45
	10	Pennamaquan	Hersey Cove	Ebb	Not recorded	W16	13:50
	10	Pennamaquan	Hersey Cove	Ebb	Not recorded	W17	14:10
	10	Pennamaquan	Hersey Cove	Ebb	Not recorded	W18	14:15
	10	Dennys	Youngs Cove	Ebb	Not recorded	W19	14:50
	10	Dennys	Youngs Cove	Ebb	Not recorded	W20	14:55
	10	Dennys	Youngs Cove	Ebb	Not recorded	W21	15:00
	10	Dennys	Youngs Cove	Ebb	Not recorded	W22	15:25
April	13	Pennamaquan	Hersey Cove	High	Not recorded	A1	17:55
	13	Pennamaquan	Hersey Cove	High	Not recorded	A2	18:00
	13	Pennamaquan	Hersey Cove	Ebb	Not recorded	A3	18:25
	13	Pennamaquan	Hersey Cove	Ebb	Not recorded	A4	18:40
	13	Pennamaquan	Hersey Cove	Ebb	Not recorded	A5	18:50
	13	Dennys	Youngs Cove	Ebb	Not recorded	A6	19:45
	13	Dennys	Youngs Cove	Ebb	Not recorded	A7	20:00
	13	Dennys	Youngs Cove	Ebb	Not recorded	A8	20:40
	13	Dennys	Youngs Cove	Ebb	Not recorded	A9	20:50
	14	Outer CB	Broad Cove	High	Not recorded	A10	06:30
	14	Outer CB	Deep Cove	Ebb	Not recorded	A11	07:00
	14	Outer CB	Deep Cove	Ebb	Not recorded	A12	07:10
	14	Outer CB	Broad Cove	Ebb	Not recorded	A13	07:50
	14	Outer CB	Broad Cove	Ebb	Not recorded	A14	08:20
	14	Outer CB	Deep Cove	Ebb	Not recorded	A15	08:50
	14	Outer CB	Deep Cove	Ebb	Not recorded	A16	09:10
	14	Outer CB	Broad Cove	Ebb	Not recorded	A17	09:30

Month	Day	Bay	Locale	Tide	Habitat	Tow	Time
	14	East	Sipp Cove	High	Not recorded	A18	18:20
	14	East	Sipp Cove	High	Not recorded	A19	18:30
	14	East	Sipp Cove	High	Not recorded	A20	18:40
	14	Outer CB	Carrying Place Cove	Ebb	Not recorded	A21	20:30
	14	Outer CB	Carrying Place Cove	Ebb	Not recorded	A22	21:00
	14	East	Sipp Cove	Ebb	Not recorded	A23	22:10
	14	East	Sipp Cove	Ebb	Not recorded	A24	22:30
May	25	South	Case Cove	Ebb	Cobble	S401	15:55
	25	South	Case Cove	Ebb	Mudflat	S402	16:20
	25	South	Case Cove	Ebb	Sea grasses	S403	16:45
	26	Outer CB	Broad Cove	High	Cobble	AS401	15:53
	26	Outer CB	Broad Cove	High	Cobble	AS402	16:14
	26	Outer CB	Deep Cove	Ebb	Not recorded	AS403	16:48
	26	Outer CB	Deep Cove	Ebb	Rockweed/cobble	AS404	17:07
	26	Pennamaquan	Hersey Cove	Ebb	Cobble	S404	16:10
	26	Pennamaquan	Hersey Cove	Ebb	Cobble	S405	16:35
	26	Pennamaquan	Hersey Cove	Ebb	Sea grasses	S406	16:52
	26	Pennamaquan	Hersey Cove	Ebb	Rockweed	S407	17:25
	26	Pennamaquan	Hersey Cove	Ebb	Rockweed	S408	17:45
	27	Whiting	Burnt Cove	Ebb	Rockweed	S409	06:40
	27	Whiting	Burnt Cove	Ebb	Rockweed	S410	07:10
	27	Whiting	Burnt Cove	Ebb	Mudflat	S411	07:35
	27	Whiting	Burnt Cove	Ebb	Mudflat	S412	08:15
	27	Whiting	Burnt Cove	Ebb	Mudflat	S413	08:35
	28	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S414	06:05
	28	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S415	06:15
	28	Outer CB	Carrying Place Cove	Ebb	Mudflat	S416	07:00
	28	Outer CB	Carrying Place Cove	Ebb	Mudflat	S417	07:15
	28	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S418	–
	28	Outer CB	Carrying Place Cove	Ebb	Cobble/grasses	S419	–
	28	Outer CB	Carrying Place Cove	Ebb	Mudflat	S420	–
	29	East	Sipp Bay	Ebb	Sea grasses	S421	06:12
	29	East	Sipp Bay	Ebb	Cobble	S422	06:25
	29	East	Sipp Bay	Ebb	Rockweed	S423	06:35
	29	East	Sipp Bay	Ebb	Cobble	S424	07:26
	29	East	Sipp Bay	Ebb	Not recorded	S425	07:34
	29	East	Sipp Bay	Ebb	Rockweed	S426	08:35
	29	East	Sipp Bay	Ebb	Rockweed	S427	08:55
	29	East	Sipp Bay	Ebb	Sea grasses	S428	19:00
	29	East	Sipp Bay	Ebb	Cobble	S429	19:08
	29	East	Sipp Bay	Ebb	Sea grasses	S430	19:40
	29	East	Sipp Bay	Ebb	Sea grasses	S431	19:50
	29	East	Sipp Bay	Ebb	Rockweed	S432	20:20
	29	East	Sipp Bay	Ebb	Rockweed	S433	20:35
	30	Dennys	Youngs Cove	Ebb	Cobble	S434	08:15

Month	Day	Bay	Locale	Tide	Habitat	Tow	Time
	30	Dennys	Youngs Cove	Ebb	Rockweed	S435	08:28
	30	Dennys	Youngs Cove	Ebb	Sea grasses	S436	08:42
	30	Dennys	Youngs Cove	Ebb	Cobble	S437	09:15
	30	Dennys	Youngs Cove	Ebb	Rockweed	S438	09:40
	30	Dennys	Youngs Cove	Ebb	Mudflat	S439	10:30
	30	Dennys	Youngs Cove	Ebb	Sea grasses	S440	21:14
	30	Dennys	Youngs Cove	Ebb	Cobble	S441	21:27
	30	Dennys	Youngs Cove	Ebb	Not recorded	S442	21:42
	30	Dennys	Youngs Cove	Ebb	Cobble	S443	22:05
	30	Dennys	Youngs Cove	Ebb	Rockweed	S444	22:20
	30	Dennys	Youngs Cove	Ebb	Not recorded	S445	22:40
	30	Dennys	Youngs Cove	Ebb	Mudflat	S446	23:15
June	23	South	Case Cove	Ebb	Cobble	S501	15:56
	23	South	Case Cove	Ebb	Mudflat	S502	16:25
	23	South	Case Cove	Ebb	Sea grasses	S503	16:50
	23	Pennamaquan	Hersey Cove	Ebb	Cobble	S504	14:46
	23	Pennamaquan	Hersey Cove	Ebb	Cobble	S505	15:00
	23	Pennamaquan	Hersey Cove	Ebb	Cobble	S506	15:15
	23	Pennamaquan	Hersey Cove	Ebb	Sea grasses	S507	15:30
	23	Pennamaquan	Hersey Cove	Ebb	Cobble	S508	15:55
	24	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S509	04:49
	24	Outer CB	Carrying Place Cove	Ebb	Mudflat	S510	05:20
	24	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S511	16:41
	24	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S512	16:50
	24	Outer CB	Carrying Place Cove	Ebb	Mudflat	S513	~17:00
	24	Outer CB	Carrying Place Cove	Ebb	Mudflat	S514	~17:20
	25	East	Sipp Cove	Ebb	Cobble	S515	04:00
	25	East	Sipp Cove	Ebb	Cobble	S516	04:15
	25	East	Sipp Cove	Ebb	Sea grasses	S517	04:26
	25	East	Sipp Cove	Ebb	Cobble	S518	04:50
	25	East	Sipp Cove	Ebb	Rockweed	S519	05:12
	25	East	Ipp Cove	Ebb	Rockweed	S520	05:30
	25	East	Sipp Cove	Ebb	Rockweed	S521	06:15
	25	East	Sipp Cove	Ebb	Sea grasses	S522	16:36
	25	East	Sipp Cove	Ebb	Sea grasses	S523	16:45
	25	East	Sipp Cove	Ebb	Sea grasses	S524	17:10
	25	East	Sipp Cove	Ebb	Cobble	S525	17:45
	25	East	Sipp Cove	Ebb	Rockweed	S526	18:50
	26	Outer CB	Broad Cove	Ebb	Cobble	AS501	17:09
	26	Outer CB	Broad Cove	Ebb	Cobble	As502	17:20
	26	Outer CB	Broad Cove	Ebb	Cobble	AS503	18:05
	26	Outer CB	Broad Cove	Ebb	Cobble	AS504	18:27
	26	Outer CB	Deep Cove	Ebb	Not recorded	AS505	19:06
	26	Outer CB	Deep Cove	Ebb	Nor recorded	AS506	19:27
	26	Outer CB	Deep Cove	Ebb	Cobble/mudflat	AS507	19:50

Month	Day	Bay	Locale	Tide	Habitat	Tow	Time
	26	Outer CB	Deep Cove	Ebb	Not recorded	AS508	20:12
	27	Whiting	Burnt Cove	Ebb	Rockweed	S532	08:55
	27	Whiting	Burnt Cove	Ebb	Rockweed	S533	09:25
	27	Whiting	Burnt Cove	Ebb	Mudflat	S534	10:10
	27	Whiting	Burnt Cove	Ebb	Mudflat	S535	10:25
	28	Dennys	Youngs Cove	Ebb	Sea grasses	S527	08:45
	28	Dennys	Youngs Cove	Ebb	Rockweed	S528	08:57
	28	Dennys	Youngs Cove	Ebb	Cobble	S529	09:30
	28	Dennys	Youngs Cove	Ebb	Rockweed	S530	09:40
	28	Dennys	Youngs Cove	Ebb	Not recorded	S531	10:00
	28	Dennys	Youngs Cove	Ebb	Cobble	S536	–
	28	Dennys	Youngs Cove	Ebb	Rockweed	S537	21:03
	28	Dennys	Youngs Cove	Ebb	Cobble	S538	21:15
	28	Dennys	Youngs Cove	Ebb	Sea grasses	S539	21:35
	28	Dennys	Youngs Cove	Ebb	Mudflat	S540	21:40
August	25	Outer CB	Deep Cove	High	Cobble	AS601	18:00
	25	Outer CB	Deep Cove	Ebb	Cobble	AS602	18:27
	25	Outer CB	Deep Cove	Ebb	Cobble/grasses	AS603	18:55
	25	Outer CB	Deep Cove	Ebb	Cobble/grasses	AS604	19:10
	25	Outer CB	Broad Cove	Ebb	Not recorded	AS605	19:30
	25	Outer CB	Broad Cove	Ebb	Cobble	AS606	19:50
	25	Outer CB	Broad Cove	Ebb	Cobble	AS607	20:10
	26	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S601	07:39
	26	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S602	07:48
	26	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S603	08:07
	26	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S604	08:20
	26	Outer CB	Carrying Place Cove	Ebb	Mudflat	S605	08:36
	26	Outer CB	Carrying Place Cove	Ebb	Mudflat	S606	08:51
	26	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S607	20:23
	26	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S608	20:35
	26	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S609	20:50
	26	Outer CB	Carrying Place Cove	Ebb	Mudflat	S610	21:15
	27	East	Sipp Cove	Ebb	Sea grasses	S611	08:16
	27	East	Sipp Cove	Ebb	Rockweed	S612	08:25
	27	East	Sipp Cove	Ebb	Not recorded	S613	08:42
	27	East	Sipp Cove	Ebb	Cobble	S614	09:20
	27	East	Sipp Cove	Ebb	Sea grasses	S615	09:35
	27	East	Sipp Cove	Ebb	Rockweed	S616	10:04
	27	East	Sipp Cove	Ebb	Rockweed	S617A	10:15
	27	East	Sipp Cove	High	Cobble	S617B	20:15
	27	East	Sipp Cove	Ebb	Sea grasses	S618	20:30
	27	East	Sipp Cove	Ebb	Cobble	S619	21:20
	27	East	Sipp Cove	Ebb	Sea grasses	S620	21:40
	27	East	Sipp Cove	Ebb	Rockweed	S621	22:25
	27	East	Sipp Cove	Ebb	Cobble	S622	22:40

Month	Day	Bay	Locale	Tide	Habitat	Tow	Time
	28	Pennamaquan	Hersey Cove	High	Cobble	S623	09:30
	28	Pennamaquan	Hersey Cove	Ebb	Cobble	S624	09:41
	28	Pennamaquan	Hersey Cove	Ebb	Sea grasses	S625	10:00
	28	Pennamaquan	Hersey Cove	Ebb	Sea grasses	S626	10:18
	28	Pennamaquan	Hersey Cove	Ebb	Cobble	S627	10:34
	28	Pennamaquan	Hersey Cove	Ebb	Cobble	S628	10:44
	29	Dennys	Youngs Cove	Ebb	Cobble	S629	11:47
	29	Dennys	Youngs Cove	Ebb	Sea grasses	S630	12:10
	29	Dennys	Youngs Cove	Ebb	Rockweed	S631	12:35
	29	Dennys	Youngs Cove	Ebb	Mudflat	S632	13:45
	30	Dennys	Youngs Cove	Ebb	Cobble	S633	00:55
	30	Whiting	Burnt Cove	Ebb	Rockweed	S634	13:49
	30	Whiting	Burnt Cove	Ebb	Rockweed	S635	14:21
	30	Whiting	Burnt Cove	Ebb	Mudflat	S636	14:52
	30	Whiting	Burnt Cove	Ebb	Mudflat	S637	15:35
	31	South	Case Cove	Ebb	Cobble	S638	13:00
	31	South	Case Cove	Ebb	Rockweed	S639	13:27
	31	South	Case Cove	Ebb	Sea grasses	S640	13:35
September	22	Outer CB	Deep Cove	Ebb	Not recorded	AS701	17:32
	22	Outer CB	Deep Cove	Ebb	Not recorded	AS702	18:10
	22	Outer CB	Broad Cove	Ebb	Not recorded	AS703	18:48
	23	Whiting	Burnt Cove	Ebb	Rockweed	S701	08:47
	23	Whiting	Burnt Cove	Ebb	Rockweed/flat	S702	09:25
	23	Whiting	Burnt Cove	Ebb	Rockweed	S703	09:35
	23	Whiting	Burnt Cove	Ebb	Mudflat	S704	09:43
	24	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S705	07:40
	24	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S706	08:05
	24	Outer CB	Carrying Place Cove	Ebb	Mudflat	S707	08:30
	24	Outer CB	Carrying Place Cove	Ebb	Mudflat	S708	09:00
	24	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S709	20:00
	24	Outer CB	Carrying Place Cove	Ebb	Sea grasses	S710	20:30
	24	Outer CB	Carrying Place Cove	Ebb	Mudflat	S711	21:30
	25	East	Sipp Cove	High	Sea grasses	S712	07:48
	25	East	Sipp Cove	High	Cobble	S713	08:10
	25	East	Sipp Cove	Ebb	Cobble	S714	08:40
	25	East	Sipp Cove	Ebb	Sea grasses	S715	09:00
	25	East	Sipp Cove	Ebb	Rockweed	S716	09:40
	25	East	Sipp Cove	Ebb	Cobble	S717	20:20
	25	East	Sipp Cove	Ebb	Sea grasses	S718	20:45
	26	Dennys	Youngs Cove	Ebb	Rockweed	S719	10:30
	26	Dennys	Youngs Cove	Ebb	Cobble	S720	11:05
	26	Dennys	Youngs Cove	Ebb	Sea grasses	S721	11:30
	26	Dennys	Youngs Cove	Ebb	Rockweed	S722	23:00
	26	Dennys	Youngs Cove	Ebb	Cobble	S723	23:35
	26	Dennys	Youngs Cove	Ebb	Mudflat	S724	01:27

Month	Day	Bay	Locale	Tide	Habitat	Tow	Time
	27	South	Case Cove	Ebb	Cobble	S751	11:10
	27	South	Case Cove	Ebb	Sea grasses	S752	11:37
	27	Pennamaquan	Hersey Cove	High	Cobble	S761	10:03
	27	Pennamaquan	Hersey Cove	Ebb	Cobble	S762	10:13
	27	Pennamaquan	Hersey Cove	Ebb	Sea grasses	S763	10:24
	27	Pennamaquan	Hersey Cove	Ebb	Sea grasses	S764	10:37
	27	Pennamaquan	Hersey Cove	Ebb	Rockweed/cobble	S765	11:35
	27	Pennamaquan	Hersey Cove	Ebb	Rockweed/cobble	S766	11:48
November	2	Outer CB	Deep Cove	High	Cobble	N1	13:35
	2	Outer CB	Deep Cove	Ebb	Cobble	N2	13:54
	2	Outer CB	Deep Cove	Ebb	Not recorded	N3	14:10
	2	Outer CB	Broad Cove	Ebb	Sea grasses	N4	15:12
	2	Outer CB	Broad Cove	Ebb	Not recorded	N5	16:00
	2	Outer CB	Broad Cove	Ebb	Rockweed	N6	16:15
	2	Outer CB	Broad Cove	Ebb	Rockweed/cobble	N7	16:40
	2	East	Sipp Cove	High	Sea grasses	6#1	14:10
	2	East	Sipp Cove	Ebb	Cobble	6#2	14:15
	2	East	Sipp Cove	Ebb	Cobble	6#3	14:20
	2	East	Sipp Cove	Ebb	Not recorded	6#4	14:30
	2	Dennys	Youngs Cove	Ebb	Sea grasses	6#5	15:20
	2	Dennys	Youngs Cove	Ebb	Cobble/mix	6#6	15:30
	2	Dennys	Youngs Cove	Ebb	Sea grasses	6#7	15:40

Table 4. Date and location of intertidal fyke net samples in Cobscook Bay during May, June, August, and September, 2012. Fyke is fyke set number; each set is composed of two fyke nets. Begin and End are the approximate times (EDT) when each set began and ended. Each fyke net was assumed to begin effective fishing at the time of high tide and to end effective fishing when the water level was low in the net. Samples partially or completely at night are highlighted in gray. BT is baited minnow trap that caught fish. CB is Cobscook Bay.

Month	Day	Bay	Locale	Fyke	Begin	End	BT
May	28	Outer CB	Carrying Place Cove	F401	17:15	20:00	
	29	East	Sipp Cove	F402	18:30	21:45	
	30	Dennys	Youngs Cove	F403	19:00	21:30	
June	24	Outer CB	Carrying Place Cove	F501	03:30	06:15	
	24	Outer CB	Carrying Place Cove	F502	16:00	18:15	
	25	East	Sipp Cove	F503	03:30	07:00	
	25	East	Sipp Cove	F504	16:00	19:00	
	27	Dennys	Youngs Cove	F505	18:30	23:00	
	28	Dennys	Youngs Cove	F506	06:00	10:30	
	28	Dennys	Youngs Cove	F507	18:30	23:15	
August	25	Outer CB	Carrying Place Cove	F601	18:00	21:00	
	26	Outer CB	Carrying Place Cove	F602	06:30	10:00	
	26	Outer CB	Carrying Place Cove	F603	19:00	22:15	
	27	East	Sipp Bay	F604	07:45	09:30	
	27	East	Sipp Bay	F605	20:15	23:00	X
	28-29	Dennys	Youngs Cove	F606	21:15	00:00	X
	29	Dennys	Youngs Cove	F607	10:45	13:15	X
	29-30	Dennys	Youngs Cove	F608	23:00	02:00	
September	23	Outer CB	Carrying Place Cove	F701	18:40	21:00	
	24	Outer CB	Carrying Place Cove	F702	06:20	09:45	
	24	Outer CB	Carrying Place Cove	F703	18:50	22:10	
	25	East	Sipp Bay	F704	07:30	10:00	X
	25	East	Sipp Bay	F705	20:00	22:45	
	26	Dennys	Youngs Cove	F706	09:30	12:30	
	26-27	Dennys	Youngs Cove	F707	22:00	01:20	

Table 5. Capture data, by month, all gear types combined, for sampling in Cobscook Bay in 2012.

Month	March	April	May	June	August	September	November	Total
Species	**Number of individuals**							
Threespine stickleback, *Gasterosteus aculeatus*	5	>4	895	903	8439	4631	77	>14954
Atlantic herring, *Clupea harengus*			2558	1231		3		3792
Atlantic silverside, *Menidia menidia*		>75	70	52	37	1858	>335	>2427
Winter flounder, *Pleuronectes americanus*			1119	892	130	162		2303
Black spotted stickleback, *Gasterosteus wheatlandi*	1	5	221	237	716	331	32	1543
Alewife, *Alosa pseudoharengus*				735	289	92	7	1123
Mummichog, *Fundulus heteroclitus*		11	188	195	133	298	5	830
Silver hake, *Merluccius bilinearis*			32	216	8	2		258
Rainbow smelt, *Osmerus mordax*			31	118	16	18		183
Longhorn sculpin, *Myoxocephalus octodecemspinosus*			87	86	4	6		183
Grubby, *Myoxocephalus aenaeus*			46	54	6	8		114
Atlantic tomcod, *Microgadus tomcod*			2	16	26	22		66
Butterfish, *Peprilus triacanthius*					53	11		65
Fourspine stickleback, *Apeltes quadracus*					33	10		43
White hake, *Urophycis tenuis*				5	8	28		41
Red hake, *Urophycis chuss*			6	7		11		24
Snakeblenny, *Lumpenus lampretaeformis*			15	6				21
Sea raven, *Hemitripterus americanus*			8	6	1			15
Ninespine stickleback, *Pungitius pungitius*					12	3		15
Atlantic cod, *Gadus morhua*			7	4				11
Atlantic halibut, *Hippoglossus hippoglossus*			2	5	1	1		9
Blueback herring, *Alose aestivalis*				2	2	3		7
Atlantic mackerel, *Scomber scombrus*					4	2		6
Pollock, *Pollachius virens*						5		5
Shorthorn sculpin, *Myoxocephalus scorpius*				3				3

Month	March	April	May	June	August	September	November	Total
Radiated shanny, *Ulvaria subbifurcata*				1	1	1		3
Spiny dogfish, *Squalus acanthias*					3			3
Winter skate, *Raja ocellatus*				2				2
Smooth skate, *Malacoraja senta*			2					2
Lumpfish, *Cyclopterus lumpus*				1				1
Rock gunnel, *Pholis gunnellus*				1				1
Little skate, *Raja erinacea*				1				1
Goosefish, *Lophius americanus*				1				1
Fourbeard rockling, *Enchelyopus cimbrius*			1					1
Windowpane, *Scophthalmus aquosus*				1				1
Clearnose skate, *Raja eglanteria*						1		1
Total	6	>95	5290	4782	9922	7507	>456	>28058

Table 6. Numbers of individuals caught by month in pelagic trawling in Cobscook Bay, 2012.

Species	May	June	August	September	Total
Atlantic herring	2539	726	0	1	3266
Rainbow smelt	4	4	0	0	8
Butterfish	0	0	3	1	4
Silver hake	1	2	0	0	3
Threespine stickleback	1	1	0	0	2
Alewife	0	1	0	0	1
Goosefish	0	1	0	0	1
Atlantic mackerel	0	0	1	0	1
Total	2545	735	4	2	3286

Table 7. Numbers of individuals caught by month in benthic trawling in Cobscook Bay, 2012.

Species	May	June	August	September	Total
Winter flounder	1119	890	125	162	2296
Silver hake	31	214	8	2	255
Longhorn sculpin	87	86	4	6	183
Rainbow smelt	13	100	1	0	114
Grubby	46	54	6	8	114
Butterfish	0	1	50	10	61
Atlantic herring	8	50	0	0	58
White hake	0	5	8	28	41
Red hake	6	6	0	11	23
Snakeblenny	15	6	0	0	21
Sea raven	8	6	1	0	15
Atlantic cod	7	4	0	0	11
Atlantic halibut	2	5	1	1	9
Alewife	0	5	3	1	9
Atlantic mackerel	0	0	3	2	5
Shorthorn sculpin	0	3	0	0	3
Radiated shanny	0	1	1	1	3
Spiny dogfish	0	0	3	0	3
Smooth skate	2	0	0	0	2
Winter skate	0	2	0	0	2
Fourbeard rockling	1	0	0	0	1
Windowpane	0	1	0	0	1
Lumpfish	0	1	0	0	1
Rock gunnel	0	1	0	0	1
Little skate	0	1	0	0	1
Clearnose skate	0	0	0	1	1
Total	1345	1442	214	233	3234

Table 8. Numbers of individuals caught by month in intertidal seining in Cobscook Bay, 2012.

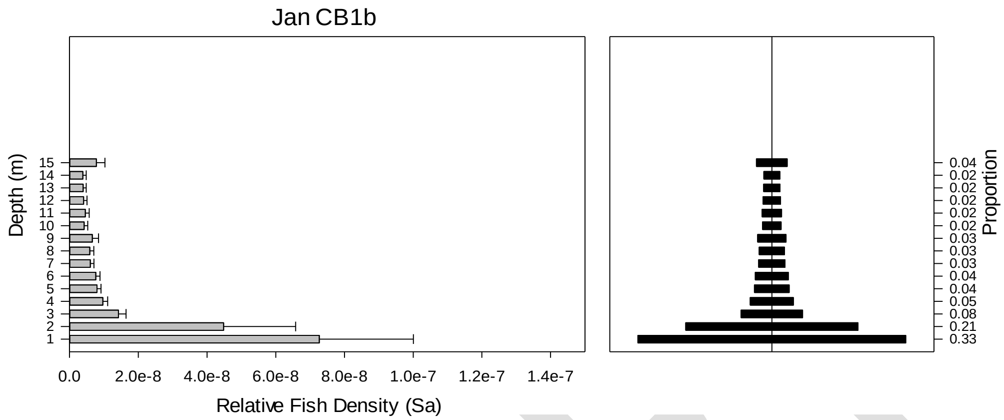
Species	March	April	May	June	August	September	November	Total
Threespine stickleback	5	>4	894	902	8333	4623	77	14838
Atlantic silverside	0	>75	70	52	37	1858	>335	2427
Blackspotted stickleback	1	5	221	237	716	331	32	1543
Alewife	0	0	0	728	286	91	7	1112
Mummichog	0	11	188	195	133	298	5	830
Atlantic herring	0	0	11	455	0	1	0	467
Fourspine stickleback	0	0	0	0	32	10	0	42
Rainbow smelt	0	0	14	14	6	7	0	41
Ninespine stickleback	0	0	0	0	12	3	0	15
Blueback herring	0	0	0	2	2	3	0	7
Atlantic tomcod	0	0	0	5	0	0	0	5
Red hake	0	0	0	1	0	0	0	1
Total	6	>95	1398	2591	9557	7225	>456	21328

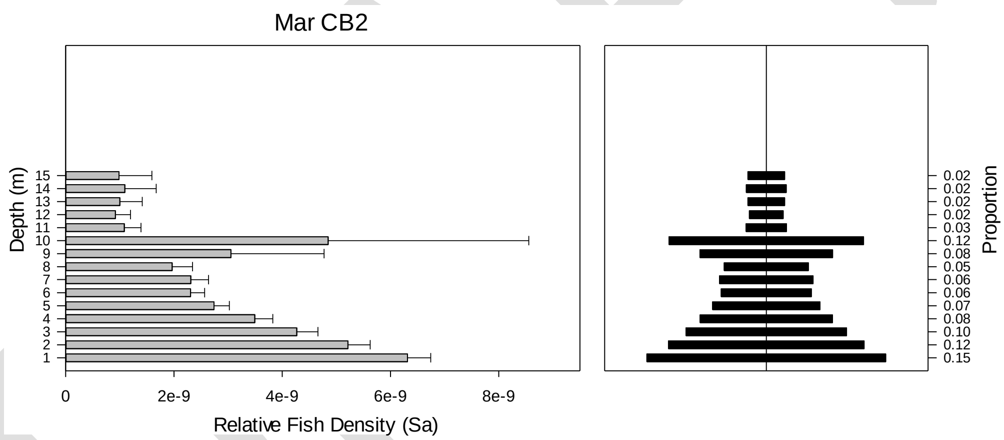
Table 9. Numbers of individuals caught by month in fyke netting and limited baited minnow trapping in Cobscook Bay, 2012. Only those baited trap sets that caught fish are included.

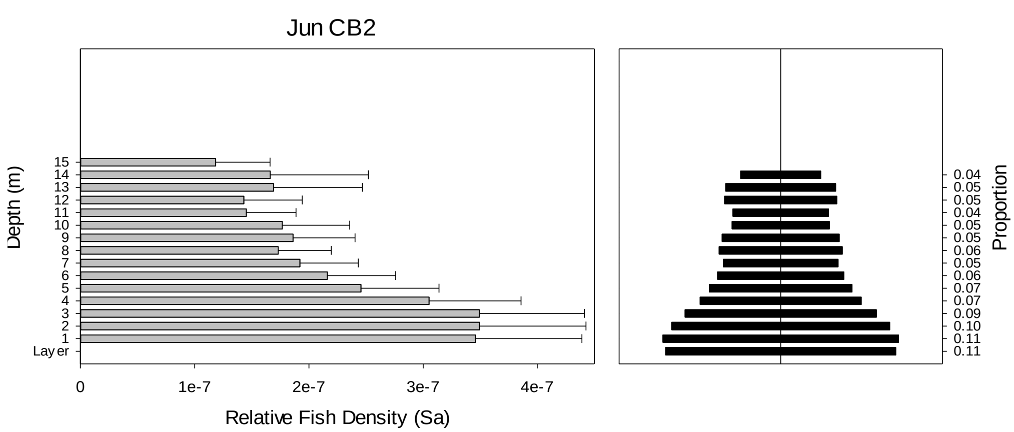
Gear	Species	May	June	August	September	Total
Fyke net	Atlantic tomcod	2	11	25	22	60
	Alewife	0	1	0	0	1
	Winter flounder	0	2	5	0	7
	Rainbow smelt	0	0	9	11	20
	Atlantic herring	0	0	0	1	1
	Pollock	0	0	0	5	5
	Total	2	14	39	39	94
Baited trap	Threespine stickleback			106	8	114
	Atlantic tomcod			1		1
	Fourspine stickleback			1		1
	Total	0	0	108	8	116

Appendix B

Vertical fish distributions for Cobscook Bay 2012, pre-deployment (Jan – Jun). Note that x-axes are not standardized across graphs. CB1a is 'next to", CB1b is 'in-line with' the turbine and CB2 is the control site.

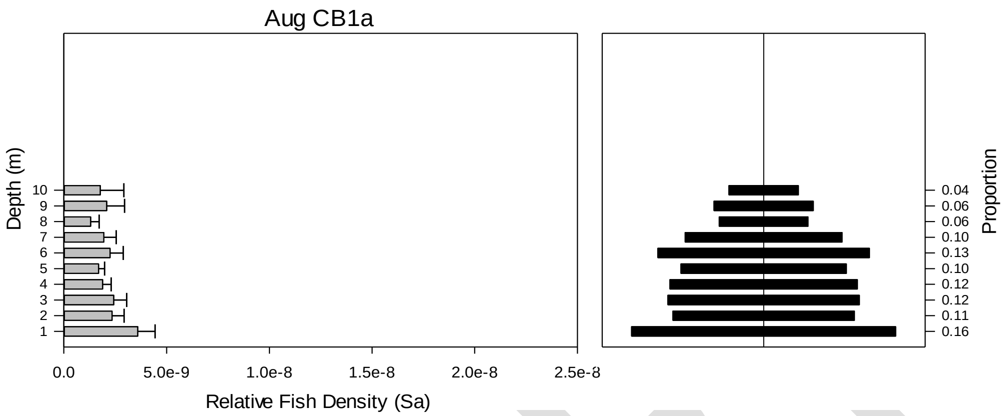


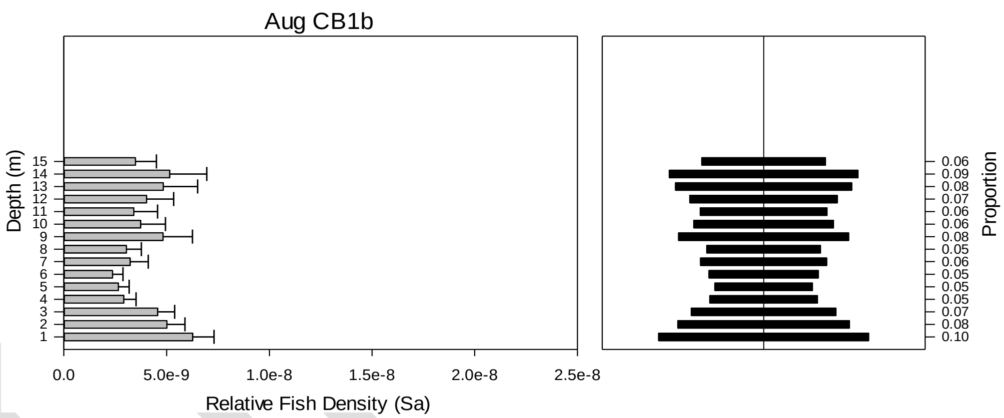


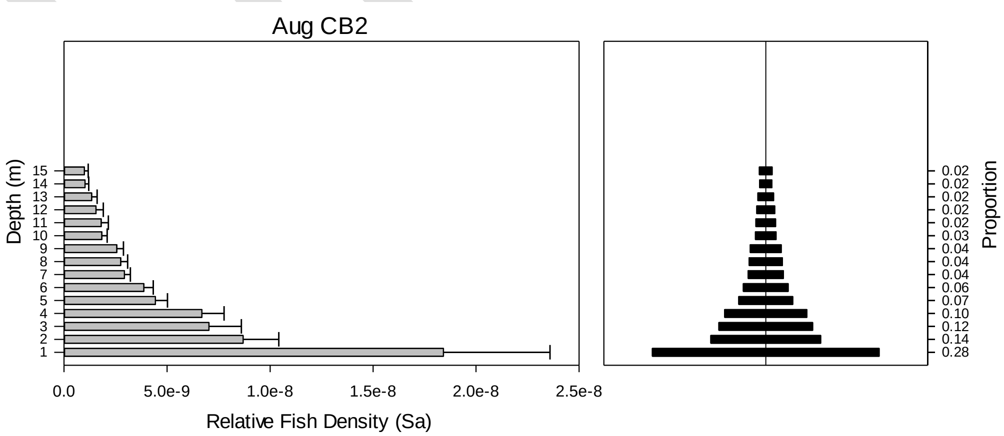


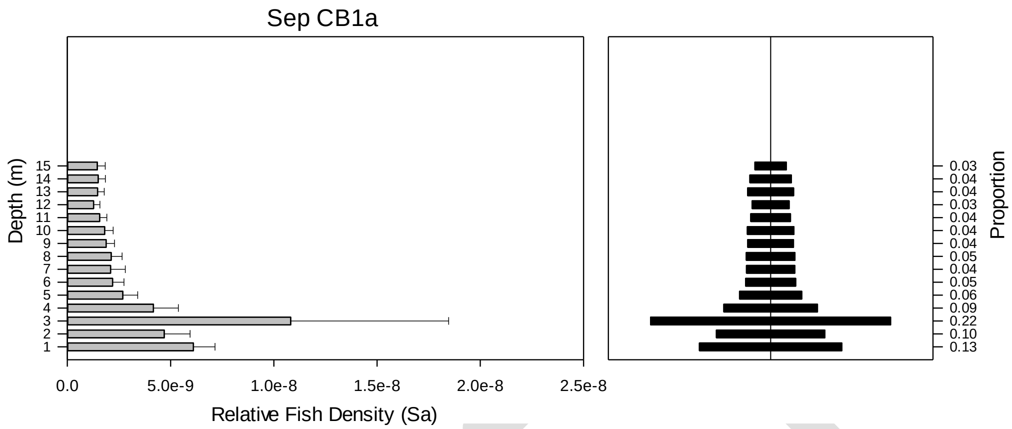
Appendix C

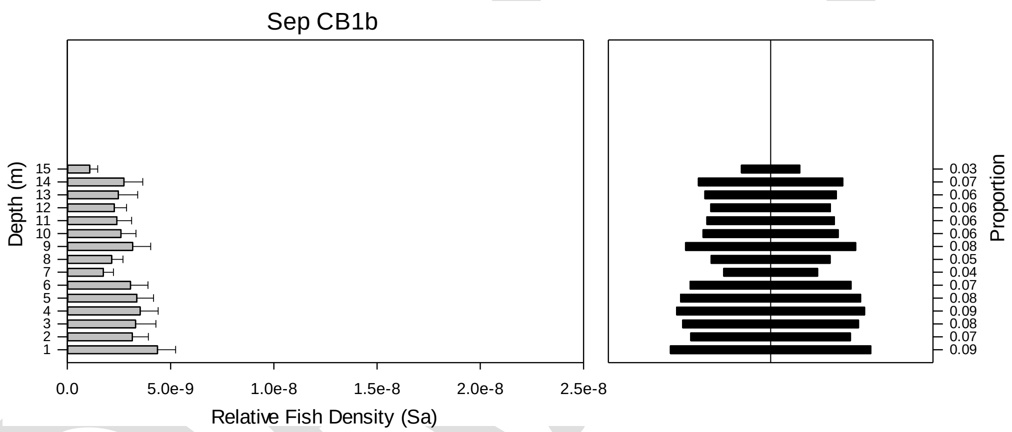
Vertical fish distributions for Cobscook Bay 2012, post-deployment (Aug and Sep). Note that x-axes are not standardized across graphs. CB1a is 'next to", CB1b is 'in-line with' the turbine and CB2 is the control site.








Sep CB1a
Depth (m)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0.0
5.0e-9
1.0e-8
1.5e-8
2.0e-8
2.5e-8
Relative Fish Density (Sa)
Proportion
0.03
0.04
0.04
0.03
0.04
0.04
0.04
0.05
0.04
0.05
0.06
0.09
0.22
0.10
0.13


Sep CB1b
Depth (m)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0.0
5.0e-9
1.0e-8
1.5e-8
2.0e-8
2.5e-8
Relative Fish Density (Sa)
Proportion
0.03
0.07
0.06
0.06
0.06
0.06
0.08
0.05
0.04
0.07
0.08
0.09
0.08
0.07
0.09

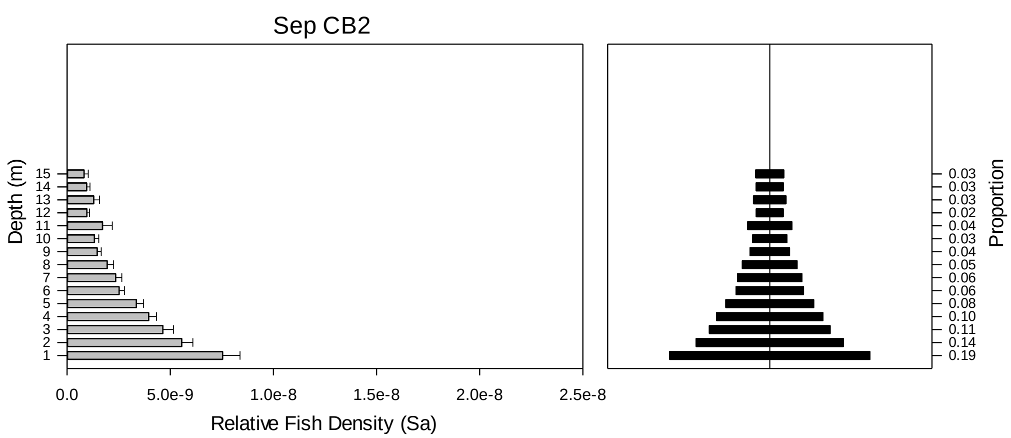

Sep CB2
Depth (m)
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0.0
5.0e-9
1.0e-8
1.5e-8
2.0e-8
2.5e-8
Relative Fish Density (Sa)
Proportion
0.03
0.03
0.03
0.02
0.04
0.03
0.04
0.05
0.06
0.06
0.08
0.10
0.11
0.14
0.19

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Table 2. *Proposed Monitoring Schedule of the Fisheries Monitoring Plan for Cobscook Bay (March 2013)*

Month	Pilot Project Deployment	Activities
Pre-Deployment		
2011		
January	No in-water structures	Moored hydroacoustics: • 24 hr, proposed deployment site • 24 hr, control site
March	No in-water structures	Moored hydroacoustics: • 24 hr, proposed deployment site • 24 hr, control site
May	No in-water structures	Moored hydroacoustics: • 24 hr, proposed deployment site • 24 hr, control site Midwater netting[1] Fish ecosystem assessment: • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
June	No in-water structures	Moored hydroacoustics: • 24 hr, proposed deployment site • 24 hr, control site Midwater netting[1] Fish ecosystem assessment: • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
August	No in-water structures	Moored hydroacoustics: • 24 hr, proposed deployment site • 24 hr, control site Midwater netting[1] Fish ecosystem assessment: • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
September	No in-water structures	Moored hydroacoustics: • 24 hr, proposed deployment site • 24 hr, control site Midwater netting[1] Fish ecosystem assessment: • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays

Month	Pilot Project Deployment	Activities
November	No in-water structures	Moored hydroacoustics: • 24 hr, proposed deployment site • 24 hr, control site
2012		
January	No in-water structures	Moored hydroacoustics: • 24 hr, proposed deployment site • 24 hr, control site
March	Bottom Support Frame	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System • 24 hr, control site
May	Bottom Support Frame	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System • 24 hr, control site Midwater netting control site[1] Fish ecosystem assessment: • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
June	Bottom Support Frame	Hydroacoustic survey: • 48 hr, control site Midwater netting control site[1] Fish ecosystem assessment • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
August	Single-device TidGen™ Power System (Not Operational)	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System Midwater netting control site[1] Fish ecosystem assessment • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
Post Deployment (Phase I)		
September	Single-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System Midwater netting control site[1] Fish ecosystem assessment • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays

2013		
March	Single-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System • 24 hr, control site
May	Single-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System • 24 hr, control site Midwater netting control site[1] Fish ecosystem assessment: • Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
June	Single-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System • 24 hr, control site Midwater netting control site[1] Fish ecosystem assessment: Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
August	Single-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System • 24 hr, control site Midwater netting control site[1] Fish ecosystem assessment: Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
September	Single-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System • 24 hr, control site Midwater netting control site[1] Fish ecosystem assessment: Netting midwater, near-shore and inshore habitats in Inner, Mid, Upper Bays
November	Single-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, two survey site in close proximity (in-line and beside) TidGen™ Power System • 24 hr, control site

2014 Post Deployment (Phase II)		
May	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site
June	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ device • 24 hr, control site Midwater netting control site[1] Fish ecosystem assessment:
September[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site
October	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ Power Systems 24 hr, control site
November	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ Power Systems 24 hr, control site
2015		
May[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site
September[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site
2016		
May[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site
September[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site

2017		
May[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site
September[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site
2018		
May[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site
September[2]	Multi-device TidGen™ Power System	Hydroacoustic survey: • 24 hr, one survey site in close proximity to TidGen™ devices • 24 hr, control site

Shaded periods indicate completed activities

[1]At least four tows (up to 30 minutes each) at one site to cover day flood, day ebb, night flood and night ebb.

[2] Sampling month may change to reflect period of expected peak fish based on previous data

Appendix F

Hydrodynamics FY12 Q4 Report, SNL-EFDC Model Application to Cobscook Bay, ME

Sandia National Laboratories, Sea Engineering, Inc., September 2012

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2.1.2.1 Hydrodynamics FY12 Q4 Report

SNL-EFDC Model Application to Cobscook Bay, ME

Jesse Roberts* and Scott James**

*Sandia National Laboratories

**Sea Engineering Inc.

September 2012

Table of Contents

Introduction

Water-current MHK turbines are receiving a growing interest in many parts of the world with available hydrokinetic resources. Because of potentially reasonable investment and maintenance costs, reliability, and environmental friendliness, this technology is considered worthy of research investment. Furthermore, small-scale MHK energy from river or tidal currents can be a solution for power supply in remote areas. However, little is known about the potential effects of MHK device operation in coastal embayments, estuaries, or rivers, or of the cumulative impacts of these devices on aquatic ecosystems over years or decades of operation. This lack of knowledge affects the actions of regulatory agencies, the opinions of stakeholder groups, and the commitment of energy project developers and investors. For example, the power generating capacity of water-current MHK turbines will depend on the turbine type, number, and current flow velocities, among other factors. In other words, each MHK-device array's footprint and performance will depend on the type of turbines and the characteristics of the local system. There is an urgent need for practical, accessible tools and peer-reviewed publications to help industry and regulators evaluate environmental impacts and mitigation measures and to establish best siting and design practices.

This study focuses on the initial development of a hydrodynamic model of Cobscook Bay, ME. This is the first deployment location of the Ocean Renewable Power Company (ORPC) TidGen™ units. One unit is currently deployed with 4 more to follow in the coming years. Potential changes to the physical environment imposed by operation of a five-MHK turbine array are evaluated using the modeling platform SNL-EFDC (James et al., 2011; James et al., 2012; James et al., 2006a; James et al., 2010a; James et al., 2010b; James et al., 2006b). Model results with and without an MHK array were compared to facilitate an understanding of how this small 5-MHK turbine array might alter the Cobscook Bay environment. These simulations can assist cost-effective planning before proceeding to detailed siting, engineering designs, and deployment of devices.

Model Configuration

The Cobscook Bay model was developed with Cartesian 100×100-m^2 cells. Bathymetric data were downloaded from National Oceanographic & Atmospheric Administration National Geophysical Data Center (http://maps.ngdc.noaa.gov/viewers/bathymetry/), specifically data sets H12257, H12258, and H12259 collected in 2010. These data were interpolated onto the model cells using the nearest neighbor technique with results shown in Figure 1. It should be noted that the tidal boundary was extended eastward for 300 m (3 cells) and the depth was bottom elevation was ramped from −40 m to −30 m in increments of 5 m from east to west. Where bathymetry was lower than the specified elevation, the lower value was maintained. This was done to ensure model stability at the inlet and to eliminate any velocity "hot spots" that can arise from a uniform flow entering a variable-depth model domain. Specifically, this "entrance length" allows the uniform-flow inlet to reorganize to a more natural flow distribution before entering the true model domain.

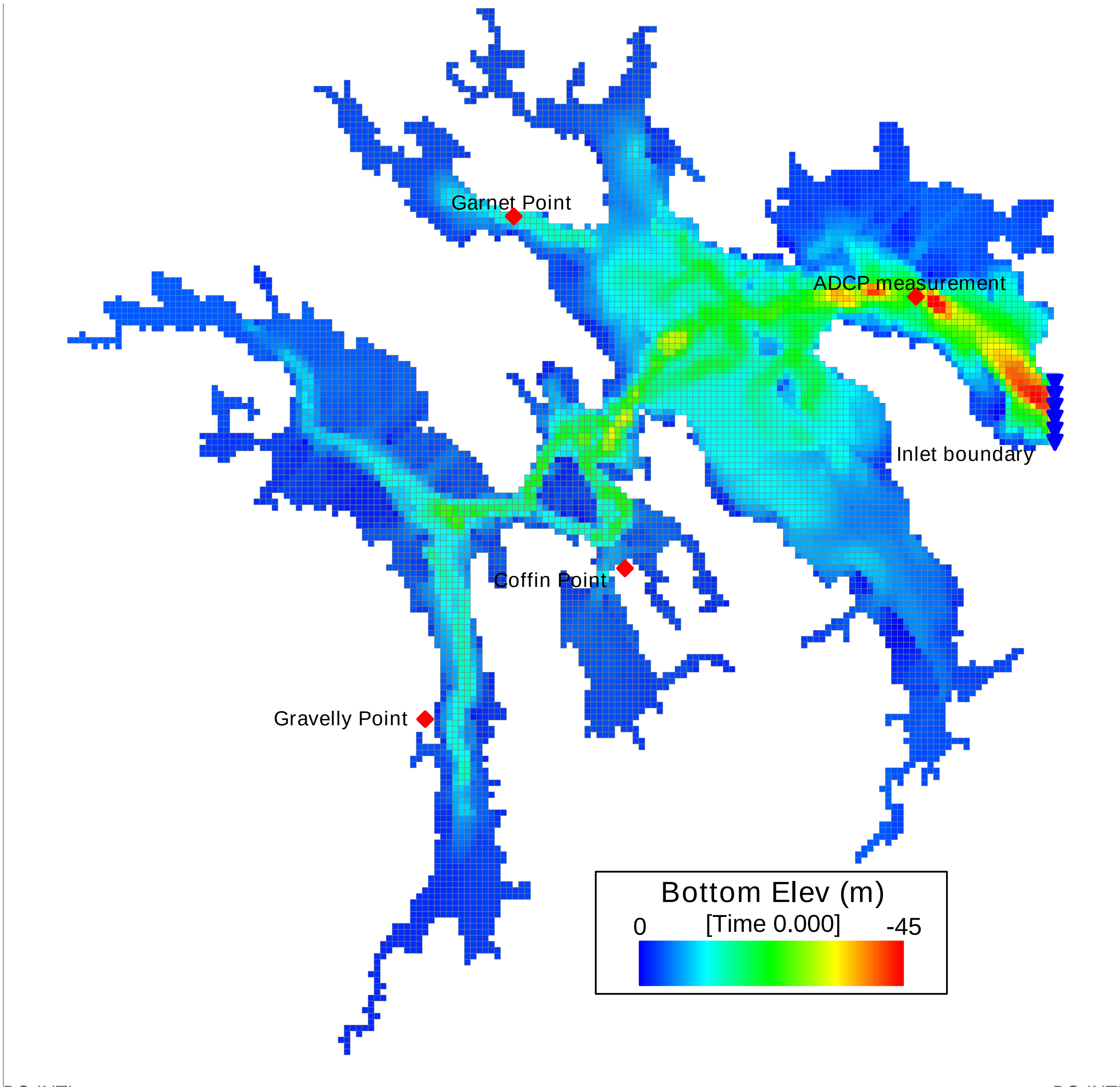

Figure 1: Cobscook Bay bathymetry showing locations of water-level collection stations.

Circulation in the Bay was driven by data collected at Eastport Maine (http://tidesandcurrents.noaa.gov/gmap3/). This collection point is less than 2 km from the actual model boundary. To ensure that these water-level data are appropriate drivers for the model, data were requested from the University of Maine FVCOM (Chen et al., 2004) model (Bao et al., 2012; Xu and Xue, 2010; Xu et al., 2006). Specifically, water levels at Eastport and at a transect coincident with the SNL-EFDC model boundary were compared as shown in Figure 2 (these data are for July 6th to July 30th, 2004). The close match between all data sets (the average difference between the FVCOM model water levels and data at Eastport is 1 cm) engenders confidence that data measured at Eastport can be used to drive the SNL-EFDC model. All SNL-EFDC model outputs (water level, water velocity, dye concentrations) are recorded on an hourly basis to manage data file sizes.

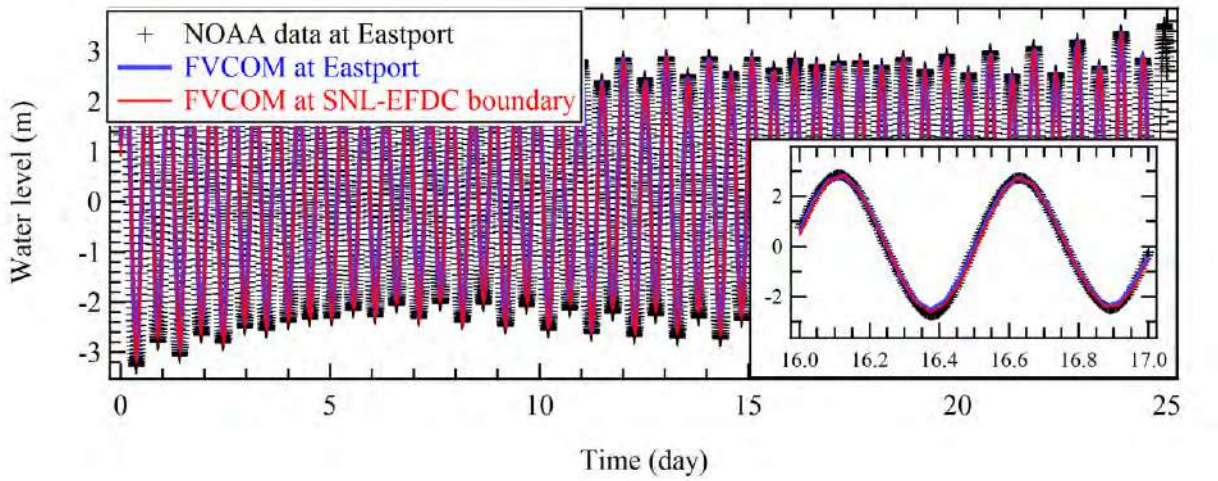

Figure 2: Comparison of water-level data between NOAA (symbols) and FVCOM (black curve) at Eastport with the water levels at the SNL-EFDC boundary from FVCOM for comparison (red curve). The inset is a close-up of days 16 to 18.

Water Level Verification

Using the Eastport water-level data to drive the model (July 6th–30th, 2004), various comparisons were made at the three locations on Figure 1 where water level data are available from NOAA (Garnet, Coffin, and Gravelly Points, see Table 1). NOAA data, SNL-EFDC data, and even FVCOM data for comparison are presented on Figure 3 (insets are close-ups of day 16).As evident, water levels are extremely close across both models and the data. The maximum simulated water-level range (amplitude) is 5% lower than the NOAA data at Garnet Point, 10% higher at Coffin Point, and 15% higher at Gravelly Point. Relative differences are harder to quantify because small changes in phase can yield significant difference in water levels at a specified time, but they are generally within 10 cm. It is worth noting that modeling from the University of Maine that used only tidal and wind forcing showed good agreement with available depth, velocity, and tracer data near Cobscook Bay (Xu et al., 2006). Conclusions from that work indicate that temperature, and density gradients are not critical factors influencing hydrodynamic circulation in the bay. Moreover, in a more recent model, Bao et al. (2012) force their Cobscook Bay model with only water levels (no wind forcing) and concluded that, “the agreement between the magnitudes wasn’t as good as in Xu et al. (2006),” but Bao et al. (2012, Figure 3) still showed quite reasonable agreement with “the phase of the modeled tidal current [agreeing] better with observations than the speed.” This suggests that temperature and salinity gradients are not very important for circulation models of Cobscook Bay but that wind forcing plays a minor role.

Table 1: Locations of NOAA water-level data collection stations.

Site	UTM Easting (m)	UTM Northing (m)
ADCP	654,267	4,974,792
Coffin Point	649,429	4,970,250
Garnet Point	647,581	4,976,135
Gravelly Point	646,107	4,967,792
Eastport		

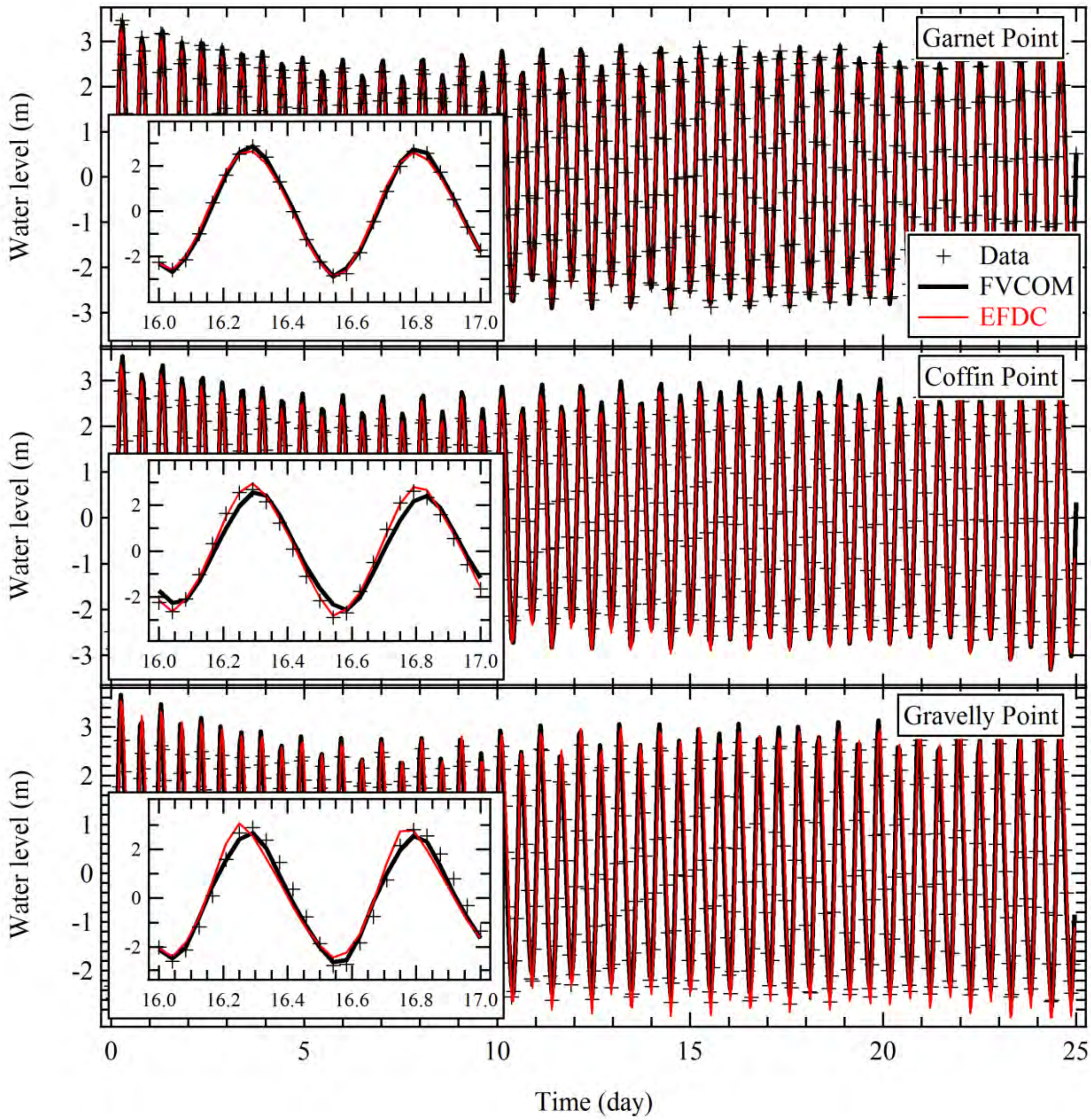

Figure 3: Comparison of the NOAA water level data (symbols) and the SNL-EFDC model results at Garnet Point (top), Coffin Point (middle), and Gravelly Point (bottom). FVCOM data are also presented for comparison. All data compare favorably and are within the data and model uncertainties.

Cross-correlation plots of the SNL-EFDC water levels (*x* axis) and the NOAA data (*y* axis) for Garnet (left), Coffin (center) and Gravelly Points (right) are shown in Figure 4. Red lines represent the one-to-one correlation indicating a perfect match between model and data The correlation coefficients are listed on the plots and they are comparable to those between the FVCOM model and the NOAA data (Garnet, Coffin, and Gravelly Points are $R^2 = 0.995$, 0.979, and 0.958, respectively). Slopes less than unity for the fit to the cross-correlation data indicate that the model tends to over-predict water levels for Coffin and Gravelly Points (slopes of 0.87 and 0.86, respectively, indicate about 13% and 14% over-predictions). The oval-shape trend in cross-correlations for Coffin Point indicates that there is a small phase shift between the model and data.

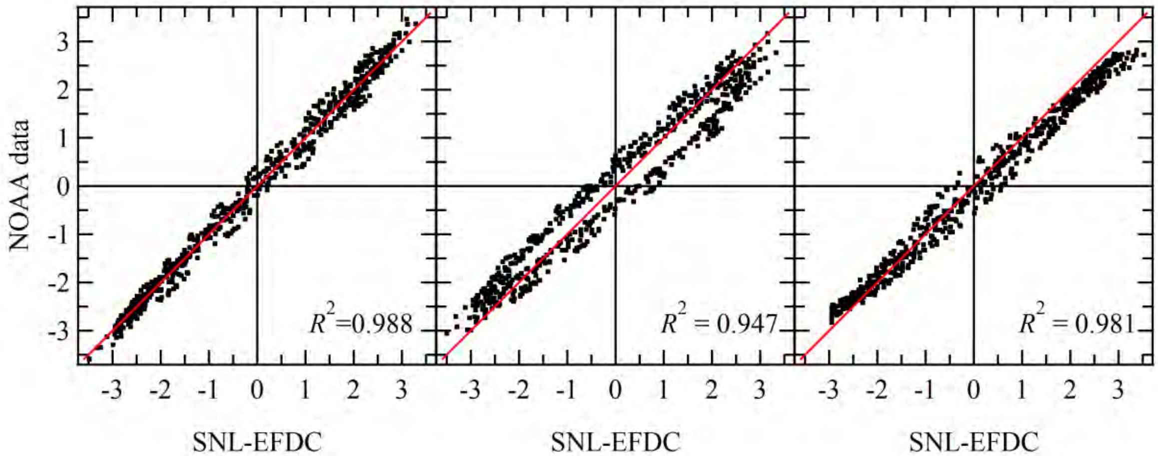

Figure 4: Cross-correlation plot between SNL-EFDC output and NOAA data for Garnet Point (left), Coffin Point (center), and Gravelly Point (right).

Water Velocity Validation

Acoustic Doppler Current Profilometer (ADCP) data were collected by ORPC from July 5th through August 5th, 2011, at UTM-NAD83 (654,267-E, 4,974,792-N, shown on Figure 1). Measured water-level data for this timeframe at Eastport are shown in Figure 5 and were used to drive the SNL-EFDC model.

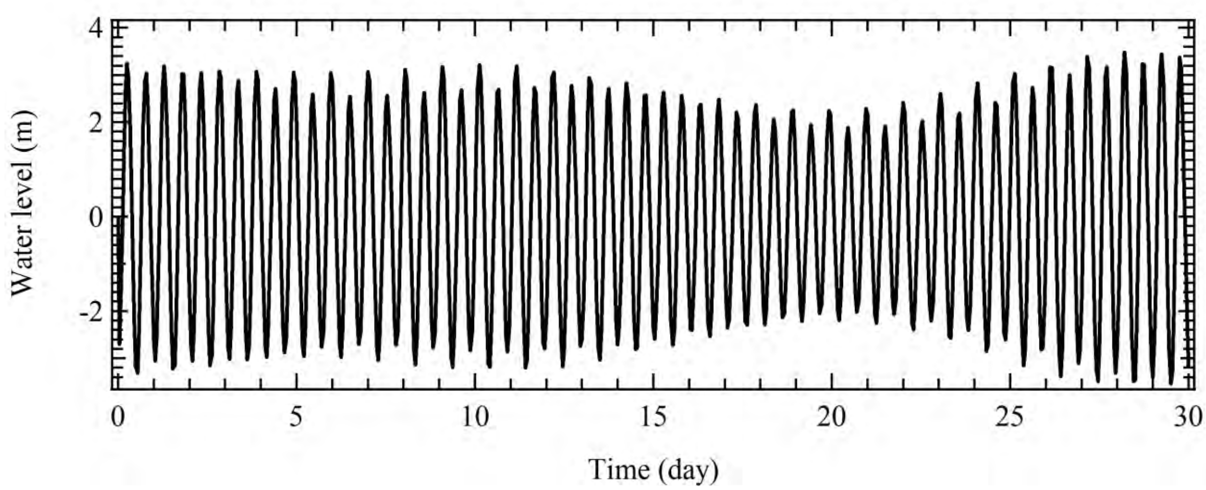

Figure 5: Measured water levels at Eastport, Maine, used to drive the SNL-EFDC model for July 5th through August 5th, 2011.

Figure 6 compares ADCP data to SNL-EFDC model results for depth-averaged water speed. SNL-EFDC under predicts the ADCP data by about 5% on average over the period of record. In agreement with what was reported by Bao et al. (2012), the phase and trend of the speeds are consistent between data and model, but the magnitude is under predicted. Moreover, the eastward velocity component is somewhat over predicted by the model while the northward velocity component is under predicted; this could easily be a difference due to neglecting wind forcing in the model. It can also be due to the Cartesian grid, grid resolution, and interpolated bathymetric resolution. To improve the model, a refined curvilinear grid should be developed.

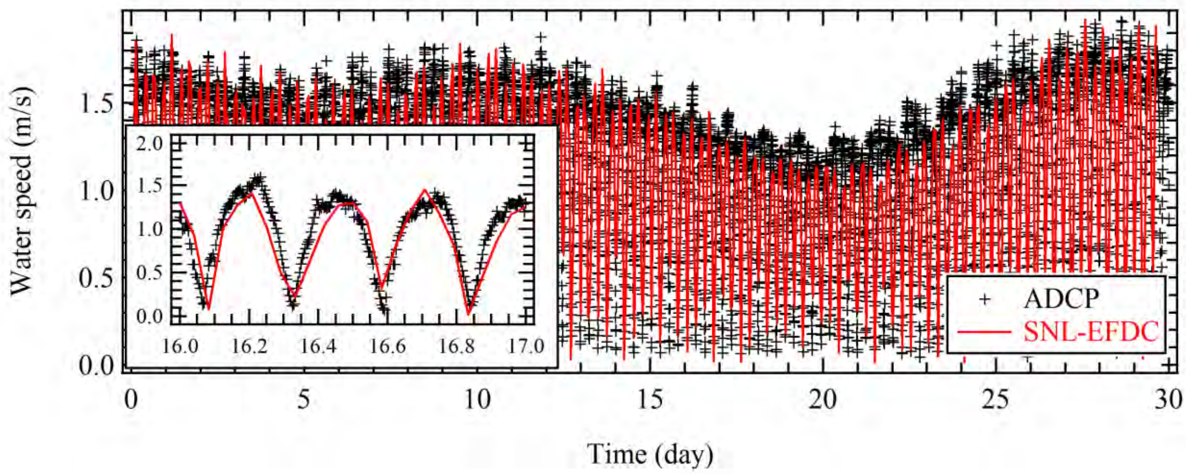

Figure 6: Comparison of ADCP (symbols) to SNL-EFDC (red curves) speeds.

Snapshots of the vertical velocity profile from ADCP data and the SNL-EFDC model are shown in Figure 7. Note that ADCP data are not available for depths less that about 4 m from the sediment bed. Also, near the water surface, there is some noise in the data. The SNL-EFDC velocity profiles replicate the ADCP data fairly well.

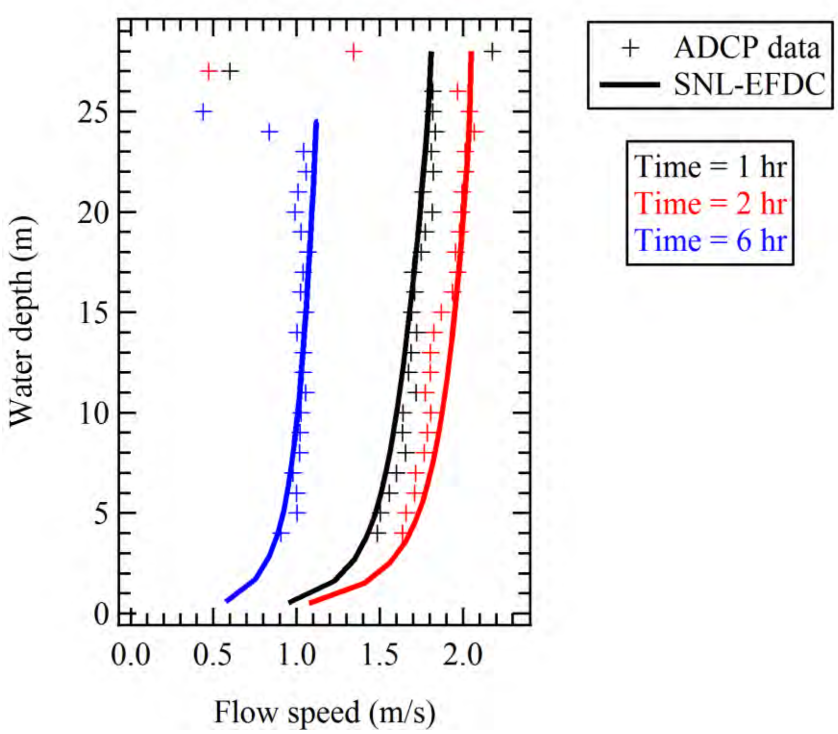

Figure 7: Snapshots of the vertical velocity profile from ADCP data (symbols) and SNL-EFDC (curves).

The cross-correlation plot of SNL-EFDC to ADCP speeds is shown in Figure 8. The red line shows the one-to-one correlation. The correlation coefficient ($R^2 = 0.717$) is a bit lower for the speed data than for the water-level data indicating more variability between the model and data, but there is not a large bias as the data are fairly symmetric about the one-to-one line. In fact, the best fit line to the correlation data has slope 1.05 suggesting that the model underpredicts the ADCP data by about 5%. The R^2 would be improved would be improved with a refined curviliear grid.

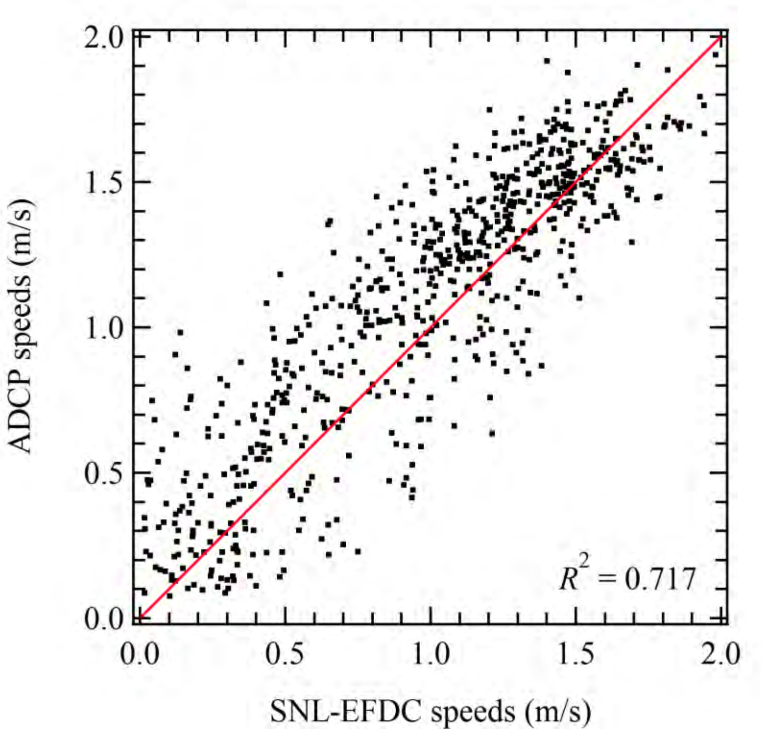

Figure 8: Cross-correlation plot of SNL-EFDC and ADCP speeds.

MHK Array

ORPC has a five-turbine array planned for Cobscook Bay; the locations of which are listed in Table 2. The cells that contain turbines are colored red in Figure 9. The TidGen™ cross-flow turbines (Figure 10) are each 30.28 m (100 ft) long and 4.3 m (14.1 ft) high with blade bottoms 9 m (29.5 ft) from the sediment bed. The support structures are assumed to occupy 3 m (9.8 ft) of the width and to extend from the sediment bed to 11.2 m (36.7 ft) height. Thrust coefficients are specified as $C_T = 0.8$ and drag coefficients for the support structures are $C_D = 1.2$. SNL chose a relatively high thrust coefficient to be environmentally conservative; because physical environmental changes are expected to increase as more energy is removed from the tidal channel. As additional turbines are included in this model analysis, more accurate turbine representations will be implemented.

Table 2: Turbine locations (latitude/longitude, UTM easting/northing, and EFDC cell I/J).

Turbine	Longitude	Latitude	Easting	Northing	Cell I	Cell J
1	–67.0458750	44.9100591	654256	4974818	143	130
2	–67.0445353	44.9096565	654363	4974775	144	129
3	–67.0472154	44.9102783	654150	4974839	142	130
4	–67.0442623	44.9090942	654386	4974713	145	129
5	–67.0464226	44.908145	654213	4974789	143	129

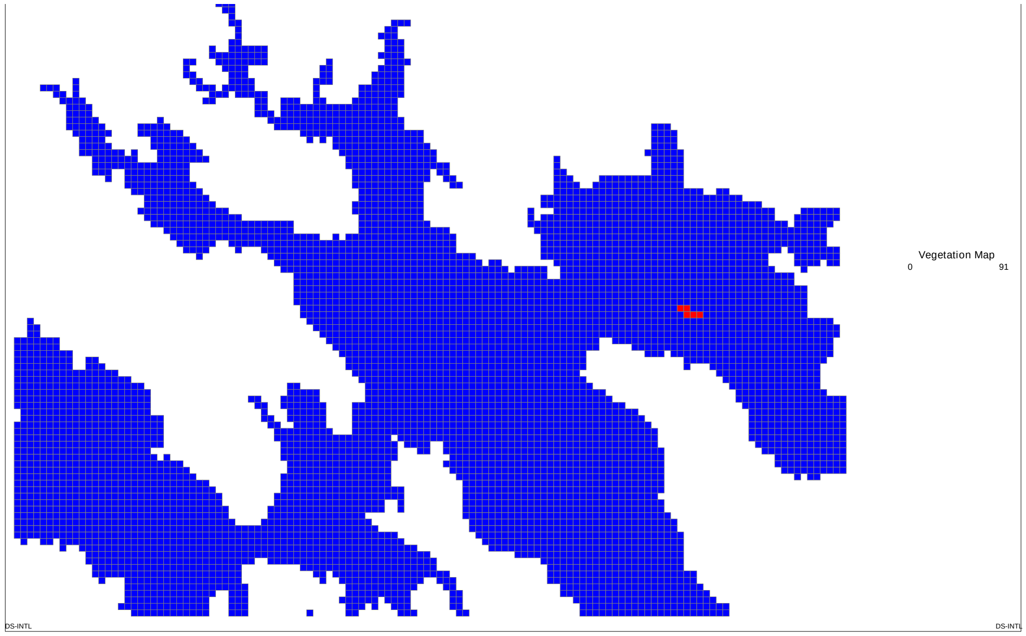

Figure 9: Turbine locations (red cells).

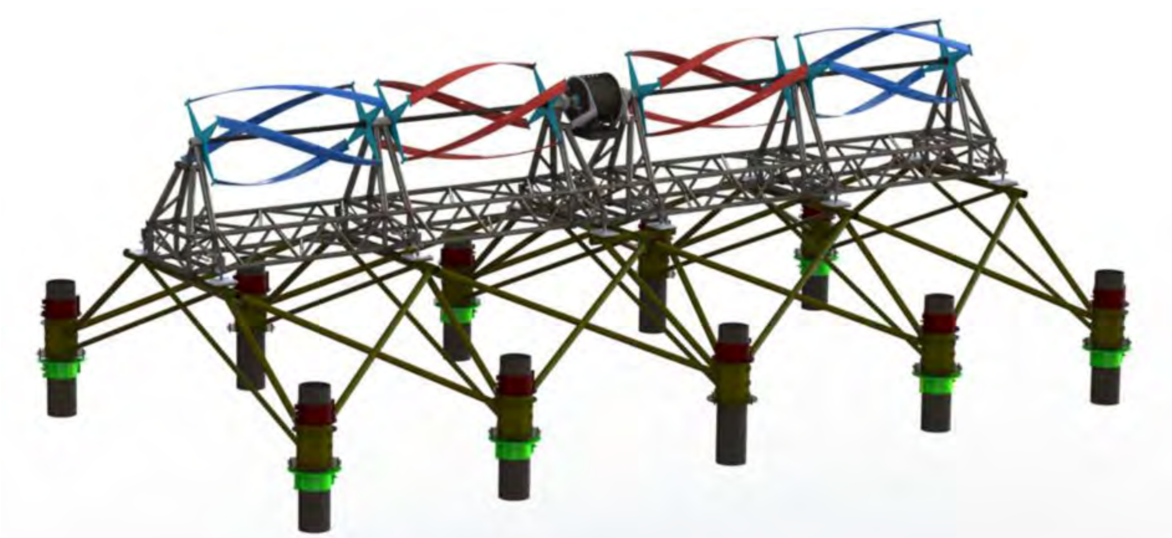

Figure 10: Schematic of the ORPC TideGen^{TM} turbine.

Because the turbines occupy only a fraction of a cell (30-m turbine in a 100-m cell), some discussion of the model implementation is warranted. Power of a turbine is calculated as:

$$P = \frac{1}{2} C_{\mathrm{T}} \rho A_{\text{flow facing}} U^3, \tag{1}$$

where ρ is the fluid density, U is the velocity, and $A_{\text{flow facing}}$ is the flow-facing area of the MHK turbine. It is assumed that the turbine is always aligned with the flow direction (although this may be impossible in a three-dimensional, bi-direction flow). From the power equation, the local force, F, applied on the water column is:

$$F = \frac{P}{U} = \frac{1}{2} C_{\mathrm{T}} \rho A_{\text{flow facing}} U^2. \tag{2}$$

Given this formulation and the known turbine area, model-calculated velocities are used to specify the force applied to the flow by the MHK device. This force is decomposed into vector components based on the directional velocity components. Area-weighted forces are then applied to each vertical face of the model cell in which the MHK (or support) resides. If the MHK device occupies only a portion of a vertical (sigma) model layer, appropriate weighting is applied. An analogous computation applies for the MHK support structures where C_{T} is replaced by C_{D}.

The five ORPC turbines generated a total of about 136 MW-hr over the 30-day simulation (July 2010 simulation). The support structures dissipated about 10 MW-hr over the same time period.

Results

Particle Tracking

Advective (no dispersion) Lagrangian particle tracks were calculated for the Cobscook Bay model. A total of 25 particles were released 1 m from the sediment bed from the 25 cells surrounding the MHK array as shown in Figure 11. This location was selected because it has the potential to have the greatest velocity differences due to the presence of the MHK turbine. The model was forced with the July 2010 tidal data shown in Figure 5 (symbols). The particles were released 30 minutes into the simulation because starting earlier resulted in the particles quickly exiting the system through the tidal boundary because of the ebb tide.

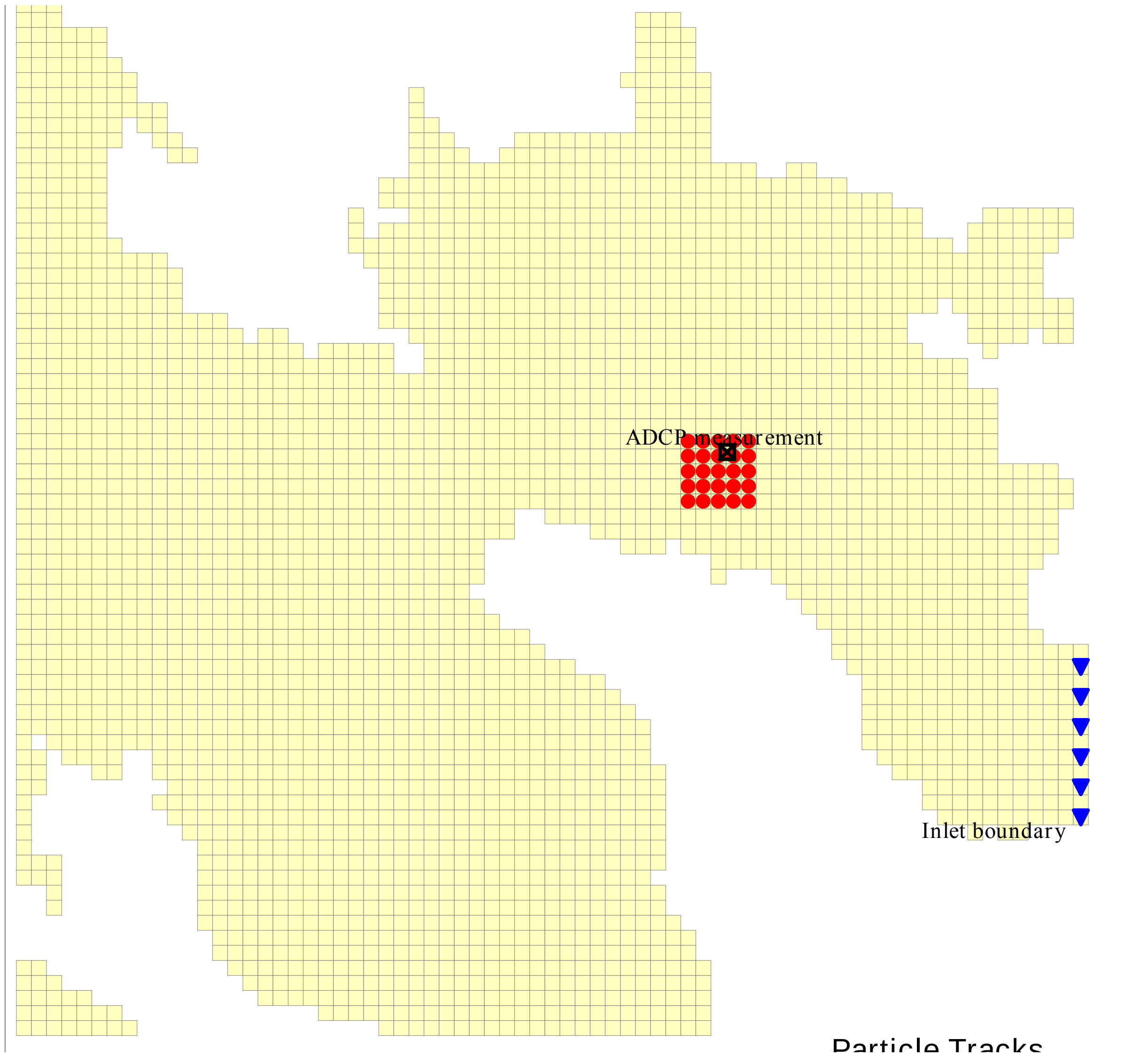

Figure 11: Particle release locations 1 m from the sediment bed.

After 18.5 days of simulation, no particles remained in the system with no MHK array; all exited through the tidal boundary. Each particle's travel history is shown in Figure 12 for a system without the MHK array (left) and with the MHK array at 10.35 days (right). While differences are noted in the particle tracks for simulations with and without the MHK array (the last particle exited the system with MHKs in it at 10.35 days), they were not considered significant and qualitatively resulted in the same sort of particle tracks. Specifically, because particle tracks follow advective flow paths, even the slightest of deviations early in the simulation result in different particle tracks (because trajectory changes early in the simulation are amplified). Overall, the 5-turbine MHK array does not seem to significantly change the general particle track characteristics when seeded from this location and time.

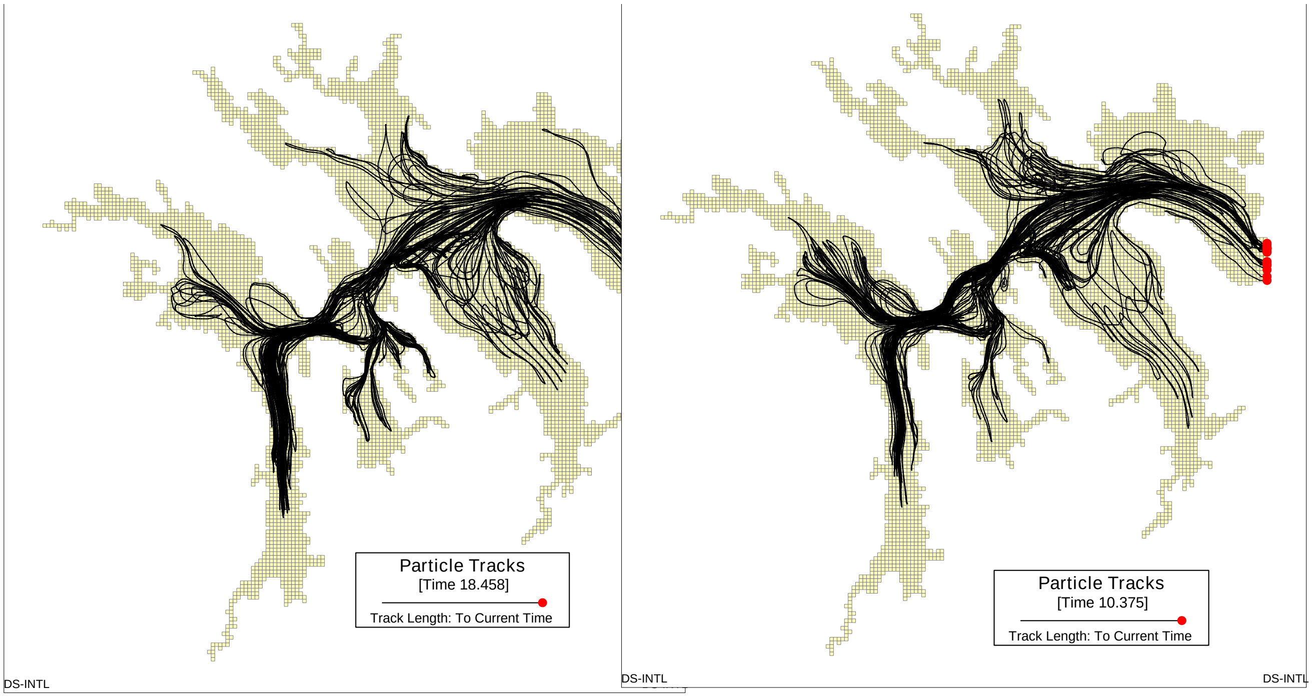

Figure 12: Particle tracks in a system with no MHK array after nearly 18.5 days of simulation when all 25 particles have left the model domain (left). Particle tracks with the MHK array after 10.5 days when the last particle exited the system (right).

Tidal Range

Tidal ranges over the 25-day simulation in July 2011 are shown in Figure 13. Tidal ranges in cells that wet and dry are represented as zero (hence the dark blue cells around the model domain). The ranges in the Bay are significant and go from 6.35 to 6.7 m in non-drying cells. When comparing tidal ranges with and without the five MHK devices, there was less than a 2-mm decrease when turbines were present. This is within the error tolerance of the model indicating effectively no change in tidal range for the investigated 5-turbine MHK array.

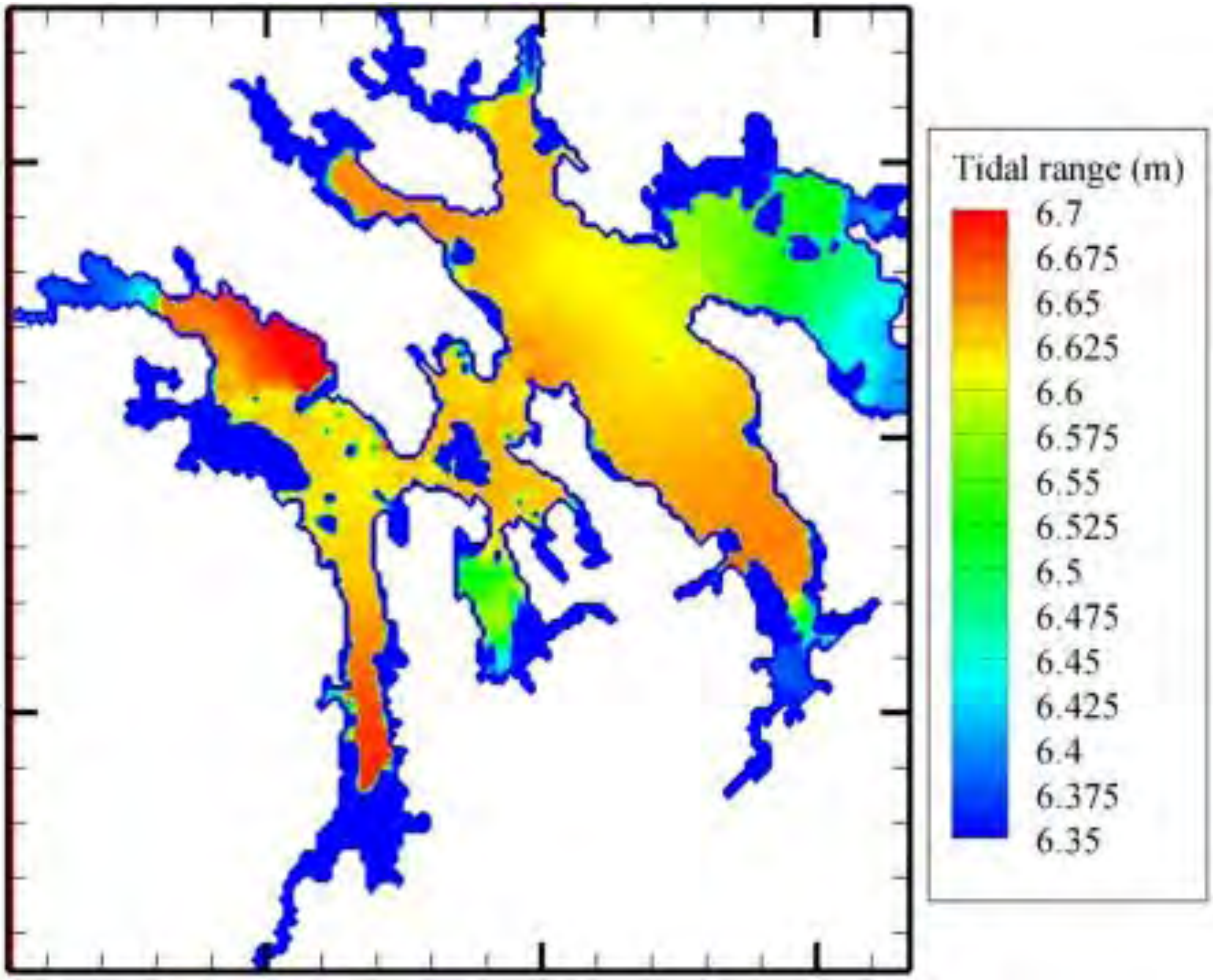

Figure 13: Tidal range over the 25-day simulation.

The change in tidal range due to the operation of the 5 MHK turbines is shown in Figure 14. These results are for the July 2010, 30-day simulation. The maximum difference is about 1 cm, but these occurred in the regions that wet and dry. These regions are most susceptible to numerical error because of the challenges associated with simulating this effect. Differences in tidal range of 1 cm or less are within the uncertainty of the model and the conclusion is that the 5-turbine MHK array does not affect tidal range in Cobscook Bay. There are only extremely small (<1cm) changes in tidal range in regions of the model that are continuously wet.

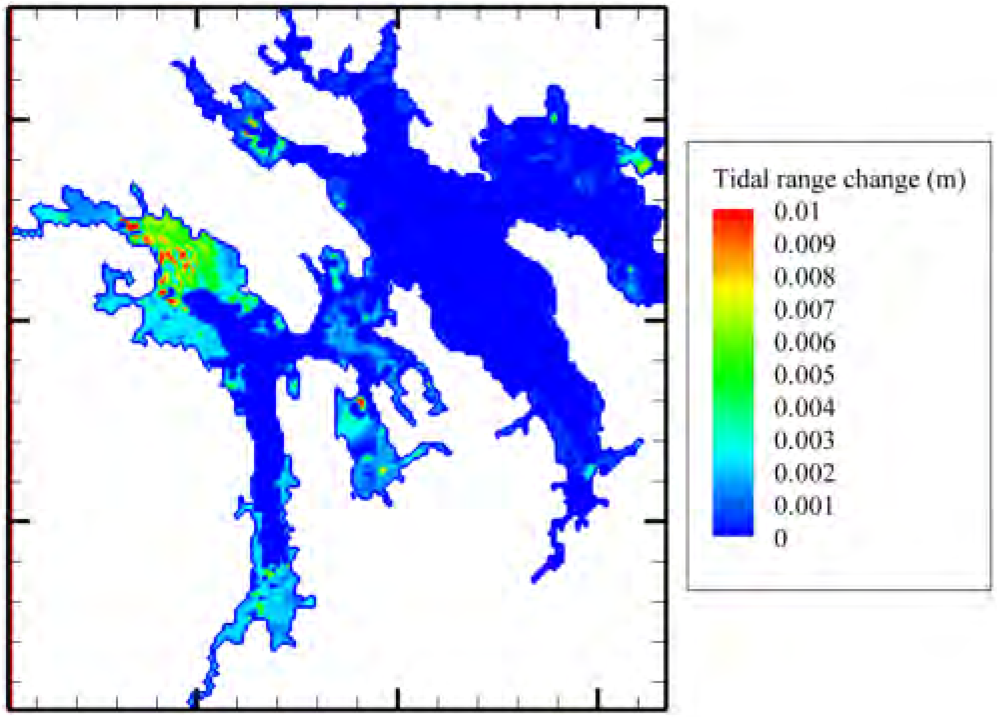

Figure 14: Change in tidal range (with MHK minus without MHK) in Cobscook Bay for the 30-day July 2010 simulation.

Flushing

Maximum changes in dye concentration over the course of the 30-day simulation are shown in Figure 15. Given that dye concentrations begin at unity, the maximum differences of 0.0007 are within model uncertainty and considered insignificant. Also, these maximum differences are in the far reaches of the Bay where dye stays most concentrated because of minimal flushing there (higher dye concentrations here lead to increased absolute differences). Again, it is concluded that the 5-turbine MHK array does not affect dye concentration, which is a surrogate for tidal flushing in the Bay.

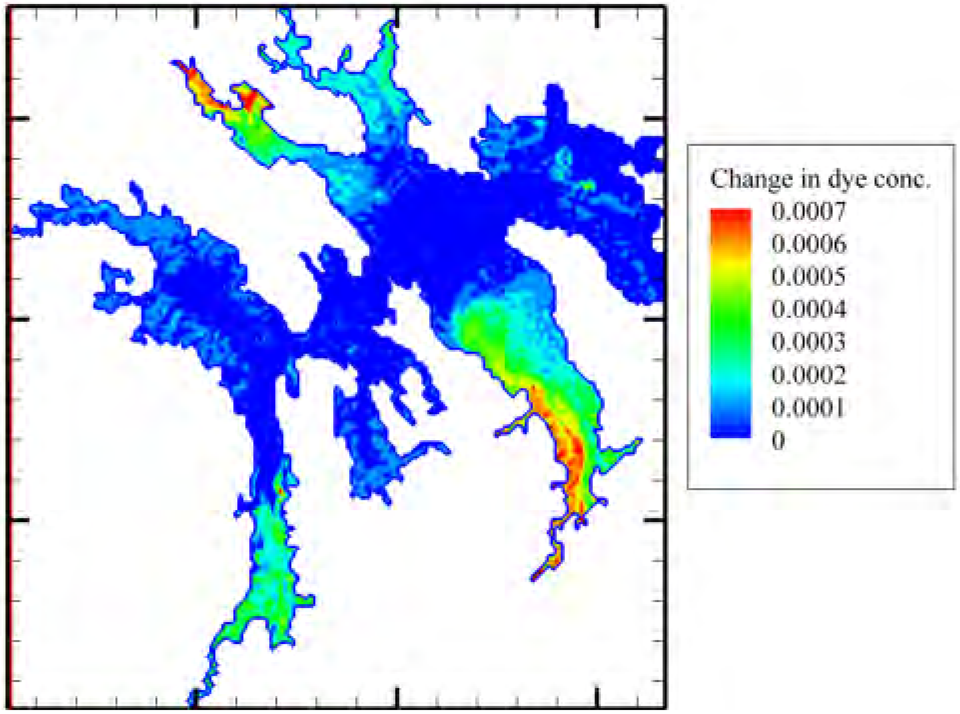

Figure 15: Maximum change in dye concentration over the 30-day July 2010 simulation.

The *e*-folding time is the time it takes dye concentration to dilute to 1/*e* (about 37%) of its original concentration through mixing with un-dyed waters; it is a measure of the flushing rate in the system. Assigning unit dye concentration in the system and running the model for two days where water that enters is dye-free results in Figure 16. A plot of system-averaged dye concentrations used to estimate the *e*-folding time is shown in Figure 17. A system-averaged dye concentration of 0.37 is first achieved around 2 days indicating quite a rapid flushing rate for Cobscook Bay. Again, differences between *e*-folding simulations with and without the MHK array were so small as to be within model uncertainty (average difference in dye concentration was 0.25% and the curves essentially overlie each other). Water age was also simulated both in the presence and absence of the five MHK devices; differences between these simulations were insignificant (within the uncertainty of the model).

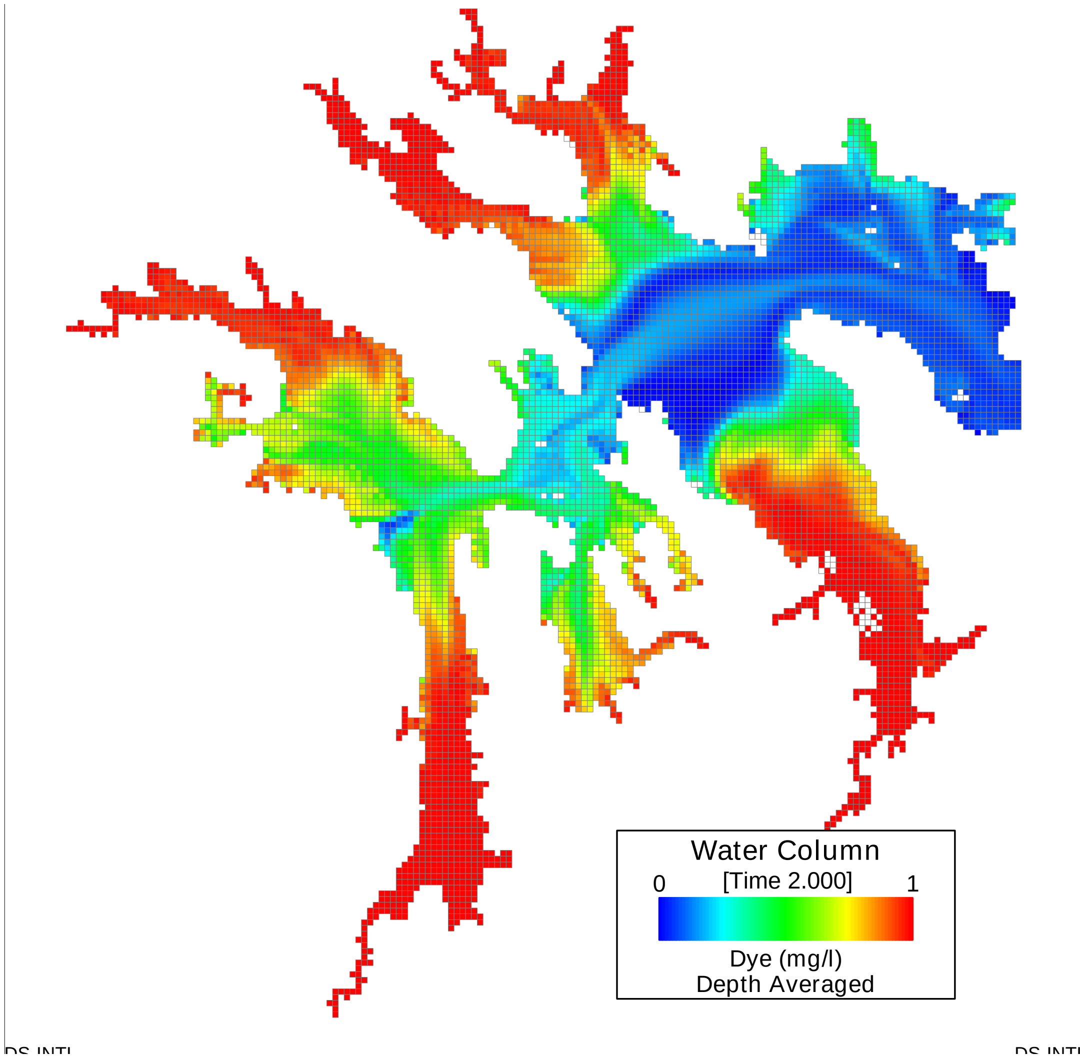

Figure 16: Depth-averaged dye concentrations after two days of simulation. Water that enters the system has no dye in it.

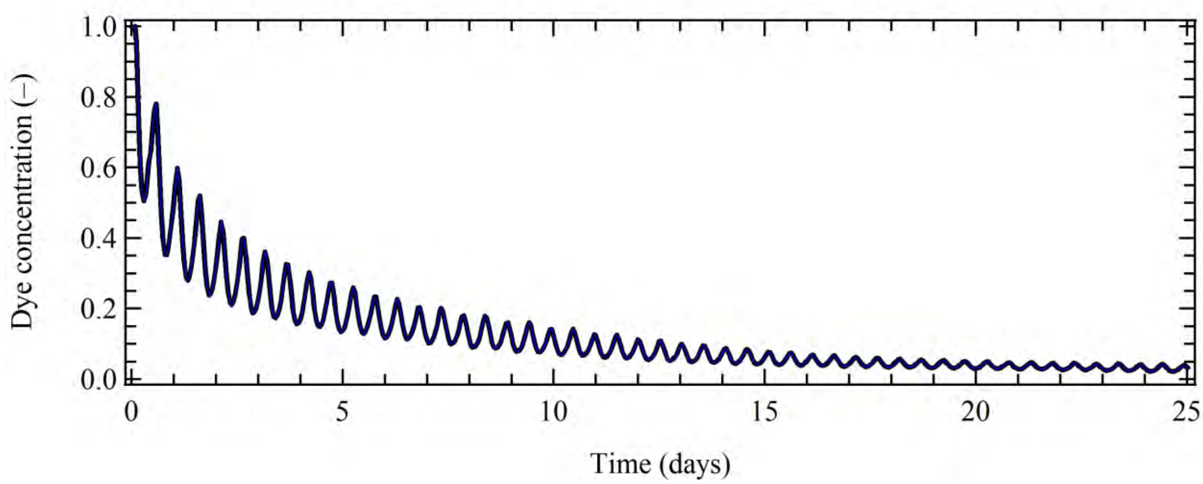

Figure 17: Dye concentration to calculate the *e*-folding time for Cobscook Bay.

Discussion and Future Work

This preliminary modeling effort was designed to evaluate the potential for the operation of 5 MHK-turbines to alter Cobscook Bay regional hydrodynamics. Large changes in system-wide hydrodynamics can significantly alter the local ecosystem and specifically aquatic habitat. Although the present effort considers only a small five turbine array, the SNL-EFDC software can be used to optimize array configurations of any size to maximize electricity generation while minimizing deleterious environmental effects. This and ongoing studies at Sandia National Laboratories can help provide early guidance on optimal array configurations, identify potential environmental concerns, and also help specify mitigation controls that are site- and technology-specific.

Overall, the present model does a good job of simulating flow in Cobscook Bay and it adequately reproduces available data sets for three water-level locations and an ADCP measurement. This work demonstrates that there are no significant changes in tidal range, flow rate, or velocity upon operation of the five ORPC tidal turbines. Therefore we conclude that the operation of 5tidal turbines in Cobscook Bay will have little to no effect on regional aquatic habitat as regional processes are unchanged. While there are several additional features that could be included in the model (e.g., exchange of groundwater, wind and wave forcing, temperature and salinity transport), this version serves as a good baseline with which to compare system behavior with and without MHK arrays.

Ongoing work at Sandia will facilitate optimization of multiple device configurations while concurrently ensuring minimal environmental impact. In particular, SNL will work towards model grid refinement to more accurately investigate near-field hydrodynamics and potential for environmental alterations within and around the array. SNL will also consider additional data sets for more thorough model validation of baseline hydrodynamics to support more accurate analyses of potential change due to the operation of MHK turbines. Further simulations will include adding various array configurations and estimating their effects on system hydrodynamics. If hydrodynamics are significantly affected, the analyses will be extended to include the effects on sediment dynamics and water quality.

Acknowledgements

Sandia would like to thank Dr. Huijie Xue and Min Bao at the University of Maine for their FVCOM model output as well as discussion and guidance on this Cobscook Bay model development.

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Appendix G

Marine Mammal Recorder Sheets

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Marine Mammal Species Observation Log

OCEAN RENEWABLE POWER COMPANY

Observer(s): Darius Neptune + Michael brown
Date: 7/13/12
Start Time: 12:51
End Time: 3:30

Location of Observation (approximate):
Capt. E - TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.[illegible]"N, 67° 3'12.13"W)
Western Passage ______
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
				none			DN

Updated April 18, 2012

Marine Mammal Species Observation Log

ORPC
OCEAN RENEWABLE POWER COMPANY

Observer(s): Jaime Mitchell
Date: 7-13-12
Start Time: 12:51
End Time: 4:30

Location of Observation (approximate):
✓ Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
✓ Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ______
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
10:30	Lubec Shore Station		Sea State 1, clear	Seal	1	Swimming	JM

ORPC OCEAN RENEWABLE POWER COMPANY

Marine Mammal Species Observation Log

Observer(s): Jaime Mitchell
Date: 8-14-12
Start Time: 15:00
End Time: 16:00

Location of Observation (approximate): Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ______
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
3:40	near come ashore station	1000 ft.	calm, clear unlimited visibility	harbor seal	1	swimming	JM

Marine Mammal Species Observation Log

ORPC OCEAN RENEWABLE POWER COMPANY

Observer(s): Nathan Johnson
Date: 8/14/2012
Start Time: 15:00
End Time: 16:00

Location of Observation (approximate):
Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ______
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
15:00	– Start Observations →		Mostly clear NW wind 5 knots unlimited vis., Sea State 1				
16:00	→ END OBSERVATIONS – NO SIGHTINGS – TGU DEPLOYED ——						

Marine Mammal Species Observation Log

OCEAN RENEWABLE POWER COMPANY

Observer(s): Jaime Mitchell, Sean Anderton
Date: 10-25-12
Start Time: 8:00 Am
End Time: 9:30 Am

Location of Observation (approximate): Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ____
Other ____

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
	none		Sunny, windy Sea state 2				JM SA

Updated April 18, 2012

Marine Mammal Species Observation Log

ORPC
OCEAN RENEWABLE POWER COMPANY

Observer(s): Jaime M. JohnT
Date: 12-7-12
Start Time: 10:50 AM
End Time: 11:25 AM

Location of Observation (approximate):
Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ______
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
			none	none			JM

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Attachment 4

Marine Mammal Species Observation

Observer(s): Jm. BUTCH

Date: 1/3/2012

Start Time: 13:00

End Time: 15:30

Location of Observation (approximate): Energy Tide 2 (44°54'34.98"N, 67° 2'43.98"W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ____________

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jm

Attachment 4
Marine Mammal Species Observation

Observer(s): Jm, BH, ML, DN
Date: 1/9/2012
Start Time: 10:00
End Time: 14:30

Location of Observation (approximate): Energy Tide 2 (44°54'34.98"N, 67° 2'43.98"W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______________

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	CLEAR / SUNNY	—	—	—	[illegible]

Attachment 4
Marine Mammal Species Observation

Observer(s): Jm, BH, SA, mL
Date: 1/10/2012
Start Time: 10:30
End Time: 13:00

Location of Observation (approximate): Energy Tide 2 (44°54'34.98"N, 67° 2'43.98"W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other —

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	CLEAR / SNOW	—	—	—	Jm

Attachment 4
Marine Mammal Species Observation

Observer(s): Jm. Burch
Date: 1/13/2012
Start Time: 10:00
End Time: 13:00

Location of Observation (approximate): Energy Tide 2 (44°54'34.98"N, 67° 2'43.98"W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jm

Attachment 4
Marine Mammal Species Observation

Observer(s): Jm. Bitch, Darius
Date: 1/16/2012
Start Time: 13:00
End Time: 13:30

Location of Observation (approximate): Energy Tide 2 (44°54'34.98"N, 67° 2'43.98"W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______________

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jm

Attachment 4

RTE and Marine Mammal Species Observation

Observer(s): JM, DT, SA
Date: 2/10/2017
Start Time: 0700
End Time: 0900

Location of Observation (approximate): ~~Energy Tide~~ CHAE 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ____________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—		—	JM

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): Jm, BH
Date: 2/12/2012
Start Time: 1000
End Time: 1300

Location of Observation (approximate): ~~Energy Tide~~ CATTE 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	[illegible]

Attachment 4

RTE and Marine Mammal Species Observation

Observer(s): JM, BH, SA
Date: 2/13/2012
Start Time: 0900
End Time: 1200

Location of Observation (approximate): CHITE Energy Tide 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—				JM

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): Jm, Sean
Date: 3/12/2012
Start Time: 07:00
End Time: 10:00

Location of Observation (approximate): CAPT E ~~Energy Tide~~ 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	JM

Attachment 4

RTE and Marine Mammal Species Observation

Observer(s): Jim, Scott
Date: 3/13/2012
Start Time: 0800
End Time: 11:00

Location of Observation (approximate): CATE ~~Energy Tide~~ 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jim

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): ~~Ste~~ Jan Stran

Date: 3/14/2012

Start Time: 0800

End Time: 1200

Location of Observation (approximate): ~~Energy Tide~~ CAPT E Tide 2 (44°54'34.98"N, 67° 2'43.98"W) ✓

Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)

Other ______________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantit y	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	[illegible]

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): Jm, JT, Sean
Date: 3/17/2017
Start Time: 1100
End Time: 1400

Location of Observation (approximate): ~~Energy Tide~~ Capt E 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—		—	Jm

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): JL, JT, SA
Date: 3/18/2012
Start Time: 1500
End Time: 1600

Location of Observation (approximate): ~~Energy Tide~~ CMTI 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantit y	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	[illegible]

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): Jm, SA, BL, DS
Date: 3/20/2012
Start Time: 1300
End Time: 19:30

Location of Observation (approximate): CATE ~~Energy Tide 2~~ (44°54'34.98"N, 67° 2'43.98"W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ____________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jm

Attachment 4

RTE and Marine Mammal Species Observation

Observer(s): Jm, SA

Date: 3/21/2012

Start Time: 15:00

End Time: 20:00

Location of Observation (approximate): ~~Energy~~ OCGT E Tide 2 (44°54'34.98"N, 67° 2'43.98"W)

Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)

Other ______________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantit y	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jm

Attachment 4

RTE and Marine Mammal Species Observation

Observer(s): Jm SA

Date: 3/22/2012

Start Time: 10:00

End Time: 12:30

Location of Observation (approximate): CAPTE ~~Energy Tide~~ 2 (44°54'34.98"N, 67° 2'43.98"W)

Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)

Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jm

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): Jm, JT, SSI
Date: 3/24/2012
Start Time: 10:00 16:00
End Time: 16:00

Location of Observation (approximate): ~~Energy~~ Capt E Tide 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—			—	[illegible]

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): Jm / JT / SSI
Date: 3/25/2012
Start Time: 0600
End Time: 1900

Location of Observation (approximate): ~~Energy~~ CAPTE Tide 2 (44°54'34.98"N, 67° 2'43.98"W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—		—	—	—	—	—	JJ

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): Jr., JT, SSI
Date: 3/25/2019
Start Time: 06:00
End Time: 18:00

Location of Observation (approximate): CAPT E ~~Energy~~ Tide 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
-							Jm

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): JR, /JT /SST
Date: 3/29/2012
Start Time: 0700
End Time: 19:00

Location of Observation (approximate): CAPT E ~~Energy Tide~~ 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
14:30	N/W	100 FT	Cloudy small Breeze	Harbor Seal	1	Checking out operation and leaving site	JR

Attachment 4

RTE and Marine Mammal Species Observation

Observer(s): Jm, JT, SSI
Date: 3/30/2012
Start Time: 07:00
End Time: 19:00

Location of Observation (approximate): CAPT E ~~Energy Tide~~ 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jm

Attachment 4

RTE and Marine Mammal Species Observation

Observer(s): Jm, JT, SSI

Date: 3/31/2012

Start Time: 0800

End Time: 2000

Location of Observation (approximate): CAPT E ~~Energy Tide 2~~ (44°54'34.98"N, 67° 2'43.98"W) ✓

Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)

Other ______________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
	—	—	—	—	—	—	Jom

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): Jm, JT, SST
Date: 4/1/2012
Start Time: 0500
End Time: 1600

Location of Observation (approximate): CHTE ~~Energy Tide~~ 2 (44°54'34.98"N, 67° 2'43.98"W) ✓
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ________

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantit y	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	Jm

Attachment 4
RTE and Marine Mammal Species Observation

Observer(s): JM, JT, DS, SSI
Date: 4/2/2012
Start Time: 05:30
End Time: ~~0[illegible]~~ 1900

Location of Observation (approximate): ~~Energy Tide~~ CAPT E 2 (44°54'34.98"N, 67° 2'43.98"W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	JM

Attachment 4

RTE and Marine Mammal Species Observation

Observer(s): Jm / JT / SS II

Date: 4/4/2012

Start Time: 0700

End Time: 1000

Location of Observation (approximate): ~~Energy Tide~~ CATE 2 (44°54'34.98"N, 67° 2'43.98"W) ✓

Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)

Other ______

Time	Estimated Bearing	Estimated Range	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	—	—	—	—	JKm

ORPC OCEAN RENEWABLE POWER COMPANY

Marine Mammal Species Observation Log

Observer(s): JT JM BH
Date: 4-20-12
Start Time: 10:30
End Time: 13:00

Location of Observation (approximate): Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W) ✓
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ______
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
11:15	NE	50'	BREEZE Sunny	H S	1	Looking Shuffout	JS

Marine Mammal Species Observation Log

OCEAN RENEWABLE POWER COMPANY

Observer(s): JM, DT, JT, SA

Date: 5/24/2012

Start Time: 13:45

End Time: 15:00

Location of Observation (approximate): Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W) ✓

Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)

Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)

Western Passage ______

Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
1400	E	200Ft	Sunny / Calm	Hbr Porpoise	5	Swimming together possibly feeding	[illegible]

Updated April 18, 2012

Marine Mammal Species Observation Log

ORPC
OCEAN RENEWABLE
POWER COMPANY

Observer(s): JT, BH
Date: 6·20·12
Start Time: 8:00 AM
End Time: 2:00 pm

Location of Observation (approximate):
✓Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
✓Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ____
Other ____

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
—	—	—	overcast	—	—	—	JI

Marine Mammal Species Observation Log

ORPC
OCEAN RENEWABLE POWER COMPANY

Observer(s): BL GM JT
Date: 6-23-12
Start Time: 8:00AM
End Time: 12:30 pm

Location of Observation (approximate):
Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ____________
Other ____________

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
–	–	–	over cast/fog	–	–	–	[illegible]

Marine Mammal Species Observation Log

ORPC
OCEAN RENEWABLE
POWER COMPANY

Observer(s): BL DT SA JT
Date: 6-26-12
Start Time: 10:00 am
End Time: 4:30 pm

Location of Observation (approximate):
X Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ______
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
1:00 pm	–	–	clear	–	–	–	JL

Marine Mammal Species Observation Log

ORPC OCEAN RENEWABLE POWER COMPANY

Observer(s): SM, JI, SH, JH,
Date: 9-4-12
Start Time: 2:30
End Time: 4:00

Location of Observation (approximate): (Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W))
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ____
Other ____

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
330pm	N/W	30Ft's	~~[illegible]~~ clear	Minkee	1	Feeding	JS

Updated April 18, 2012

Marine Mammal Species Observation Log

ORPC OCEAN RENEWABLE POWER COMPANY

Observer(s): DAVE T JT
Date: 11-1-12
Start Time: 8:20 AM
End Time: 11:00 AM

Location of Observation (approximate):
Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W) ✓
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ____________
Other ____________

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
8:45	CB	50 YARDS	choppy	SEAL	1	Feeding Playing	JT

Marine Mammal Species Observation Log

ORPC
OCEAN RENEWABLE POWER COMPANY

Observer(s): JT

Date: 11-29-12

Start Time: 9:00AM

End Time: 1:00pm

Location of Observation (approximate): ✓ Capt. E – TidGen #1 (44°54'34.98"N, 67° 2'43.98"W)
Energy Tide 2 – Shackford Head (44°54.020'N 67°01.582'W)
Lubec Come-Ashore (44°54'12.71"N, 67° 3'12.13"W)
Western Passage ______
Other ______

Time	Estimated Bearing	Estimated Distance	Weather Conditions (visibility, sea state)	Species	Quantity	Notes (observed behavior/direction of travel)	Initals
12pm	C B	25 yds	clear. Cold	SEAL	1	Playing/Feeding	JL

Report to ORPC on Bird Studies in Cobscook Bay, Maine,
Second Winter Season Period of Investigation, November 2011 - March 2012 (August 2012)
and Interim Bird Report to ORPC for the North Lubec Study Site, (January 2013)

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Report to ORPC on Bird Studies in Cobscook Bay, Maine

Second Winter Season

Period of Investigation

November 2011 - March 2012

Prepared by
Peter D. Vickery, Ph.D.
Center for Ecological Research

August 2012

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Introduction

The Center for Ecological Research (CER) conducted waterfowl and seabird inventories off the waters of North Lubec where Ocean Renewable Power Company (ORPC) plans to install a TidGen™ Power System (Fig. 1). CER monitored the waters off North Lubec from late October 2011 through March 2012. The purpose of these inventories was to determine the species and numbers of seabirds and other birds that use the proposed Deployment Area of the TidGen™ Power System, the onshore Landing Site where the bundled cables are likely to come ashore in North Lubec, and the waters immediately off the Landing Site. We also wanted to determine the behaviors of the species that used these specific areas. These results should help determine whether the presence of ORPC's TidGen™ Power System might potentially impact the birds that use these specific parts of eastern Cobscook Bay, and should help ORPC minimize potential impacts when it deploys and operates its equipment.

Background

Cobscook Bay is a rich marine environment with 5-7 meter tides and strong currents (Larsen 2004). This bay is an important fishing area and we regularly observed 12-20 scallop draggers in the bay during our surveys in December to February. Numerous salmon pens are also scattered throughout the bay; boats service these pens on a daily basis.

Cobscook Bay is considered an important area for wintering ducks, especially American Black Ducks (*Anas rubripes*; Longcore and Gibbs 1988). This bay also supports substantial numbers of seaducks (C. Bartlett, pers. obs.) but it is unclear whether ducks and other seabirds use the eastern portions of Cobscook Bay, especially the Deployment Area. Large numbers of Razorbills (*Alca torda*) are also known to occur in winter in the Bay of Fundy and nearby Grand Manan Island, New Brunswick (Huettmann et al. 2005).

Seaducks (scaup, eiders, scoters, Long-tailed Duck [*Clangula hyemalis*], goldeneyes, mergansers), loons, grebes, cormorants, and alcids are all diving birds foraging for benthic invertebrates or fish. Although most species dive to shallow depths (2-10 meters), a few species can dive to depths of over 100 meters (Table 1) and it is possible that these diving birds might interact with the bottom-mounted TidGen™ Power System, which is expected to be approximately 25 meters below the surface at low tide. Because of this potential interaction, we were interested in documenting the number of diving birds that use the Deployment Area and Landing Site, along with these birds' behaviors. We paid specific attention to species known to dive to depths of 20 meters or more; these include Long-tailed Duck (*Clangula hyemalis),* White-winged Scoter (*Melanitta fusca*), Common Loon (*Gavia immer*), Black Guillemot (*Cepphus grylle*), and Razorbill (*Alca torda*) (Table 1).

We paid special attention to federal and state endangered, threatened, and special-concern species and communicated with the Maine Department of Inland Fisheries and Wildlife to confirm that the updated list of these bird species in Maine was accurate (http://www.maine.gov/ifw/wildlife/species/endangered_species/state_federal_list.htm; see Appendix 1).

Table 1. Diving depths of waterbirds and seabirds known to occur in Cobscook Bay, North Lubec, Maine.[1] Diving depths taken from species accounts, Birds of North America (see Literature Cited).

WATERFOWL		Diving Depth	Food Taken	Occurrence in Cobscook Bay
Greater Scaup	Aythya marila	7.0 meters [1]	Benthic Invertebrates	Common
Common Eider	Somateria mollissima	+/- 10 meters [1]	Benthic Invertebrates	Common
Surf Scoter	Melanitta perspicillata	9 meters [1]	Benthic Invertebrates	Common
White-winged Scoter	Melanitta fusca	5-20 meters [1]	Benthic Invertebrates	Common
Black Scoter	Melanitta americana	3- <10 meters [1]	Benthic Invertebrates	Common
Long-tailed Duck	Clangula hyemalis	66 meters [1]	Benthic Invertebrates	Common
Bufflehead	Bucephala albeola	<3 meters [1]	Benthic Invertebrates	Common
Common Goldeneye	Bucephala clangula	2 - 9 meters [1]	Benthic Invertebrates	Common
Hooded Merganser	Lophdytes cucullatus	<10 meters [1]	Fish and crustaceans	Uncommon
Red-breasted Merganser	Mergus serrator	5 - 10 meters [1]	Fish and crustaceans	Common
LOONS AND GREBES				
Red-throated Loon	Gavia stellata	2 - 9 meters [1]	Fish and crustaceans	Rare
Common Loon	Gavia immer	to 60 meters [1]	Fish and crustaceans	Common
Horned Grebe	Podiceps auritus	< 10 meters [1]	Fish and crustaceans	Uncommon
Red-necked Grebe	Podicaps grisegena	< 10 meters [1]	Fish and crustaceans	Uncommon
CORMORANTS				
Double-crested Cormorant	Phalacrocorax auritus	<8 meters [1]	Fish	Common
Great Cormorant	Phalacrocorax carbo	<20 meters [1]	Fish	Common
ALCIDS				
Thick-billed Murre	Uria lomvia	to 210 meters [1]	FIsh and invertebrates	Rare
Razorbill	Alca torda	10 - >100 m [1]	Schooling fish	Occasional
Black Guillemot	Cepphus grylle	5 - 35 meters [1]	FIsh and invertebrates	Common

STUDY OBJECTIVES

The objective of this study was to determine the species and numbers of seabirds and other birds that use the proposed Deployment Area of the TidGen™ Power System. We also wanted to determine the behaviors of these seabirds.
CER also wanted to determine which species used the onshore Landing Site where the bundled cables are likely to come ashore, and the waters immediately off the Landing Site.

SURVEY SITE

ORPC Landing Site - North Lubec

We used the ORPC Landing Site in North Lubec as the location for our land-based observations because we wanted to determine the species composition, numbers, and behavior close to this proposed facility area where the bundled power and data cables for the TidGen™ Power System are likely to come ashore. We conducted the land-based surveys from the defunct landing dock. We used these land-based surveys to determine which species used the Landing Site and the waters immediately adjacent to the Landing Site (Fig. 1; A) and the mid-channel surrounding the Deployment Area (Fig. 1). The land-based surveys covered a broad mid-channel area (B in figure 1). We also surveyed the beach east of the Landing Site.

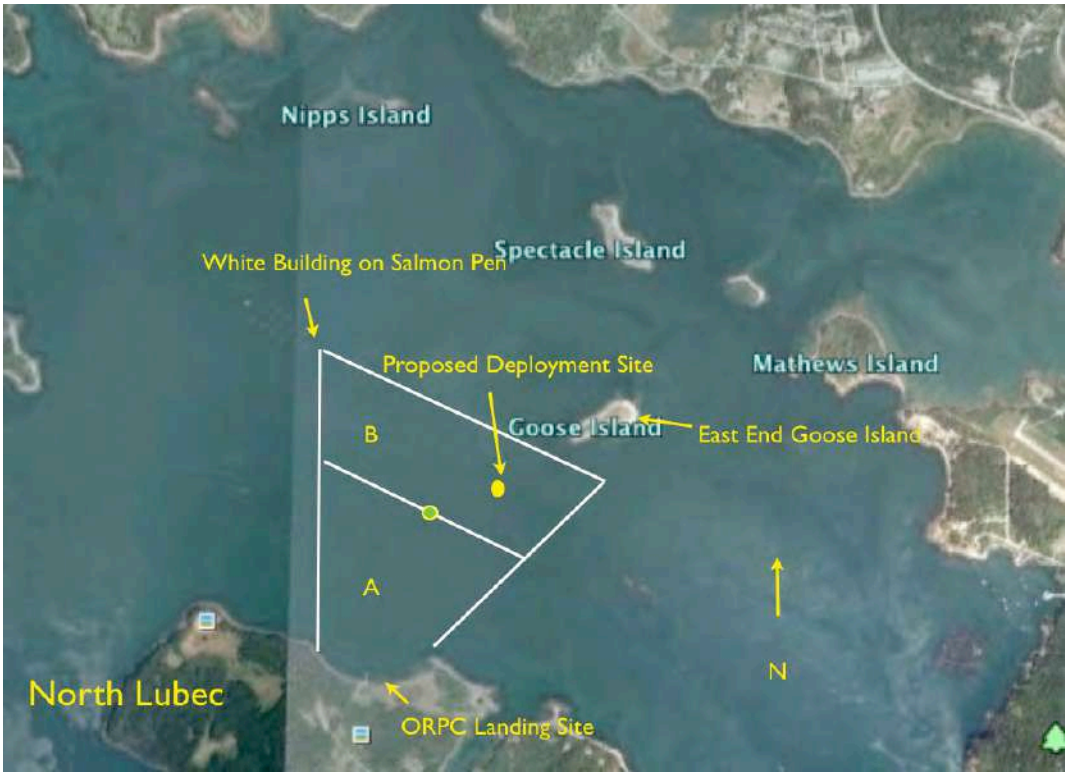

Figure 1. Land-based surveys were conducted from the Landing Site in North Lubec, Maine. The surveys was separated into the near shore area (A) just offshore from the Landing Site and the mid-channel area (B) where the TidGen™ Power System is likely to be deployed. The beach east of the Landing Site (yellow arrow at ORPC Landing Site) was also monitored.

The land-based survey area for the nearshore Landing Site and the mid-channel was delineated by an imaginary line extending from the ORPC Landing Site to the east end of Goose Island (Fig. 1). The west side of the survey area was defined by a line extending from the western boundary of the Landing Site to a white building on a salmon farm directly northwest of the Landing Site. The northern edge of the inshore area (A) was marked by a green navigation buoy north of the Landing Site. The mid-channel area (B) was delimited by the green buoy and a white marker west of Goose Island. The beach and adjacent pond to the east of the Landing Site were clearly visible from this position.

The two separate areas in the water surveys (mid-channel, nearshore area) were not independent. If one or more birds moved from one survey area to another area during a 15-minute survey, these birds were included in both areas because they occupied both areas during the survey period.

SURVEY METHODS

This phase of this study documented the number of wintering waterfowl and seabirds that used the nearshore North Lubec Landing Site and the general deployment mid-channel area.

Wintering Waterfowl and Seabirds

Starting in late October 2011, CER continued surveys for wintering waterfowl and seabirds from the Landing Site at North Lubec. Each survey was conducted for a period of 2 - 6 hours. Each survey was divided into 15-minute periods and the maximum number of each species and its behavior (see below) were recorded during each period. For reporting purposes, CER condensed the 15-minute observation periods into hour units by selecting the largest count in each of the four 15-minute periods. We then used the average of these hour counts to determine the number of individuals present for each survey date (see Figs. 2 - 9).

Behaviors

We registered all behaviors of birds on the water's surface. Birds were identified as Loafing (floating on the surface), Diving (active feeding below the surface), or Surface Feeding (active feeding on the surface) (Holm and Burger 2002). Birds that flew past the survey area but did not land on the water were recorded but were not included in this report.

Observers used 8x or 10x binoculars and a 20-60x telescope for the land-based surveys. We used a continuous scan method to identify and count all species present (Martin and Bateson 1986).

RESULTS

CER conducted nine land based surveys from North Lubec between October 27, 2011 and March 31, 2012 (Table 2). These surveys totaled 38 hours of observation time.

Table 2. Surveys of the area of interest for ORPC in eastern Cobscook Bay, Maine were conducted from the Landing Site in North Lubec. This table provides the locality, date of survey, duration of survey, and the time of high tide in North Lubec.

Survey Site	Date	Duration (hrs)	High Tide
Landing Site	Oct 23, 2011	5	8:30 AM
Landing Site	Nov 6, 2011	4	7:54 AM
Landing Site	Nov 27, 2011	4	12:02 PM
Landing Site	Dec 11, 2011	2	11:35 AM
Landing Site	Jan 7, 2012	4	9:46 AM
Landing Site	Jan 29, 2012	5	6:23 AM
Landing Site	Feb 18, 2012	4	8:07 AM
Landing Site	Feb 27, 2012	3	3:13 AM
Landing Site	Mar 31, 2012	6	12:39 PM

Waterfowl and Seabirds

These results are separated into two broad ecological categories based on feeding behaviors. Diving birds, including eiders and other seaducks, loons, grebes, cormorants, and guillemots, differ substantially from surface feeding birds, i.e., dabbling ducks and large gulls.

Diving Birds:

Common Eider was the only species of waterfowl to use the mid-channel and nearshore area off North Lubec in any numbers (Fig. 2). Common Eider numbers fluctuated in both the mid-channel and in the near shore area of North Lubec. This species was observed more regularly in the mid-channel area. The maximum count for 2010-2011 was 185.5 individuals on February 12, 2011. In general, there were fewer eiders in the mid-channel in 2011-2012, with a maximum of 120.7 individuals on February 27, 2012. In the near shore area, Common Eiders were more numerous in 2011-2012 than in 2010-2011. In the winter of 2011-2012, the maximum count in the near shore area was 25 individuals on January 15, 2011, and 42.3 individuals on February 27, 2012 (Fig. 2).

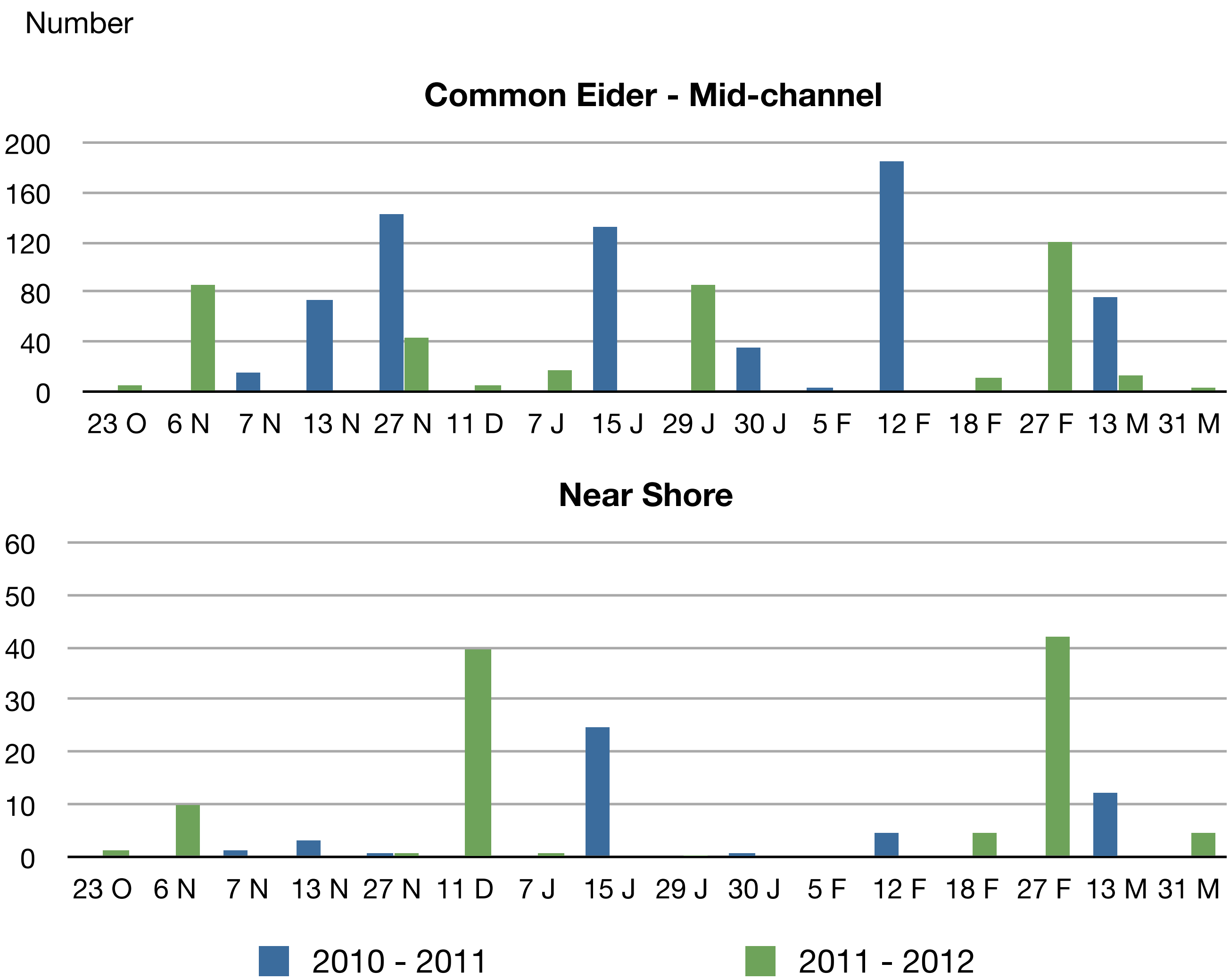

Figure 2. Common Eiders were regular in varying numbers in the Mid-channel of the Cobscook Bay study area, Maine. They were more numerous in 2010-2011 than in 2011-2012. Eiders were less regular in the near shore area of North Lubec. O= October, N= November, D= December, J= January, F= February, M= March.

Long-tailed Ducks occurred in the mid-channel on three occasions in the winter of 2010-2011 (maxima of 5.5 individuals on January 15, 20110 and four times in 2011-2012 (maxima of 10.5 individuals on February 18, 2012). This species was seen in the near shore of North Lubec on four occasions in 2010-2011 (max. 2.3 individuals on March 5, 2011) and on six occasions in 2011-2012 (max. 2.0 on December 11, 2011).

Red-breasted Mergansers were first observed in November and occurred in small numbers in the near shore area and the mid-channel, North Lubec, Maine. We recorded a peak count of 10.0 individuals on March 13, 2011 (Fig. 3).

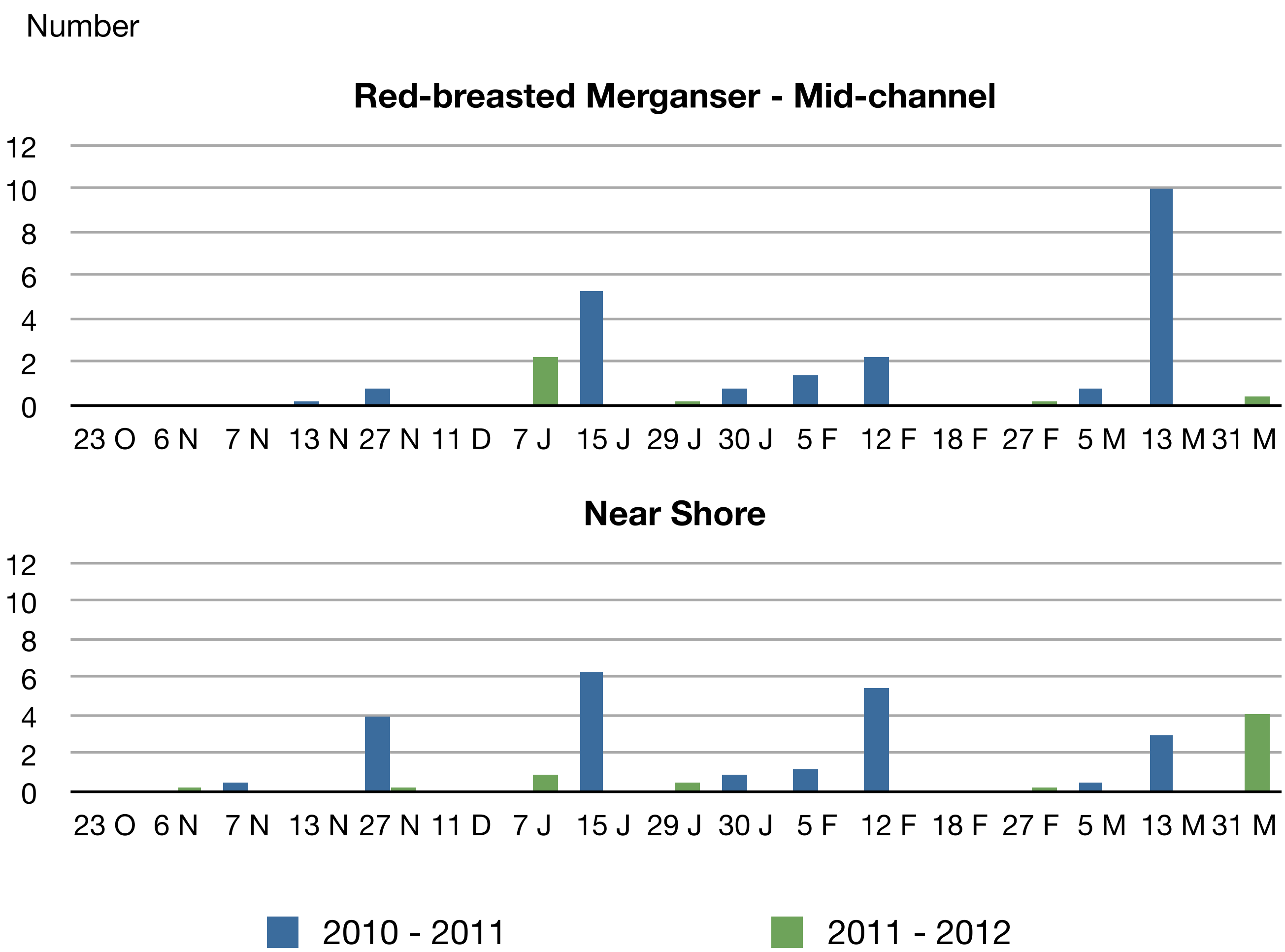

Figure 3. Red-breasted Mergansers occurred in small numbers in both the near shore and the mid-channel of the study area of Cobscook Bay, Maine. O= October, N= November, D= December, J= January, F= February, M= March.

Other ducks were generally uncommon and irregular. We observed scoters, primarily Surf Scoters, on four occasions in 2010-2011; the only time we noted >3 individuals was January 15, 2011 when we noted an average of 55.5 individuals. Two hundred White-winged Scoters appeared briefly in the mid-channel on January 15, 2011 but remained for less than 15 minutes and never reappeared in large numbers. We observed scoters on three occasions in 2011-2012; never more than 2 individuals. This species was observed flying west into the upper reaches of Cobscook Bay on several occasions, but the fact that it did not return to the general Deployment Area appears to indicate that this area does not provide optimal feeding habitat for this species. Common Goldeneyes were seen in the near shore at North Lubec on six surveys with the maximum average number of 1.5 individuals on January 29, 2011. We did not observe Common Goldeneyes in the winter of 2011-2012. A single Barrow’s Goldeneye (*Bucephala islandica*) was seen in near shore on Feb 12, 2011. We observed Hooded Mergansers (*Lophdytes cucullatus*) in the near shore on two occasions and also in mid-channel once (Table 3).

Common Loons were regular in small numbers in the study area throughout both winters (Fig. 4). We observed Red-throated Loon (*Gavia stellata*) on two occasions: in near shore (Table 3).

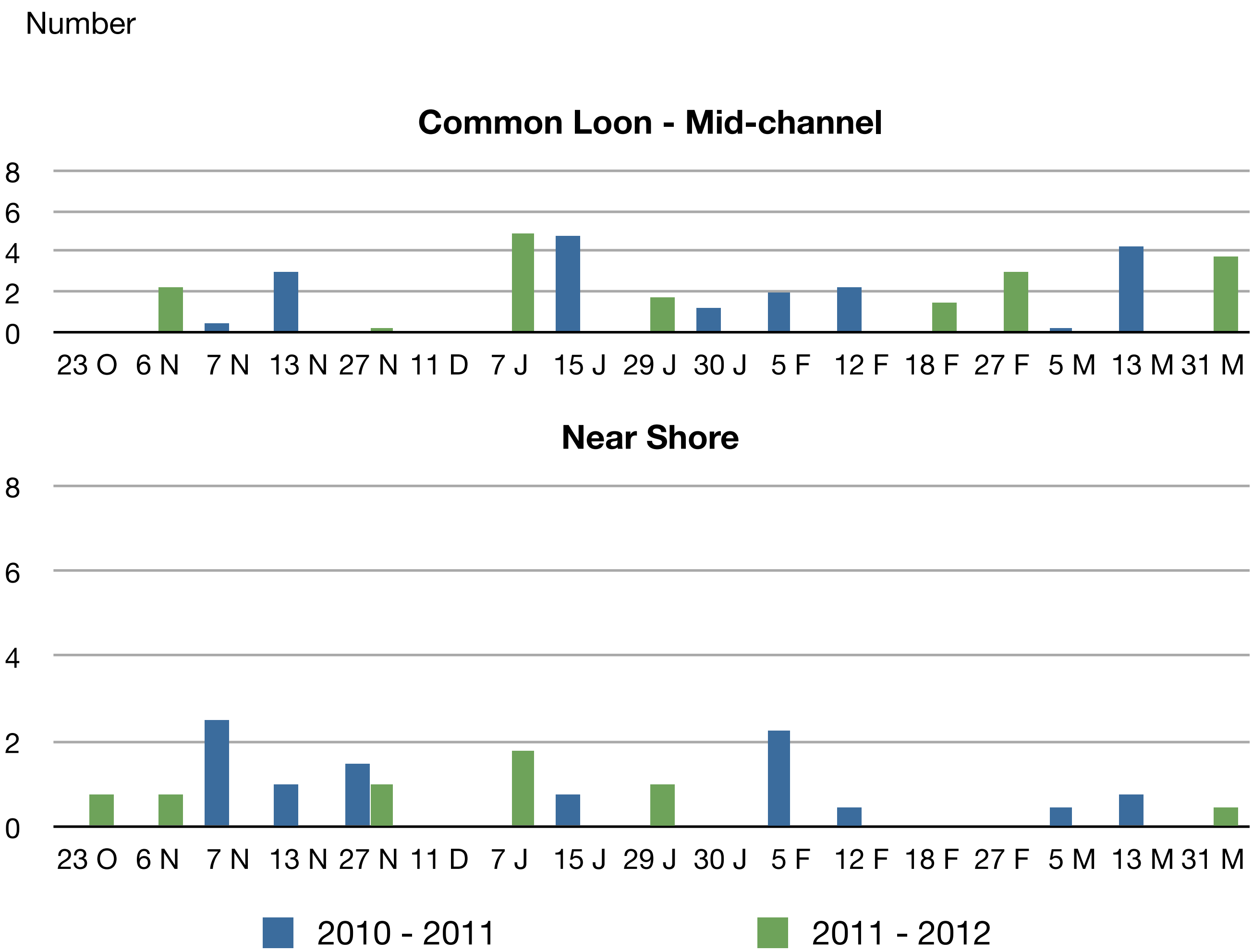

Figure 4. Small numbers of Common Loons were regular in both the mid-channel and in the near shore area of North Lubec, Maine. These birds appeared to be resident and we detected no obvious movement of wintering loons in either winter. O= October, N= November, D= December, J= January, F= February, M= March.

Red-necked Grebes were regular in small numbers in both the near shore area and the mid-channel in Cobscook Bay, Maine (Fig. 5). During the past two winters, single Horned Grebes (*Podiceps auritus*) were seen on three occasions in the near shore area and once in the mid-channel (Table 3).

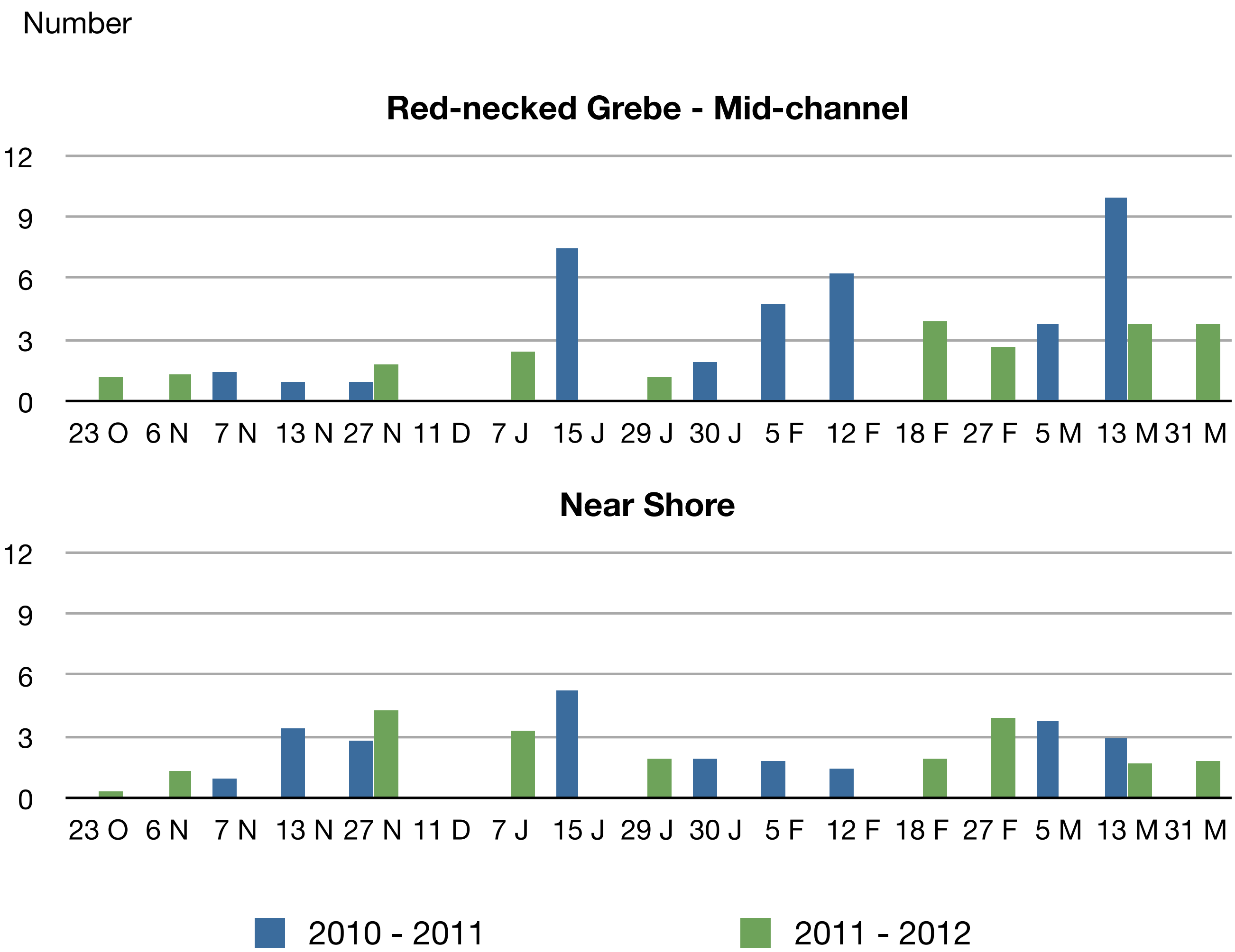

Figure 5. Red-necked Grebe numbers increased slightly in the Mid-channel between January and March. We observed a maximum of 10 individuals in the mid-channel on March 13, 2011. This species was regular but less numerous in the near shore area off North Lubec, Maine. O= October, N= November, D= December, J= January, F= February, M= March.

Great Cormorants and Double-crested Cormorants were present in small numbers and were somewhat more numerous in 2010-2011 (Fig. 6). Cormorants occurred in very small numbers in the near shore area. Double-crested Cormorants were observed until November, and then departed the area, migrating south. Great Cormorants, the regular wintering cormorant species in Maine, were present from late December to March, when they migrated from the area. We counted a maxima of 10.5 Great Cormorants on January 15, 2011. There were substantially fewer Great Cormorants in the winter of 2011-2012.

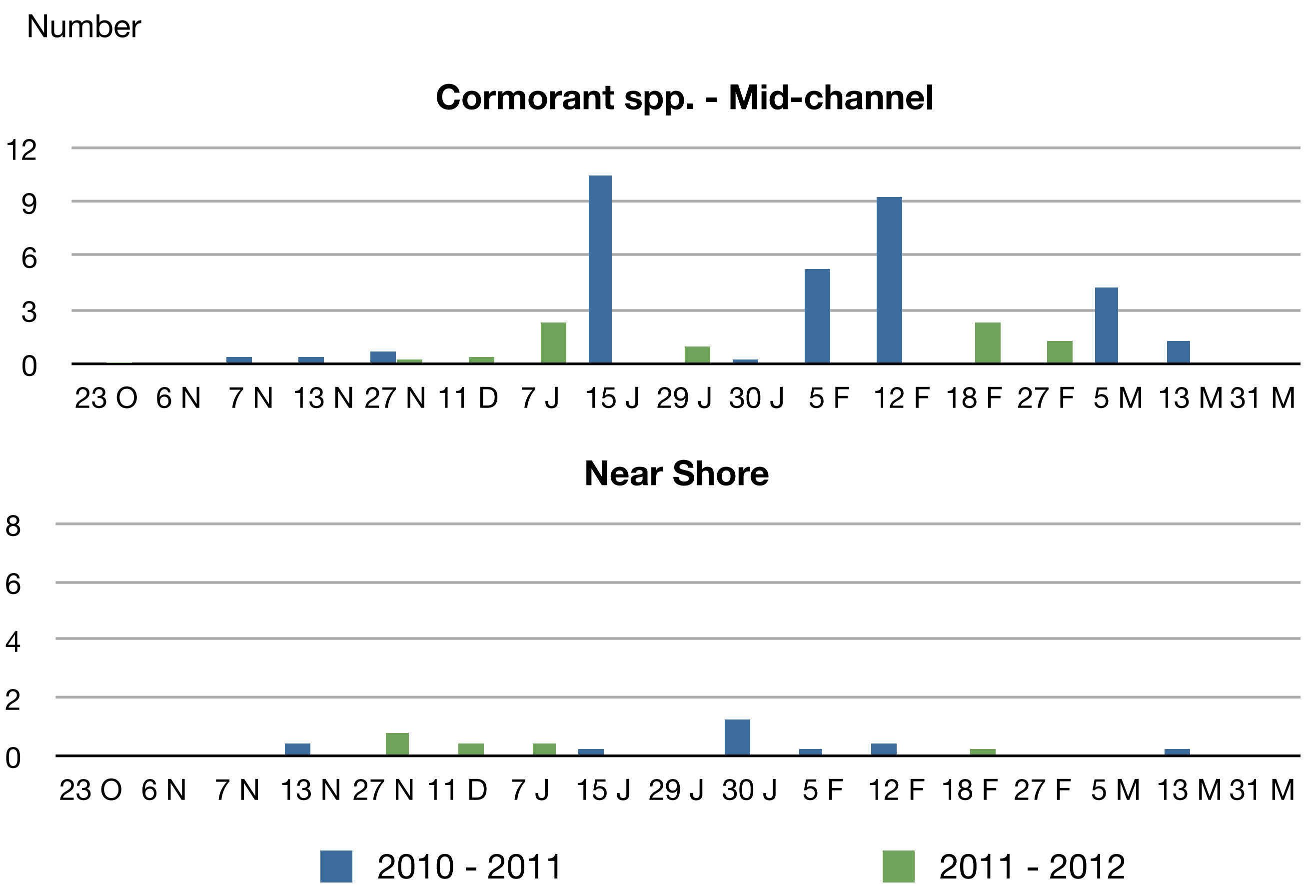

Figure 6. Cormorants are generally uncommon in the mid-channel and in the near shore at North Lubec, Maine. We counted a maxima of 10.5 cormorants on January 15, 2011. Few Great Cormorants were observed in the winter of 2011-2012. O= October, N= November, D= December, J= January, F= February, M= March.

Black Guillemots were uncommon in winter (Fig. 7). We observed fewer than three individuals per survey in the mid-channel or the near shore during the period between November and March (Fig. 7). Razorbills were very uncommon and were observed on three occasions: three Razorbills were seen in the mid-channel on Nov 27, 2010 (0.8 individuals); one individual was observed in the mid-channel on Feb 5, 2011; a total of nine individuals were seen January 29, 2012: seven in the mid-channel area, and two in the near shore area (Table 3).

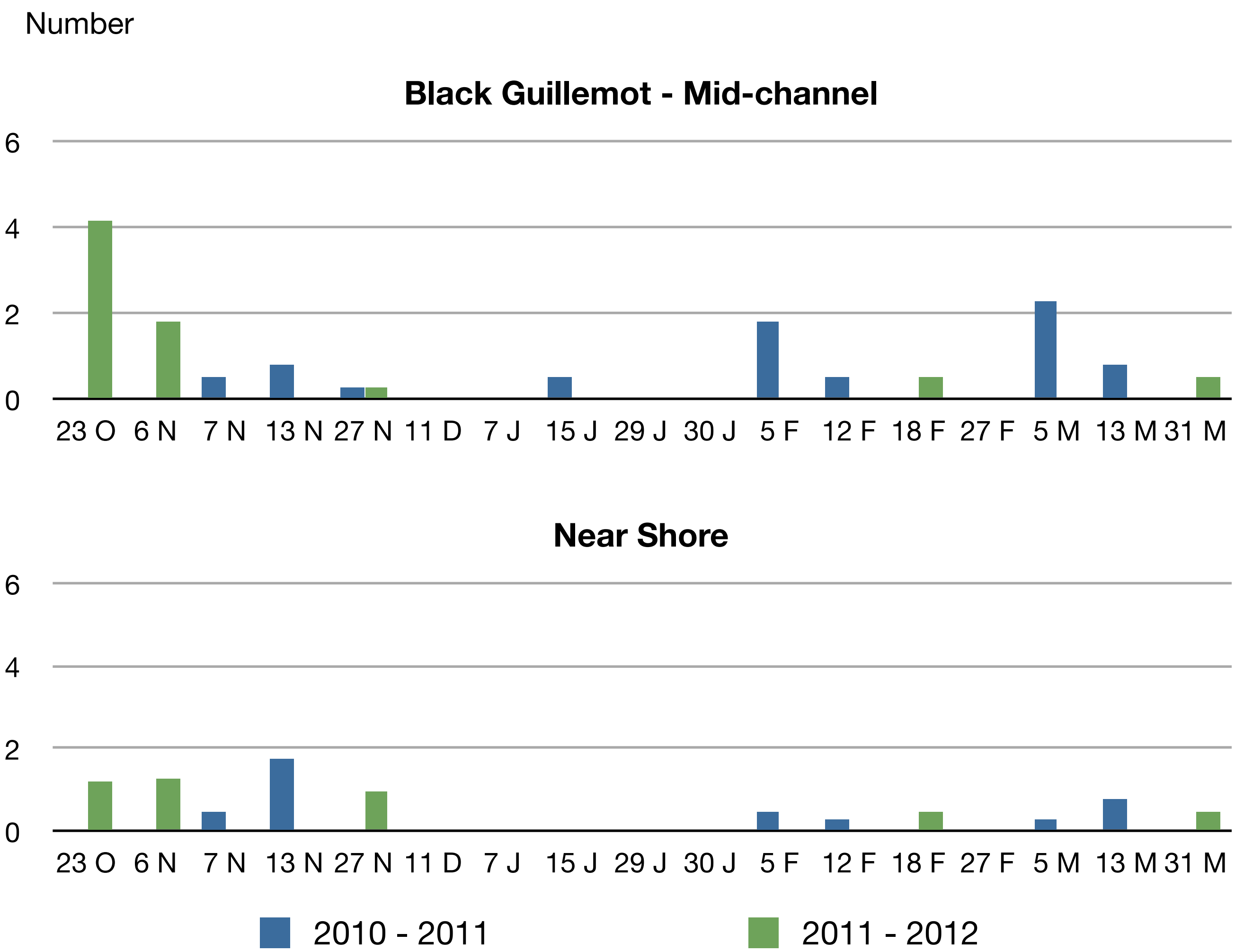

Figure 7. Black Guillemots in Cobscook Bay, Maine, were present in small numbers in both 2010-2011 and 2011-2012. This species was slightly more numerous in October and early November than during the winter months. O= October, N= November, D= December, J= January, F= February, M= March.

Surface Feeding Birds:

Three species of dabbling ducks (Mallard [*Anas platyrhynchos*], American Black Duck, Northern Pintail [*Anas acuta*]) were observed almost exclusively along the shore line in the near shore area of North Lubec, Maine, (Fig. 8). Dabbling duck numbers increased from January to early March 2011 but diminished thereafter. This increase was likely due to northbound migrants. We did not observe this trend in 2012 (Fig. 8). Three migrant Canada Geese (*Branta canadensis*) were seen once, in the near shore, March 31, 2012 (Table 3).

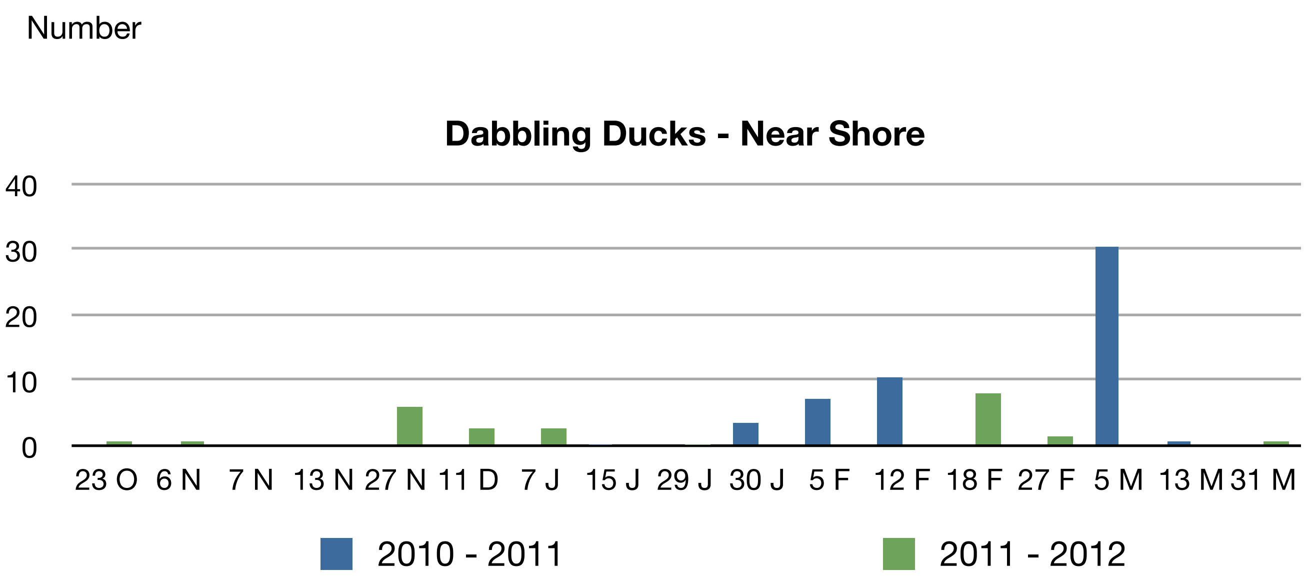

Figure 8. Small numbers of dabbling ducks, primarily American Black Ducks but including Mallards and Northern Pintails, occurred in small numbers along the shoreline adjacent to the Landing Site at North Lubec, Maine. The largest concentration of 30.5 dabbling ducks was observed 5 March 5, 2011. These were probably migrants as few ducks were observed after this date. O= October, N= November, D= December, J= January, F= February, M= March.

Large gull species were comprised of Great Black-backed Gulls (*Larus marinus*), Herring Gulls (*L. argentatus*), Ring-billed Gulls (*L. delawarensis*), and Glaucous Gull (*L. hyperboreus*). Large gulls were generally present in small numbers except in the mid-channel on November 27, 2011, when we observed an average of 94.1 individuals, primarily Ring-billed Gulls and Great Black-backed Gulls (Fig. 9).

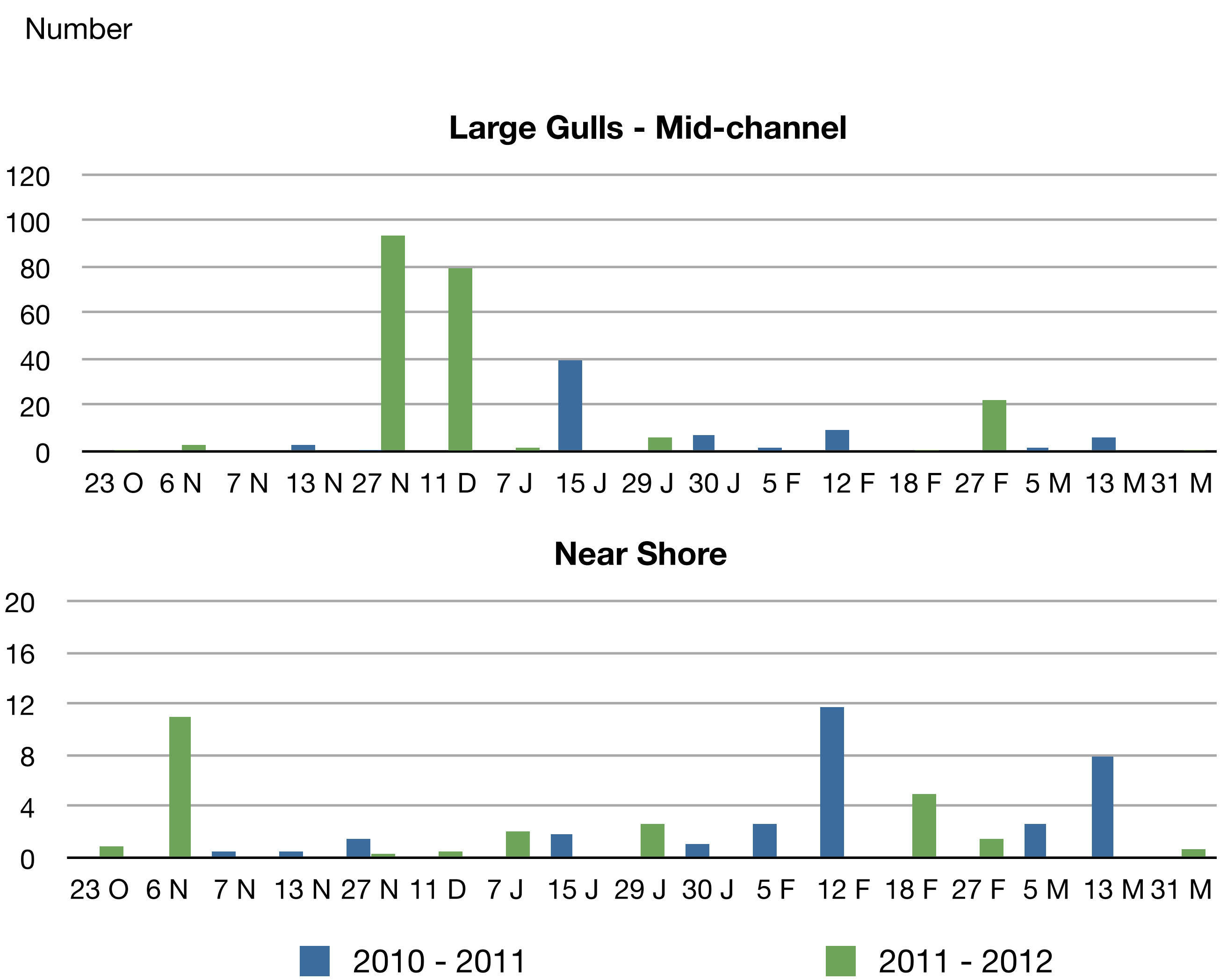

Figure 9. Large Gulls were not numerous in the mid-channel during the winter of 2010 - 2011 but were present in substantial numbers in November and early December 2011. Large Gulls occurred in small numbers in the near shore area of North Lubec, Maine. Note scale differs fin this figure. O= October, N= November, D= December, J= January, F= February, M= March.

Bonaparte's Gulls (*Chroicocephalus philadelphia*) appeared in large numbers for a short period in late November and December 2011. Three hundred individuals were observed feeding in the mid-channel on November 27, 2011 and 500 individuals were feeding in the mid-channel on December 11, 2011. This species was not present on January 7, 2012 and was not seen for the remainder of the winter. We did not observe Bonaparte's Gulls during the winter of 2010-2011.

There were 11 species that occurred uncommonly or rarely in the Cobscook Bay, Maine study area. Great Blue Herons (*Ardea herodias*) are common in summer and early fall but depart by October. The other species were unusual between late October and March.

Table 3. Several species of birds were uncommon or rare in the study site at Cobscook Bay, Maine, during the winters of 2010-2011 and 2011-2012.

	Date	7 N	13 N	27 N	15 J	5 F	12 F	13 M	23 O	6 N	27 N	29 J	31 M
	Year	2010	2010	2010	2011	2011	2011	2011	2011	2011	2011	2012	2012
Species	Site												
Canada Goose													3
Common Goldeneye	North Lubec				3			1					
	Mid-channel				13								
Barrow's Goldeneye	North Lubec						1						
Hooded Merganser	North Lubec		2								2		
Red-throated Loon	North Lubec			4									
	Mid-channel			1				1					
Horned Grebe	North Lubec						1		1	1			
	Mid-channel									1			
Wilson's Storm-Petrel (*Oceanites oceanites***)**	North Lubec								2				
	Mid-channel								2				
Great Blue Heron	North Lubec		1						1				
Black-legged Kittiwake (*Rissa tridactyla***)**	Mid-channel	3											
Razorbill	North Lubec			3		1						2	
	Mid-channel											7	
Alcid spp.												6	

Diving Behavior

During the 2011-2012 winter season (late October - March), most diving waterfowl and seabirds spent a large proportion of their time actively feeding (Table 4). Nearly all species were actively feeding >80% of the time. Black Guillemots were observed diving 100% of the time in both study units. In general, the percent time feeding in the mid-channel area and the near shore area were similar for all species. Common Eiders were observed diving <50% of the time in both the near shore and the mid-channel. Among non-diving species, Dabbling Ducks fed 86% of the time in the near shore. Large Gull species fed 97% of the time in the near shore and 88% of the time in the mid-channel.

Table 4. All of the regularly occurring waterfowl and seabirds, except Common Eider, in the study area in eastern Cobscook Bay, Maine were observed actively feeding (>80 % of time) between November 2011 and March 2012. Common Eiders fed approximately 40% of the time.

	Proportion of Time Feeding (%)		
	Species		
Diving Birds		Near Shore	Mid-channel
	Common Eider	39	42
	Scoter spp.	100	81
	Common Loon	96	91
	Red-necked Grebe	100	96
	Cormorant spp.	100	86
	Black Guillemot	100	100
Surface Feeders			
	Dabbling Ducks	N/A	86
	Large Gulls spp.	97	88

Bald Eagle and shoreline:

One to four Bald Eagles were seen on all nine surveys in the study area. Usually this species was seen flying over the study area or perching in a tree. Bald Eagles were formerly listed as federally and state endangered, but this species was down-listed to threatened and is no longer listed at any level (http://www.maine.gov/ifw/wildlife/species/endangered_species/state_federal_list.htm). Dabbling ducks were the primary birds to use the shoreline at this time of year. We did observe a single Great Blue Heron on October 23, 2011.

DISCUSSION

Wintering Waterfowl and Seabirds: Generally, few ducks and seabirds used this section of Cobscook Bay in the winter of 2011-2012. Common Eider was the most common species with >100 individuals seen on three separate occasions (Fig. 2). Throughout the winter survey period, Common Loons, Red-necked Grebes, Red-breasted Mergansers, and cormorants were present in small numbers, typically 2-10 individuals. We usually recorded fewer than two Black Guillemots on most winter surveys, which was fewer than during the fall when we had regularly observed 10-20 individuals. Dabbling Duck (American Black Duck, Mallard, Northern Pintail) numbers increased through the winter, reaching a peak of 30 individuals March 5, 2011, but they were less numerous in the winter of 2011-2012. These birds usually fed along the shoreline approximately 100-200 meters east of the Landing Site.

Diving Behavior:
Long-tailed Duck, Red-breasted Merganser, Common Goldeneye, Common Loon, Red-necked Grebe, and the two species of cormorants were observed actively diving >80% of the time. Black Guillemots were observed diving 100% of the time and Common Eiders approximately 40% of the time. Common Eiders dive for invertebrate prey such as Blue Mussels (*Mytilus edulis*) and other invertebrates. Although we saw this species regularly in the study area, the limited diving activity in the Deployment Area appears to indicate that this site is not a major feeding ground for this species. Feeding activity was similar in the near shore and mid-channel areas for all species except Scoter spp., which fed more actively in the near shore. It seems unlikely that there will be substantial interaction between these diving birds and the TidGen™ Power System.

Endangered and Threatened Species:
CER surveys did not find any federally or state endangered or threatened species. We did regularly observe Bald Eagles, a species that was removed as a threatened species in 2009 (Charles Todd, pers. comm.; MDIF&W).

ORPC Spring Construction Activities:
In March 2012, ORPC installed the base for the TidGen™ Power System in Cobscook Bay, Maine. CER conducted two surveys from the Landing Site at North Lubec on March 31, 2012, to determine if these installation activities might have an affect on seabirds in this study area. This phase of this study documented the number of seabirds that used the general deployment area during both vibratory and diesel impact hammer operations and compared the results to previous survey data from the area. Each survey lasted 2 hours.

The responses of seabirds to the vibratory hammer noises were generally minimal or of short duration. Given the degree of fishing boat activity in the area, CER could only detect brief displacements that were less than 15 minutes long and it was not possible to determine if the seabird response was precipitated by the installation activities. For example, Common Eiders were displaced by a fishing vessel that passed through the deployment area while the vibratory hammer was in use. But after the passage of the fishing boat, the eiders quickly settled in the same area where they had been foraging. This suggests that eiders were not impacted by the noise or action on the barge.

We observed no obvious seabird response to the louder diesel impact hammer. Common Eider numbers declined from 8 to 5 individuals during operation but this was within the normal fluctuation of this species in this area at the time (Vickery 2012). Common Loon numbers declined briefly but it was not clear whether this was in response to the diesel impact hammer noise or it was part of the normal loon movements in this area. Loon numbers returned to previous levels (3 individuals) within 15 minutes.

All seabirds were actively feeding prior to and during installation activities. The fact this behavior did not change when the vibratory or diesel impact hammers were in use seems to indicate that the seabirds present were not adversely affected by the noise.

Potential Impact for ORPC Activities in Winter:
The small number of birds found in the Deployment Area and along the near shore or shoreline at the expected Landing Site in the winter season indicates that ORPC installation and maintenance activities are unlikely to have any affect on birds at this season. The winter season provides an excellent opportunity for major installation activities.

Future Monitoring Schedule

Calendar of expected TidGen™ Power System installations in Cobscook Bay:

September 2012: the single-device TidGen™ Power System is deployed:

CER monitoring schedule:

> Continue post-deployment monitoring for 12 months - 1-2 times/month, weather permitting.

Winter 2012-2013: four additional TidGen™ devices are deployed to create a five-device TidGen™ Power System:

> During deployment, monitor 2-3 times/week with standard 3-hour surveys to determine potential disturbance of this installation.
>
> Continue post-deployment monitoring for 12 months - 1-2 times/month, weather permitting.

Final Report of 2012-2013 Winter Season due August 2013:

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Interim Bird Report to

Ocean Renewable Power Company

for the

North Lubec Study Site

2012

prepared by

Peter Vickery, PhD111

Richmond, ME 04357

January 2013

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The Center for Ecological Research (CER) conducted monthly surveys at the Tidgen deployment site in North Lubec, Maine between November 2011 - May 2012 to monitor wintering seabirds and waterfowl (Report to ORPC on Bird Studies in Cobscook Bay, August 2012 [Note, because of logistical difficulties no survey was conducted in April 2012 so an additional survey was conducted May 2012]). Previous surveys between August - October 2010 (Final Report to ORPC February 2011) failed to find any substantial numbers of diving birds during the fall migration period. Given the general absence of fall migrants, it was agreed that CER would concentrate survey effort in the winter months (November through April) when we found a variety of seabirds using this area (Second Interim Report to ORPC, August 2011). Diving seabirds such as Common Eider (*Somateria mollissima*), Red-breasted merganser (*Mergus serrator*), Common Loon (*Gavia immer*), Red-necked Grebe (*Podiceps grisegena*), and Black Guillemot (*Cepphus grylle*) all occur during this period. Because CER has limited its surveys to the winter period, we are providing a single final report in July or August, at the conclusion of the winter season. CER is not reporting at the end of a calendar year because that falls in the middle of the winter season.

Preliminary results from November and December 2012 show the same general number of seabirds as was observed in the previous two winters. On November 27, 2012, we recorded the following numbers of diving birds: Common Eiders (0 individuals), Common Loon (2), Red-necked Grebe (5), Great Cormorant (*Phalacrocorax carbo*: 1), Black Guillemot (1). As expected these numbers increased somewhat in December when we recorded the following numbers on December 20, 2012: Common Eider (85), Black Scoter (*Melanitta americana*: 1), Red-breasted Merganser (2), Common Loon (2), Red-necked Grebe (2), Great Cormorant (1). A full report will be prepared at the end of the winter season.