FAU
SOUTHEAST NATIONAL MARINE RENEWABLE ENERGY CENTER
College of Engineering and Computer Science
Florida Atlantic University

Project Application

to the

U.S. Department of Interior
Bureau of Ocean Energy Management, Regulation and Enforcement

for an

Outer Continental Shelf Renewable Energy Program Interim Policy Lease

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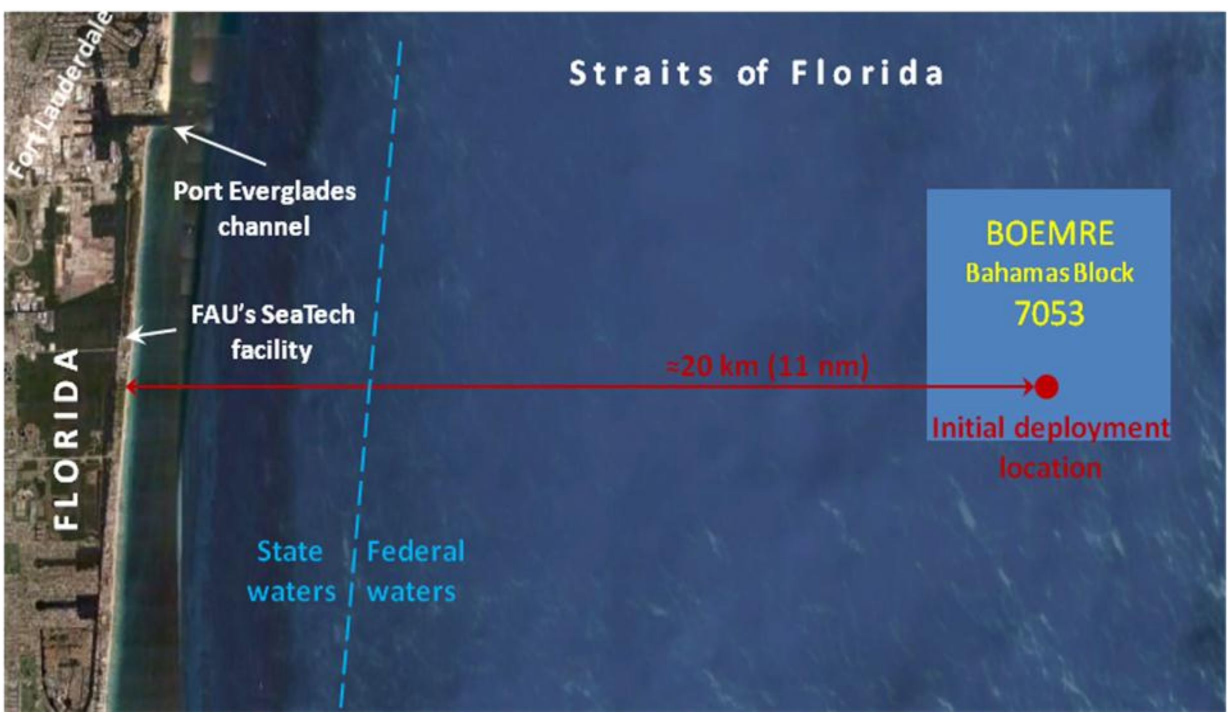

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Acronyms

ADCP	Acoustic Doppler Current Profiler
AEAU	Alternative Energy and Alternate Use
AIS	Automatic Identification System
BOEMRE	Bureau of Ocean Energy Management, Regulation and Enforcement (USDOI)
CECS	College of Engineering and Computer Science (FAU)
CES	Center for Environmental Studies (CESCOS/FAU)
CESCOS	Charles E. Schmidt College of Science (FAU)
CFR	US Code of Federal Regulations
CHAPC	Coral Habitat Area of Particular Concern
CZMA	Coastal Zone Management Act
DoR	Division of Research (FAU)
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FAD	Fish Aggregating Device
FAU	Florida Atlantic University
FDEP	Florida Department of Environmental Protection
FFWC	Florida Fish and Wildlife Commission
FLPMA	Federal Lands Policy Management Act
GCAFA	Golden Crab Allowable Fishing Area
GIS	Geographic Information System
GPS	Global Positioning System
HAPC	Habitat Area of Particular Concern
HBOI	Harbor Branch Oceanographic Institute (FAU)
LNG	Liquified Natural Gas
MHK	Marine and Hydrokinetic (energy)
MSD	Marine Sanitation Device
MTB	Mooring and Telemetry Buoy
NEPA	National Environmental Protection Act
NMFS	National Marine Fisheries Service (NOAA)
NOAA	National Oceanic and Atmospheric Administration (U.S. Dept. of Commerce)
NOMAD	Navy Oceanographic Meteorological Automatic Device (weather buoy)
NPDES	National Pollutant Discharge and Elimination System
NSWCCD	Naval Surface Warfare Center Carderock Division
OCS	Outer Continental Shelf
OCSLA	Outer Continental Shelf Lands Act
PSD	Prevention of Serious Deterioration
REN	Renewable Energy
ROV	Remotely Operated Vehicle
ROW	Right(s) of Way

SAFMC	South Atlantic Fisheries Management Council
SEAMAP	Southeast Area Monitoring and Assessment Program (SAFMC)
SeaTech	Institute for Ocean and Systems Engineering (CECS/FAU)
SFOMF	South Florida Ocean Measurement Facility (NSWCCD)
SHPO	State (of Florida) Historic Preservation Officer
SNMREC	Southeast National Marine Renewable Energy Center (CECS/FAU)
USDOI	U.S. Department of the Interior
USACE	U.S. Army Corps of Engineers
USDOE	U.S. Department of Energy
USFWS	U.S. Fish and Wildlife Service (USDOI)
USCG	U.S. Coast Guard
VHF	Very High Frequency

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SNMREC Renewable Energy Program Interim Policy Lease Project Application

1 Introduction

This application[1] seeks to lease BOEMRE Bahamas Blocks 7003, 7053, and 7054 for the purpose of deploying single-anchor mooring systems with attached surface buoys, similar to the NOMAD weather buoys. An initial system will be installed within Block 7053 (about 21 km east-southeast of Port Everglades in ~270 m of water) in order to test for limited periods equipment designed to use the Florida Current to generate electricity. This marine and hydrokinetic (MHK) energy project, conducted by a U.S. Department of Energy (USDOE)-designated center at a public research university in the State of Florida university system, is a testing and research component of the nation's development of marine renewable energy resources.

1.1 Applicant

At Florida Atlantic University (FAU), the Southeast National Marine Renewable Energy Center (SNMREC) is organized as a research center within the College of Engineering and Computer Science (CECS), overseen by an Executive Director who reports to the CECS Dean. In addition to CECS, major units at FAU involved in SNMREC include: the Harbor Branch Oceanographic Institute (HBOI), the Charles E. Schmidt College of Science (CESCOS), and the College of Education.

The SNMREC Executive Director works closely with a core management and advisory team, which is composed of the SNMREC Scientific Director, Program Manager, the Interim Dean of the College of Engineering and Computer Science, the FAU Assistant Vice President for Research, and members of the HBOI and CESCOS faculty. In addition to the research and development activities (which include environmental research and monitoring), key elements of the SNMREC program include permitting/licensing, communication and public awareness, education, control of intellectual property, and stakeholder coordination. Locations follow, and Table I lists key SNMREC personnel at FAU.

[1] This document is an integrated and updated compilation of the application originally submitted to the Minerals Management Service (MMS) by the FAU Center for Ocean Energy Technology (COET) dated June 11, 2010, plus subsequent addenda dated February 10, 2011, and clarifying material. Both MMS and SNMREC have undergone name changes in the interim, and other material has been updated as appropriate.

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CECS: College of Engineering and Computer Science CESCOS: C.E. Schmidt College of Science DoR: Division of Research HBOI: Harbor Branch Oceanographic Institute SNMREC: Southeast National Marine Renewable Energy Center **(*) Member of Core Management Team**	**Addresses:** (1) FAU, 777 Glades Road, Boca Raton, FL 33431 (2) FAU/SeaTech, 101 Dania Beach Blvd, Dania Beach, FL 33004 (3) FAU/CES, 5353 Parkside Drive, Jupiter, FL 33458 (4) FAU/HBOI, 5600 US 1 North, Fort Pierce, FL 34946

1.2 Project Description

SNMREC is a partnership created to further the assessment and characterization of hydrokinetic and thermal ocean-energy resources off the east coast of Florida and to advance the development of those resources for commercial-scale electrical power production. SNMREC's programs are selected to bridge the gap between concept and commercial implementation of ocean-energy development by fostering and leveraging research and testing of monitoring systems, prototype components, and devices that will lead to deployment of ocean-energy technologies to replace existing fossil-fuel-based power generation. The programs are based on a coordinated systems approach that integrates a multi-disciplinary range of enabling expertise and physical assets in a variety of disciplines including: ocean monitoring and dynamics, marine and environmental sciences, system hydrodynamics, corrosion, biofouling, advanced materials, and machine condition monitoring and control. SNMREC cultivates collaboration among stakeholders in academia, industry, governmental organizations, laboratories, and the public.

A variety of factors motivates the development of renewable energy, oceanic and otherwise, especially in states such as Florida that have little in the way of traditional energy production resources. In the process of developing new renewables, an important and fundamental consideration is the identification, assessment, and mitigation (as appropriate) of potential impacts on the environment. Although the development of offshore hydrokinetic energy is a decades-old concept, there have been no deployments lasting more than a few hours, and possible environmental impacts are therefore unknown. Statistical estimates of wildlife impacts, based on observed and inferred species densities, are useful for guidance, but the actual interaction of deployed systems with the environment cannot be assessed without in-water experiments. Impacts on the flow field itself are similarly unknown. Thus, this application involves an essential experimental component, an initial step at gathering data to begin quantifying any environmental impacts and extrapolate them to commercial deployment scales.

The proposed activities correspond to a phase of SNMREC implementation that involves the deployment and operations of small, prototype, experimental turbines near the core of the Florida Current for limited time periods. In the overall SNMREC plan, this is the phase in which we will install experimental turbine generators with rotor blade sizes ranging from 3 to 7 m in diameter, yielding, in a 2-m/s current, maximum power generation capacities between 20 and 100 kW, respectively. Conventional 2- and 3-blade rotors, similar to wind turbine rotors, will be lowered into the current on the downstream side of a deployment vessel. The turbines will operate between 5 and 50 m below the mean sea surface.

This application proposes to install a mooring and telemetry buoy (MTB) with a single-point mooring in the Gulf Stream current in the Florida Straits offshore of Ft. Lauderdale, Florida in a water depth between 250 and 300 m at location approximately 26.042 deg N, 79.92 deg W. The MTB will act as both a sensor and measurement platform and a mooring point for a platform or vessel which can deploy small-scale ocean current devices. Initially, it is proposed to deploy SNMREC's experimental demonstration device (20 kW maximum power and 3-meter rotor diameter) from a vessel moored to the buoy (Figure 1)[2]. A variety of resource, mechanical system health and status, and environmental sensors will measure the activity during operation.

[2] Future scaled devices for testing are likely to be provided by commercial ocean energy developers.

For this work, the turbine will not be connected to a power cable to shore, its produced power will be dissipated onboard the vessel in the form of heat; further, the turbine will be deployed only periodically for attended testing (proposed schedule can be found in section 1.4). The deployment vessel will be used to ferry the turbine to and from port. It is anticipated that a customized barge or "platform" will function as a replacement deployment vessel in subsequent years of testing to allow for more availability on-station and to minimize costs. A detailed system description follows in section 2.1.

It is proposed that SNMREC will leverage the experimental device and deployment infrastructure to evaluate: (1) environmental and resource effects of operating Marine Hydrokinetic (MHK) devices, (2) demonstrate and evaluate technology needs for further MHK development, (3) develop and evaluate methodologies and procedures to safely and responsibly test similar scaled experimental commercial devices, and (4) develop and refine tools to characterize performance, effects, and technologies necessary for MHK progress. Based on the results of these careful evaluations, future SNMREC deployments will leverage this initial effort and allow assessment of effects of multiple systems and of varying current conditions.

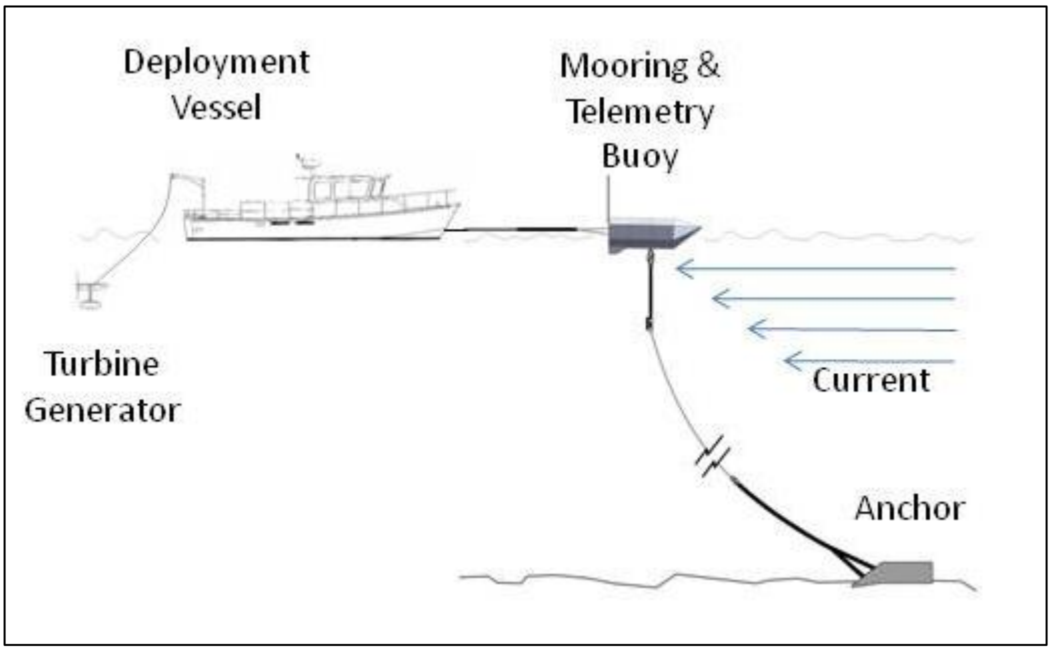

Figure 1: Initial SNMREC deployment configuration.

1.3 Site Assessment and Selection

In order best to address all possible aspects of affected constraints to select an area for the proposed activities, the following criteria were evaluated and addressed: activity requirements including safety and risk mitigation, anchoring and mooring constraints, proximity to port, mitigating or avoiding possible environmental impacts, and avoiding potential user conflicts.

1.3.1 Activity Requirements

To effectively test systems that may ultimately be deployed commercially in the Gulf Stream current, it is imperative to locate testing in areas where representative environmental and resource conditions exist, particularly current speed and current direction. Not all testing, however, requires maximum current conditions. Many test objectives for initial technology investigation at small device scales are more reasonably accomplished in moderate current speed conditions. Data[3] regarding the local variability and ranges of current speeds within the defined lease blocks indicate that appropriate conditions occur where the bottom conditions are more favorable to other aspects of the project, namely mooring and seafloor device installation. The location is situated in an area away from abrupt changes in depth, rough bottom contours, and areas likely to contain benthic habitat for deep-water corals and other sensitive species. The data suggests that an east-west swath approximately 8 km wide at 26.08° N is available with current speeds regularly ranging from 0.5 m/s to 2.0 m/s. This location is also adjacent to an area to the east which is within the maximum velocity core of the Florida Current, and that could be used for high current testing as well. Therefore, selection criteria for the device testing location have been refined based upon maximum current condition availability, identifying areas that are sufficient for moderate current condition testing, and acceptable for seafloor activities related to the testing infrastructure.

Because this initial location lies shoreward of the core of the Gulf Stream, surface conditions tend to be more favorable to at-sea working conditions there. This safety consideration is also a factor in our choice of this location.

1.3.2 Anchoring/Mooring Constraints

The selection of appropriate seafloor characteristics for an anchor to support the proposed activity is based upon the depth and availability of an appropriate sediment layer (sand). A drag-embedment anchor is proposed due to its high holding power, its relatively small size, its recoverability, and its effectiveness in similar applications. This anchor style is dependent upon an available minimally thick sediment layer (at least 0.5 meters) for the anchor to develop sufficient holding power. The holding power would also be augmented by a length of chain between the anchor and mooring line, further increasing the anchor's efficacy. Therefore, selection of suitable areas considered identifying likely occurrences of thicker sediment surface layers.

1.3.3 Port Proximity

Selecting a project location in close proximity to a commercial port, namely Port Everglades, was desired to facilitate convenient access to shore-based and support vessel resources, as well as the location of the SNMREC data collection facility. Port Everglades (26.1 N, -80.1 W) is approximately 27 km from the average Gulf Stream current core (26.1 N, -79.8 W), and within 22 km of the proposed SNMREC test area which lay within the moderate currents available just west of the core.

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[3] Both historical datasets and more recent observations by SNMREC support this conclusion.

1.3.4 Environmental Impact

The primary goals of the work proposed in this application are to demonstrate the responsible and attainable extraction of energy from natural offshore resources while also assessing both environmental baselines (at nearby locations and at the mooring site when the deployment vessel is not on station) as well as the effects of the structures and program activity on the ocean floor and water column. This assessment work includes monitoring the potential effects of the project on migratory turtles, marine mammals, and other constituents of the ecosystem.

The activities summarized in the following section are proposed to monitor the ocean floor and the water column (more detail is available in sections 2.3 and 2.4). Both existing datasets and new observations will be used in this work. An important activity will be the establishment of an integrated ecosystem database which will serve as a repository of all data collected and will be organized in a standard format so that it can serve as an analytical tool for this and other projects in the area. This database will be made available to the public and to government agencies.

The topics discussed here reflect those raised in Cada *et al.* (2007) concerning the broader effects on aquatic environments of all hydrokinetic technologies. In the present case, the deep-water location and the steady, high-speed current automatically mitigate some concerns, but several remain. These are listed below and discussed briefly.

1. <u>Benthic environmental studies.</u>

Possible disturbances of habitats on the ocean floor are a concern, resulting from the anchor of the SNMREC prototype system (**Error! Reference source not found.**) and from future, industry-deployed commercial-scale systems, which may involve many anchors of various types. Detailed observations of the proposed region regarding the bathymetry and benthic habitat on the Miami Terrace are available from recent surveys related to the proposed Calypso LNG port and its pipeline benthic surveys, the CFX-1 fiber optic cable survey, the Seafarer LNG pipeline benthic surveys, a Department of Energy sponsored survey, and a variety of Harbor Branch Oceanographic Institute’s (HBOI) *Johnson-Sea-Link* submersible surveys. Use of these existing data in conjunction with new, detailed surveys to be conducted as part of the work discussed here will allow site selection of minimal potential effect on hard/live bottom communities. These new surveys, designed and conducted in collaboration with the National Marine Fisheries Service of NOAA, will provide additional data that are needed to ensure protection of bottom-community species, including hard and soft corals, shellfish and mollusks, and benthic fish.

2. <u>Pelagic environmental studies.</u>

In the water column, various potential issues related to sea turtles, pelagic fishes, marine mammals, and other ecosystem components arise. Our approach, based on discussions with marine scientists from several institutions, focuses on those issues of greatest concern.

a. Sea turtles.

We will characterize turtle habitat use (water and bottom) before, during, and after deployment of buoys, lines, support platforms, and turbines. The necessary data collection, already begun and involving both aerial and on-water surveys under appropriate permits, will (i) characterize the spatial and temporal distributions of sea turtles generally, and for various sea turtle species specifically, (ii) characterize baseline data on habitat use, (iii) identify species-specific concerns relative to construction, placement of the buoys, lines, and turbine, and (iv) ascertain possible long-term issues concerning sea turtles utilizing the area either on a seasonal or annual basis. Stranding response data available from the FFWC and NOAA Sea Turtle Stranding and Salvage Network will be requested and evaluated as a preliminary measure of status and seasonal variation in sea turtle abundance and nesting patterns. These issues are discussed at greater length in section 2.4 of this application.

b. Pelagic fishes.

It is well known that underwater structures attract fish. Indeed, *fish aggregating devices* (FADs) have been the subject of considerable research, discussed in more detail in Section 2.4 below. Our assessment and monitoring work will begin with a literature study of direct and indirect anthropogenic effects, such as fish population shifts and overpopulation, alterations in migration paths and predation rates, and decreased health associated with fish aggregating devices. Observations of aggregations in the vicinity of our underwater structures will then be related to these results to determine possible adverse impacts of large-scale ocean energy deployments. Anecdotal reports of similar deployments in other locations (in particular, the Agulhas Current off Mozambique) suggest there are no FADs issues in steady currents of this magnitude.[4] This will need careful verification in our location, however, and monitoring for this purpose will be in place.

c. Marine mammals.

Possible marine mammal interactions also require attention in parallel with turtle monitoring and aerial surveys. Because there is substantial literature, our assessment will begin with a literature study of noise effects on marine mammals, to be followed by study of other marine mammal issues. An assessment will be carried out with an appropriate research program on this topic if it is judged that noise levels and other marine mammal effects will be a significant issue. Because turtle monitoring during deployments will involve underwater video cameras, marine mammals will also be detected, providing valuable information in assessing possible risk levels.

We anticipate noise levels associated with the operations of the turbine system in **Error! Reference source not found.** to be well below the background of this busy shipping channel, but acoustic emissions will be measured for both their spectral characteristics and their overall levels. This measurement will ensure the protection of noise-sensitive marine species, and it will provide valuable information about future emissions associated with a commercial-scale deployment.

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[4] Paul Greyshock (personal communication) of Cyclocean, Inc., which has recently deployed turbines in the Agulhas Current near Madagascar. This anecdotal evidence suggests that the energy expended by fish to maintain position against the current may deter the development of FADs in these high-speed current regimes. Clearly, more study is needed.

d. Additional considerations.

SNMREC, as a public university-based R&D center, is focused on testing and assessment of new ocean-energy technologies rather than on power generation *per se*. While this application does not include the provision for transmission lines to shore, commercial deployments will need them; further, the periodic testing of the generator (**Error! Reference source not found.**) will involve electrical fields locally. We will therefore begin a long-term study to assess the effects of electrical transmission. A three-step approach will be employed, and the first of these will begin as part of work discussed here. A survey and ongoing monitoring of the deployment site will be conducted to determine which species are most likely to be encountered during deployments. In the process, the emissions of the *in situ* generator will be put in the appropriate local context, and monitoring for its influence on the species locally will be ongoing.

As noted above in paragraph *b*, the installation of the equipment discussed here might attract fish; this, in turn, could attract recreational fishers as well as commercial sport-fishing operators. During turbine test runs, when the full system in **Error! Reference source not found.** is deployed, the equipment will be attended, so adverse effects will be minimized. But because the mooring buoy shown in **Error! Reference source not found.** is intended to be a permanent installation for the duration of this work, there may be a small effect at other times. This impact should be on the scale of that associated with other such installations, NOAA meteorological buoys, in particular. As such, it is not expected to have a significant long-term effect.

Additional topside concerns include marine birds and exhaust emissions. It is inevitable that birds will roost on the buoys, as they do on all structures at sea. Although there are Class-1 air quality areas in the region (two National Parks, in particular), the emissions associated with work boats will be insignificant in the context of the nearby metropolitan area and therefore will have no impact on visibility or other measures of air quality (additional information provided in section 2.9).

3. <u>Flow disturbances.</u>

Observations both on the scale of the Florida Straits (e.g., Leaman *et al.*, 1987; Beal *et al.*, 2008) and locally at the location of the proposed SNMREC mooring (Figure 2) reveal significant vertical structure, or baroclinicity, in the Florida Current. Near the surface, current speeds can reach over 2.5 m s^{-1}; toward the bottom at this location, they taper off dramatically so that bottom currents are only a few cm s^{-1}. These bottom speeds are confirmed by video taken by SNMREC during submersible dives.

Thus, at the seafloor, current speeds are so slow that (after the initial anchor deployment) any new sediment transport patterns will be highly localized and quite minimal. Because the anchor will be deployed in a soft-bottom, sandy “desert” area, as discussed in the application (see e.g., Figure 11), such changes will have insignificant impact on the benthic environment. Between the surface and the bottom, it is reasonable to assert that the anchor line will create no significant impact on the flow. The primary disturbance of concern, therefore, is at the depth (and downstream) of the prototype turbine system itself during the testing periods when it is deployed.

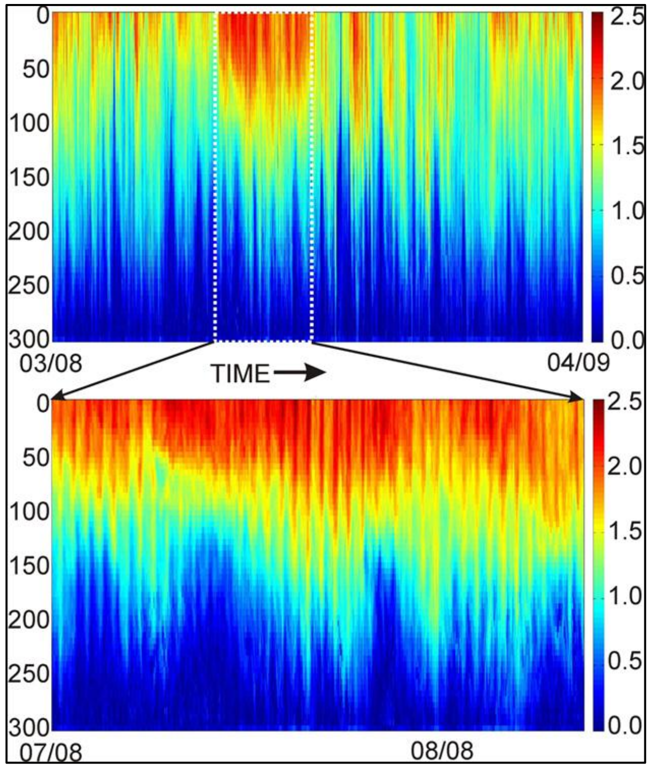


Figure 2: 400-day time/depth plot of current speed, from an acoustic current meter moored ~15 m above the ~325 m bottom at 26°4.3´N, 79°50.5´W, under the core of the Florida Current, with half-hour averaging bins. Top panel shows the 400-day record; bottom panel expands a 40-day period beginning on 1 July 2009.

The variations in time shown in Figure 2 cannot be resolved into mechanisms (for example, is the current surging or meandering?) with only this data. However, these variations (on time scales of an hour or more) suggest that there are significant spatial and temporal changes in the undisturbed current at this location, changes much larger than will be introduced by the deployment of the SNMREC equipment. Future large-scale, commercial deployments of multiple systems are not part, and far beyond the scope, of this application.

This leaves the question of the SNMREC prototype turbine system's wake, and wakes of other systems of the same size class, to be considered. Little research on the wakes of axial-rotor water turbines of this nature is available. Relying on results from wind-power turbine research requires great care, because the Reynolds numbers of this class of ocean systems will be more than three orders of magnitude smaller than atmospheric systems. Initial results from numerical simulations at SNMREC suggest that (i) the radial expansion of these underwater wakes will be smaller than that from wind turbines and (ii) the downstream length scale for wake decay will be much less (Reza, 2010). Because background turbulence levels in the Florida Current at this location are unknown (quantitatively), precise calculations of the downstream distance at which the wake will be detectable are not possible. One purpose of the SNMREC monitoring program is to assess this distance during active testing of the experimental prototype.

The equipment to be used in these deployments will include current meters as well as turbulence instruments both at the turbine and (on a work boat) downstream, so data will be obtained to allow such calculations and to verify them. Indeed, one of the purposes of this work is to obtain wake measurements that can be scaled to other size classes of equipment and to arrays of turbines—it is such commercial-scale deployments that may introduce significant flow disturbance. Because the SNMREC turbine deployments will be intermittent, even its minor effects will happen only occasionally, so any long-term impacts should be overwhelmed by turbulence from passing cargo ships and from upper-ocean mixing due to weather events.

1.3.5 Potential user conflicts

Various potential user conflicts were considered when selecting our proposed lease areas, including surface traffic (commercial and military), subsurface traffic (military), and recreational and commercial fisheries. Significant and established surface traffic routes are important to avoid because the proposed activities will include infrastructure either persistently or occasionally deployed on the surface. Because the anchor and mooring systems extend throughout the water column in the installed location, sub-surface traffic routes should be avoided to minimize the avoidance requirements that might be imposed. Finally, co-located commercial and recreational fisheries could be potentially affected because fishing near the proposed lease activities would naturally be limited and restricted to avoid entanglements and other potentially hazardous conditions. The following sections describe in more detail how these considerations were incorporated into the selection process for lease area(s).

a. U.S. Navy Operating Areas

The Naval Surface Warfare Center Carderock Division (NSWCCD) operates the South Florida Ocean Measurement Facility (SFOMF), an offshore testing and evaluation facility in the waters offshore Port Everglades, portions of which are collocated with the proposed SNMREC testing areas. The SFOMF consists of an area designated as a Restricted Area defined in Title 33 of the Code of Federal Regulations (CFR), specifically 33CFR334.580, and other areas designated by SFOMF as submarine operation areas and a training minefield (Figure 3).

A variety of U.S. Navy projects are tested at SFOMF, including surface vessels and submerged assets. While testing is dependent on unobstructed water space, the proposed location of the SNMREC test area is located approximately 14 km from the primary testing area, and the SNMREC assets would be fixed in position and could be readily avoided by both naval and civilian vessels. There are also potential opportunities to use oceanographic data collected by SNMREC to benefit the Naval testing activities. Additionally, SFOMF maintains an extensive underwater cable system used for connecting sensors for real-time monitoring. While avoidance of these existing cables are a priority, there also exists the possibility of utilizing some of these cables for SNMREC sensors in the future.

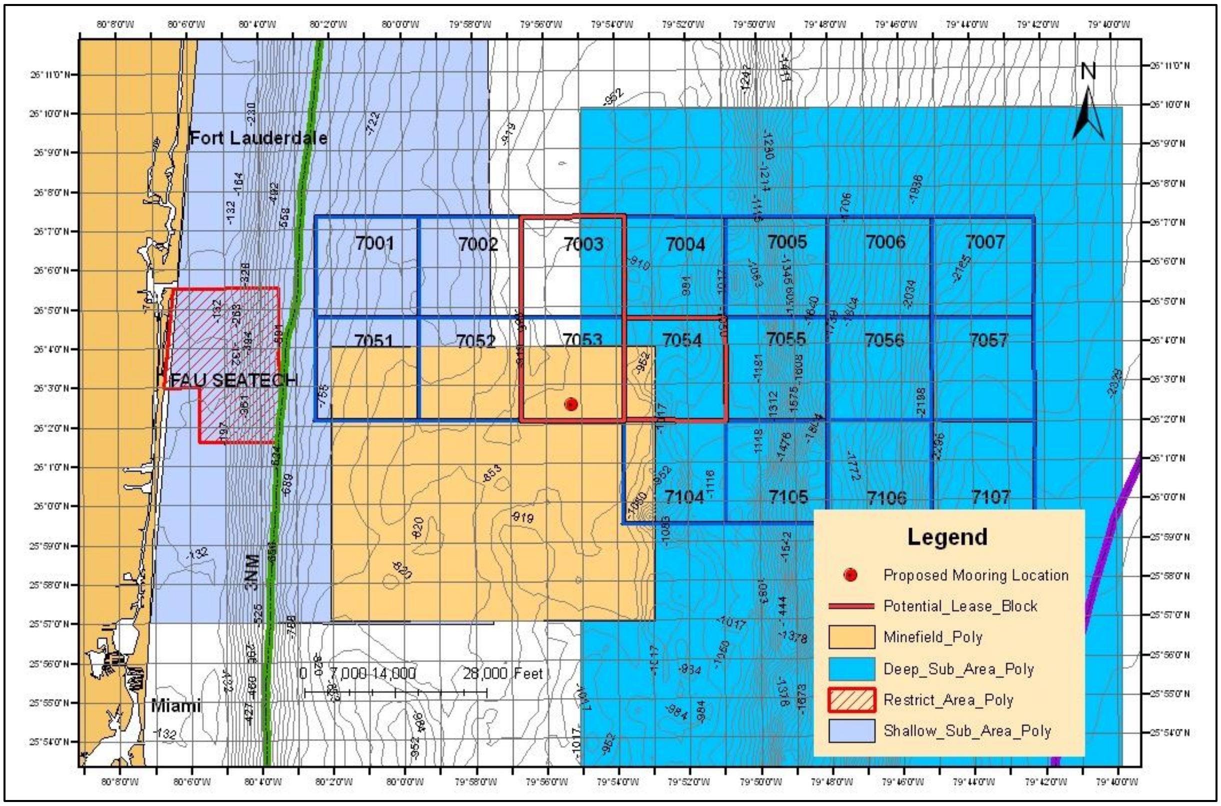


Figure 3: NSWCCD-SFOMF operating areas in relation to proposed SNMREC lease blocks. This figure, and several below, also show (outlined in dark blue) the Blocks originally under consideration for SNMREC activities; this application refers only to Blocks 7003, 7053, and 7054, outlined in red. Others were eliminated based on factors discussed here.

b. <u>Commercial Surface Traffic</u>

The proposed SNMREC test area is in the vicinity of Port Everglades, a deep water port adjacent to Fort Lauderdale, Florida, which services commercial passenger and shipping vessels, occasional military vessels, and a large number of private vessels. The entrance to the port is approximately 16.3 km west of the western edge of the proposed lease block, as shown in Figure 4. A surface vessel traffic study conducted in 2001 indicated that there were two primary traffic "lanes" through the area around Port Everglades, which are also shown in Figure 4. These were an inshore north-south route and an offshore south-north route. The inshore route was located approximately 11 to 15 km offshore and was used to enter and exit Port Everglades by both commercial vessels and private craft. The commercial vessels using the inshore route consisted of small and medium size coastal freighters (91 to 152 m), shallow draft tugs and barges, and local Coast Guard cutters. The offshore route was located approximately 30 to 37 km offshore and was used almost exclusively by large commercial vessels (182 to 244 m) such as freighters, tankers, bulk carriers, and deep draft tugs and barges. There was also a smaller east-west route, consisting mostly of smaller island freighters (55 to 76 m), large motor yachts (25 to 61 m), and medium sized cruise ships (123 to 182 m) making daily runs to the Bahamian islands.

The proposed SNMREC location lies between the inshore and offshore routes revealed by this survey, with buffer zones of approximately 2 km and 4 km between the lease block's western and eastern edges, respectively, and the shipping lanes (Figure 4). The proposed presence that would be located on the surface, namely the mooring buoy and turbine support vessel, would be stationary, and would appear as fixed navigational obstructions. The buoy and vessel would be equipped with lights, radar reflectors, active radar transponders, and an Automated Identification System (AIS) beacon to continuously transmit its position to all AIS-equipped vessels transiting the area. A Notice to Mariners document has also been approved for inclusion in periodic U.S. Coast Guard navigation publications, which will require updating to adjust the mooring's position discussed here, and a request has been submitted to have the mooring buoy added to navigational charts of the area.

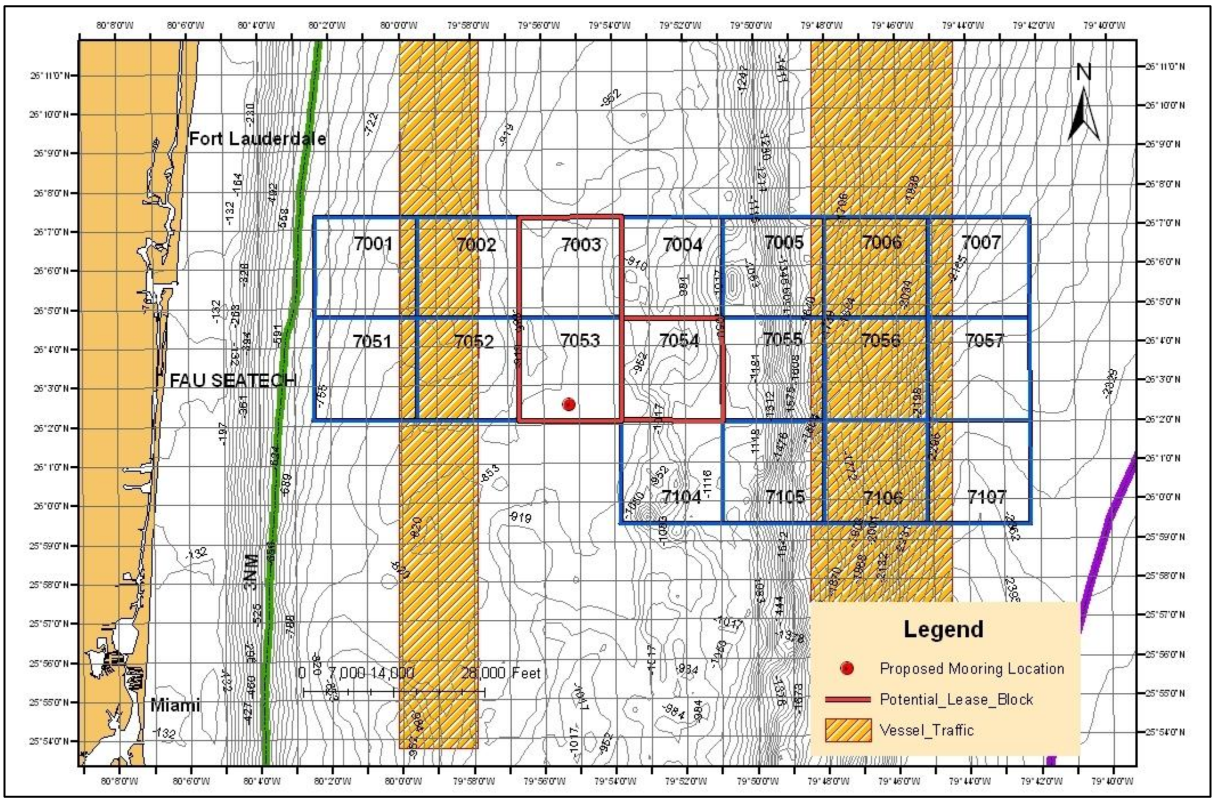


Figure 4: Typical offshore vessel transit lanes in relation to proposed SNMREC lease blocks.

c. <u>Fisheries</u>

The OCS Interim Policy lease blocks off Fort Lauderdale, Florida are located either entirely or partially within two managed areas for corals and certain bottom species, or Essential Fish Habitat (EFH). These areas are the South Atlantic Fishery Management Council's Stetson-Miami Terrace Coral Habitat Area of Particular Concern (CHAPC) and a Golden Crab Allowable Fishing Area (GCAFA). The CHAPC was designated based upon recent scientific evidence of the distribution of deepwater coral species and the importance of these systems as habitat for managed species and overall biodiversity. The GCAFA was established to minimize the impact to fisheries from the designation of the CHAPC, and would allow continued fishing of certain species, including golden crab (Chaceon fenneri), wreckfish (Poluprion americanus), and tilefishes (Lopholatilus chamaeleonticeps and Caulolatilus microps). Both of these areas exist to protect damage to benthic communities and existing fisheries from activities that could impact these resources. The CHAPC and GCAFA boundaries are shown on Figure 5, along with the proposed SNMREC blocks.

The location of these management areas was one of the selection criteria used in choosing the proposed SNMREC blocks, and as shown in Figure 5, the blocks are outside of the GCAFA, and within the CHAPC. In order to avoid benthic communities, available bathymetry and bottom type information was used to identify areas devoid of hard bottom, ledges, and other bottom features where communities may exist. The MTB anchor location was selected in an area where depth contours and multibeam sonar surveys noted previously indicate there are no substantial bottom features, which tends to indicate open, sandy or smooth seafloor characteristics. Prior to deployment, SNMREC will survey the anchor locations in more detail for verification of bottom type and potential coral habitats. The final mooring location will be properly sited away from deepwater corals and associated ecosystems to avoid adverse effects to bottom habitats in the proposed area.

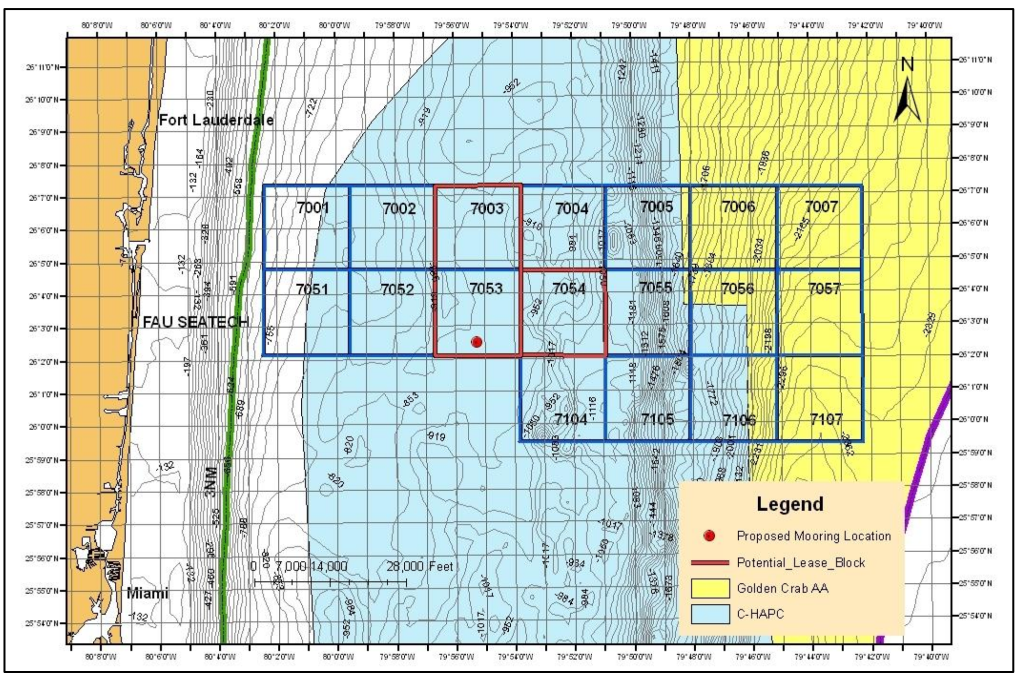
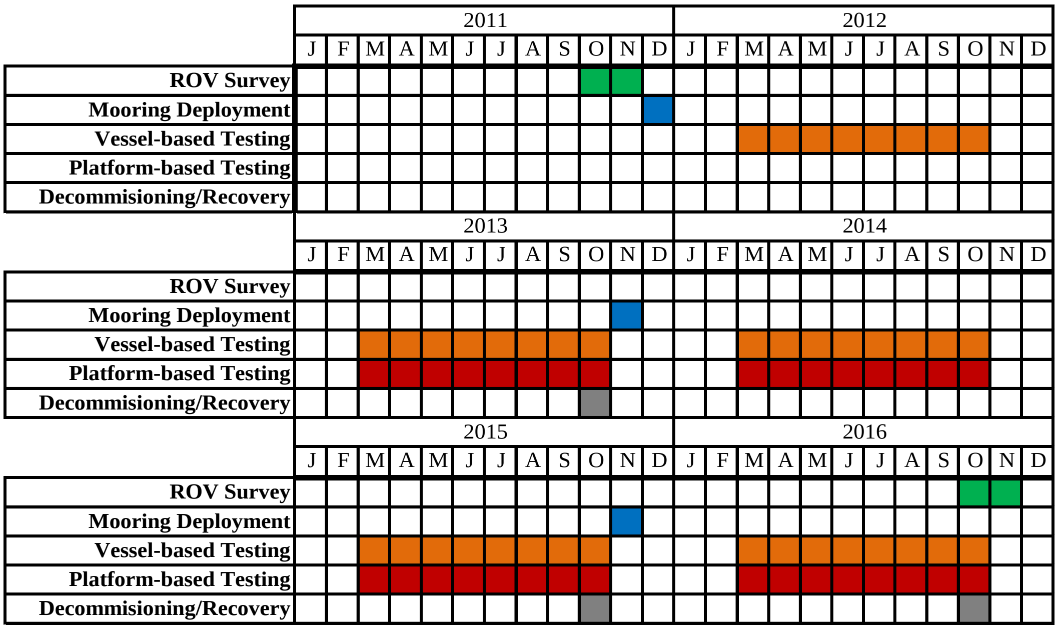


Figure 5: Fishery management areas in relation to proposed SNMREC lease blocks.

1.4 Schedule of Activities

The following table describes the proposed schedule of activities for the survey, installation, testing, and decommissioning of the initially proposed mooring and associated SNMREC experimental research turbine testing. The schedule to install and test additional systems is dependent upon regulatory approval and demand. The proposed turbine testing schedule is a maximum of 12-24 annual test sessions (up to 5 days duration each, with a minimum 1 day duration). Specific hours of experimental testing will vary with each test mission, but both day and night operations are expected (during any of the 24 hours in a day).

Table II: Schedule of proposed lease activities.



1.5 Authorizations, Approvals, or Permits Required

The various authorities associated with oversight of the deployments and operations in the SNMREC program are extensive. It is our understanding, with respect to the SNMREC deployments discussed here, that the major permits, approvals, and authorized actions necessary to construct, operate, maintain, and abandon project facilities are listed in Table III. Note that the SNMREC activities, while falling outside of State of Florida waters (i.e., the deployment and operations will be more than 3 miles offshore), will involve an interaction with the Florida Fish and Wildlife Commission due to its agreements with the USFWS. In addition, shore-side activities in support of the offshore deployment will be conducted within State waters, at a commercial marina under the purview of the Florida Department of Environmental Protection.

Federal Permits Authorizations and Coordination

Development on the Outer Continental Shelf (OCS) must comply with the federal Outer Continental Shelf Lands Act. The goal of the BOEMRE Atlantic OCS Regional Office is to assure safe and clean oil, gas, sulfur or other operations including renewable energy operations on the Outer Continental Shelf. BOEMRE reviews require an applicant to comply with the following conditions:

- Operations must result in the diligent development and efficient recovery of resources

- All activities must comply with applicable federal, state and local laws and regulations applicable to federal leases including the Coastal Zone Management Act (CZMA) and the Endangered Species Act (ESA)
- All activities must include adequate safeguards to protect the environment
- Disturbed lands must be properly reclaimed
- All activities must protect public health and safety

Five Presidential *Executive Orders* (EOs) affect implementation of the project. These EOs, which are binding on all government agencies, place restrictions on government approval of construction activities and apply to energy efficiency (EO 12902), pollution prevention (EO 12856**),** cultural resources and historic preservation (EO 11593 and EO 13287), and endangered species (EO 13112).

A list of the major permits, approvals, and authorized actions necessary to construct, operate, maintain, and abandon project facilities is summarized in Table III.

Table III: Federal, State, and Local Permits, Approvals, and Authorizing Actions

Regulatory Agency	**Permit/Approval Actions/Requirements**
Federal Agencies	
U.S. Army Corps of Engineers (USACE)[A]	• Issues a Section 404 permit under the Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1344) for discharge of dredged and fill material into U.S. waters, including wetlands. • Issues a Section 10 permit under the Rivers and Harbors Appropriations Act of 1899 (33 USC § 403) for structures or work in, of affecting, navigable waters in the U.S. Under Section 10 of the Rivers and Harbors Act of 1899, as extended by the Outer Continental Shelf Lands Act (OCSLA), the Corps requires a permit for the creation of "any obstruction" in federal waters to preserve unhindered navigational access of the nation's waters. (33 U.S.C. § 403 (1999).) The OCSLA extended the Corps' section 10 authority into the EEZ allowing the agency to regulate "installations and other devices permanently or temporarily attached to the seabed, which may be erected thereon for the purpose of exploring for, developing or producing resources from [the outer continental shelf]" (43 U.S.C. § 1333(a), (e) (1999).) including CZMA and ESA

Regulatory Agency	Permit/Approval Actions/Requirements
Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE)	• **Renewable Energy (REN)** activities on the **Outer Continental Shelf** (OCS), as authorized by Section 388 of the Energy Policy Act of 2005 (EPAct), and codified in subsection 8(p) of the Outer Continental Shelf Lands Act (OCSLA). Developments in the Outer continental Shelf must comply with the OCSLA as well as with CZMA and the ESA. The goal of the Outer Continental Shelf Lands Act as administered by BOEMRE is to assure safe and clean oil, gas, sulfur, or other operations on the Outer Continental Shelf. BOEMRE would grant a lease and, if applicable, issue a pipeline ROW permit. BOEMRE reviews require an applicant to comply with the following conditions: o operations must result in the diligent development and efficient recovery of resources; o all activities must comply with applicable federal, state, and local laws and regulations applicable to federal leases; all activities must include adequate safeguards to protect the environment; o disturbed lands must be properly reclaimed; and • all activities must protect public health and safety.
Federal Energy Regulatory Commission	• Issuance of licenses for the construction of a new project that connects to the grid. FERC and BOEMRE have agreed that offshore ocean-energy development is an BOEMRE responsibility to the point of grid connections.
National Oceanic and Atmosphere Administration-National Marine Fisheries Service (NMFS) [C]	• Provides consultation under ESA with the Magnuson-Stevens Fishery Conservation and Management Act for the effects on Essential Fish Habitat and Habitat Areas of Particular Concern (50 CFR 600.905-930). Under the Magnuson-Stevens Fishery Conservation and Management Act, the National Marine Fisheries Service (NMFS) has regulatory responsibilities that will affect ocean energy development in the EEZ. • Provides consultation under the Endangered Species Act of 1973 (16 USC 1531-1543), regarding effects to threatened or endangered species. • Provides consultation under the Marine Mammal Protection Act of 1972 as Amended in (2007) (16 USC Chapter 31) regarding the protection of marine mammal species and their habitats in an effort to maintain sustainable marine mammal populations.
U.S. Fish and Wildlife Service (USFWS)	• Issues a Title XI right-of-way permit for construction of a transportation or utility system across refuge lands (43 CFR 36). The ROW application process would require a NEPA analysis (43 CFR 36.6) of the entire development scenario. • Provides consultation under the Endangered Species Act of 1973 (16 USC 1531-1543), regarding effects to threatened or endangered species.
U.S. Coast Guard (USCG)[D]	• The U.S. Coast Guard is responsible for the regulation and enforcement of various activities in the navigable waters of the U.S. and requires that such research-related projects are marked with lights and signals in order to ensure safe passage of vessels. Installation and maintenance of the markers must be done by the engineers as long as the structures are located in navigable waters. The Coast Guard provides detailed requirements for markings.
State Agencies	
Florida Department of Environmental Protection (FDEP)[E]	• Issues a Certificate of Reasonable Assurance for discharge of dredged and fill material into U.S. waters under Section 401, Federal Water Pollution Control Act of 1972, as amended in 1977 (Clean Water Act; 33 USC § 1341 et seq.); AS 46.03.020; under Part IV of Chapter 373 of the Florida Statutes. • Issues a Certificate of Reasonable Assurance/NPDES and Mixing Zone Approval for wastewater disposal into all state waters under Section 402,

Regulatory Agency	**Permit/Approval Actions/Requirements**
	Federal Water Pollution Control Act of 1972, as amended (Clean Water Act; 33 USC § 1341 et seq.); AS 46.03.020, .100, .110, .120, and .710; subsection 62-730.180(1), F.A.C. • Approves domestic wastewater collection, treatment, and disposal plans for domestic wastewaters (Chapter 62-604, F.A.C.). • Issues a Title V Operating Permit and a PSD permit under Clean Air Act Amendments (Title V) for air pollutant emissions from construction and operation activities (Chapter 62-212.400, (F.A.C.)). • Approves Coastal Zone Management Act Federal Consistency Program, Chapter 380, Part II, F.S.
Florida Fish and Wildlife Commission (FFWC)[F]	• Issues permits for activities involving marine turtles in Florida under authority granted to the state through a Cooperative Agreement with the U.S. Fish and Wildlife Service (USFWS) under Section 6 of the U.S. Endangered Species Act (ESA). All activities relating to marine turtles must be authorized under subsection 370.10, Florida Statutes. • Restricts the speed and operation of vessels where necessary to protect manatees from harmful collisions with vessels and from harassment by the Manatee Sanctuary Act, 379.2431(2), Florida Statutes (FS). The rules appear in Chapter 68C-22 of the Florida Administrative Code (FAC). Issues Fish Habitat Permits (AS 41.14.820 and AS 41.14.870) for activities within fish-bearing streams that may impede fish passage. Stream diversion, gravel removal, stream crossings (fords), ice bridge/road construction, water withdrawal, and bridge or culvert construction are activities that normally require a Title 41 (Fish Habitat) Permit.
Key: F.A.C. – Florida Administrative Code; F.S. – Florida Statutes	

Notes:

A. USACE

Authority: Under Section 10 of the Rivers and Harbors Act of 1899, as extended by the Outer Continental Shelf Lands Act (OCSLA), the Corps requires a permit for the creation of "any obstruction" in federal waters to preserve unhindered navigational access of the nation's waters (33 U.S.C. § 403 (1999).) The OCSLA extended the Corps section 10 authority into the EEZ allowing the agency to regulate "installations and other devices permanently or temporarily attached to the seabed, which may be erected thereon for the purpose of exploring for, developing or producing resources from [the outer continental shelf]" (43 U.S.C. § 1333(a), (e) (1999).)

The necessary permit is the Section 10 permit; a Nationwide or General permit may be available in which case the Corps issues a letter of permission that serves as the permit. The Corps considers a broad range of potential environmental and other impacts before issuing or denying a Section 10 permit for open ocean energy technologies.

B. USEPA

Authority: Under Section 318 of the Clean Air Act, the EPA has asserted jurisdiction to require point source pollution discharge permits for projects in the open ocean. (Regulations are located at 40 C.F.R. § 122.24 (NPDES).)

In addition, the Ocean Dumping Act (33 U.S.C. § 1412 (1999)) grants authority to the EPA to permit the dumping of material into U.S. waters when such dumping will not unreasonably degrade or endanger human health or the marine environment, ecological systems, or economic potentialities. The criteria for reviewing such permits include the need for the proposed dumping; the effect of such dumping on human health and welfare, including economic, aesthetic and recreational values; the effect of such dumping on fisheries resources, plankton, fish, shellfish, wildlife, shorelines and beaches; and the effect of such dumping on marine ecosystems.

Further, OCS air permit regulations at 40 CFR 55 require compliance with all the applicable air requirements for the State of FL. Additional federal requirements are listed in 40 CFR 55.13 and 55.14 of the OCS air regulations. The permit would only be for the air quality aspects of the project. The air emissions are likely to come from mobile sources - such as the vessels or drilling rigs used to install the equipment.

C. NOAA/NMFS

Authority: Under the Magnuson-Stevens Fishery Conservation and Management Act, the National Marine Fisheries Service (NMFS) has regulatory responsibilities that will affect ocean energy development in the EEZ. For scientific research, the NMFS requires the applicant to apply for a Letter of Acknowledgement and the NMFS will inform the other agencies (the U.S. Coast Guard and state agencies, if necessary) that this activity is occurring in federal waters.

D. USCG

The U.S. Coast Guard is responsible for the regulation and enforcement of various activities in the navigable waters of the U.S. and requires that such research-related projects are marked with lights and signals in order to ensure safe passage of vessels. Installation and maintenance of the markers must be done by the engineers as long as the structures are located in navigable waters. The Coast Guard provides detailed requirements for markings.

E. FDEP

Authority: The Florida Department of Environmental Protection (FDEP) administers Florida's NPDES permitting authority and houses the Florida Coastal Management Program for CZM purposes.

F. FFWC

Authority: Since the streamlining of Florida's regulatory program for aquaculture, the Florida Fish & Wildlife Conservation Commission (FWCC) has very limited authority over the marine species in the state. The remaining authority is derived from Florida Statutes section 372.072(4) (a).

1.6 Private, Non-profit, or Public Agencies Consulted

SNMREC's home at Florida Atlantic University means that a wide range of expertise is available to participate in Center activities; see, for example, Table I. The Center is also working with a variety of organizations to advance the development of hydrokinetic and thermal ocean energy resources. Individuals with technical expertise and public interest in the activities of SNMREC have been and continue to be consulted with respect to the effects of SNMREC deployments and operations on their areas of interest. The following list includes both formal partners and other stakeholder groups that have been consulted about the activities planned for the Florida Straits described here; these consultations will continue.

<u>International</u>
European Marine Energy Center (U.K.)
University of Edinburgh (U.K.)
Heriot-Watt University (U.K.)
New Renewable Energy Centre (U.K.)
College of the Bahamas
Counsel General of the Bahamas
Consul General of the United Kingdom

<u>Federal</u>
Federal Energy Regulatory Commission, Washington
Federal Communications Commission, Washington
U.S. Navy – Carderock Division, Naval Surface Warfare Center
U.S. Army Corps of Engineers – West Palm Beach Office
U.S. Coast Guard – Miami Office
National Oceanic and Atmospheric Administration (Miami & Washington)

National Marine Fisheries Service, Miami
U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy
National Renewable Energy Laboratory, National Wind Technology Center
U.S. Department of Interior, Minerals Management Service (New Orleans & Washington)

<u>State</u>
Florida Energy Office
Florida Department of Agriculture and Consumer Services
Florida Department of Environmental Protection
Florida Fish and Wildlife Commission
University of Central Florida
Florida State University
Florida International University
Nova Southeastern University (Ft. Lauderdale)
Florida Energy Systems Consortium
Miami-Dade County Parks and Recreation
Broward County Government
City of Lake Worth
Town of Lauderdale-by-the-Sea

<u>Not-for-Profit</u>
Mary Brogan Museum of Art and Science (Tallahassee, FL)
Broward County Alliance
Museum of Science and Discovery (Ft. Lauderdale, FL)
International Game Fish Association
National Wildlife Defense Fund
Northwest National Marine Renewable Energy Center
Hawai'i National Marine Renewable Energy Center
University of New Hampshire Center for Ocean Engineering
Oregon State University Center for Renewable Marine Energy
University of Miami
World Wildlife Fund
Sierra Club
The Nature Conservancy
Hydropower Association
Ocean Renewable Energy Coalition

<u>Private</u>
Hillsboro Club (Deerfield Beach, FL)
Industry partners[5]

[5] Due to confidentiality requirements, industry partners are not listed individually.

2 Project Detail

2.1 Proposed Infrastructure

The initial SNMREC deployment is to be an experimental turbine testing system consisting of a permanently anchored mooring system with a buoy, a deployment vessel that will be used for observation, control, and deployment, and an axial-flow horizontal turbine driven by a 3-blade rotor. The buoy, vessel, and turbine will be extensively instrumented to monitor both the equipment and the local environment (see Appendix B). While there may be various turbine systems deployed over the term covered by this phase of the overall SNMREC program, they are bounded in size (< 7 m diameter), they are all of a similar power class (< 100 kW), and they will all have similar supporting structures and deployment, as shown in **Error! Reference source not found.**.

One mooring site is planned initially. We would like to reserve the option, however, to simultaneously deploy up to two separate additional single-point moorings of the same class and design to evaluate effects of multiple systems on the current (wake effects), to increase testing flexibility, and maximize availability for concurrent device testing. The requested block area will be surveyed to establish additional candidate sites for future moorings. Siting any moorings will involve the same considerations discussed here for the initial proposed site. There is an existing multi-beam survey available for blocks 7053 and 7054. Specific anchor location(s) are expected to be surveyed in greater detail. The detailed survey plan is under development and dependent upon guidance in draft at BOEMRE.

The mooring system that is proposed to anchor the buoy is designed for up to a two year lifespan under normal operating conditions. It will be necessary to remove the majority of the mooring and the buoy (leaving the anchor and some of the attached chain) for maintenance and retrofitting during the five year deployment of the initial system. It is anticipated that this maintenance would be necessary twice over the span of the lease. If additional buoys are installed, their system maintenance requirements will depend on the installation date with respect to the remaining lease time, but will similarly need to be serviced before two years of installed deployment are complete.

Mooring

The mooring, which is the primary subject of this application, consists of a self-contained, streamlined buoy, termed the Mooring and Telemetry Buoy (MTB), connected directly to an anchor; the buoy is designed for long-term operations in the Florida Current. The buoy serves three functions: 1) an offshore mooring point for the tender vessel and experimental turbine when it is deployed, 2) an instrument and data relay platform, and 3) a navigational aid. The buoy, designed based on the NOAA/Navy NOMAD buoys[6], is fitted with sufficient flotation to support its mooring hardware and to survive hurricane conditions; its design will also minimize

[6] Buoy hull dimensions are 6.4x3.0x1.9 m. (21.1x9.9x6.2 ft.) (LxWxH). Overall height above the mean water line is approximately 6.4 m. (21 ft.), including mast. A typical 3-ton drag-embedment anchor (DANFORTH) is 3.0x2.8x1.9 m. (9.8x9.3x6.2 ft.). (Overall Length x Stock Length x Fluke Length).

damage (to itself and the ship) in the event of a ship strike. It includes an array of navigation, safety, communication, security, and environmental sensors. The navigational instruments include required safety and navigation lights, GPS, passive and active radar target enhancers, and an Automatic Identification System (AIS) transmitter that broadcasts to other vessels fitted with AIS receivers information about the buoy, like its name, location, and status. Safety systems include: leak, fire, smoke, and intrusion detection, battery and charging system health and status, and redundant, independent communication and power packages that allow the buoy to provide personnel with minimally needed information of overall system fidelity and location. The on-board systems meet the requirements of the U.S. Coast Guard as noted in Table III.

Communication capabilities include redundant buoy-to-shore systems such as a broadband cellular internet modem, an RF receiver and transmitter, and an Iridium satellite modem to allow the buoy to communicate via internet or email with personnel located anywhere in the world. Security instrumentation includes on-deck surveillance camera(s) and intrusion detection. Environmental instruments include a buoy-mounted ADCP, a bottom-anchored ADCP that communicates with the buoy via an acoustic modem, and a weather and atmospheric sensor suite that provides wind speed and direction, barometric pressure, and solar irradiance.

The mooring buoy is powered by a combination of renewable energy systems that charge a battery bank. Solar panels will be chosen to ensure that partial shading and/or regular immersion due to wave activity do not cripple the power regeneration available to the system. In addition, because the ocean current will generally be sufficiently fast, commercial, off-the-shelf sailboat water generators supply additional charging capacity to the batteries. For further redundancy, conventional sailboat wind turbines have been installed to ensure regular strong charge of the system battery bank. The battery bank is sufficient to supply all power requirements for at least 7 days without recharging. All of the mooring system and sensor information is processed, stored, and transmitted using a low-power, ruggedized industrial embedded-PC platform.

The mooring hardware consists (top-down; see Figure 6) of the main mooring line, a series of line floats, an acoustic release device, another length of mooring line, the anchor chain, and the anchor.

In its initial configuration, the turbine is negatively buoyant. It is lowered from the tender vessel into the current for operational purposes. The main mooring line itself is conventional galvanized wire rope common to most deep water moorings with the upper half faired with hydrodynamic foils to reduce drag and anchor-line strum. Because of the high-current environment, a scope of approximately 3:1 will be used to help minimize anchor size and line loading. Because the current meanders in the vicinity of the mooring and the MTB can experience a variety of environmental loading conditions (such as wind and waves), the line loading may occasionally decrease such that some of the chain lies on the bottom. To mitigate potential scouring of the bottom in this circumstance, synthetic floatation will be placed along the mooring line at several locations to ensure that the line does not touch the seabed. If the line would break, the flotation attached to the mooring line will keep it off the bottom, and when it is released it will float to the surface. This floatation also facilitates buoy removal for maintenance, where the acoustic release, located just above the chain, would be activated, releasing the chain and allowing the mooring line to rise to the surface for retrieval. In the event the release does not operate, a short section of mooring line is located between the release and the chain. This line could be cut with a ROV to release the buoy and mooring line from the chain as well if required, or at the time of decommissioning.

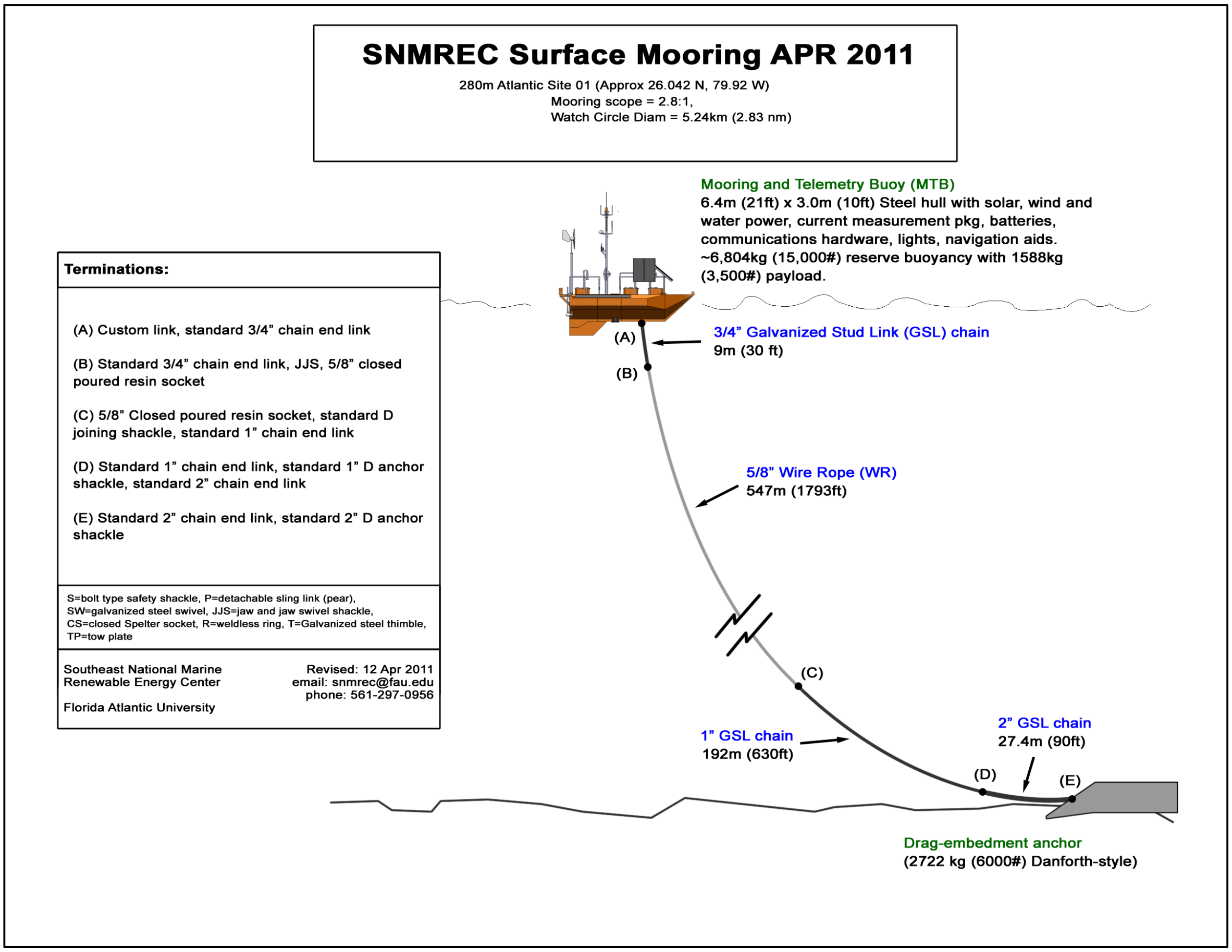


Figure 6: Detailed proposed mooring for initial SNMREC deployment as of April 2011.

Significant investigation, which included consideration of various alternatives, has concluded that the most appropriate type of anchor for this mooring system will be a standard Danforth-type drag embedment anchor. Such anchors are equipped with flukes that embed in the bottom sediments after dragging a short distance to obtain their holding power. We anticipate that the benthic survey work described in sections 2.3 and 2.4 will reveal areas of bottom sediment appropriate for deployment of such an anchor.

These anchors are reliable, known to minimize impact on the sea bed, and recoverable. Three to four shots (90-ft lengths) of chain will also be used to act as a “shock absorber” to the mooring line, so that in the case of waves or larger mooring forces as when the buoy and turbine is attached, the chain would be lifted off the seafloor and its suspended weight would counter the additional drag, balancing the entire mooring system. When the additional loads decrease, then the chain again lies along the seafloor and the balance is also maintained in that configuration.

Our calculations show the need for a 3000 kg Danforth drag embedment anchor with a 5 cm steel chain, which would then attach to the 1.5 cm diameter wire-rope mooring line that runs to the surface buoy and holds the entire system in the current as shown in **Error! Reference source not found.**. Since the chain is designed to move during changes in mooring loads, the seafloor under the chain would experience periodic encounters with the chain, such that the area will experience some disturbance. The anticipated area of periodic chain contact will be approximately 2,500 square meters, or a quarter hectare (~82 m of chain periodically scrubbing a ~40° arc). Based on the 70-m drop radius (discussed in Section 2.6), the total mooring bottom contact area, which accounts for emplacement drag of the anchor itself through part of that drop area, is estimated to be ~0.6 hectare.

When the anchor is recovered, a work vessel will be used along with a Remotely Operated Vehicle (ROV) to dive to the anchor and attach recovery gear to it. The ship used will not require anchors to hold position over the worksite, so no additional bottom disturbance would occur as a result of anchor recovery. Because the maintenance of the mooring requires re-deployment during the course of the lease, the above described approach will be used to recover all of the anchors and chain that are not recovered for maintenance. The maximum number of anchors that are expected to be recovered at a site is three.

Deployment vessel

Observation, control, and deployment of generating systems under test will be conducted using a deployment vessel that will: (1) carry the turbine and its support hardware during transit between the dock and the test site, (2) launch and recover the test turbine, and (3) support on-site operations. This vessel will be the main operations platform and will house the instruments for operating and monitoring the turbine system in a portable shipping container. This arrangement will allow flexibility in choosing an appropriate vessel for the requirements of a particular mission (including anticipated weather conditions). The turbine is connected to the vessel by a specialized cable that performs two functions: (1) deployment, operations, and recovery of the turbine and (2) power and communications to monitor and control the turbine as well as to transmit power from the turbine. A redundant tow line will provide a safety factor to ensure the turbine is not lost in the unlikely event of damage to or failure of the main cable

It is not economical to exclusively rely upon a specific vessel to provide turbine deployment support at the proposed sites. Therefore, it is likely that a purpose-built platform may be built to deploy ocean current turbines of the proposed class. This platform would be towed or self-propelled to the site and moored to the MTB in the latter portion of the lease term. Any platform would comply with all governing standards and requirements.

Turbine system

Performance: The first experimental turbine system (Figure 7) will be an axial-flow, horizontal turbine generator with a rotor blade size of 3 m diameter, yielding a maximum power generation of about 20 kW. Subsequent systems, based on the same design with larger rotors (up to 7 m diameter), will yield at most ~100 kW. Conventional 2- and 3-bladed rotors, similar in appearance to those commonly used for wind turbines, will be employed, with the rotors located on the downstream side of the turbine housing. The system will operate at depths between 5 and 50 m.

Actual power output will depend on the current speeds encountered. Based on a 1-year dataset (Figure 2) of current measurements obtained near the proposed deployment site, we estimate the average current speed to be ~1.7 m/s with speeds exceeding 2 m/s only rarely. Thus, on average, the power produced by the 7-m system will be less than 60 kW most of the time, spiking to ~80 kW on occasion. Similarly, the rotation rate of the 3m and 7 m turbine at the average current velocity will be 45 rpm and 20 rpm, respectively, with maximum values of 70 rpm and 35 rpm occurring during the rare, high-speed events. The resulting blade tip speeds will be similar for all turbine sizes on average, ~7 m/s and up to 11 m/s peak. It is important to emphasize that these tip speeds are lower by an order of magnitude than those for wind turbine systems. Although the tip-speed ratio, the ratio of the tip speed to the wind speed, will be similar for the two types of systems, the oceans' current systems are more than ten times slower than the wind.

Design and Layout: The initial 3-m turbine and future generations covered by this application are/will be designed using accepted ocean engineering principles, backed up by extensive numerical modeling and independent review. The basic layout of all experimental turbines will be similar; it consists of a set of rotor blades connected to a drive train that transmits the energy from the rotor blades to a gearbox/generator assembly.

The generator and supporting electronics are housed within a watertight pressure vessel with components designed to a minimum safety factor of five for deployments (three for operations), that thermally couples the internal heat-generating components to the seawater to maintain acceptable temperatures inside the vessel. Ballast is provided via the stabilizing pods (Figure 7), which are attached to legs that act as a moment arm, providing a large force and righting moment that both trims the turbine in pitch and roll and counters the torque generated by the rotor blades. A surface-accessible lift point is welded to the top of the turbine nacelle, enabling a quick turbine recovery. Redundant tow lines will be used to ensure protection of the turbine asset.

The generators and onboard electronics are housed within a pressure-resistant housing with redundant watertight seals. The bearings supporting the drive shaft that connects the rotor blades to the gearbox/generator are housed in a lubricant-filled section with redundant dynamic seals between the seawater and the lubricant to ensure no leakage; this feature will meet the EPA requirements noted in Table III.

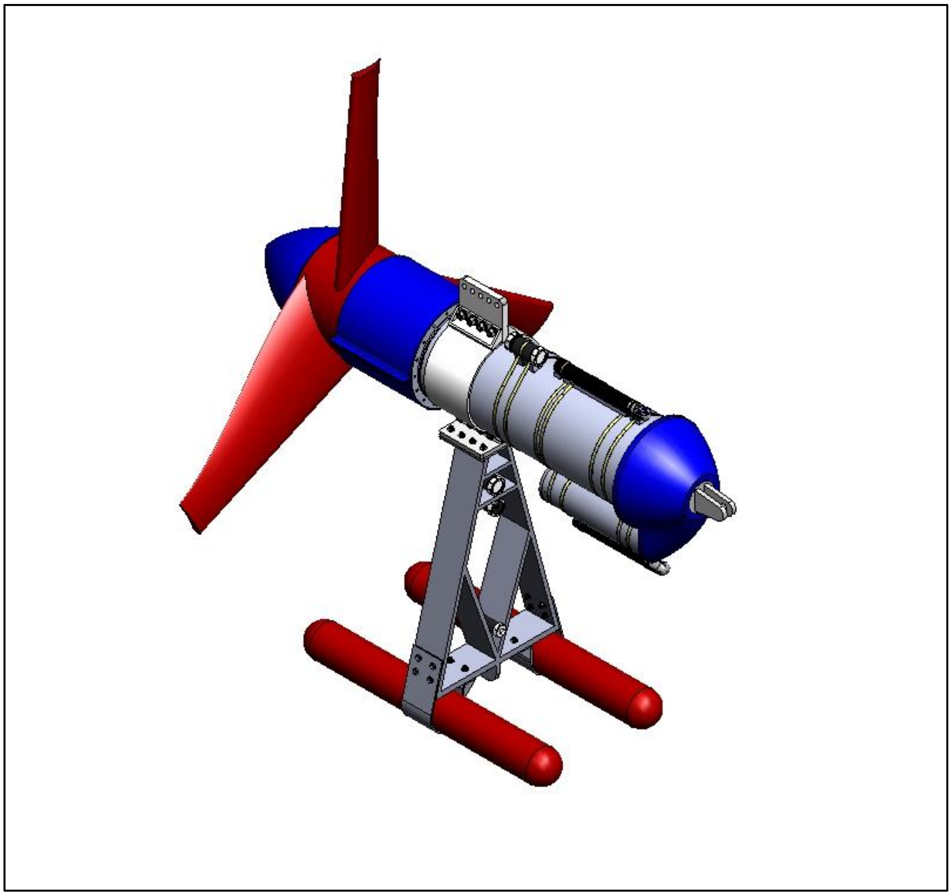


Figure 7: Illustration of SNMREC experimental turbine system.

To increase the reliability and lifetime of turbine components, machine condition monitoring techniques will be implemented to supervise the system. Critical components to be monitored include: the turbine nacelle pressure vessel, motor/gearbox, propeller, and electrical system. The temperature, position, roll, pitch, yaw, and bilge water level of the turbine nacelle pressure vessel will be monitored using thermometers, a 6-axis inertial measurement unit, and water sensors. Vibrations in the transmission shaft, gearbox, and motor will be monitored using low and high-frequency accelerometers, indicating any imbalance or wear on bearings or gears. The torque, strain/vibration, water flow, turbulence, and immediate environmental surrounding of the propeller during operation will be monitored respectively by a load cell, strain gauge, flow meter, ADCP, and video cameras. This will indicate any instability, excessive strain on the blades, or significant imbalance. In addition, a ground fault interrupter will detect and protect the system from ground faults in the electric motor or electric cable. When fabrication is completed, a series of on-shore and at-sea tests will be conducted to ensure that the system can withstand the rigors of deployment in the Florida Current. The at-sea testing will be accomplished via tow tests, in which the turbine is deployed from a work boat and towed at speeds representative of the current at the mooring site. These towed tests are independent of this permit application.

2.2 Location

Our initial notice of intent referenced the entire area designated as IP lease blocks on the OCS for renewable energy projects, those outlined in dark blue in Figs. 3-5; portions are also shown above in Figure 8. After investigating existing bathymetric and oceanographic data, considering the potential user conflicts discussed in Section 1.2, and further defining the objectives of the SNMREC program, the number of blocks required was reduced to three lease blocks. These blocks (red boxes in Figure 8), specifically 7003, 7053, and 7054, include a fairly flat seafloor which would facilitate mooring and instrumentation installation, as well as an available current velocity sufficient for testing small-scale ocean current devices. Although there are other lease blocks where the water velocity is greater, the seafloor in those areas contains ledges, steep slopes, and potential hard bottom which could possibly be affected by moorings or other bottom-mounted devices.

The proposed lease areas cover 38 square km of seafloor, and range from a depth of 262 m in Block 7053 to 366 m in the lower half of Block 7054. As can be seen in Figure 8, the seafloor appears to be relatively flat in these blocks, with a section of slope in the western portion of Block 7054, although there is adequate space to locate the proposed mooring and instrumentation while avoiding both bottom structure and areas of potential habitat. The seafloor also appears to contain sufficient sand overburden to support the proposed anchoring system, although additional site characterization will determine the actual depths and amounts.

The proposed MTB mooring location, then, was selected based upon the criteria explained in the previous sections in addition to site-specific bottom type and slope, location of potential coral communities and benthic habitat, and oceanographic conditions. The anchoring system for the MTB mooring was designed to hold the buoy, support vessel, and energy device in the Gulf Stream current at water speeds exceeding 2 meters per second. The mooring would interact with the seafloor and hold due to the embedment of the anchor into the sediment layer, primarily of sand. The chain would lay out from the anchor downstream, absorbing the mooring loads from the wire and buoy. Since the bottom type is important to the mooring holding power, a level, sandy area is preferred over a rough, high slope type seafloor. Given the need for a smooth seafloor, and since coral communities typically prefer a rough, highly sloped seafloor such as an area of ledges, an escarpment, or other irregular bottom profile, the site selection was naturally reconciled between the engineering requirement and avoiding the biological resources in the area.

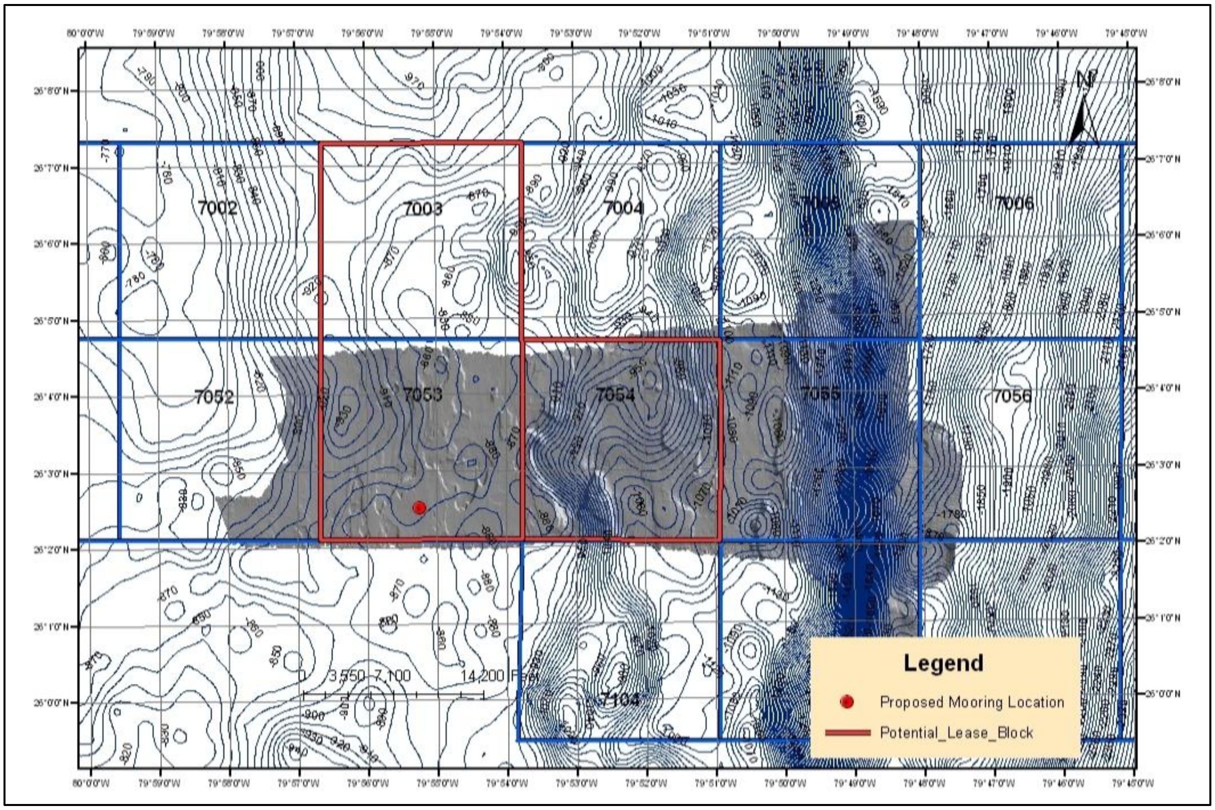


Figure 8: Proposed MTB mooring location overlaid upon multibeam bathymetry data. The proposed initial anchor location is noted by the red dot (26.042 deg N, 79.92 deg W).

A recent multibeam survey sponsored under a USDOE project to develop appropriate benthic survey techniques for MHK energy development, along with existing NOAA bathymetry data for the area, was used to identify suitable anchoring locations within the assigned OCS IP lease blocks, while also avoiding benthic habitats and remaining within sufficient water velocities for device testing. Figure 8shows the proposed SNMREC lease blocks, along with existing NOAA depth contours (grey contour lines), and bottom sonar imagery with accompanying depths. The figure shows the areas of high slope, as well as relatively flat, featureless seafloor that could potentially support a mooring. It also shows how the NOAA data, while of lower resolution, generally agrees with the new bathymetry contours, and as such provided a good baseline for assessing areas where more detailed information is not available. This figure also indicates the **proposed initial anchor location**, at **26.042 deg N, 79.92 deg W**, in 270 m of water (noted by red dot on Figure 8).

To summarize: from the initial multibeam sonar surveys (the shaded area superimposed on the detailed site bathymetry in Figure 8), the preferred site for the deployment discussed here lies near 26°N, 79.9°W, within Bahamas Block 7053, about 21 km southeast of Port Everglades in ~270 m of water. Based on the discussion to follow, however, it may be appropriate to position the mooring within one of the blocks adjacent to Bahamas Block 7053 if more appropriate bottom characteristics are located; this is why this lease application requests 7003 and 7054 as well as 7053 (these blocks are shown in red in the various charts). It is for the purpose of locating appropriate bottom characteristics that Section 2.3 includes an extensive discussion of benthic habitats and bottom types.

We chose this location for several reasons:

- it is near the core of the Florida Current, which is the mean location of the maximum flow and fully representative of likely spots for future commercial-scale hydrokinetic deployments;
- it is close to the operating and monitoring facility, i.e. the onshore support base, FAU's SeaTech campus in Dania Beach (see cover picture), thus providing ready access to and monitoring capabilities for all offshore activities from shore as well as quick response from shore to the lease area. It will also minimize fuel consumption (and associated exhaust emissions) during site visits;
- it is located outside of maintained channels (such as that for Port Everglades), shipping lanes, military reservations, and other such high-use areas and as such has minimal interference with military, commercial, and recreational use;
- existing structures, facilities, pipelines and cables in the area are minimal;
- none of the equipment (platforms, vessels) will be visible from shore;
- our preliminary surveys of the area suggest that the anchor can be located in a recessed area on the Miami Terrace with low benthic populations (benthic species densities are the greatest on the top of and on the slopes of benthic structure on the Miami Terrace, and species densities are the lowest in recessed areas); and
- the bottom is relatively flat and appears to be largely sandy, soft-bottom habitat.

Avoiding potential environmental impact was an important selection criterion for the lease activity location(s). Potential environmental impact was estimated based upon whether sensitive benthic species or habitat is believed to be present with the goal of avoiding areas of potentially greater benthic density. These concerns are affected by the anchoring footprint, installation and decommissioning, and mooring line contact with the bottom during reduced current conditions. Generally, if areas significantly larger than the proposed mooring watch circle could be identified without high benthic density and without sensitive benthic habitat, they were considered favorable for selection. Information about seafloor characteristics in the area of interest is available from sonar and photographic surveys conducted by FAU and others.[7] On the basis of this information, the bottom areas avoided were those that have either been observed or reported to support hard bottom habitat or deep water coral species. Details of anticipated mooring impact(s), pre-installation survey and other considerations are available in sections 2.3 and 2.4, however, approximately 2 km diameter watch circles for the mooring system were considered.

[7] These include privately funded surveys using sidescan and video in association with an offshore liquified gas storage port proposal in the mid-2000s; video surveys by FAU's Harbor Branch Oceanographic Institute in 2008 and 2009; and a sidescan and multibeam survey funded by the U.S. Department of Energy in 2010, in which SNMREC participated. Figure 8includes a sidescan image of the area in question from the last of these.

2.3 Geotechnical survey

Protocol and Terminology

The South Atlantic Fisheries Management Council (SAFMC) refers to “hard bottom” as a class of coral communities occurring in temperate, subtropical, and tropical regions (SAFMC, 1998). Sometimes referred to as “live bottom” due to the amount of living organisms attached to these substrates, hard bottom is cemented or solid substrates that provide anchorage for sessile or semi-sessile organisms, notably corals. Note that in this context, coral includes non-accreting taxa such as octocorals and antipatharians (black corals) as well as stony corals and other taxa with solid calcareous skeletons. Such habitat includes various sizes of loose rocks (gravel, rubble, cobble, boulders, slabs), pavements, ledges, coral rubble, and both dead and live standing coral. It ranges from relatively flat, low-relief surfaces (<0.5 m vertical relief) to several meters in relief. Vertical relief of bottom features (e.g., boulder, slab) were reported in the Calypso LNG pipeline and deep-water port reports as low relief (<0.5 m), moderate relief (0.5-1.0 m), or high-relief features (>1.0 m). Soft substrates are defined as unconsolidated sediments.

The SAFMC Southeast Area Monitoring and Assessment Program (SEAMAP) deep-water mapping project has documented deep-water, hard-bottom habitat from existing data throughout the South Atlantic Bight and Straits of Florida. SEAMAP has defined deep-water hard bottom using the following subcategories: coral, rock rubble, coral rubble, exposed hard pavement, thinly covered hard substrate, and artificial structures. In addition, a “Special Habitats” category includes the subcategories of canyons, tilefish burrows, consolidated mud, methane seeps, sinkholes, and coral banks (Table V). They define deep-water corals as Scleractinia (stony corals), Octocorallia (gorgonians), Stylasteridae (lace corals), and Antipatharia (black corals).

The productivity of hard-bottom communities varies depending upon environmental and physical factors including but not limited to depth, current, light penetration, substrate topography, habitat availability, and location. Areas of hard bottom provide cover and foraging areas for many fish and invertebrates, including several commercially important species. The importance of hard bottom to fisheries stocks has been recognized and the SAFMC has designated all natural and artificial hard bottom as Essential Fish Habitat (EFH) and/or Habitat Area of Particular Concern (HAPC).

The continental slope off southeastern Florida is interrupted by the Miami Terrace, a 65-km long carbonate platform that occurs at depths of 200-400 m in the northern Straits of Florida. The Miami Terrace consists of high-relief Tertiary limestone ridges, scarps and slabs that provide extensive hard bottom habitat. Reed *et al*. (2006) published the state of knowledge regarding deep-water reefs off the southeastern U.S. including the Miami Terrace based on recent submersible dives. Expeditions from 1999 to 2004 explored various deep-sea coral ecosystems (DSCE) off the southeastern U.S. (Blake Plateau, Straits of Florida, and eastern Gulf of Mexico). Habitat and benthos were documented from 57 dives with human occupied submersibles and three with an ROV, and resulted in ~100 hours of videotapes, 259 in situ digital images, 621 museum specimens, and >400 microbial isolates. These were the first dives to document the habitat, benthic fauna and fish diversity of some of these poorly known deep-water reefs. Fifty-eight fish species and 142 benthic invertebrate taxa were identified.

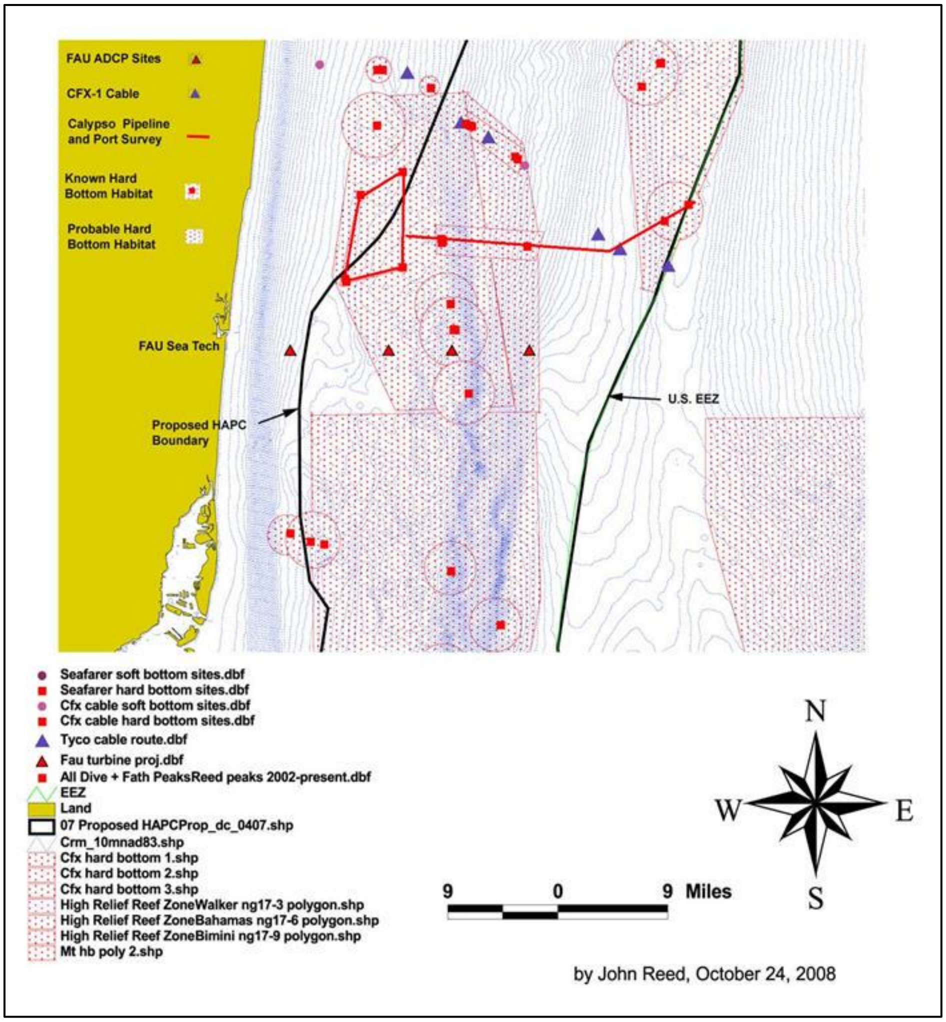


Figure 9: Proposed SNMREC ocean turbine site in relation to Miami Terrace bathymetry and bottom structures. The second seaward red triangle is approximately the currently proposed turbine site (300 m depth). ADCP buoy sites = red triangles; known hard-bottom areas (from previous submersible, ROV dives) = red squares; probable hard-bottom habitat (from bathymetry charts) = red stippled polygons; survey of proposed Calypso LNG pipeline route = red line; survey of proposed Calypso LNG port = red polygon; and survey of CFX-1 fiber-optic cable route = blue triangles; black lines = east (also U.S. EEZ) and west boundaries of proposed deep-water coral Habitat Area of Particular Concern.

Study Area of the Proposed SNMREC Site

Both Reed *et al*. (2008) and Messing *et al*. (2006a,b) have recently conducted quantitative biological benthic surveys near the proposed SNMREC site (Figure 9). Messing *et al*. (2006a) described the proposed Calypso LNG pipeline route from 65 to 200 m depth and from the U.S. EEZ to the 3-nm Florida State limit and Messing *et al*. (2006b) surveyed the proposed Calypso LNG port on the Miami Terrace. The Calypso pipeline and port surveys encountered hard/live bottom habitat in three regions: the Miami Terrace and Miami Terrace escarpment (rock and coral habitat), the base of the Miami Terrace escarpment (rock and coral rubble), and the Straits of Florida near U.S. EEZ (high-relief coral mounds and coral habitat). Reed *et al*. (2008) surveyed the CFX-1 cable route on the northern Miami Terrace and found extensive low relief hard-bottom habitat (rock rubble, cobble, pavement, and outcrops) on the Miami Terrace and slope. The hard bottom of the Miami Terrace apparently ends slightly north of the CFX-1 cable route. Due north of Miami Terrace, Reed (2006) found no evidence of hard bottom during the benthic survey of the proposed Sea Farer LNG pipeline route. However, high-relief coral habitat was found at the eastern end of this survey near the U.S. EEZ.

In September 2008, two JSL submersible dives were conducted near a SNMREC ADCP mooring location in block 7055. Both dives found hard/live bottom. The first site had a high cover of sponges and should be avoided. The second site had lower density of biota although no quantitative assessment was made. Both sites are near the high biodiversity habitat that occurs along the Terrace shelf break (Figure 9; details of the bathymetry are shown in Figure 8). Even more recently (October, 2009), additional JSL surveys in the same vicinity verified the existence of low-density soft bottom, suitable for anchor placement, and found the location of a SNMREC ADCP mooring to be within ~30 m of its planned landing site. This suggests that accurate positioning from on-ship deployments is possible and, consequently, that sensitive bottom communities can be avoided with future deployments.

Reed *et al*. (2006 and unpublished data) describe hard-bottom habitat at numerous sites on the Miami Terrace and escarpment and Straits of Florida in this region. Benthic macrofauna found on the Miami Terrace and escarpment include scleractinian corals, lace corals, bamboo corals and a variety of sponges and other octocorals, as well as schools of squid, jacks, alfonsino, and wreckfish. Two geological studies using submersibles were completed in the 1970s on the Miami Terrace. In 1970, Ballard and Uchupi (1971), using the *Ben Franklin,* crossed the northern Miami Terrace. At the western end of their dive, they reported a thin veneer of rippled sand grading first into an area of phosphoritic nodules in a carbonate sand matrix and then, with increasing depth to the east, massive phosphorite outcrops. The outer edge of the Terrace was continuous phosphorite and included steep ridges of 50 to >80 m relief with some near-vertical slopes, undercuts and slump blocks, as well as shallower steps. Neumann and Ball (1970), using the *Aluminaut,* described the outer Terrace margin as a pair of north-south ridges with steep phosphoritic limestone escarpments with vertical relief reaching ~90 m. At the base of the Miami Terrace escarpment, they observed thickets of the deep-water corals on depressions, sand ridges, and mounds.

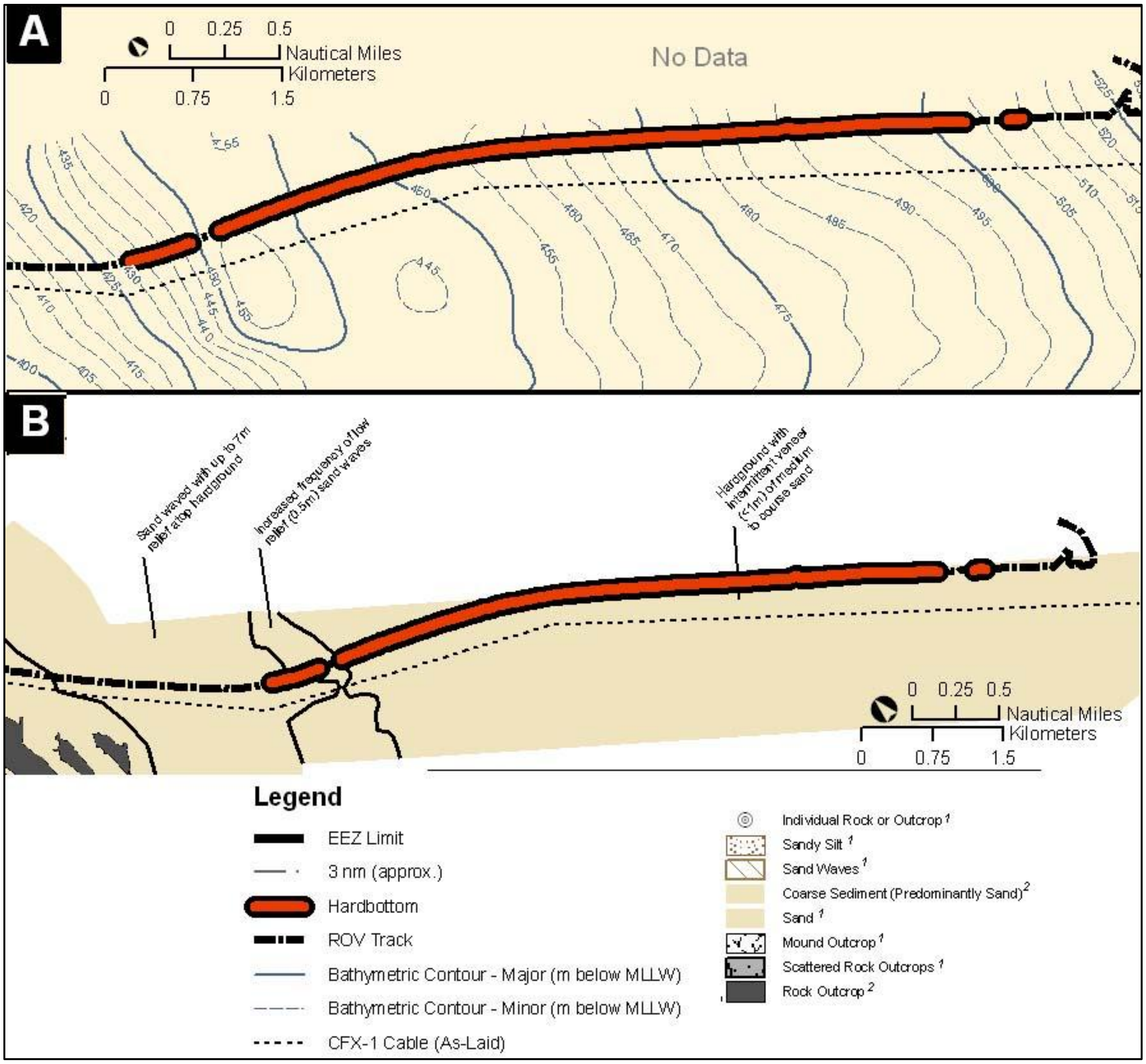


Figure 10: Presence of hard-bottom habitat (red line) documented by video observations during a ROV survey of the CFX-1 cable route on the Miami Terrace. a. Hard bottom relative to bathymetric survey. b. Hard bottom relative to side-scan sonar survey.

Predicted vs. Actual Hard/Live Bottom Habitat

Often visual inspection is required to document the presence of deep-water hard/live bottom habitat in this region. Inspection of bathymetric data and sonar data (side scan and multi-beam) alone may not always provide evidence of hard/live bottom where in fact it exists. For example, during the CFX-1 cable survey (Reed *et al*. 2008), an overlay of the ROV track with the high-definition bathymetric chart shows the difficulty of interpreting bathymetry alone as a predictor of hard bottom (Figure 9a). Previous surveys in this region typically found that high-relief bathymetric features will indicate live-bottom habitat as verified by inspection with submersible or ROV. However, low relief or flat bottom may or may not be an indicator of hard/live bottom habitat. Hard-bottom sites discovered during the CFX-1 surveyed occurred on a relatively featureless slope. A comparison of actual hard-bottom sites with the side-scan sonar data also shows that the side scan data is not always a predictor of hard/live bottom (Figure 9b). The CFX-1 survey found that the most extensive region of hard bottom (Site HB-4, 6540 m length) appeared on the sonar map as soft bottom. In each case a benthic video survey was required to verify the presence of hard/live bottom habitat.

Site Selection

With this background, it is possible to outline a process for specific site selection for the SNMREC mooring that will avoid or minimize impacts on hard/live bottom habitat.

To completely avoid any deep-water hard-bottom habitat for deployment, the site would have to be moved north of the Miami Terrace and CFX-1 cable route (Figure 9). This, however, lies outside the BOEMRE blocks under consideration. As an alternative, use of these data from the recent Calypso surveys and from new surveys to be conducted based on the new BOEMRE protocol involving both video and still imagery will allow site selection of minimal potential impact to hard/live bottom communities. Sites will be selected that are sandy, soft-bottom habitat in order to deploy prototype turbines within the lease block areas. An example of sandy, soft-bottom conditions is shown in Figure 11.

2.4 Biological Survey

Benthic Biological Survey

Protocol for benthic video surveys by submersible and/or ROV will adhere to those outlined by the *Guidelines for Conducting Offshore Benthic Surveys* as applied by Messing *et al*. (2006a,b) and Reed *et al*. (2008) and as recently promulgated by the BOEMRE. The purpose of the surveys will be to characterize the seafloor habitat types and document the presence or absence of hard- and live-bottom habitat by conducting a quantitative video/photographic survey of the specific site of the mooring.

Video and photographic surveys from either an ROV or manned submersible, equipped with ultra-short baseline (USBL) positioning, will be used to document and characterize the benthic habitat and biota at all sites where there could be potential benthic impact. For pre-site selection and for post-deployment monitoring, transects will be made at an approximate speed of 0.5 m/s. The vehicle would operate within 1 or 2 meters off the seafloor whenever possible to avoid hampering the observer's ability to discern objects of interest on the seafloor. Continuous video will be recorded for the duration of each dive while on the bottom to provide a complete record of *in situ* observations. Throughout the dive, scientists will provide audio descriptions of the habitat and biota. These data will be entered into an Excel database and will include date, geo-referenced coordinates, time, depth, height off bottom, ROV/sub heading, course over ground, speed, habitat descriptions (habitat type, geomorphology, estimated percent cover), and biota descriptions (species, estimated sizes, and abundance). The video time can also be related back to the vehicle's track to verify geographic positioning with respect to the deployment vessel, which will be tracked using GPS. Video images will be annotated with date, time, and depth. The color video camera will be angled down ~45^{o} and will be used primarily for general habitat documentation and characterization and will have a set of parallel lasers for scale. Depending on the cameras' degree of zoom, the field of view may range from 25 cm to ~3 m which can be determined by the scaling lasers.

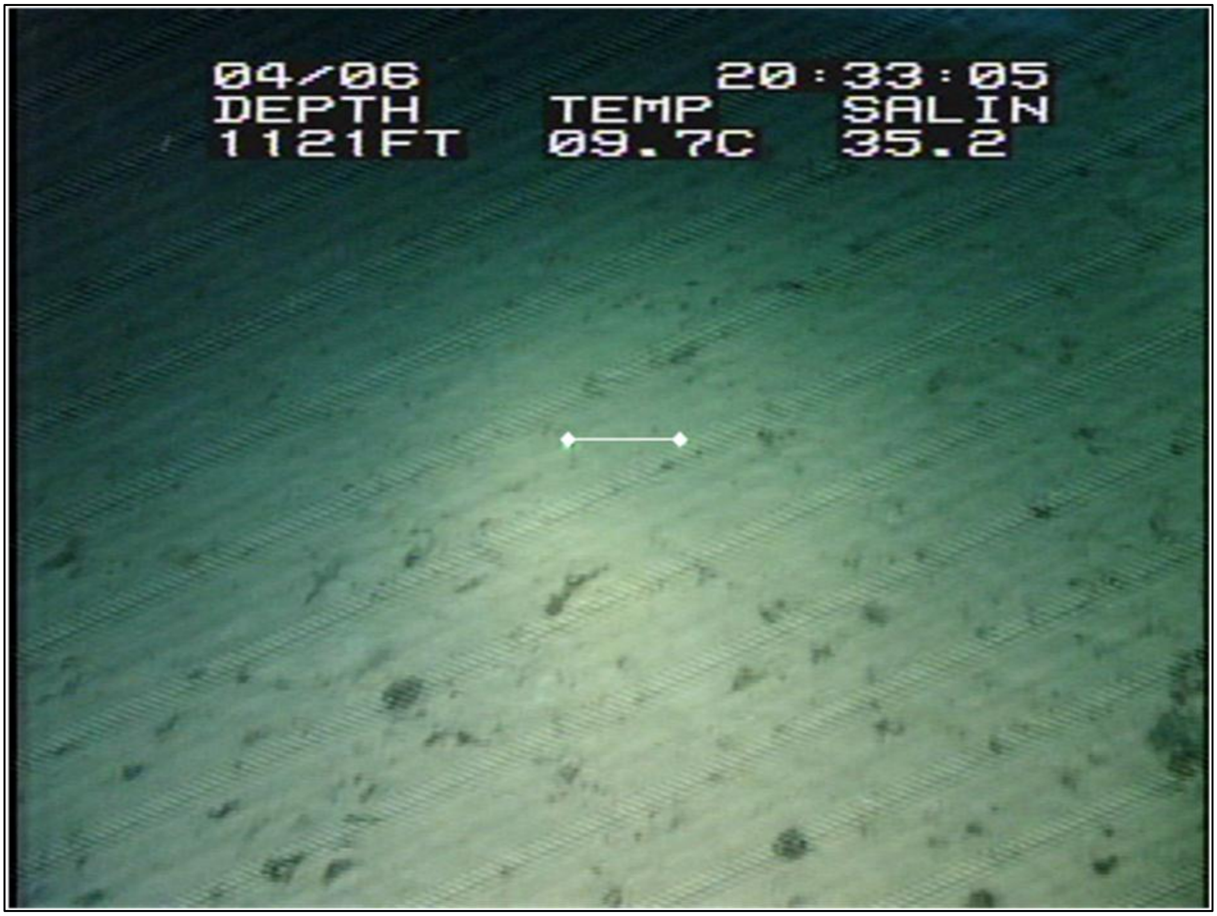


Figure 11: Example of sandy, soft-bottom habitat on the Miami Terrace, filmed during a benthic survey in April, 2009. This is the preferred site type for the anchor discussed here. NOTE: The diagonal "tracks" in the image are artifacts produced during video-taping and image-capture process. The scale bar is 25 cm.

A digital still camera with high resolution (at least 8 MP and/or 1 MB in quality) will be used to take representative photographs of the different habitats encountered and representative benthic species. The digital camera will be positioned straight down, ~1 m off the bottom, and will have parallel lasers for sizing objects and calculating densities. Still images will be captured at 10 min intervals while over soft-bottom habitat and continuously over all hard-bottom habitats. Overlapping images will be deleted from the quantitative analyses. Representative sites for each hard/live habitat type (e.g., rock pavement, rock ledge, rock rubble/cobble, standing coral, coral rubble) will be selected based on apparent substrate composition, geomorphology (structure, relief, and slope), biological complexity, and diversity relative to surrounding substrates. Approximately 100 images will be taken of each representative habitat type. If the region is too small to allow 100 photos, then rapid continuous photos will be taken.

The video and still photography will be analyzed upon completion of the survey to allow for GIS mapping of deep-water coral habitats. Video and photographic data will be reviewed in the laboratory to confirm organism identifications as far as possible and to define biological zones and benthic habitats. Attempts will be made to identify to organisms to species based on videos, photos, and taxonomy of representative samples. Original field transcripts will be summarized to produce habitat descriptions and identify transitions between habitats. Four habitat categories are anticipated; hard bottom, hard bottom covered with a sediment veneer, deep-water coral, and no hard bottom (sand/mud).

Sea Turtle Biological Survey

Five species of marine turtles (all protected under the Endangered Species Act of 1973) are found in Florida's coastal waters, including the adjacent Florida Current and Gulf Steam, using them for migratory pathways, feeding grounds, and breeding grounds. All marine turtles are migratory specialists that travel from shore to offshore nursery areas, travel among feeding grounds and undergo seasonal migrations. In addition, various life history stages occur in Florida waters throughout the year. Adults of at least three species of sea turtles are present along Florida's east coast during the spring and summer during mating and nesting periods, while hatchlings swim offshore from Florida's southeast coast during summer and fall after hatching from some of the most substantial nesting beaches for green, loggerhead, and leatherback turtles in the world. Several species of juvenile sea turtles, including green, loggerhead, and hawksbill turtles rely on Florida's near-shore habitat as developmental grounds throughout the year. These turtles "settle" along southeast Florida's coastal reefs after traveling within the Gulf Stream and Florida Current and remain in this habitat for several years. In-water populations of sea turtles are poorly understood, as it is difficult to study these highly migratory animals that require multiple habitats throughout their long lived existence. Further information regarding the temporal and spatial distribution of sea turtles in the proposed study area is needed to ascertain and mitigate the possible impacts to the several species and life history stages of sea turtles in the region.

The impacts of ocean energy technology on large scales may vary across species and life-history stage as each species and life-history stage may utilize coastal waters in different ways. All species are divers and most can reach the proposed depths of the deepest mooring buoy anchor, although it is expected that most species will use the upper 60-70 m of water more frequently. The exception may be the leatherback. All sea turtles breathe air and must surface frequently to breathe. Several sea turtle species are well known to associate with flotsam and with structures. Sea turtles are known to use in-water structures for predator avoidance as well as for resting and/or foraging sites. It is likely that turtles will interact with the proposed structures and understanding how and when turtles will be attracted to and actually use these structures is important. Impacts to hatchlings swimming offshore may result from the turbine structures' altering magnetic fields in the marine environment, as hatchlings are known to use the earth's magnetic field to reach offshore currents. Adults mating in the area may be attracted to the turbines as resting and predator avoidance sites. Juveniles may use the proposed structures as foraging areas once algae and biological material begins to form on the structures. All of these potential issues will be monitored.

Information on species-specific spatial and temporal distribution will serve as a guide to predict areas and times of concentration as well as the significance of turbines for various stages in the life cycle. Additionally, the behavior of the five sea turtle species will be assessed to determine if the kinds of structures that attract or entrain sea turtles are present in the turbine or its support structures and lines.

The methodology will include characterizing turtle habitat use (water and bottom) by all species before, during and after deployment of buoys, lines, support platforms, and turbines. The necessary data collection will (i) detail the spatial and temporal distributions of sea turtles generally, and various sea turtle species, (ii) characterize baseline data on habitat use, (iii) identify species-specific concerns relative to construction, placement of the buoys, lines, and turbine, and (iv) ascertain possible long-term threats to sea turtles utilizing the area either on a seasonal or annual basis. In addition, stranding response data available via participation in the Florida FWC and NOAA Sea Turtle Stranding and Salvage Network will be requested and explored as a general measure of status and seasonal variation in sea turtle abundance.

There is a need to characterize the regional habitat use and understand its significance for foraging habitat, sleeping sites, migratory corridors, or mating sites. The goals of this monitoring plan, which will proceed in a stepwise plan, are to (i) estimate annual and seasonal density of marine turtles throughout the area where construction, deployment, and maintenance will occur and within several minutes of latitude up- and downstream from the areas, (ii) identify the spatial and temporal risk factors to the turtles as they relate and interact with the gear, (iii) identify and deploy monitoring systems that will allow ongoing assessment, and (iv) develop a plan to prevent or minimize protected species takes.

Step 1- Species Survey and Potential for Takes of Protected Species

- Conduct extensive review of peer-reviewed and grey literature and historic data mining of turtle occurrence in the proposed areas. Review literature for possible turtle interactions with previously deployed structures in the marine environment. Estimate and prioritize project impacts by species, life history data and season.
- Determine sea turtle abundance, density, and species assemblage in the proposed area through several concurrent methods. Initial work will employ contracted aerial surveys (stratified random design, to be coordinated with marine mammal surveys). Surveys will be conducted prior to any deployment of project equipment to establish baseline data for comparison against further monitoring and systematic data collection after deployment[8].

Step 2- Attraction/Entrainment/Interactions with System Components

- Continue weekly/monthly scheduled sea/air population surveys and develop and manage population database and environmental data collection to determine responses to surface support structures, lines, and turbines.
- Purchase and deploy sonar imaging systems for the MTB and deployment vessel. While the intent is to screen for turtle attraction to the buoys, these imaging devises will allow for identification of other large vertebrates and marine debris. Turtle activity and relative occurrence associated with buoys and the environmental variables will be measured.

[8] Surveys have been conducted monthly since January 2011. A minimum of a full year's data will be available before turbines are deployed for testing to establish baselines for marine turtle activity, distribution, and abundance *a priori*.

- Continue deployment of GPS, sonar, VHF, and satellite tracking devices on juvenile and adult turtles utilizing the proposed study area to assess interactions with project gear and components.
- Coordinate and collect data from concurrent surveys for other species (marine mammals, benthic fauna, planktonic species) which will be collected opportunistically to supplement the baselines obtained from aerial surveys.

Step 3- Monitoring Methods and Equipment

- Conduct aerial surveys using standard techniques to obtain population estimates.
- Develop automated techniques for aerial surveys to increase comprehensiveness and transect size.
- Install acoustic instruments on at-sea platforms for monitoring.
- Utilize video equipment on-board prototype systems for real-time operational monitoring.

Step 4- Potential Mechanisms to Exclude Turtles

- Based on the identified risks, develop approaches that involve temporal, spatial, mechanical, and behavioral methods to prevent interactions between the gear and marine turtles.
- Develop modifications to structures that will reduce or prevent or minimize marine turtle-equipment interactions and/or interference.
- Identify risks to turbines and support structures from marine turtles.

Marine Mammals Biological Survey

The installation discussed here will occur in a region of the southwest Atlantic Ocean – the Florida Current – that is utilized by several species of migratory and (possibly) resident Cetacean species (e.g., dolphins and whales). These marine mammals include offshore Atlantic Bottlenose Dolphin, Atlantic Spotted Dolphin, Striped Dolphin, Rough Toothed Dolphin, Pygmy Sperm Whale, Dwarf Sperm Whale, Humpback Whale, Beaked Whale, Sperm Whale, and North Atlantic Right Whale. Some of these species may also utilize this (or a portion of this) described habitat for mating and/or calving, and it is likely that marine mammal activity in the region varies seasonally. All marine mammals are federally protected under the U.S. Marine Mammal Protection Act (1972).

The SNMREC experimental turbine system may interact with or adversely affect marine mammals because of its location, position in the water column, and various lines, attachments and mechanisms. Further, all species of marine mammals utilize echo-locating sonar and have an acute sense of hearing, which they rely on for communication, navigation, and foraging. Because the Florida Straits are a high-volume international cargo ship channel as well as a heavily used recreational boating area, the additional background noise introduced by the SNMREC installation of a single, small unit will be insignificant[9].

[9] Baseline acoustic measurements can be obtained only after the buoy is *in situ*. It is not possible to obtain these measurements otherwise (using a boat is not feasible). Before any experimental turbine testing is begun, the acoustic

We will document the interactions of marine mammals with the installed equipment and provide context for this new information via a comprehensive literature and document search to establish a knowledge base in this area. The review and analysis will identify key areas for specific new research and monitoring in association with the turbine and platform installation.

In addition, we will conduct marine mammal population surveys in conjunction with the sea turtle surveys discussed previously. Any additional aerial surveys conducted by the NOAA National Marine Fisheries Service (NMFS, 2009) to compile U.S. Marine Mammal Stock Assessment Reports and sighting data from OBIS-SEAMAP (2009) will be also used to provide additional information on species presence and abundance in the surrounding region. In addition, stranding response data available from HBOI's participation in the NOAA SE Regional Stranding network will be evaluated as a rough measure of status and seasonal variation in marine mammal abundance. Finer-grained data regarding population parameters of cetaceans utilizing the area can be derived from individual recognition data derived from photo-identification studies. Photographic mark-recapture methods will be used to detail the geographical and temporal distribution, site fidelity, and social organization of marine mammals occurring in these waters. Vessel-based surveys will be conducted as part of SNMREC physical oceanographic measurements to assess population trends and collect baseline data on life history. Information on species-specific spatial and temporal distribution will serve as a guide to predict areas and times of concentration as well as significance for various stages in the life cycle, such as calving or mating, which may require conservation measures in relation to human activity.

Endangered and Threatened Species

The Florida Fish and Wildlife Conservation Commission list of all endangered and threatened species known to inhabit the location of the proposed activities can be found in Appendix A, Section 3.2.7 (FWCC, 2009). Endangered and threatened marine mammals and sea turtles are addressed above.

Fish and Essential Fish Habitat

Any floating structure in the ocean, whether natural (e.g., logs, seaweed rafts, jellyfish) or manmade (e.g., trash and buoys, rafts, sea-cage fish farms, boats, oil platforms) may act as a FAD, and the SNMREC mooring system may to fall into this role (e.g., Relini et al, 2000), although, as noted in Section 1.2.2b, deployments in other such fast-current regimes have not. In addition to these incidental FADs, FADs have been constructed with the main purpose of attracting fish for thousands of years (Morales-Nin, et al., 2000). In the last decade, new structures have been included in the list of potential FADs: offshore wind and current power generators. Although no direct empirical research has been conducted on their specific effects in the marine ecosystem, these wind and current power generators will, in all likelihood, act as FADs.

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environment will be characterized locally with deployed sensors. Acoustic calculations (Guerra, MS Thesis, FAU Department of Ocean and Mechanical Engineering, May 2011) show that the acoustic signature from flow-generated noise of the device is well below expected background levels across most of the frequency spectrum. The exception is at very low frequencies (<20Hz), where background levels are generally very low. These frequencies are outside the hearing/communication range of marine mammals that are generally found in the proposed area of testing.

Two hypotheses are proposed as to why fish are attracted to FADs. The meeting-point hypothesis (Freon and Dagorn, 2000) suggests that the FADs can be used as a way to increase the encounter rate between isolated individuals or small schools, in order to gain advantages in mating and/or protection. The second hypothesis, the indicator-log hypothesis (Castro et al., 2002), suggests that fish are attracted to floating objects (such as logs) since they are often indicators of areas of high productivity. They are also a direct source of food, with many small organisms attaching themselves to the surface of the FADs. The abundance of fish found near FADs is documented to be higher than in surrounding waters; however, the species richness and diversity do not differ. Fish at FADS span all stages of life, from larva to juveniles to adults.

Temporal variation documented in appearances of fish at FADs may be due to changes in season, life stage needs, or abiotic factors such as water temperature. Intertwined with both abiotic and biotic factors are the migratory patterns of certain fishes. In addition to these long-term changes, variation in visitation to FADs has also been documented on a shorter time scale.

Moreover, interactions among the visiting species may also affect the composition of a population at a FAD. Although FADs provide a small amount of juvenile fishes with protection from predators, their large aggregations at a station may bring in larger predators seeking to feed on them. The presence of such piscivorous predators cause a short term decrease in the number of small fishes. However, overall, fish that associate with FADs are more commonly juveniles.

Ecological concerns regarding the SNMREC mooring/generator system (a possible large moored FAD) include direct and indirect effects, such as fish population shifts and overpopulation, alterations in migration paths, predation rates, and decreased health of associated fish. Moreover, unreported harvest and lack of enforcement in recreational fisheries would likely worsen as fishermen learn to exploit the FADs.

Aside from problems with fishing pressures, FADs can create an "ecological trap" (Battin, 2004). As a result of a FAD's ability to attract fish and keep them resident for substantial periods of time, the structure has the potential to alter migrations patterns. The sole empirical study focused on this issue at moored FADs concluded that this was not the case for tunas in Hawaii; however, they do conclude that the FADs present create an increase in fishing pressure on the fish. At moored FADs, increased cannibalism and prey-switching to invertebrates from deep in the water column has been documented in large yellowfin tuna. Dolphinfish populations associated with moored FADs have exhibited a change in sex-ratio, with more females caught at the structures than in open water. Kingsford (1999) suggests that factors such as the type of FAD, location to shore, proximity to other FADs, and other anthropogenic and biological factors must be considered in order to attempt to determine the full ecological effects of a FAD.

In order to provide context for the degree to which the mooring/turbine system to be installed during this phase of SNMREC's program acts as a FAD, we will monitor the changes in the water column in the vicinity of the buoys and the underwater structures throughout the duration of the operations. Because the deployments are planned to be intermittent and of relatively short duration, it is unlikely that there will be long-term impacts of significance from this single deployment site, but the data gathered will be valuable for long-term assessments related to larger scale installations in the future. This activity is relevant because the area is part of a designated Essential Fish Habitat for coastal migratory pelagic species and for snapper and grouper.

It has been suggested that fish strike is a possible interaction of turbine devices with individuals. It has also been suggested that a calculation of collision forces between turbine rotors and fish would be indicative of realistic fish strike possibilities. However, the physical characteristics of both the rotor and object with which it collides, as well as details about the collision (time or distance elapsed during energy transfer) must be known in order to determine the force per-area impact at any suggested blade tip speeds. An alternative to this complicated and specialized case problem, is the considerable research available for fish mortality and strike(s) from conventional hydropower and corollary marine hydrokinetic system research, which suggests 99% (or better) survival rate for tip speeds less than 12 m/s (Amaral, 2010).

Other matters related to the designation of the region as a HAPC for deep-water corals are discussed in the benthic survey section.

Other Considerations

Although concern about long-term effects of underwater electric fields on certain marine species (notably sharks) is supported by the literature, it will be difficult during the work discussed here to quantify them. This is because of the relatively short-term periods during which fields will be generated and because, as noted previously, the equipment may act as a FAD. Thus, it will not be possible, in general, to separate attraction of E/M sensitive species to the electric fields or to the prey fish attracted by the FAD. Further study of this will be needed, and our approach is to begin this work as part of this phase of the SNMREC program with a thorough literature survey.

Interactions with stakeholder groups, as mentioned in the Executive Summary, may also be associated with the FAD nature of the equipment commercial fishing operations and sports fishing enthusiasts may also be attracted to the site. Because the permanent equipment – the mooring buoy and its anchor hardware – is not unique in any way, no unknown issues are expected. When the full suite of equipment is deployed, it will be attended, so that real-time warnings to other vessels encroaching on the site will be possible. Other stakeholder groups' issues were discussed previously (Section 1.2) as part of the site selection strategy.

The nature of the SNMREC deployment and operations discussed here is such that the risks associated with accidents are minimal. The design of the mooring buoy, which is based on the NOMAD design used for permanent NOAA meteorological buoys, is such that it will glance off ships that accidentally impact it, for example. Certain exotic combinations of circumstances could endanger protected species, and our monitoring equipment will provide an extra measure of safety in these rare situations. Overall, the design parameters of the equipment – all of it has significant design safety factors and fail-safe mechanisms built in – should prevent this. Absolute guarantees are not possible.

Power dissipation on the tender buoy via heat exchangers will be protected using common bird-deterrence strategies (roost inhibitors). As noted in the Appendix A (Section 3.2), there are no known threatened or endangered avian species in the area.

Lights and lighting are not a significant component of any project activities and will not impact marine species. No underwater lights are proposed to be installed. However, per U.S. Coast Guard Private Aids to Navigation Permit Letter serial # 08-076, the installation is required to mount three (1 second period/0.3 second flash length) all-around yellow lights as markers on the line between the MTB and a moored testing vessel (or tender platform) located 75ft, 150ft, and 225ft aft of the MTB at a 6ft height above the mean water line. These lights must have a visible range of at least 3 nautical miles. The permit additionally requires installation of a navigation light on the MTB (4 second flash period with 0.4 second flash length). This light must be an all-around style yellow with a visible range of at least 5 nautical miles. The selected light, model number FA-249 (Automatic Power), is packaged with the proposed and authorized (FCC FRN:0009279951 – application to renew pending installation authorization) Class A AIS beacon transmitter, and will be installed on a mast aboard the MTB 12ft above the mean water line. Finally, if a tender platform is used for testing, it is also required to display a fixed all-around white light with a visible distance of at least 5 nautical miles and installed at least 12ft above the mean water line.

2.5 Deployment activities

The installation of components will involve the mooring deployment, which will serve to hold everything else deployed against the current. The anchor, chain, mooring line, and mooring buoy will be deployed and then the deployment vessel will attach to the buoy to provide additional drag which will set the anchor and develop its proper holding power. Vessel position will be monitored to make sure the mooring does not drag along the seafloor, and to determine the final location of the MTB.

The anchor deployment will be accomplished from a vessel which is precisely navigated above the planned anchor location prior to anchor deployment. The buoy will be towed behind the deployment vessel, the mooring line will be laid out to the chain and anchor, and then upon reaching the deployment site, the anchor will be released, pulling the chain along with it and pulling the buoy along the surface until it becomes moored in location. This is a typical “anchor last” mooring deployment, and eliminates the need for a moored vessel to lower the anchor to the seafloor.

Given the weight of the anchor and chain, the entire mooring system will fall essentially vertically to the bottom and land in a close proximity (±~70 m) to the planned anchor location. As noted previously, the potential disturbance area of seafloor based upon this deployment method will be well less than a hectare. Anchor location will be verified with an acoustic positioning transponder installed at the anchor.

It is planned that the installation is one ship-day and decommissioning, which involves the recovery of all anchors and mooring line components, will consume up to three ship-days. Periodic maintenance (recovery of MTB and the majority of the mooring components *sans* chain and anchor) will require one ship-day for each occurrence.

2.6 Vessel, Marine Vehicle, and Aircraft Use

The table below describes proposed marine vehicle and vessel characteristics and duty for activity installation, operation, and decommissioning. There are no aircraft proposed for use executing the activities in this lease application.

Table IV: Vessels and Marine Vehicles

Name	Description	Motors	Trip frequency or duration on site	Mission Description	Type of ROV, if any, used	Onshore support
R/V Ocean Power	*Length*: 33 ft. *Beam*: 10ft. 10in. *Draft*: 16 in. *Crew*: 3 crew/5 passenger *MST*: none *No. Fuel Tanks*: 1 *Largest Fuel Tank Cap*: 260 gal.	*Main Engines*: (2) 4-stroke 4L Suzuki 300 hp outboard *Generators*: None *Hydraulic Pumps*: None	2x per day, 2-3 days each test session, 1-2x per month, 2+ years total	Crew shuttle, instrument deployment, and minor tow	NA	Port Everglades, Dania Beach, FL
R/V Lee	*Length*: 21 ft. *Beam*: 7ft. 6in. *Draft*: 8 in. *Crew*: 2 crew/4 passenger *MST*: none *No. Fuel Tanks*: 2 *Largest Fuel Tank Cap*: 40 gal.	*Main Engines*: (1) 4-stroke 3.6L Suzuki 225 hp outboard *Generators*: None *Hydraulic Pumps*: None	2x per day, 2-3 days each test session, 1-2x per month, 2+ years total	Crew shuttle and instrument deployment / tow support	NA	Port Everglades, Dania Beach, FL
M/V Thunder-force	*Length*: 85 ft. *Beam*: 26ft. *Draft*: 7ft. *Crew*: 4 crew/24 passenger *MST*: Type III *No. Fuel Tanks*: 4 *Largest Fuel Tank Cap*: 2475 gal.	*Main Engines*: (2) 12V71N Detroit *Generators*: (2) 371N Delco 30kW *Hydraulic Pumps*: (1) 100 gal. Oil Gentech	2-3 days on site each test session, 1-2x per month, years 1 and 2	Turbine support and deployment platform	NA	Port Everglades, Dania Beach, FL (as port-of-operations, Ft. Pierce, FL permanent port)
R/V F.G. Walton Smith	*Length*: 96 ft. *Beam*: 40ft. *Draft*: 5ft. 6in. *Crew*: 6 crew/14 passenger *MST*: Type III *No. Fuel Tanks*: 2 *Largest Fuel Tank Cap*: 5000 gal.	*Main Engines*: (2) QSK19 760hp Cummins *Generators*: (2) 80KW 208AC 3P *Hydraulic Pumps*: (1) 300 gal. Elec., (2) 50 gal. auxiliary (off mains)	ROV survey: 4 days min. (or more as needed) Mooring recovery: ROV support, 2 days	ROV Survey and mooring recovery; possible turbine deployment	Panther Research ROV (66"L x 41"W x 42.5"H, 2,000lb weight, 1000m depth, electro-hydraulic propulsion)	Port of Miami, Virginia Key, FL

Name	Description	Motors	Trip frequency or duration on site	Mission Description	Type of ROV, if any, used	Onshore support
M/V Richard L. Becker	*Length*: 96 ft. *Beam*: 24ft. *Draft*: 8ft. 4in. *Crew*: 5 crew/49 passenger *MST*: Type III *No. Fuel Tanks*: 5 *Largest Fuel Tank Cap*: 7000 gal.	*Main Engines*: (2) 12V71N Detroit *Generators*: (2) 371N Detroit 30KW *Hydraulic Pumps*: (1) 100 gal. 471N Detroit	Mooring deployment and recovery: 3 days ROV survey: if needed, 4 days min. (or more as needed)	Mooring deployment and recovery. Possible turbine deployment ROV Survey, if needed	Panther Research ROV (66"L x 41"W x 42.5"H, 2,000lb weight, 1000m depth, electro-hydraulic propulsion)	Port Everglades, Dania Beach, FL

Aerial surveys discussed in section 2.4 will be conducted using a Cessna M337. These surveys, however, are not dependent on this permit and will occur independently of the work conducted under permit's auspices.

2.7 Archaeological Resources

We will conduct an archeological survey to identify any submerged archaeological resources in the proposed Area of Potential Effect (APE). We will ensure that the proposed APE includes all bottom-disturbing activities (anchors, chains, mooring sites, transmissions lines, and any modifications to the proposed APE). We will follow the guidance set forth in the BOEMRE Renewable Energy Program Interim Policy to ensure that the mooring deployment is well removed from any resources.

The Straits of Florida have been a shipping channel since the mid-1500s, and innumerable vessels have passed through the general area of the proposed turbine site. Although it is unlikely that there are shipwrecks or artifacts at the exact site of the mooring, a full archaeological survey will be conducted as part of the benthic survey work discussed here. The survey will follow the guidelines as stipulated in the BOEMRE Renewable Energy Program Interim Policy, and as appropriate we will coordinate with the State Historic Preservation Officer (SHPO) / Florida Division of Historic Resources and will reveal anything of this nature in the vicinity of the mooring location. As noted previously, the anchor/chain scour area will be small (of the order of half a hectare), so avoiding sensitive sites will be a simple matter. In the unlikely event a historic site is located, appropriate measures will be taken to identify the type and extent of the site per approved methods, and the Florida SHPO and Florida Division of Historic Resources will be contacted so that any action can be coordinated with them. (Although the proposed site is outside of Florida waters, the experience of the Florida SHPO in this area would be beneficial and most likely take precedence over Federal involvement.)

2.8 Federal Law Compliance Information

The physical resources affected by the project are the Florida Current, the ocean floor, the air over and the nearby ocean over and around the turbine and buoy. The biological resources are those of the nearby ocean floor, fish, crustaceans and marine mammals, especially threatened/endangered species in the water, and sea birds. The socioeconomic and human activities which might be impacted are military activities, shipping, fishing, pleasure boating, and diving.

Impact producing factors include bottom disturbance during anchor deployment and chain drag after deployment; emissions and noise from the turbines during testing; lights and electrical emissions at installation and during test periods; possible interactions with fish, mammals, turtles, and birds during installation and testing; and the impact of periodic boat visits at schedules listed above in Section 2.5.

Table V presents a matrix in which various impact-producing factors of SNMREC deployments and operations (the columns) are matched with the potential environmental effects (the rows) to produce an *estimated* level of risk as defined by a mapping of probability of occurrence onto the level of impact. These risk levels are low or insignificant for all aspects of this activity because: the area impacted is so small; the actual operations will be of short duration, attended, and intermittent; the safety factors built into the equipment are high; and the background environment is already significantly disturbed by its serving as a major international shipping and recreational boating channel.

Affected resources and impact factors**:**

Table V: Matrix of impact-producing factors vs. affected environment.

Factors / **Environment**	Emissions	Bottom Disturbances	Noise	Traffic	Lights & E/M	Hazards	Accidents
Oceanography/Meteorology	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Bottom Sediments	N/A	L:2.3	N/A	N/A	N/A	L:2.3	L:2.3
Air and Water Quality	I	I	N/A	I	N/A	N/A	L:2.4
Noise & Visual Quality	I	I	L:2.4	I	L:2.4	N/A	N/A
Benthic Communities	N/A	L:2.3	N/A	N/A	I	N/A	L:2.3
Birds	N/A	N/A	I	I	I	N/A	N/A
Fish & Habitat	N/A	I	I	I	L:2.4	N/A	L:2.4
Sea Turtles	N/A	I	L:2.4	L:2.4	L:2.4	N/A	L:2.4
Marine Mammals	N/A	I	L:2.4	L:2.4	L:2.4	N/A	L:2.4
Threatened/Endangered Species	N/A	L:2.3	L:2.4	L:2.4	L:2.4	N/A	L:2.4
Commercial Fisheries	N/A	I	I	I	I	N/A	I
Recreational Resources	N/A	I	I	I	I	N/A	I
Archaeological Resources	N/A	L:2.7	N/A	N/A	N/A	I	I
Key: N/A=Not Applicable; I=Insignificant; L=Low Impact Numbers in Low Impact cells refer to sections in the text where the topic is discussed							

2.9 Air and Greenhouse Gas Emissions

As shown in Figure 12, the SNMREC deployment site lies within 100 km of three Class-1 Air Quality Areas. Emissions, however, will be limited to exhaust from gasoline- and diesel-powered workboat engines during their sporadic trips to and from the site and their work at the site, including deployments/removals and ROV surveys. Maximum emission estimates are quantified in the table below. These can be considered to be insignificant in the context of daily emissions from shipping in the Florida Straits and from automobile and truck traffic in the Miami-Ft. Lauderdale-West Palm Beach metropolitan area, the seventh largest in the nation. A detailed lifecycle emissions worksheet is included in Appendix C.

Table VI: Emissions

Source	Purpose	Fuel	CO_2/year (tonne)
R/V Lee	Crew shuttle, station keeping	Unleaded gas	17.4
R/V Ocean Power	Crew shuttle, station keeping	Unleaded gas	40.1
R/V Walton-Smith	ROV survey; deployment; possible prototype testing	Diesel	101.8 / 25.4[a]
M/V Becker	ROV survey; deployment; possible prototype testing	Diesel	60.5[b]
M/V Thunderforce	Prototype testing	Diesel	201.5
[a] Year 1 / Year 4 only; [b] Year 1 only			

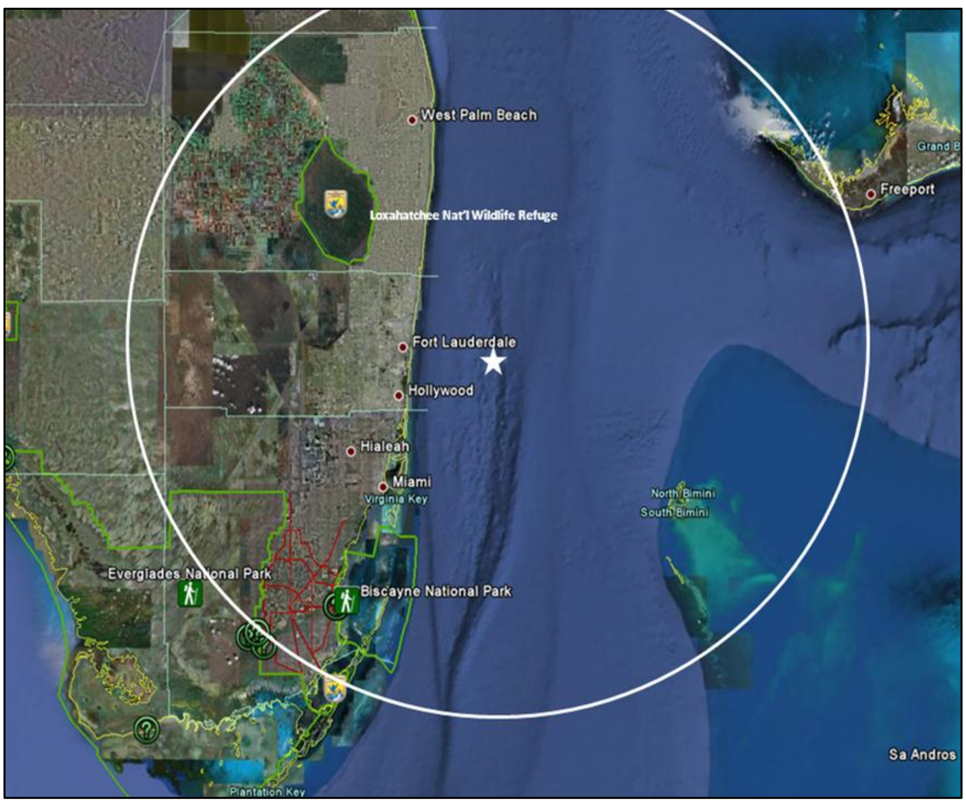

Figure 12: 100-km-radius circle about SNMREC offshore site, enclosing part of Everglades National Park and all of Biscayne National Park and the Loxahatchee National Wildlife Refuge, all Class-1 Air Quality Areas.

2.10 Noise and In-water Acoustic Levels

Expected noise and in-water acoustic levels during operations are anticipated to be minimal, well below 90dB above background, as no piling or excessive vessel noise is part of the project activities. While there will be some noise generated by the equipment during the periods of in-water testing, this will very likely be in the background of the noise generated by the shipping through the Florida Straits. Acoustic emissions will be monitored closely as part of the project's machine condition monitoring efforts to diagnose equipment behavior. Specific acoustic properties of active acoustic instruments are included as datasheets in Appendix D.

2.11 Solid and Liquid Waste

Discharges during on-site offshore operations are limited to disposal of human waste. Appropriate Marine Sanitation Devices (MSD) are installed on all deployment vessels to accommodate the treatment of human waste. Support vessels will discharge bilge water occasionally, but comply with all state and federal laws regarding those systems.

There will be four systems that require some sort of lubricant: (1) turbine pressure-compensated shaft bearing chamber, (2) hydraulic activation unit in turbine to activate mechanical shaft brakes, (3) turbine motor-generator gear box lubricant, and (4) hydraulic winch systems. The first three systems are located sub-surface within the turbine housing. All of the systems are designed to be sealed, and will not be directly exposed to the surrounding environment. However, in case of possible accidental leakage, all lubricants (for all four systems) will be specifically chosen to be environmentally-friendly and bio-degradable. Other industries have driven advances in bio-based fluid technology recently. Biodegradable/ Biobased Hydraulic Fluids will be found which use vegetable oils such as canola, rapeseed, sunflower or soybean as the base oil. The properties of these fluids are equivalent to that of mineral oil-based, anti-wear hydraulic fluid, and will be appropriately chosen for each of the four applications for this project.

In addition, all maintenance of lubricant systems will not be offshore. As the system(s) with lubricant will be ferried out to location for each deployment, any and all maintenance will be completed at port, and there is no foreseen capability planned to access any of the lubricant systems while offshore.

2.12 Avoiding, Minimizing, Reducing, or Eliminating Environmental Impacts

Minimization measures related to benthic disturbances and to the water column have been discussed in Sections 2.3 and 2.4.

Power generated by the turbine (AC voltage) will be brought to the surface via armored underwater cable, conditioned (converted to DC voltage) and then dissipated through an air-heat exchanger located on the deployment vessel (**Error! Reference source not found.**). The air-heat exchanger will be mounted away from casual human contact, well-marked, and will incorporate bird-deterrence strategies to minimize potential bird contact.

2.13 Decommissioning and Site Clearance

Decommissioning and site clearance will be in accordance with Subpart I of the Renewable Energy rule. Because the only long-term equipment at the site will be the mooring system, including the anchor, buoy, and associated hardware described in Section 2.1, decommissioning and site clearance will involve recovering the buoy and towing it back to shore, and, as noted above in Section 2.5, recovering the anchor, its chain, and related material for transport back to shore.

3 Closing Remarks

Harnessing marine renewable energy resources is not yet fully commercially viable. However, many privately and publicly funded efforts are underway to demonstrate its future potential. Exploring new frontiers often requires rigorous investigation and creative approaches, especially when the goal is to provide a net positive environmental outcome. The Southeast National Marine Renewable Energy Center is committed to expanding understanding of natural marine energy resources, the associated environment, and proposed technology. SNMREC is pioneering methods, procedures, and tools for this growing sector to address common knowledge gaps. The Center is not investing in projects to commercially produce energy, but rather enabling private developers to accelerate their own development efforts. As this research continues, all non-proprietary information collected by SNMREC will be made available to the public, agencies, and stakeholders in publication and via the web (http://snmrec.fau.edu).

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5 Appendix A: Environmental Information Required for Application

1.0. Introduction

Please see Section 1 of the application for a brief description of the project and associated activities.

1.1. Description of Site Assessment Activities

A description of site-assessment activities is provided in Sections 1.3 and 2.2 of the application.

2.0. Impact-producing Factors

Impact producing factors are discussed in Section 2.8 of the application.

2.1. Construction, Routine Operations, and Decommissioning

Construction, routine operations and decommissioning procedures are discussed in Sections 2.1, 2.5 and 2.13 are of the project application respectively.

2.1.1. Emissions

Emissions resulting from project activities are discussed in Section 2.9 of the project application.

2.1.2. Sea Bottom Disturbances

Potential sea bottom disturbances are discussed in Section 2.3.

2.1.3. Wastes and Overboard Discharges

Wastes and overboard discharges as a result of project activities are discussed in Section 2.11 of the project application.

2.1.4. Noise

Noise and in-water acoustic levels during project activities are addressed in Section 2.10 of the project application.

2.1.5. Onshore Facility Construction or Modification

Onshore facility construction or modification is not a component of the activities in this application.

2.1.6. Vessel Traffic

Vessel traffic as a result of project activities is discussed in Section 2.6 of the application.

2.1.7. Lights and Electromagnetic Forces

Lights and electromagnetic forces associated with the proposed project activities are discussed in Section 2.8 of the application.

2.2. Environmental Hazards and Accidental Events

2.2.1. Environmental Hazards

Comments on Environmental Hazards are included in Sections 2.3-2.13 of the application.

2.2.2. Accidental Events

Accidental events are discussed in Sections 2.1 of the application.

3.0. Affected Environment

3.1. Physical Resources

Physical resources are discussed in Section 2.8 of the application.

3.1.1. Physical Oceanography and Meteorology

Physical oceanography and meteorology are discussed in Section 2.8 of the application.

3.1.2. Bottom Sediments

Bottom sediments are addressed in Section 2.3 of the application.

3.1.3. Shallow Hazards

Shallow hazards are not a component of the activities covered in this application.

3.1.4. Water Quality

Water quality issues as affected by leaks, spills, and discharges are discussed in Section 2.11 (see also 2.1.3 above).

3.1.5. Air Quality

As noted in Section 2.9, air quality will not be significantly affected by activities conducted under this application.

3.1.6. Noise and Visual Quality

Noise is discussed in Section 2.10 of the project application. Visual quality both in the ocean and above the water will not be significantly affected by project activities.

3.2. Biological Resources

3.2.1. Coastal Environments and Wetlands

Coastal environments and wetlands are not applicable to this application.

3.2.2. Benthic Communities

Benthic communities are discussed in Sections 2.3 and 2.4 of the project application.

3.2.3. Coastal and Marine Birds

Coastal and marine birds are discussed in Section 2.4 of the application.

3.2.4. Fish and Essential Fish Habitat

Fish and essential fish habitat are discussed in Section 2.4 of the document.

3.2.5. Sea Turtles

Sea turtles are discussed in Section 2.4 of the document.

3.2.6. Marine Mammals

Marine mammals are addressed in Section 2.4 of the document.

3.2.7 All Endangered or Threatened Species

Below is a list of all endangered and threatened species as listed in FWCC (2009).

Endangered and threatened species are addressed in Section 2.4 of the document.

Table VII: Endangered or Threatened Species

Common name	Scientific Name	Status
REPTILES		
loggerhead sea turtle (loggerhead sea turtle)	*Caretta caretta*	T
leatherback sea turtle (leatherback sea turtle)	*Dermochelys coriacea*	E
green sea turtle (green sea turtle)	*Chelonia mydas*	E
hawksbill sea turtle (hawksbill sea turtle)	*Eretmochelys imbricata*	E
Kemp's ridley sea turtle (Kemp's ridley sea turtle)	*Lepidochelys kempii*	E
MAMMALS		
sei whale	*Balaenoptera borealis*	E
fin whale (finback whale)	*Balaenoptera physalus*	E
North Atlantic right whale (right whale)	*Eubalaena glacialis* (*Balaena glacialis* [*incl. australis*])	E
humpback whale	*Megaptera novaeangliae*	E
sperm whale	*Physeter macrocephalus*	E

3.3. Socioeconomic and Human Resources

3.3.1. Commercial Fisheries

Commercial fisheries are discussed in Section 2.8 of the document.

3.3.2. Recreational Resources

Recreational resources are discussed in Section 2.8 of the document.

3.3.3. OCS and Coastal Infrastructure

New OCS infrastructure is discussed in Section 2.1 of the document. No coastal infrastructure will be modified or impacted by these activities.

3.3.4. Land Use Patterns

Not applicable to proposed project activities.

3.3.5. Archaeological Resources

Archaeological resources in the area of the proposed activity are discussed in Section 2.7 of the document.

3.3.6. Competing Use of State Waters and OCS

Proposed project should not interfere with shipping traffic or commercial and private boating activities.

3.3.7. Demographic Patterns and Employment

Not applicable to proposed project activities.

4.0 CONSULTATIONS

A list of consultations can be found in Section 1.6 of the project application.

5.0 REFERENCES CITED

References are listed in Section 4 of the document.

6 Appendix B: Buoy and Turbine Instrumentation

Mooring buoy: The mooring and telemetry buoy (MTB) will be anchored at the site for the duration of the work discussed here.

Table VIII: MTB Sensors.

Sensor	Parameter Monitored	Location	Quantity
ADCP	Water Current Velocity	Hull Mounted on MTB	1
Leak	Conductivity Between Electrodes	MTB Hull	4
Deck Camera	Deck Security	Antenna Arch	1
Weather Station	True and Apparent Wind Speed and Direction, Barometric Pressure, Air Temperature, Wind Chill Temperature, Heading, Tilt, Rate of Turn, GPS	Antenna Arch	1
GPS	Location	Antenna Arch	1
Radar Target Enhancer	Radar Signals	Antenna Arch	1
AIS Transmitter	Navigational Hazards	Antenna Arch	1
Smoke/Heat	Smoke/Heat in MTB	MTB Hull	1
Battery Monitor	Voltage, Current, Temperature	MTB Hull	1
Solar Charge Controller	Charging Voltage, Current	MTB Hull	1
Water Turbine Charge Controller	Charging Voltage, Current	MTB Hull	1

Deployment vessel: The deployment vessel will carry an instrument van (a portable shipping container) to enable observation and control of the turbine system. It will be on-station only during operations, and attended (in the following, a PCB is a **printed circuit board** and OCDP refers to the **deployment vessel**).

Table IX: Deployment Vessel Sensors.

Sensor	Parameter Monitored	Location	Quantity
Voltage	OCDP Safety System Input Voltage	OCDP Safety System PCB	1
Current	OCDP Safety System Input Current	OCDP Safety System PCB	1
Voltage	OCDP Safety System Output Voltage to OCDP Sensors	OCDP Safety System PCB	1
Current	OCDP Safety System Output Current to OCDP Sensors	OCDP Safety System PCB	1
Voltage	OCDP Safety System Output Voltage to Turbine Safety System	OCDP Safety System PCB	1
Current	OCDP Safety System Output Current to Turbine Safety System	OCDP Safety System PCB	1
Voltage	Turbine Brake Voltage	OCDP Safety System PCB	1
Current	Turbine Brake Current	OCDP Safety System PCB	1
Digital Ambient Thermocouple	Temperature	OCDP Safety System PCB	1
Leak	Conductivity Between Electrodes	Scientific Van	1
True RMS Voltage, Current, Power	True RMS Voltage, Current, Power of Variable Frequency Drive Input	Input to Variable Frequency Drive	1
True RMS Voltage, Current, Power	True RMS Voltage, Current, Power of Variable Frequency Drive Output	Output of Variable Frequency Drive	1
Ground Fault Monitor	Insulation Resistance Level of DC Floating System	48VDC Power Bus of Variable Frequency Drive	1
Ground Fault Monitor	Insulation Resistance Level of AC Floating System	Variable Frequency Drive Output	1
DC Voltage, Current	Regenerative Braking Power	Medium DC Voltage Bus of Variable Frequency Drive	1

Turbine system: The turbine system will be deployed for limited time periods using the deployment vessel and attended during operations.

Table X: Experimental Turbine Sensors.

Sensor	Parameter Monitored	Location	Quantity
Voltage	Turbine Safety System Input Voltage	Turbine Safety System PCB	1
Current	Turbine Safety System Input Current	Turbine Safety System PCB	1
Voltage	Turbine Safety System Output Voltage to Turbine Sensors	Turbine Safety System PCB	1
Current	Turbine Safety System Output Current to Turbine Sensors	Turbine Safety System PCB	1
Voltage	Turbine Brake Voltage	Turbine Safety System PCB	1
Current	Turbine Brake Current	Turbine Safety System PCB	1
Exposed Wire Thermocouple	Temperature	Motor (2), Pressure Vessel Tube (1)	3
Air Probe Thermocouple	Temperature	Gearbox	1
Digital Ambient Thermocouple	Temperature	Turbine Safety System PCB	1
Thermistor	Water Temperature	Buoyancy Compensation Module	1
Leak	Conductivity Between Electrodes	Forward End Cap, Forward Pressure Vessel Tube, Aft End Cap, Aft Pressure Vessel Tube	4
Incremental Encoder	Speed	Gearbox Shaft	1
Three-Axis Orientation Sensor/Compass	Heading, Pitch, Roll, Three-Axis Acceleration	Buoyancy Compensation Module	1
Isolated Pressure Transducer	Depth	Buoyancy Compensation Module	1
Pressure Sensor	Ambient Pressure	Turbine Safety System PCB	1
Camera	Environmental Impacts	Turbine Pressure Vessel (4), Buoyancy Compensation Module (1)	5
HF Accelerometer	Vibration/System Imbalance	Gearbox	2
LF Accelerometer	Vibration/System Imbalance	Gearbox Shaft	4

7 Appendix C: Air Emissions Worksheet

OMB Control No. 1010-0151
OMB Approval Expires: 12/31/2011

EXPLORATION PLAN (EP)
AIR QUALITY SCREENING CHECKLIST

COMPANY	FAU
AREA	South Atlantic
BLOCK	7003, 7053, 7054
LEASE	
PLATFORM	
WELL	
COMPANY CONTACT	Susan Skemp
TELEPHONE NO.	561-297-2339
REMARKS	

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EMISSIONS FACTORS

Fuel Usage Conversion Factors	Natural Gas Turbines		Natural Gas Engines		Diesel Recip. Engine		REF.	DATE
	SCF/hp-hr	9.524	SCF/hp-hr	7.143	GAL/hp-hr	0.0483	AP42 3.2-1	4/76 & 8/84

Equipment/Emission Factors	units	PM	SOx	NOx	VOC	CO	REF.	DATE
NG Turbines	gms/hp-hr		0.00247	1.3	0.01	0.83	AP42 3.2-1& 3.1-1	10/96
NG 2-cycle lean	gms/hp-hr		0.00185	10.9	0.43	1.5	AP42 3.2-1	10/96
NG 4-cycle lean	gms/hp-hr		0.00185	11.8	0.72	1.6	AP42 3.2-1	10/96
NG 4-cycle rich	gms/hp-hr		0.00185	10	0.14	8.6	AP42 3.2-1	10/96
Diesel Recip. < 600 hp.	gms/hp-hr	1	1.468	14	1.12	3.03	AP42 3.3-1	10/96
Diesel Recip. > 600 hp.	gms/hp-hr	0.32	1.468	11	0.33	2.4	AP42 3.4-1	10/96
Diesel Boiler	lbs/bbl	0.084	2.42	0.84	0.008	0.21	AP42 1.3-12,14	9/98
NG Heaters/Boilers/Burners	lbs/mmscf	7.6	0.593	100	5.5	84	P42 1.4-1, 14-2, & 14	7/98
NG Flares	lbs/mmscf		0.593	71.4	60.3	388.5	AP42 11.5-1	9/91
Liquid Flaring	lbs/bbl	0.42	6.83	2	0.01	0.21	AP42 1.3-1 & 1.3-3	9/98
Tank Vapors	lbs/bbl				0.03		E&P Forum	1/93
Fugitives	lbs/hr/comp.				0.0005		API Study	12/93
Glycol Dehydrator Vent	lbs/mmscf				6.6		La. DEQ	1991
Gas Venting	lbs/scf				0.0034			

Sulphur Content Source	Value	Units
Fuel Gas	3.33	ppm
Diesel Fuel	0.4	% weight
Produced Gas(Flares)	3.33	ppm
Produced Oil (Liquid Flaring)	1	% weight

EMISSIONS CALCULATIONS 1ST YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT			PHONE	REMARKS					
FAU	South Atlantic	7003, 7053, 705						Susan Skemp		561-297-2339						
OPERATIONS	**EQUIPMENT**	**RATING**	**MAX. FUEL**	**ACT. FUEL**	**RUN TIME**		**MAXIMUM POUNDS PER HOUR**					**ESTIMATED TONS**				
	Diesel Engines	**HP**	**GAL/HR**	**GAL/D**												
	Nat. Gas Engines	**HP**	**SCF/HR**	**SCF/D**												
	Burners	**MMBTU/HR**	**SCF/HR**	**SCF/D**	**HR/D**	**DAYS**	**PM**	**SOx**	**NOx**	**VOC**	**CO**	**PM**	**SOx**	**NOx**	**VOC**	**CO**
MOORING INSTALLATION	DP VESSEL	1520	73.416	1761.98	8	1	1.07	4.91	36.83	1.10	8.04	0.00	0.02	0.15	0.00	0.03
	VESSELS>600hp diesel(ROV)	720	34.776	834.62	6	2	0.51	2.33	17.44	0.52	3.81	0.00	0.01	0.10	0.00	0.02
	AUXILIARY EQUIP<600hp diesel	214	10.3362	248.07	8	1	0.47	0.69	6.60	0.53	1.43	0.00	0.00	0.03	0.00	0.01
	AUXILIARY EQUIP<600hp diesel	80	3.864	92.74	12	2	0.18	0.26	2.47	0.20	0.53	0.00	0.00	0.03	0.00	0.01
TURBINE TESTING	VESSELS>600hp diesel(turbine)	720	34.776	834.62	12	24	0.51	2.33	17.44	0.52	3.81	0.07	0.34	2.51	0.08	0.55
	AUXILIARY EQUIP<600hp diesel	80	3.864	92.74	24	120	0.18	0.26	2.47	0.20	0.53	0.25	0.37	3.55	0.28	0.77
	MISC.	**BPD**	**SCF/HR**	**COUNT**												
	TANK-	0			0	0				0.00					0.00	
	OIL BURN	0			0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GAS FLARE		0		0	0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
2011	**YEAR TOTAL**						**2.91**	**10.78**	**83.25**	**3.07**	**18.14**	**0.34**	**0.75**	**6.37**	**0.37**	**1.38**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**											**399.60**	**399.60**	**399.60**	**399.60**	**17821.04**
	12.0															

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EMISSIONS CALCULATIONS 2ND YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
FAU	South Atlantic	7003, 7053, 705					Susan Skemp	561-297-2339	

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
TURBINE	PRIME MOVER>600hp diesel	720	34.776	834.62	12.00	24.00	0.51	2.33	17.44	0.52	3.81	0.07	0.34	2.51	0.08	0.55
TESTING	AUXILIARY EQUIP<600hp diesel	80	3.864	92.74	24.00	120.00	0.18	0.26	2.47	0.20	0.53	0.25	0.37	3.55	0.28	0.77
	MISC.	BPD	SCF/HR	COUNT												
	TANK-	0			0	0				0.00					0.00	
	OIL BURN	0			0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GAS FLARE		0		0	0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
2012 YEAR TOTAL							**0.68**	**2.59**	**19.91**	**0.72**	**4.34**	**0.33**	**0.71**	**6.06**	**0.36**	**1.32**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**											**399.60**	**399.60**	**399.60**	**399.60**	**17821.04**
	12.0															

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EMISSIONS CALCULATIONS 3RD YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
FAU	South Atlantic	7003, 7053, 705					Susan Skemp	561-297-2339	

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
TURBINE	PRIME MOVER>600hp diesel	720	34.776	834.62	12	24	0.51	2.33	17.44	0.52	3.81	0.07	0.34	2.51	0.08	0.55
TESTING	AUXILIARY EQUIP<600hp diesel	80	3.864	92.74	24	120	0.18	0.26	2.47	0.20	0.53	0.25	0.37	3.55	0.28	0.77
	MISC.	BPD	SCF/HR	COUNT												
	TANK-	0			0	0				0.00					0.00	
	OIL BURN	0			0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GAS FLARE		0		0	0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
2013 YEAR TOTAL							**0.68**	**2.59**	**19.91**	**0.72**	**4.34**	**0.33**	**0.71**	**6.06**	**0.36**	**1.32**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**											**399.60**	**399.60**	**399.60**	**399.60**	**17821.04**
	12.0															

EMISSIONS CALCULATIONS 4TH YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT		PHONE	REMARKS
FAU	South Atlantic	7003, 7053, 705						Susan Skemp	561-297-2339	

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
TURBINE	PRIME MOVER>600hp diesel	720	34.776	834.62	12	24	0.51	2.33	17.44	0.52	3.81	0.07	0.34	2.51	0.08	0.55
TESTING	AUXILIARY EQUIP<600hp diesel	80	3.864	92.74	24	120	0.18	0.26	2.47	0.20	0.53	0.25	0.37	3.55	0.28	0.77
	MISC.	BPD	SCF/HR	COUNT												
	TANK-	0			0	0				0.00					0.00	
	OIL BURN	0			0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GAS FLARE		0		0	0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
2014 YEAR TOTAL							**0.68**	**2.59**	**19.91**	**0.72**	**4.34**	**0.33**	**0.71**	**6.06**	**0.36**	**1.32**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**											**399.60**	**399.60**	**399.60**	**399.60**	**17821.04**
	12.0															

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EMISSIONS CALCULATIONS 5TH YEAR

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL		CONTACT	PHONE	REMARKS
FAU	South Atlantic	7003, 7053, 705					Susan Skemp	561-297-2339	

OPERATIONS	EQUIPMENT	RATING	MAX. FUEL	ACT. FUEL	RUN TIME		MAXIMUM POUNDS PER HOUR					ESTIMATED TONS				
	Diesel Engines	HP	GAL/HR	GAL/D												
	Nat. Gas Engines	HP	SCF/HR	SCF/D												
	Burners	MMBTU/HR	SCF/HR	SCF/D	HR/D	DAYS	PM	SOx	NOx	VOC	CO	PM	SOx	NOx	VOC	CO
DECOMMISSION	DP VESSEL	1520	73.416	1761.98	12	1	1.07	4.91	36.83	1.10	8.04	0.01	0.03	0.22	0.01	0.05
	VESSELS>600hp diesel(ROV)	720	34.776	834.62	12	2	0.51	2.33	17.44	0.52	3.81	0.01	0.03	0.21	0.01	0.05
	AUXILIARY EQUIP<600hp diesel	214	10.3362	248.07	24	2	0.47	0.69	6.60	0.53	1.43	0.01	0.02	0.16	0.01	0.03
	AUXILIARY EQUIP<600hp diesel	80	3.864	92.74	24	2	0.18	0.26	2.47	0.20	0.53	0.00	0.01	0.06	0.00	0.01
TURBINE TESTING	VESSELS>600hp diesel(crew)	720	34.776	834.62	12	24	0.51	2.33	17.44	0.52	3.81	0.07	0.34	2.51	0.08	0.55
	AUXILIARY EQUIP<600hp diesel	80	3.864	92.74	24	120	0.18	0.26	2.47	0.20	0.53	0.25	0.37	3.55	0.28	0.77
	MISC.	BPD	SCF/HR	COUNT												
	TANK-	0			0	0				0.00					0.00	
	OIL BURN	0			0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	GAS FLARE		0		0	0		0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00
2015 YEAR TOTAL							**2.91**	**10.78**	**83.25**	**3.07**	**18.14**	**0.35**	**0.79**	**6.71**	**0.39**	**1.46**
EXEMPTION CALCULATION	**DISTANCE FROM LAND IN MILES**											**399.60**	**399.60**	**399.60**	**399.60**	**17821.04**
	12.0															

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SUMMARY

COMPANY	AREA	BLOCK	LEASE	PLATFORM	WELL
FAU	South Atlantic	7003, 7053, 7054			

Year	Emitted		Substance		
	PM	SOx	NOx	VOC	CO
2011	0.34	0.75	6.37	0.37	1.38
2012	0.33	0.71	6.06	0.36	1.32
2013	0.33	0.71	6.06	0.36	1.32
2014	0.33	0.71	6.06	0.36	1.32
2015	0.35	0.79	6.71	0.39	1.46
Allowable	399.60	399.60	399.60	399.60	17821.04

8 Appendix D: Active Acoustic Instrument Data Sheets

TELEDYNE RD INSTRUMENTS MARINE MEASUREMENTS

Workhorse Long Ranger

75 kHz ADCP

The Name Says It All...

Long-range and long-term, the **Long Ranger** is the best choice for gathering detailed data on seasonal and annual current structure fluctuations for scientific research and offshore oil and gas applications. Hundreds of Long Ranger units are currently deployed on:

- environmental monitoring buoys
- offshore oil rigs
- polar research moorings

The highly flexible Long Ranger unit is available in three product configurations: self-contained, direct reading, or remote-head—depending on your application requirements.

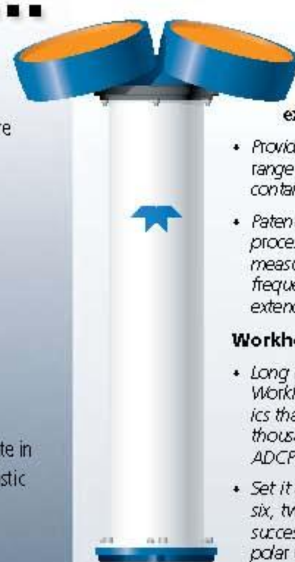
Third-party solutions

Collect data at your desk: the Long Ranger is designed to operate in real-time data mode. Third-party products are available for acoustic and radio data transfer direct to your location.

Programmable modes for deployment flexibility

Mode	High Power	Low Power
Long range	600m	434m
High precision	503m	267m

Source: Plan ADCP 2.04



Cost-effective extended capability

- *Provides the longest profiling range available from a self-contained ADCP.*
- *Patented Broadband signal processing produces precise measurement, allowing frequent sampling with extended battery life.*

Workhorse reliability

- *Long Ranger inherits the Workhorse family electronics that have been proven in thousands of Teledyne RDI ADCP applications.*
- *Set it and forget it: Three, six, twelve-month-long successful deployments from polar waters to the tropics.*

MEASURING AND MOTION IN WATER MEASURING

TELEDYNE RD INSTRUMENTS
A Teledyne Technologies Company

Workhorse Long Ranger

75 kHz ADCP

Technical Specifications

Mode (maximum power)	Depth Cell Size (m)	Std. Dev.[1] (cm/s)	Range[2,3,4] (m)
High Resolution (wide bandwidth)	*4*	*15.0*	*432*
	8	*7.6*	*465*
	16	*3.9*	*503*
	32	*2.0*	*545*
Long Range (narrow bandwidth)	*4*	*29.0*	*525*
	8	*14.6*	*560*
	16	*7.6*	*600*
	32	*3.9*	*644*

Source: Plan ADCP2.04

[1] Standard deviation is ADCP uncertainty given a single ping.
[2] Maximum range is a nominal value based on 5°C, 35ppt, and typical ocean backscatter; actual range will vary depending on environmental conditions.
[3] Assuming the ADCP is pointed vertically (0° tilt), the maximum range is limited to 94% of the distance to the surface.
[4] Assumes a power supply of 32VDC (typical average battery voltage).

Profile Parameters

Not designed for use on moving vessels

Velocity accuracy: ± 1% ± 5mm/s
Velocity resolution: 1mm/s
Velocity range: ± 5m/s default
± 10m/s max
Depth cell size: 4–32m
Number of depth cells: 1–128
Ping rate: 1Hz (typical)

Echo Intensity Profile

Vertical resolution: depth cell size
Dynamic range: 80dB
Precision: ±1.5dB (relative measure)

Transducer and Hardware

Beam angle: 20°
Beam width: 4°
Configuration: 4-beam, convex
Internal memory: Two PCMCIA card slots; one memory card included
Communications: RS-232 or RS-422; ASCII or binary output at 1200-115,200 baud.

Power

DC Input: 20–50VDC. Four internal alkaline battery packs.
Voltage: 42V DC(new) 28VDC (depleted)
Capacity Each pack @ 0°C: 450 watt hours/1800 Wh total

Standard Sensors

Pressure Sensor:
Maximum range: 2000m
Accuracy: ±5m (0.25% FS)
Temperatures (mounted on transducer):
Range: -5° to 45°C
Precision: ±0.4°C
Resolution: 0.01°

Tilt: Range: ±50°
Accuracy: ±0.5°
Precision: ±1.0°
Resolution: 0.01°

Compass (fluxgate type, includes built-in field calibration feature):
Accuracy: ±2° [5]
Precision: ±0.5° [5]
Resolution: 0.01°
Maximum tilt:±15°

[5] <±1.0° is commonly achieved after calibration

Environmental

Standard depth rating: 1500m (3000m optional)
Operating temperature: -5° to 45°C
Storage temperature without batteries: -30° to 60°C
Weight in air: SC 86kg, DR 58kg, ExtBC 39kg
Weight in water: SC 55kg, DR 36kg, ExtBC 16kg

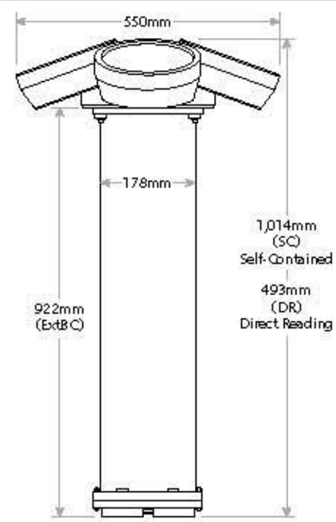
Software

Use Teledyne RDI's Windows™-based software for the best results:
- WinSC—Data Acquisition
- WinADCP—Data Display and Export
- Teledyne RDI Tools—Utilities

Available Options

- 3000m pressure-rated configuration
- External Battery Case (ExtBC)
- Remote head configurations
- Memory: 2 PCMCIA slots, total 4GB

Dimensions



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Free online product training
Free 24/7 emergency support

ORE Offshore
An Affiliate of EdgeTech

TRACKPOINT 3P

PORTABLE ULTRA SHORT BASE LINE ACOUSTIC TRACKING SYSTEM

FEATURES

- User friendly interfaces
- Calibrated for improved accuracy
- Compatible with Windows 98, NT, 2000, and XP
- Rugged and reliable
- Runs on 90 to 250 VAC
- 4 target sequential tracking

The TP3P is the most versatile low cost acoustic tracking system available anywhere. This system is manufactured to be extremely rugged for use in small boats. The TP3P packaging is both water resistant and light weight for portability. The software is user friendly and intuitive. The interface is standard RS/232 to a PC running a compatible Windows operating system. The TP3P is calibrated for exceptional accuracy.

For more information please visit ORE.com

sales@ORE.com | USA 1.508.291.0960

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TRACKPOINT 3P

PORTABLE ULTRA SHORT BASE LINE ACOUSTIC TRACKING SYSTEM

KEY SPECIFICATIONS

SYSTEM PERFORMANCE	
Transponder / Responder Absolute accuracy in horizontal position (over entire hemisphere) (does not include motion)	+/- 0.75% RMS of slant range
Repeatability Accuracy (does not include motion)	+/- 0.5% RMS of slant range
Azimuth resolution	0.1 degree
Slant range accuracy	+/- 0.3 meters RMS (with correct sound speed)
Slant range resolution	0.3 meters
Signal to noise ratio	40 dB @ WB filter
Receive frequency	22 to 30 kHz in 1 kHz increments
Transmit frequency	17 to 21 kHz in 500Hz increments (400 Watt transmit output)
Receive pulse width	1.3 milliseconds minimum
Transmit pulse width	1 to 15 milliseconds
OPERATIONAL CONTROLS VIA SUPPLIED SOFTWARE	
Target selection	Interrogation rate
Tracking On/Off	Scaling (feet, meters, yards)
Target type	Filtering levels
Receive threshold	Frequencies and pulse widths
WEIGHTS AND DIMENSIONS	
Deck Unit (4430C)	L 16 in (40.6 cm) x W 13 in (33 cm) x D 7 in (17.5 cm) 17 lbs (7.7 kg)
Hydrophone (4213C)	L 20 in (50.8 cm) diameter 2.9 in (7.4 cm) 10 lbs (4.5 kg)
Cable (4113C)	L 50 ft (15 meters) diameter .5 in (1.3 cm) 8 lbs (3.6 kg)

For more information please visit ORE.com

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DIGITAL SCIENTIFIC ECHOSOUNDERS

BioSonics, Inc. – World Leader in Digital Scientific Echosounder Technologies

DT-X

HYDROACOUSTIC ASSESSMENT SOLUTIONS

- **Fish and Marine Life**
- **Submerged Aquatic Vegetation**
- **Bottom Classification & Bathymetry**
- **Automated Monitoring Systems**

DT-X Series Features

- Rugged, weather resistant surface unit with programmable LINUX-based embedded processor
- Multiplex up to 4 transducers from a single echosounder surface unit
- Wired or wireless ETHERNET control
- Wide selection of BioSonics renowned digital transducers, split beam and single beam
- Digital, real-time, streaming, hydroacoustic data
- DGPS, integrated orientation and other external sensor inputs

Applications

- Mobile surveys to assess fish and marine life, submerged aquatic vegetation, bottom classification and bathymetry
- Fully autonomous fixed location surveys for long term assessment of fish and marine life abundance, behavior and migratory routes

BioSonics Software

- **Visual Acquisition™** for real time data acquisition, visualization, storage and playback
- **Visual Analyzer™** for fish, plankton and marine life
- **EcoSAV™** for submerged aquatic vegetation (SAV)
- **VBT™** for bottom type classification and bathymetry

Additional Analysis Software

- Echoview™
- SONAR5-Pro™
- QTC Impact™

BioSonics

Seattle, Washington, USA • 206.782.2211 • www.biosonicsinc.com

BioSonics, an authorized reseller of the Panasonic TOUGHBOOK®

DT-X Series Technical Specifications and Features

Performance Features

- System Noise Floor: Extremely quiet -140dB
- Dynamic Range: Greater than 160dB
- Ping Rates: User selectable from 0.01 to 30 pings per second
- Pulse Duration: User selectable from 0.1 to 1.0 milliseconds
- Range Settings: User selectable from 0.5 to 500 meters
- Transmit Power: User selectable from 100 to 1000 Watts rms

Dimensions

- Echosounder Surface Unit:
  49 cm X 39 cm X 19 cm - 13.6 kg
  (19 in X 15 in X 8 in - 30 lbs.)
- Digital Transducer (typical):
  18 cm diameter X 17 cm - 4kg
  (7 in diameter X 6.5 in - 9.5 lbs.)

Power Requirements

- 10-14 Volts DC or
- 85-264 Volts AC
- 30 Watt consumption

Digital Transducers

- Unique design allows acoustic data to be fully digitized within the transducer
- Wide range of frequencies for numerous fisheries and habitat assessment applications; 38, 70,120, 200, 420, &1000 kHz
- Scientific grade split beam or standard single beam
- Ultra-low side lobes to -35 dB
- Network up to four separate transducers at four distinct frequencies from a single echosounder
- Digital signal cables 8 - 160 meters (25 - 500 feet)
- Heavy duty anodized aluminum or stainless steel housings

Echosounder Surface Unit

- Portable, weather resistant case
- Fully programmable, multiple transducer, multiplexing configuration
- Wired or wireless communication with laptop computer
- Programmable LINUX-based embedded processor
- Military grade connectors
- Integrated DGPS
- Self diagnosis and calibration on start-up
- High resolution, full color echogram
- User friendly Windows touch screen interface
- Numerous, user selectable, software controlled, configuration, display and data storage options
- Integrated orientation and other external sensor inputs

Data Analysis Software Features

- Echo counting
- Target strength analysis
- Automatic bottom tracking, manual editing
- Population and biomass estimation
- EMS deconvolution
- Target tracking and behavior
- Simultaneous echo integration and target recognition
- SAV coverage, canopy height and density assessment
- Substrate classification
- Bathymetry

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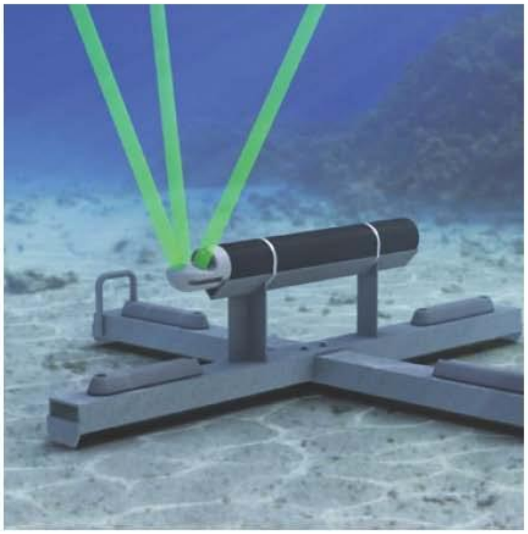
BioSonics, an authorized reseller of the Panasonic TOUGHBOOK®

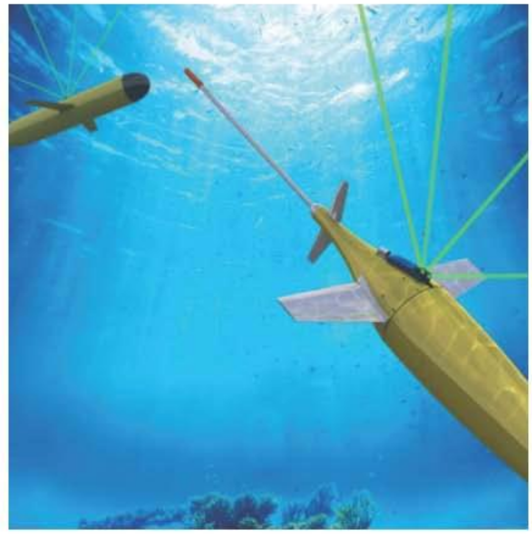
Aquadopp© Profiler

400kHz, 600kHz, 1/2MHz
with Z-Cell option

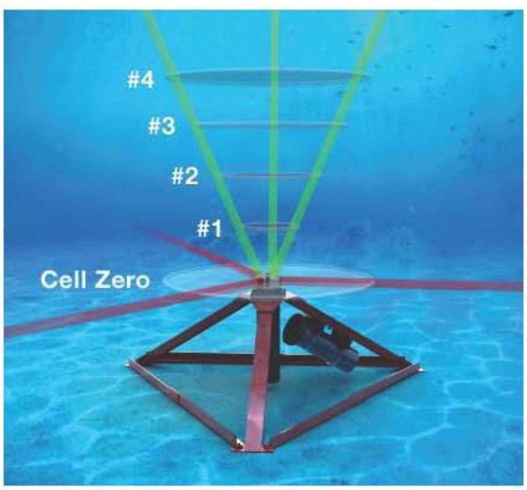
The Aquadopp® profiler measures the current profile in water using acoustic Doppler technology. It is designed for a wide range of applications and can be deployed on the bottom, on a mooring rig, buoy or on any other fixed structure. It is a complete system and includes all parts required for a self contained deployment with data stored to an internal data logger. The Aquadopp profiler is a small and lightweight profiler for use over profiling range from of 1 to 100m.

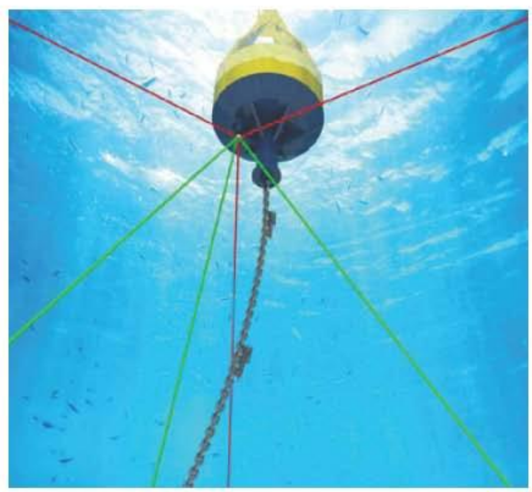


Bottom framed Aquadopp Profiler: Typical applications include coastal studies, online monitoring and scientific studies in rivers, lakes, and channels. The Aquadopp Profiler works equally well in typical ocean surface water and in the high sediment suspensions found near the coast or in rivers.



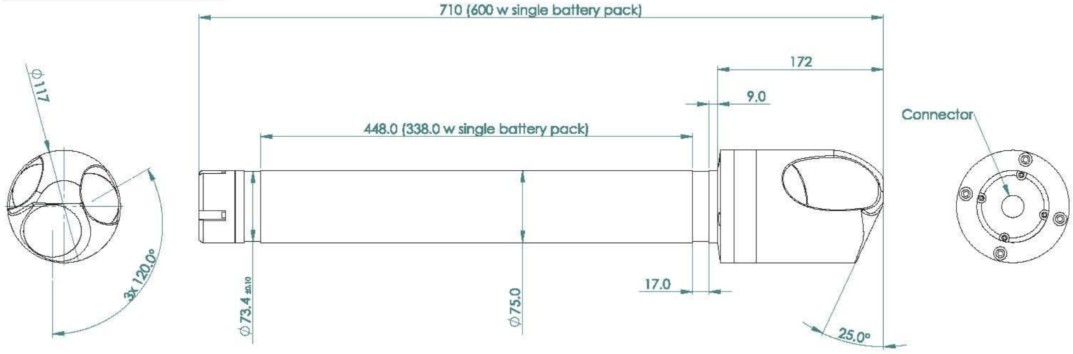
The Aquadopp current profiler can be mounted on moving structures and will measure the relative motion between the structure and the water.



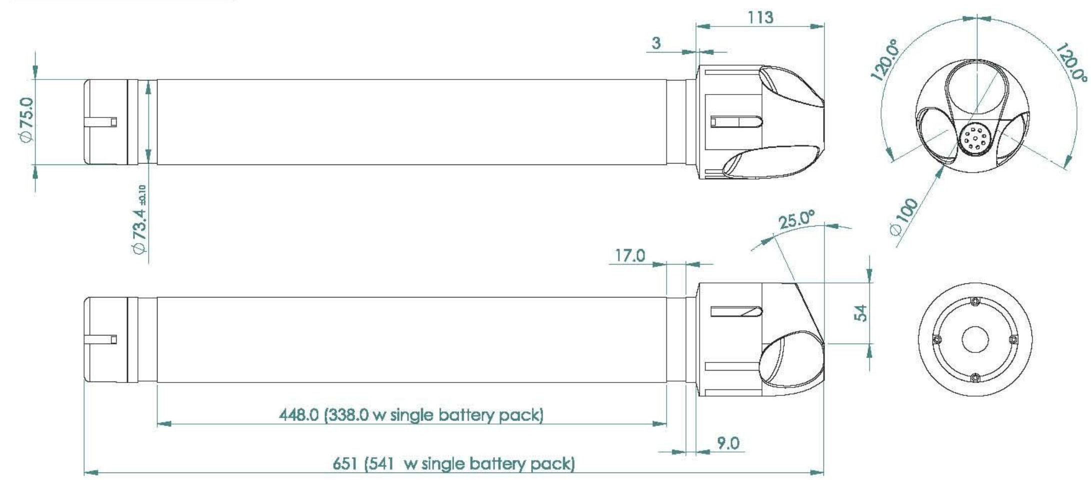


A standard current profiler cannot measure the complete profile from the bottom to the surface. Instead, it loses data close to the instrument and close to the far boundary. The Aquadopp Z-Cell extends the profiling range by introducing a «Cell Zero». The data is generated by an extra set of horizontal transducers. The transducers operate at a different frequency (2 MHz) and provide the 2D current velocity at the level of the instrument. This is to the benefit of anyone who is interested in the detailed current velocity in the boundary layer.

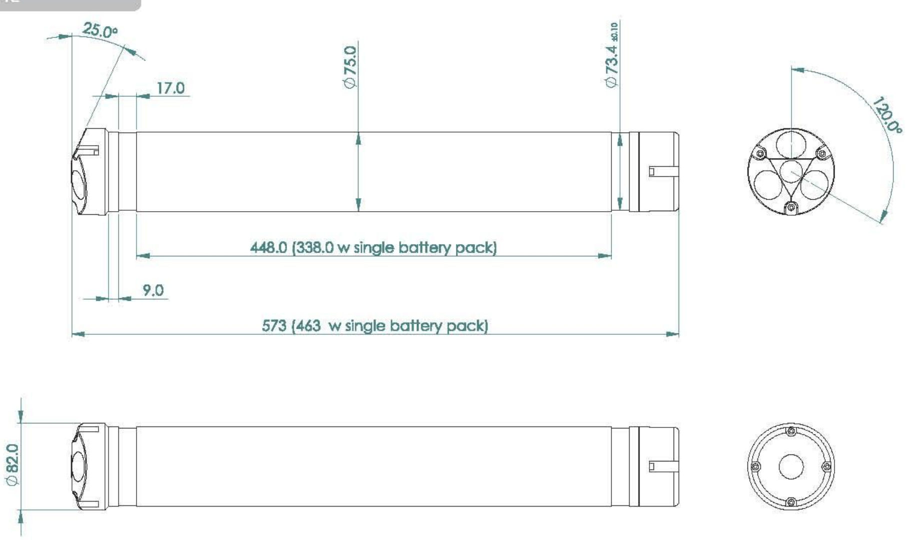
400kHz



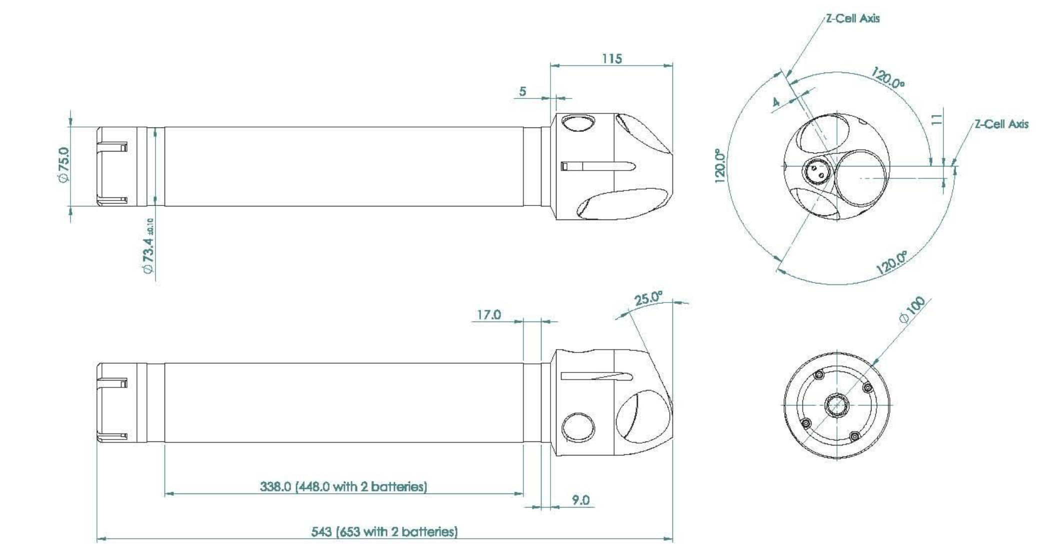
600kHz



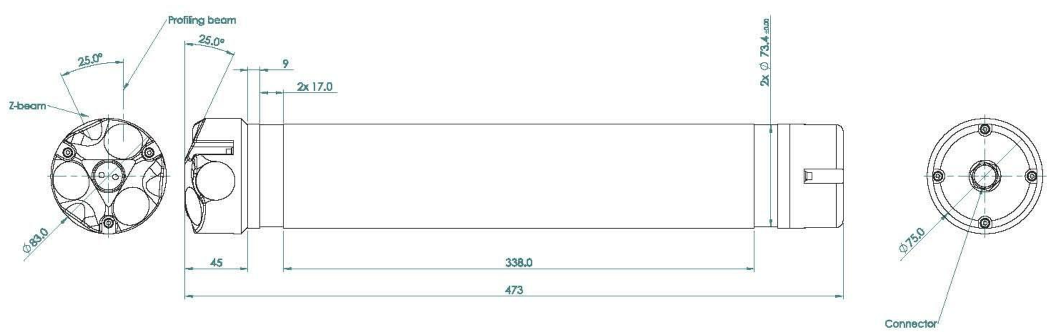
1/2 MHz



Z-Cell 600kHz



Z-Cell 1MHz



Sidelooking

All dimensions in mm.

Technical Specifications

Water velocity measurement

Acoustic frequency:	0.4MHz	0.6MHz	1.0MHz	2.0MHz
Maximum profiling range*:	60–90m	30–40m	12–20m	4–10m
Cell size:	2–8m	1–4m	0.3–4m	0.1–2m
Beam width:	3.7°	3.0°	3.4°	1.7°
Minimum blanking:	1m	0.50m	0.20m	0.05m
Number of beams:	3			
Maximum # cells:	128			
Velocity Range:	±10m/s (inquire for extended range)			
Accuracy:	1% of measured value ±0.5cm/s			
Max. Sampling rate:	1Hz			
Velocity uncertainty:	Consult software program			

*) The Aquadopp profiler measures the current profile in a user specified number of cells from the instrument out to a maximum range that depends on the acoustic scattering conditions. The lower range should be expected with clear water and small cells and the higher range with large cells and acoustically turbid water.

Cell zero (optional for 0.6MHz and 1MHz tranducers)

Cell zero acoustic frequency:	2Mz
Maximum profiling range*:	0.4-0.9m
Number of beams:	3

Echo intensity

Sampling:	Same as velocity
Resolution:	0.45dB
Dynamic range:	90dB

Standard sensors

Temperature:	Thermistor embedded
Range:	–4°C to 30°C
Accuracy/resolution:	0.1°C/0.01°C
Time response:	10 min
Compass:	Magnetometer
Accuracy/resolution:	2°/0.1° for tilt <20°
Tilt:	Liquid level
Accuracy/resolution:	0.2°/0.1°
Maximum tilt:	30°
Up or down:	Automatic detect
Pressure:	Piezoresistive
Range:	0–100m (standard)
Accuracy/resolution:	0.5%/0.005% of full scale

Analog inputs

Number of channels:	2
Voltage supply:	Three options selectable through firmware commands: •Battery voltage / 500 mA •+5V / 250 mA •+12V /100 mA
Voltage input:	0–5V
Resolution:	16 bit A/D

Data communication

I/O:	RS232, RS422. Software supports most commercially available USB–RS232 converters
Communication Baud rate:	300–115200 (baud)
Recorder download baud rate:	600/1200 k.Baud for both RS232 and RS422

Data recording

Capacity:	9 MB, can add 32/176/352/MB & 4GB Prolog
Data record:	32 bytes + 9xNcells
Mode:	Stop when full (default) or wrap mode
Software:	AquaPro
Operating system:	Windows®XP, Windows®7
Functions:	Deployment planning, data retrieval, ASCII conversion, online data collection, and graphical display

Power

DC Input:	9-15VDC
Peak current:	3A
Max average consumption at 1Hz:	0.2–1.5W
Sleep consumption:	0.0003 mW (RS232), 0.005 mW (RS422)
Transmit power:	0.3–20W, 3 adjustable levels

Real time clock

Accuracy:	+/- 1min/year
Backup in absence of power:	4 weeks

Internal batteries

Type/capacity:	18 AA Alkaline cells/50Wh
New battery voltage:	13.5VDC
Duration (10-minute avg.):	80 days for 2MHz, 0.5m cells 50 days for 1MHz, 1.0m cells

Exact battery consumption and velocity uncertainty are complex functions of the deployment configuration. Please consult the AquaPro software for more exact predictions.

Materials

Standard:	Delrin and polyurethane plastics with titanium screws
Intermediate and deepwater models:	Titanium and Delrin plastics

Connectors

Bulkhead (Impulse):	MCBH-8-FS
Cable:	PMCIL-8-MP on 10-m polyurethane cable

Environmental

Operating temperature:	–5°C to 35°C
Storage temperature:	–20°C to 60°C
Shock and vibration:	IEC 721–3–2
Depth rating:	300m

Dimensions

	0.4MHz	0.6MHz	1MHz/2MHz
Weight in air:	3.4 kg	2.9 kg	2.2 kg
Weight in water:	0.2 kg	0.4 kg	0.2 kg
Length:	see dimensional drawings		
Diameter:	see dimensional drawings		

Options

Batteries:	Lithium, Li-Io rechargeable
External batteries:	Alkaline, Lithium or Lithium Ion. See battery brochure for details
Transducer head:	Right angle head for 1 or 2MHz. Inquire for special configurations
Deep water systems:	Inquire for 3000m & 6000m versions
Communication:	Request special harness for RS422

TS-031-en-052010

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