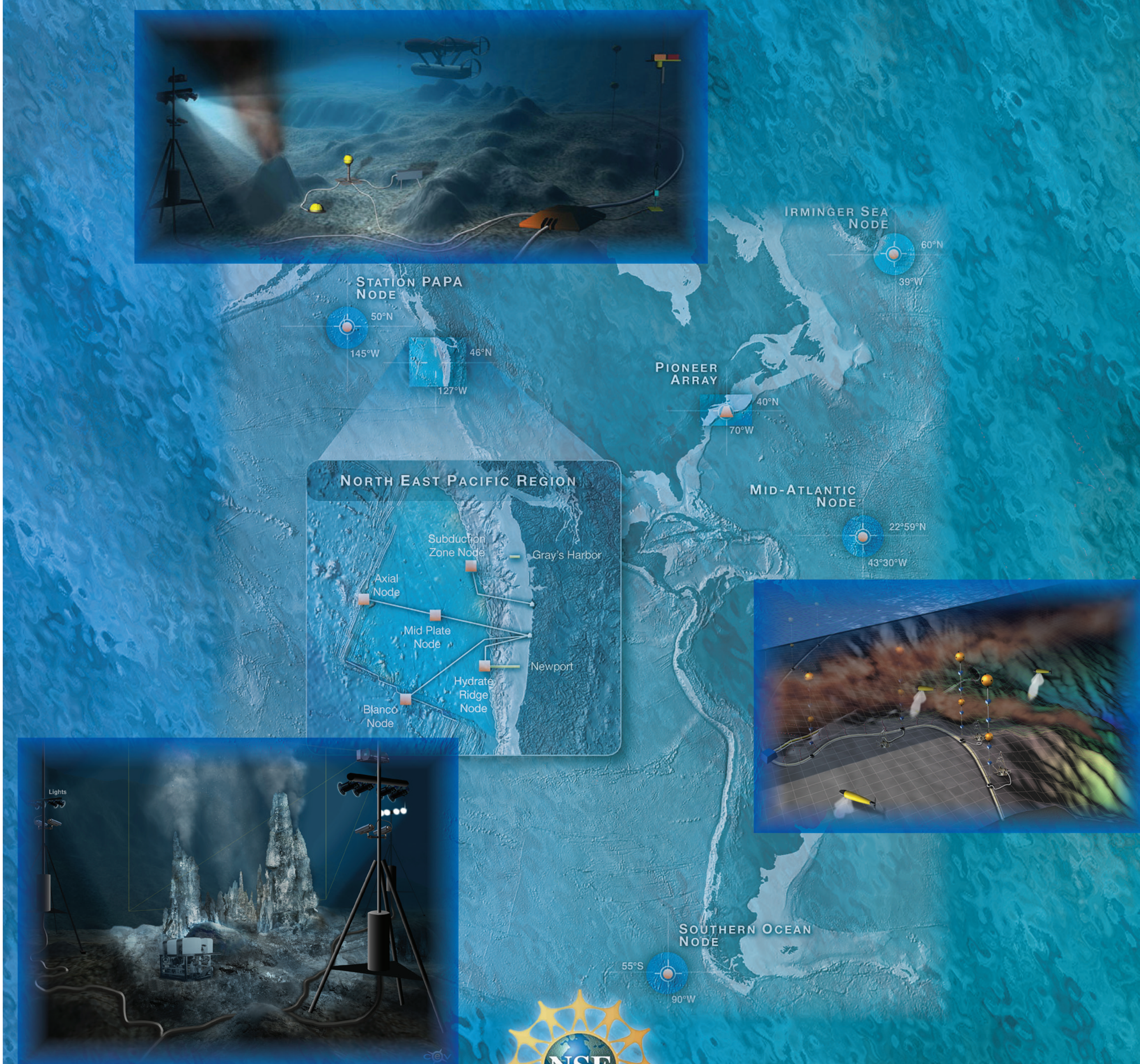
Draft

Programmatic Environmental Assessment/ for National Science Foundation-Funded Ocean Observatories Initiative (OOI)



April 2008

Acronyms and Abbreviations

~	approximately
ADCP	acoustic Doppler current profiler
ADV	acoustic Doppler velocimeter
AGM	absorbed glass mat
AWOIS	Automated Wreck and Obstruction Information System
AUV	autonomous underwater vehicle
BAP	bio-acoustic profiler
BMPs	Best Management Practices
CAA	Clean Air Act
CDR	Conceptual Design Review
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
CGSN	Coastal/Global-Scale Nodes
cm	centimeter(s)
CND	Conceptual Network Design
CO_2	carbon dioxide
CPS	Coastal Pelagic Species
CSN	Coastal-scale Nodes
CTD	conductivity-temperature-depth
CWA	Clean Water Act
CZMA	Coastal Zone Management Act
DA	Double Armored
DART	Deep-ocean Assessment and Reporting of Tsunamis
DAS	days at sea
DoN	Department of the Navy
DPS	Distinct Population Segment
EA	Environmental Assessment
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EOM	electrical-optical-mechanical
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FERC	Federal Energy Regulatory Commission
FMC	Fisheries Management Council
FMP	Fisheries Management Plan
ft	foot/feet
GSN	Global-scale Nodes
ha	hectare(s)
HAPC	Habitat Area of Particular Concern
HDD	horizontal directional drilling
HMS	Highly Migratory Species
HPIES	horizontal electrometer-pressure-inverted echosounder
ICES	International Council for the Exploration of the Sea
ICPC	International Cable Protection Committee
in	inches
IO	Implementing Organization
IODP	Integrated Ocean Drilling Program
IOOS	Integrated Ocean Observing System
Jbox	junction box
JOI	Joint Oceanographic Institutions
kg	kilogram(s)
kHz	kilohertz
km	kilometer(s)
LPJbox	low-power junction box
LVN	Low-voltage Node
LW	Lightweight
LWA	Light-wire Armored
m	meter(s)
MARS	Monterey Accelerated Research System
MBARI	Monterey Bay Aquarium Research Institute
MBES	multibeam echosounder
MFN	Multi-function Node
MHz	megahertz
MMPA	Marine Mammal Protection Act
MPJbox	medium-power junction box
MREFC	Major Research Equipment and Facilities Construction
ms	millisecond
MSA	Magnuson-Stevens Act
NANOOS	Northwest Association of Networked Ocean Observing Systems
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
nmi	nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NOTMAR	Notice to Mariners
NPDES	National Pollutant Discharge Elimination System
NRC	Natural Resources Consultants
NRHP	National Register of Historic Places
NSF	National Science Foundation
O&M	Operations and Maintenance
ODAS	Oceanographic Data Acquisitions Systems
ODEQ	Oregon Department of Environmental Quality
OFCC	Oregon Fishermen’s Cable Committee
OOI	Ocean Observatories Initiative
OrCOOS	Oregon Coastal Ocean Observing System
ORION	Ocean Research Interactive Observatory Networks
OSC	Observatory Steering Committee
PND	Preliminary Network Design
ROI	Region of Influence
ROV	remotely operated vehicle
RSN	Regional-scale Nodes
SAUP	Sea Around Us Project
SBP	sub-bottom profiler
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SOP	Standard Operating Procedure
SP	Special Applications
STAC	Science and Technical Advisory Committee
SWPPP	Storm Water Pollution Prevention Plan
TRF	trawl resistant frame
UCSD	University of California-San Diego
UNOLS	University-National Oceanographic Laboratory System
µs	microsecond
U.S.	United States
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
W	Watts
WHOI	Woods Hole Oceanographic Institution

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PROGRAMMATIC ENVIRONMENTAL ASSESSMENT

FOR THE

OCEAN OBSERVATORIES INITIATIVE

APRIL 2008

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EXECUTIVE SUMMARY

PROPOSED ACTION

This Programmatic Environmental Assessment (EA) has been prepared to analyze the potential impacts on the human and natural environment associated with the installation and operation of the Ocean Observatories Initiative (OOI). This EA has been prepared on behalf of the National Science Foundation (NSF) in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 United States Code §4321 et seq.) and the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations §§1500-1508). The NEPA process ensures that environmental impacts of proposed major federal actions are considered in the decision-making process.

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division developed the OOI from community-wide, national, and international scientific planning efforts. OOI builds upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI would be an interactive, globally distributed and integrated network of cutting-edge technological capabilities for ocean observatories. This network of sensors would enable the next generation of complex ocean studies at the coastal, regional, and global scale. OOI would complement the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked with the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System and the Global Earth Observation System of Systems.

The OOI infrastructure would include cables, buoys, deployment platforms, moorings, junction boxes, electric power generation (solar, wind, fuel cells, and/or diesel), mobile assets (i.e., autonomous underwater vehicles [AUVs] and gliders), and two-way communications systems. This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The initiative would also support related elements, such as unified project management, data dissemination and archiving, modeling of oceanographic processes, and education and engagement activities essential to the long-term success of ocean science.

The OOI design is based upon three main technical elements across global, regional, and coastal scales. At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors and use a satellite link to shore and the Internet. Up to four Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans. The Regional-scale Nodes (RSN) off the coast of Washington and Oregon would consist of seafloor observatories with various chemical, biological, and geological sensors linked with submarine cables to shore that provide power and Internet connectivity. Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon and the Pioneer Array off the coast of Massachusetts. In addition, there would be an integration of mobile assets such as AUVs and gliders with the GSN, RSN, and CSN observatories.

PURPOSE AND NEED

The OOI would build a network of sensors that would collect ocean and seafloor data at high sampling rates over years to decades. These sensors would be linked to shore using the latest communications technologies, enabling scientists to reconfigure them from their laboratories and use the incoming data in near-real time in their models. Scientists and educators from around the country, from large and small institutions, and from fields other than ocean science, would be able to take advantage of OOI's open data policy and emerging cyberinfrastructure capabilities in distributed processing, visualization, and integrative modeling.

Researchers would make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, biological, severe storm-related), to more subtle, longer-term changes or emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, ecosystem trends). Through a unifying cyberinfrastructure, researchers would control sampling strategies of experiments deployed on one part of the infrastructure in response to remote detection of events by other parts of the infrastructure. The long-term introduction of ample power and bandwidth to remote parts of the ocean by the OOI would provide the ocean science community with unprecedented access to detailed data on multiple spatial scales, studying the coastal-, regional-, and global-scale ocean, and using mobile assets (AUVs, gliders, and vertical profilers) to complement fixed-point sensors. The discoveries, insights, and the proven new technologies of the OOI effort would continuously transfer to more operationally oriented ocean-sensing systems operated by other agencies and countries. Increased ocean coverage, the growth of technical capability, development of new and more precise predictive models, and increasing public understanding of the ocean would all be tangible measures of the OOI's contribution to transforming ocean science. In this manner, OOI would play a key role in keeping the U.S. science effort at the cutting edge of ocean knowledge.

PROGRAMMATIC APPROACH

Because the OOI action would occur over several different locations across the Atlantic and Pacific oceans and would be phased in over time, it was determined that a programmatic approach would be the most efficient in terms of overall analysis. A programmatic analysis at a conceptual level of detail provides early identification and analysis of potential impacts, methods to mitigate anticipated impacts, and a strategy to address issue areas at a tiered level if necessary.

Preparing a Programmatic EA serves several purposes. First, it provides a format for a comprehensive impact analysis by taking a view of the planned OOI activities as a whole. This is accomplished by assembling and analyzing the broadest range of potential direct, indirect, and cumulative impacts associated with all proposed OOI activities in addition to other past, present, and reasonably foreseeable projects in the region of influence.

A Programmatic EA also sets up a framework for addressing the time- and location-specific aspects of the proposed OOI, as well as more detailed technical information (when it becomes available) through site-specific tiered EAs. Tiering of environmental documents in this manner makes subsequent documents of greater use and meaning to the public as the OOI and associated research develops, without duplicating paperwork and analysis from a previous assessment.

ALTERNATIVES

Numerous alternative configurations were considered for the CSN, RSN, and GSN components of the proposed OOI. As a result of extensive technical and NSF review of numerous planning and technical supporting documents, no other action alternatives to the Proposed Action emerged that would satisfy the identified purpose and need and scientific objectives and siting criteria. Consequently, only the Proposed Action and the No-Action Alternative are carried forward for analysis in this EA.

IMPACT CONCLUSIONS

Potential impacts resulting from the Proposed Action and the No-Action Alternative were analyzed for marine biological resources, geological resources, water quality, cultural resources, and socioeconomics (fisheries). No significant environmental impacts were identified with implementation of the Pioneer and Endurance arrays of the CSN, the RSN, and the GSN.

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PROGRAMMATIC EA
OCEAN OBSERVATORIES INITIATIVE

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CHAPTER 1
PURPOSE AND NEED

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1.1 PROJECT BACKGROUND

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division developed the OOI from community-wide, national, and international scientific planning efforts. OOI builds upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI would be an interactive, globally distributed and integrated network of cutting-edge technological capabilities for ocean observatories. This network of sensors would enable the next generation of complex ocean studies at the coastal, regional, and global scale. OOI would complement the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked with the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The OOI infrastructure would include cables, buoys, deployment platforms, moorings, junction boxes, electric power generation (solar, wind, fuel cells, and/or diesel), mobile assets (i.e., autonomous underwater vehicles [AUVs] and gliders), and two-way communications systems. This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The initiative would also support related elements, such as unified project management, data dissemination and archiving, modeling of oceanographic processes, and education and engagement activities essential to the long-term success of ocean science.

The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node, regional-scale cabled observatory; long-term coastal arrays coupled with AUVs and gliders; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Project Office is managed by Consortium for Ocean Leadership (Ocean Leadership) and funded through a cooperative agreement with NSF through the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

1.2 MISSION OF NSF

Established by Congress with the National Science Foundation Act of 1950 (Public Law 810507, as amended), NSF is the federal government's only agency dedicated to the support of fundamental research and education in all scientific and engineering disciplines. In accordance with the Act, NSF's mission is to "promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes." The primary roles of NSF are to support and fund the Nation's academic-based research in science and engineering, enhance the quality of education, and ensure that the U.S. maintains leadership in scientific discovery and the development of new technologies. The Act authorizes and directs NSF to initiate, support, and fund:

- basic scientific research and research fundamental to the engineering process,
- programs to strengthen scientific and engineering research potential,
- science and engineering education programs at all levels and in all fields of science and engineering,
- an information base on science and engineering appropriate for development of national and international policy,
- the interchange of scientific and engineering information nationally and internationally, and
- the development of computer and other methodologies (NSF 2006, 2008).

In particular, the research and education activities of NSF promote the discovery, integration, dissemination, and application of new knowledge in service to society and prepare future generations of scientists, mathematicians, and engineers who would be necessary to ensure America's leadership in the global marketplace. In addition, the emerging global economic, scientific, and technical environment challenges long-standing assumptions about domestic and international policy, requiring NSF to play a more proactive role in sustaining the competitive advantage of the U.S. through superior research capabilities (NSF 2006, 2008).

1.3 COASTAL, REGIONAL, AND GLOBAL SCALES OF OOI

The OOI design is based upon three main technical elements across global, regional, and coastal scales. At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors and use a satellite link to shore and the Internet. Up to four Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1-1). The Regional-scale Nodes (RSN) off the coast of Washington and Oregon would consist of seafloor observatories with various chemical, biological, and geological sensors linked with submarine cables to shore that provide power and Internet connectivity. Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon and the Pioneer Array off the coast of Massachusetts. In addition, there would be an integration of mobile assets such as AUVs and gliders with the GSN, RSN, and CSN observatories. A more detailed discussion of the GSN, RSN, and CSN and associated infrastructure and assets is provided in Chapter 2.

Figure 1-1
Geographic Locations of the Proposed OOI Infrastructure

1.4 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.4.1 Purpose of the Proposed Action

Physical, geological, chemical, and biological processes interact in the ocean, at the seafloor, and at the air-sea interface in complex ways, strongly influencing everything on Earth. This complex ocean system modulates climate, absorbs greenhouse gases, liberates significant amounts of oxygen, significantly influences rainfall and temperature patterns on land, fuels coastal storms, produces major energy and raw-material resources, and supports the largest biosphere on Earth. Ship-based expeditionary research and satellite imagery continue to contribute enormously to our knowledge of the ocean system, but they are restricted by spatial and temporal limitations and many critical ocean phenomena remain unexplored.

The ocean is a challenging environment for collecting data. It is opaque to radio frequencies, it is corrosive, it exerts tremendous pressure at depth, it harbors marine life that fouls sensor surfaces, it can destroy mechanical structures, and most of its volume is not readily accessible and is far from shore-based power sources and signal cables. At present, most ocean scientists still cannot access their *in situ* data in near-real time because of power and communication constraints, requiring them to study events that, at best, occurred months previous. In some locations, such as high latitudes, scientists still lack the capability to deploy long-term moorings that collect data from the sea surface to the seafloor.

The OOI would meet these challenges by building a network for sensors that would collect ocean and seafloor data at high sampling rates over years to decades. These sensors would be linked to shore using the latest communications technologies, enabling scientists to reconfigure them from their laboratories and use the incoming data in near-real time in their models. Scientists and educators from around the country, from large and small institutions, and from fields other than ocean science, would be able to take advantage of OOI's open data policy and emerging cyberinfrastructure capabilities in distributed processing, visualization, and integrative modeling.

Researchers would make simultaneous, interdisciplinary measurements to investigate a spectrum of phenomena including episodic, short-lived events (tectonic, volcanic, biological, severe storm-related), to more subtle, longer-term changes or emergent phenomena in ocean systems (circulation patterns, climate change, ocean acidity, ecosystem trends). Through a unifying cyberinfrastructure, researchers would control sampling strategies of experiments deployed on one part of the infrastructure in response to remote detection of events by other parts of the infrastructure. Distributed research groups can form virtual collaborations to collectively analyze and respond to ocean events in near real time. The long-term introduction of ample power and bandwidth to remote parts of the ocean by the OOI would provide the ocean science community with unprecedented access to detailed data on multiple spatial scales, studying the coastal-, regional-, and global-scale ocean, and using mobile assets (AUVs, gliders, and vertical profilers) to complement fixed-point sensors.

The OOI would provide the opportunity to make groundbreaking advances in our understanding of critically important global oceanographic processes by funding the needed transformative observatory infrastructure. Each of the OOI's coastal, regional, and global elements would provide revolutionary ocean-observing capabilities capitalizing on cutting-edge technologies including:

- high-bandwidth, two-way communication with advanced sensors in the remote open ocean;
- continuous measurements of physical, chemical, and biological properties with durations of decades;
- advanced profiling moorings;

- delivery of high power to instruments in the water column or on the seafloor;
- seafloor cabled networking arrays of ocean bottom instruments to a central mooring; and
- autonomous vehicles (gliders and AUVs) capable of adaptive sampling and responding to episodic events in the presence of multi-scale processes.

Copper and electical-optic cable installed across a tectonic plate would supply continuous power and communications to commandable, multidisciplinary instrument suites. A combination of moorings and mobile samplers (gliders and AUVs) would collect high-resolution, time-series data at the complicated boundary between coastal and deep-ocean regimes on both the west and east coasts of the U.S. Moored observatories stationed in the high northern and southern latitude oceans would record information critical to understanding ocean-atmosphere interactions, and ocean dynamics and biogeochemistry. The OOI cyberinfrastructure would make available the distributed observing assets to all users in near-real time.

The use of large numbers of interconnected, space- and time-indexed, remote, interactive, fixed, and mobile assets by a global user community, collaborating through the Internet and Internet-enabled software, represents the most fundamental shift in oceanic investigative infrastructure since the arrival of satellites. It would induce major changes in funding strategies, the community structure, the nature of collaborations, the style of modeling and data assimilation, the approach of educators to environmental sciences, the manner in which the scientific community relates to the public, and the recruitment of young scientists. The discoveries, insights, and the proven new technologies of the OOI effort would continuously transfer to more operationally oriented ocean-sensing systems operated by other agencies and countries. Increased ocean coverage, the growth of technical capability, development of new and more precise predictive models, and increasing public understanding of the ocean would all be tangible measures of the OOI's contribution to transforming ocean science. In this manner, OOI would play a key role in keeping the U.S. science effort at the cutting edge of ocean knowledge.

1.4.2 Need for the Proposed Action

1.4.2.1 Advancing Ocean Science Research

The proposed OOI Network would provide the necessary infrastructure to advance research in the following areas:

Ocean-Atmosphere Exchange. Quantifying the air-sea exchange of energy and mass, especially during high winds, is critical to providing estimates of energy and gas exchange between the surface and deep ocean, and improving the predictive capability of storm forecasting and climate-change models. Conventional technology has been unable to support observations under high wind conditions.

Climate Variability, Ocean Circulation, and Ecosystems. Being a reservoir and distributor of heat and carbon dioxide, the ocean modifies and is affected by climate. Understanding how climate variability affects ocean circulation, weather patterns, the ocean's biochemical environment, and marine ecosystems is an important driver for multidisciplinary observations.

Turbulent Mixing and Biophysical Interactions. Mixing occurs over a broad range of scales and plays a major role in transferring energy, materials, and organisms throughout the world's oceans. It has a profound influence on primary productivity, plankton community structure, biogeochemical processes in the surface and deep ocean, and the transport of material to the deep ocean. Quantifying mixing is essential to improving models of ocean circulation and ecosystem dynamics.

Coastal Ocean Dynamics and Ecosystems. Understanding the spatial and temporal complexity of the coastal ocean is a long-standing challenge. Quantifying the interactions between atmospheric and terrestrial forcing, and coupled physical, chemical, and biological processes, is critical to understanding the role of coastal margins in the global carbon cycle and developing strategies for coastal resource management in a changing climate.

Plate-Scale, Ocean Geodynamics. Movements and interactions at plate boundaries at or beneath the seafloor are responsible for short-term events like earthquakes, tsunamis, and volcanic eruptions. These tectonically active regions are also host to the densest hydrothermal and biological activity in the ocean basins. The degrees to which active plate boundaries influence the ocean from a physical, chemical, and biological perspective are largely unexplored.

1.4.3 Summary

The overall goal of the OOI is to provide a sustained, adaptable infrastructure at selected sites spanning representative processes that are globally significant, expressed locally or regionally, and addressable using new modes of investigation. Among the assets of the OOI is the creativity that would emerge from members of the science community as they embrace and apply these new tools. In addition to the suite of opportunities enabled by the infrastructure, advances would come about partly as a result of influences and developments outside the field of oceanography. The use of a large network of space- and time-indexed, interactive assets connected to a global user community via Internet-enabled tools represents a fundamental shift in oceanic investigative philosophy and capability.

By selecting critical locations at high latitude (i.e., GSN), where extremes of surface forcing result in major transport of volatiles and heat within and between the ocean and the atmosphere, the OOI would open new arenas for crucially important, long-term studies and longer range forecasting tied to these instrument-hostile environments. By selecting contrasting east and west coast continental shelf-slope environments (i.e., CSN), the OOI would begin to address questions spanning the full horizontal and vertical scales of these coastal systems including the impact of climate variability on coastal ecosystems and the role of the coastal ocean in the global carbon and biogeochemical cycles. At a regional scale (i.e., RSN), the OOI would include an entire tectonic plate below the divergence of the current between two major oceanic gyres and a productive eastern boundary current. In this regional setting there is a unique opportunity to assess simultaneously major plate tectonic processes and their effects on the overlying ocean, while documenting interannual and decadal forcing of regime shifts that reflect global-scale phenomena.

As the system matures and becomes more extensive and adaptable, users would experience ocean processes as they unfold in real time, using multiple, selectable, *in situ* data streams. Users would follow entire three-dimensional events or phenomena evolving through space and time. Success of the OOI would induce major changes in our scientific interactions, in the complexity of our investigations, and in our style of data assimilation and model development. The technologies would transform our abilities to capture and understand transient and long-term changes. The program would invigorate the public's ability to share in discoveries, insights, and excitement about understanding the ocean.

1.5 PROGRAMMATIC APPROACH

Because the OOI action would occur over several different locations across the Atlantic and Pacific oceans and would be phased in over time, it was determined that a programmatic approach would be the most efficient in terms of overall analysis. A programmatic analysis at a conceptual level of detail provides early identification and analysis of potential impacts, methods to mitigate anticipated impacts, and a strategy to address issue areas at a tiered level if necessary.

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1.6 SUMMARY OF KEY FEDERAL ENVIRONMENTAL COMPLIANCE REQUIREMENTS

1.6.1 National Environmental Policy Act (NEPA) (42 USC 4321 *et seq*.)

NEPA requires federal agencies to take into consideration the potential environmental consequences of proposed actions in their decision-making process. The intent of NEPA is to consider impacts on the environment through informed federal decision making. The CEQ was established under NEPA to implement and oversee federal processes and through *Regulations for Implementing Procedural Provisions of the National Environmental Policy Act* (40 CFR §1500-1508). These regulations specify that an EA:

- briefly provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement (EIS) or a Finding of No Significant Impact (FONSI);
- aid in an agency's compliance with NEPA when no EIS is necessary; and
- facilitate the preparation of an EIS when one is necessary.

1.6.2 Coastal Zone Management Act (CZMA) (16 USC 1451 *et seq*.)

The CZMA requires that "any federal activity within or outside of the coastal zone that affects any land or water use or natural resource of the coastal zone" shall be "consistent to the maximum extent practicable with the enforceable policies" of a state's coastal zone management plan. Federal agencies, prior to carrying out activities, must comply with the "consistency" regulations of the CZMA promulgated by the Secretary of Commerce. These regulations set forth the procedures that federal agencies must follow to coordinate with coastal states prior to carrying out activities that are reasonably likely to affect coastal uses or resources within a state's coastal zone.

1.6.3 Clean Water Act (CWA), Sections 401 and 404 (33 USC 1251 *et seq*.)

The CWA is the primary Federal law that protects the nation's waters, including lakes, rivers, aquifers, and coastal areas. The primary objective of the CWA is to restore and maintain the integrity of the nation's waters. Jurisdictional waters of the U.S. are regulated resources and are subject to Federal authority under Section 404 of the CWA. This term is broadly defined to include navigable waters (including intermittent streams), impoundments, tributary streams, and wetlands. Areas meeting the waters of the U.S. definition are under the jurisdiction of the U.S. Army Corps of Engineers (USACE). Anyone proposing to conduct a project that requires a Federal permit or involves dredging or fill activities that may result in a discharge to U.S. surface waters and/or waters of the U.S. is required to obtain a

CWA Section 401 Water Quality Certification, verifying that the project activities would comply with state water quality standards.

1.6.4 Rivers and Harbors Act, Section 10 (33 USC 401 *et seq.*)

Section 10 of the Rivers and Harbors Act of 1899 regulates structures or work in or affecting navigable waters of the U.S. Structures include any pier, wharf, bulkhead, etc. Work includes dredging, filling, excavation, or other modifications to navigable waters of the U.S. The USACE is authorized to issue permits for work or structures in navigable waters of the U.S.

1.6.5 National Historic Preservation Act (NHPA) of 1966 (16 USC 470 *et seq*.)

The NHPA established historic preservation as a national policy and defined it as the protection, rehabilitation, restoration, and reconstruction of districts, sites, buildings, structures, and objects that are significant in American history, architecture, archaeology, or engineering. Section 106 of the Act requires Federal agencies to take into account the effects of their undertakings on historic properties that are potentially eligible for listing on the National Register of Historic Places (NRHP).

1.6.6 Magnuson-Stevens Act (MSA) (16 USC 1801-1882)

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act or MSA) established U.S. jurisdiction from the seaward boundary of the coastal states out to 200 nmi for the purpose of managing fisheries resources. The MSA is the principal federal statute that provides for the management of marine fisheries in the U.S. The purposes of the MSA include: (1) conservation and management of the fishery resources of the U.S.; (2) support and encouragement of international fishery agreements; (3) promotion of domestic commercial and recreational fishing; (4) preparation and implementation of Fishery Management Plans; (5) establishment of Regional Fishery Management Councils; (6) development of fisheries which are underutilized or not utilized; and (7) protection of Essential Fish Habitat (EFH).

EFH is defined as those waters and substrate necessary to fish or invertebrates for spawning, breeding, feeding, or growth to maturity. Areas designated as EFH contain habitat essential to the long-term survival and health of U.S. fisheries. Under provisions of the MSA, eight Regional Fishery Management Councils were established for the New England, Mid-Atlantic, South Atlantic, Caribbean, Gulf of Mexico, Pacific, Western Pacific, and North Pacific regions.

Federal agencies that authorize, fund, or undertake actions that may adversely affect EFH must consult with the Secretary of Commerce, through the National Marine Fisheries Service (NMFS), regarding potential effects to EFH, and NMFS must provide conservation recommendations. To carry out this mandate efficiently, NMFS typically combines EFH consultations with existing environmental reviews required by other laws, so almost all of the consultations are completed within the time frames of those other reviews. The MSA reiterates that the Councils may, or in the case of anadromous fisheries must, comment on federal or state actions that affect fishery habitat, including EFH. Federal agencies are required to respond in writing within 30 days of receiving EFH conservation recommendations from NMFS or the Councils. This Programmatic EA would be used by NSF to consult on EFH as required by the MSA.

1.6.7 Marine Mammal Protection Act (MMPA) (16 USC 1431 *et seq.*)

The MMPA of 1972 protects marine mammals by strictly limiting their "taking" in waters or on lands under U.S. jurisdiction, and on the high seas by vessels or persons under U.S. jurisdiction. The term "take," as defined in Section 3 (16 USC 1362) of the MMPA and its implementing regulations, means "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The term "harassment" was further defined in the 1994 amendments to the MMPA as any act of pursuit, torment, or annoyance, at two distinct levels:

- Level A Harassment – potential to injure a marine mammal or marine stock in the wild.
- Level B Harassment – potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of natural behavior patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

The incidental, but not intentional, taking of marine mammals by U.S. citizens is allowed if certain findings are made and regulations are issued.

1.6.8 Endangered Species Act (ESA) (16 USC 1531 *et seq.*)

The ESA of 1973 and subsequent amendments provide for the conservation of threatened and endangered species of animals (including some marine mammals) and plants, and the habitats in which they are found. The ESA prohibits jeopardizing endangered and threatened species or adversely modifying critical habitats essential to their survival. Section 7 of the ESA requires consultation with NMFS and the U.S. Fish and Wildlife Service (USFWS) to determine whether any endangered or threatened species under their jurisdiction may be affected by a proposed action. Generally, the USFWS manages land and freshwater species while NMFS manages marine species, including anadromous salmon. However, the USFWS has responsibility for some marine animals such as nesting sea turtles, walruses, polar bears, sea otters, and manatees.

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CHAPTER 2
DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

As early as 1988, the ocean sciences community began discussions about the science, design concepts, and engineering of ocean research observatories. In 1997, NSF funded the Dynamics of Earth and Ocean Systems (DEOS) committee to provide a focus for exploratory planning and to formulate advice on technical specifications and management issues for an ocean observatory network. This committee emphasized two technical approaches and the proposed OOI design developed from these two main technical directions: 1) seafloor observatories linked with submarine cables to land that provide power and Internet connectivity, and 2) buoy observatories that provide locally generated power to seafloor and platform instruments and use a satellite link to land and the Internet. A third technical element, integration of mobile assets such as AUVs and gliders, also emerged during program planning. The community developed these ideas simultaneously, and NSF supported them through numerous related projects and workshops. These activities led to the vision of three observatory scales – coastal, regional, and global – within one distributed, integrated network. Two National Research Council reports (2000, 2003) and more than a dozen nationally circulated science and technical reports reflect broad community involvement in this initiative. In 2000, the National Science Board, the highest-level oversight committee for the NSF, approved the OOI as a MREFC account project.

Numerous workshops were held that have provided the forum for the interchange of ideas, proposals, and refinements to the OOI design process (Table 2-1). In addition, there have been many committee and *ad hoc* team reviews of preliminary design plans, infrastructure plans, Conceptual Network Designs (CNDs), and white papers covering all aspects of the proposed OOI network. Based on these workshops, preliminary design plans, etc., criteria were developed that provided guidance as to what sites or configurations for the OOI would effectively meet the scientific, logistical, and financial requirements and goals of the OOI Network. The following discussion provides a history of the selection of the current configuration of the proposed OOI, including a summary of alternative configurations that were considered but, for reasons identified, were not carried forward for analysis, and the associated scientific and logistical rationale for the proposed configuration analyzed in this Programmatic EA (i.e., the Proposed Action).

2.1 OOI PROJECT HISTORY AND ALTERNATIVES CONSIDERED BUT NOT CARRIED FORWARD FOR ANALYSIS

In 2004, a cooperative agreement was awarded to the Joint Oceanographic Institutions (JOI) by NSF's Division of Ocean Sciences for the purpose of establishing an OOI Project Office to coordinate OOI planning and design activities. At this time, the OOI project was also known as the Ocean Research Interactive Observatory Networks (ORION). The ORION name was coined by the research community as part of a vision for an OOI network and a linked research program. Early in 2007, NSF and JOI replaced the ORION project name (to avoid confusion with the NASA's new space shuttle named Orion) with OOI.

In 2005, JOI issued a Request for Assistance (RFA) to the ocean research community soliciting ideas for conceptual science experiments that could not be addressed by traditional oceanographic techniques. Applications in the form of detailed conceptual proposals for ocean science research experiments using the OOI were sought by the then ORION Project Office, in coordination with NSF. The science was to address priority areas as described in the OOI Science Plan (ORION Executive Steering Committee 2005). Highly rated proposals were used to further refine the concept of the OOI.

Table 2-1. Summary of Major Workshops and Associated Documents Related to the Development of the Proposed OOI

Date	*Workshop and/or Report*
1988	Workshop on Broad-Band Downhole Seismometers in the Deep Ocean, 26-28 April 1988, Woods Hole, MA. http://www.joiscience.org/usssp/workshops/downhole_seis.
1990	Chave, A.D., R. Butler, and T.E. Pyle, eds. 1990. Workshop on Scientific Uses of Undersea Cables. Joint Oceanographic Institutions, Washington, DC.
1995	Purdy, G.M. and J.A. Orcutt, eds. 1995. Broadband seismology in the oceans - Towards a five-year plan. Prepared for Ocean Seismic Network/Joint Oceanographic Institutions, Inc., Washington, DC.
1999	UNESCO. 1999. First International Conference on the Ocean Observing System for Climate (OceanObs99). Intergovernmental Oceanographic Commission Report IOC/INF-1137. 18-22 October 1999, St. Raphael, France. http://unesdoc.unesco.org/images/0012/001205/120594Eo.pdf.
	DEOS Global Working Group. 1999. Moored Buoy Ocean Observatories Report. December. http://orionprogram.org/PDFs/DEOS_Global_Buoy_Rpt.pdf.
2000	R. Detrick, D. Frye, J. Collins, J. Gobat, M. Grosenbaugh, R. Petitt, A. Plueddeman, K. von der Heydt, B. Wooding, J. Orcutt, J. Berger, R. Harriss, F. Vernon. J. Halkyard, and E. Horton. 2000. DEOS Moored Buoy Ocean Observatory Design Study. http://obslab.whoi.edu/buoy.html.
2002	Ocean.US. 2002. An Integrated and Sustained Ocean Observing System (IOOS) for the United States: Design and Implementation. Workshop, 23 May 2002, National Office for Integrated and Sustained Ocean Observations, Arlington, VA. http://www.ocean.us/documents/docs/FINAL-ImpPlan-NORLC.pdf.
	Office of Naval Research/Marine Technology Society Buoy Workshop. 9-11 April 2002, Seattle, WA. http://www.whoi.edu/buoyworkshop/2002/program_final.html.
	Jahnke, R., L. Atkinson, J. Barth, F. Chavez, K. Daly, J. Edson, P. Franks, J. O'Donnell, and O. Schofield. 2002. Coastal Ocean Processes and Observatories: Advancing Coastal Research. Coastal Ocean Processes (CoOP) Report No. 8. Skidaway Institute of Oceanography Technical Report TR-02-01. Report on the CoOP Observatory Science Workshop, 7-9 May 2002, Savannah, GA. November. http://www.skio.peachnet.edu/research/coop/materials/COS_report.pdf.
2003	Glenn, S.M. and T.D. Dickey, eds. 2003. SCOTS: Scientific Cabled Observatories for Time Series. NSF Ocean Observatories Initiative Workshop, 26-28 August 2002, Portsmouth, VA. http://www.geo-prose.com/projects/pdfs/scots_rpt_6.20.03.pdf.
	Rudnick, D.L. and M.J. Perry, eds. 2003. ALPS: Autonomous and Lagrangian Platforms and Sensors. Report on the Workshop held 31 March-2 April 2003, La Jolla, CA. http://www.geo-prose.com/ALPS/alps_rpt_12.16.03.pdf.
	Jahnke, R., J. Bane, A. Barnard, J. Barth, F. Chavez, H. Dam, E. Dever, P. DiGiacomo, J. Edson, R. Geyer, S. Glenn, K. Johnson, M. Moline, J. O'Donnell, J. Oltman-Shay, O. Persson, O. Schofield, H. Sosik, and E. Terrill. 2003. Coastal Observatory Research Arrays: A Framework for Implementation Planning. Coastal Ocean Processes (CoOP) Program Report No. 9. Skidaway Institute of Oceanography Technical Report TR-03-01. Report on the CoOP CORA Workshop, 12-13 November 2003, Chicago, IL. http://www.skio.peachnet.edu/research/coop/cora.php.
	Howe, B.M., A.M. Baptista, J.A. Barth, E.E. Davis, J.K. Horne, S.K. Juniper, R.M. Letelier, S.E. Moore, J.D. Parsons, D.R. Toomey, A.M. Tréhu, M.E. Torres, and N.L. Penrose. 2003. Science Planning for the NEPTUNE Regional Cabled Observatory in the Northeast Pacific Ocean. Report of the NEPTUNE Pacific Northwest Workshop, 23-24 April 2003, Portland State University, Portland, OR.
	JOI/USSSP and NEPTUNE. 2003. Workshop on Linkages between the Ocean Observatories Initiative and the Integrated Ocean Drilling Program, 17-18 July 2003, University of Washington, Seattle, WA. Final Version–23 December. http://www.neptune.washington.edu/pub/workshops/IODP_OOI/.
	RECONN: REgional Cabled Observatory Network (of Networks). Report of the Cabled Regional Observatory Workshop, 7-10 October 2003, San Francisco, CA. March. http://www.geo-prose.com/cabled_wksp/.

Table 2-1. Summary of Major Workshops and Associated Documents Related to the Development of the Proposed OOI

Date	*Workshop and/or Report*
2004	ORION: Ocean Research Interactive Observatory Networks. A Report of the Workshop held 4-8 January 2004, San Juan, PR. http://www.joiscience.org/ocean_observing/workshops/SanJuan.
	NEPTUNE Canada. 2004. NEPTUNE Canada Ocean Observing Systems Workshop 1 Report, 3-5 May 2004, University of Victoria, BC. http://www.neptunecanada.ca/workshops/index.html.
2005	ORION Executive Steering Committee. 2005. Ocean Observatories Initiative Science Plan: Revealing the Secrets of Our Ocean Planet. Joint Oceanographic Institutions, Inc. Washington, DC. http://oceanleadership.org/files/OOI_Science_Plan.pdf.
2006	JOI. 2006. Report of the ORION Design and Implementation (D & I) Workshop, 27-30 March 2006, Salt Lake City, UT. http://orionprogram.org/PDFs/DI_report_final.pdf.
	JOI. 2006. Coastal Observatory Conceptual Network Design for ORION's Ocean Observatories Initiative (OOI). Version 2.0. Issued by the ORION Program Office, Washington, DC. 30 June. http://orionprogram.org/PDFs/OOI_CND_Coastal30June.pdf.
	JOI. 2006. Regional Cabled Conceptual Network Design for ORION's Ocean Observatories Initiative (OOI). Version 2.0. Issued by the ORION Program Office, Washington, DC. 19 June. http://orionprogram.org/PDFs/OOI_CND_RCO19June.pdf.
	JOI. 2006. Global Conceptual Network Design for ORION's Ocean Observatories Initiative (OOI). Version 3.0. Issued by the ORION Program Office, Washington, DC. 30 June. http://orionprogram.org/PDFs/OOI_CND_Global30June.pdf.
	NSF. 2006. Review Report of the NSF Conceptual Design Review Panel for the Ocean Observatories Initiative. 14-17 August 2006, Monterey Bay Aquarium Research Institute, Moss Landing, CA. 8 September. http://orionprogram.org/capabilities/cdr/Final_OOI_CDR_Report.pdf.
	JOI. 2006. Cyberinfrastructure Conceptual Architecture Conceptual Design Review. 14-18 August 2006, Monterey Bay Aquarium Research Institute, Moss Landing, CA. http://orionprogram.org/advisory/committees/ciarch/default.html.
2007	JOI. 2007. ORION's Ocean Observatories Initiative Conceptual Network Design: A Revised Infrastructure Plan. Washington, DC. 8 March. http://orionprogram.org/PDFs/RevisedOOICND08Mar07.pdf.
	Consortium for Ocean Leadership. Profiling Mooring Workshop, 9-12 July 2007, Denver CO. Report in prep. http://oceanleadership.org/ocean_observing/workshops/profiling.
	University of Washington. 2007. Regional Scale Nodes Wet Plant Primary Infrastructure White Paper. Prepared for JOI, Washington, DC. 11 June. http://oceanleadership.org/files/ocean_observing/OOI_RSN_WetPlant_1_4.pdf.
	University of Washington. 2007. Regional Scale Nodes Shore Station Options White Paper. Prepared for JOI, Washington, DC. 15 June. http://oceanleadership.org/files/ocean_observing/OOI_RSN_ShoreStation.pdf.
	University of Washington. 2007. Regional Scale Nodes Secondary Infrastructure White Paper. Prepared for JOI, Washington, DC. 30 July. http://oceanleadership.org/files/ocean_observing/OOI_RSN_Secondary.pdf.

At this time, the RFA referred to the basic conceptual design elements: 1) deep-sea buoys, which could be deployed in harsh environments such as the Southern Ocean, to investigate global-scale processes; 2) a regional cabled network in the northeast Pacific Ocean on the Juan de Fuca plate consisting of interconnected sites on the seafloor spanning several geological and oceanographic features and processes; and 3) new construction or enhancements to existing facilities leading to an expanded network of coastal observatories.

The OOI Capabilities Description, referred to in the RFA, contained the high level description of the three basic observing components: 1) a regional cabled network consisting of interconnected sites on the seafloor of the Juan de Fuca plate spanning several geological and oceanographic features and processes, 2) two types of instrumented, potentially relocatable, deep-sea buoys/moorings, and 3) short-term and long-term instrumented arrays constituting one or more coastal observatories. At the time, these components were known as the Regional Cabled Observatory, the Global Observatory, and the Coastal Observatory.

A total of 48 proposals was submitted describing research and the infrastructure required to execute the science. The submissions represented the input of 550 investigators spanning 137 research and educational institutions and agencies. These proposals were peer reviewed and the infrastructure and scientific objectives described in the highly rated proposals provided the basis for the initial draft OOI design.

To facilitate the development of the initial design, JOI instituted a large advisory structure of six committees comprising approximately 80 community stakeholders. Among the tasks performed by the OOI advisory committees was the development of an OOI Science Plan (ORION Executive Steering Committee 2005). The advisory committees, specifically the Science and Technical Advisory Committee (STAC), Engineering Committee, and Sensors Committee were charged with developing an OOI draft design based on requirements in highly rated proposals. In March 2006, an “open invitation” Design and Implementation Workshop was held to allow the broad ocean science community to comment on the resulting OOI draft design. Approximately 290 national and international scientists from academia, government agencies, and industry participated. The OOI advisory committees further refined the OOI design based on the comments in the workshop report and developed the Conceptual Network Design (CND). The OOI Project Office posted the CND documents (known as the June 2006 CND) on the OOI project website as the OOI design to be reviewed at the NSF Conceptual Design Review (CDR), a major review in the path to MREFC funding.

In August 2006, NSF convened a formal CDR to assess OOI scientific goals and merit, the proposed facility’s technical feasibility and budget, the project’s management plan, including schedules and milestones, and education and outreach plans. The 20-member review panel (experts from the science, engineering, and education communities) affirmed that the OOI as proposed would transform oceanographic research in the coming decades, and that the CND provided a good starting point for developing the OOI network.

2.1.1 Description of the June 2006 CND

The June 2006 CND consisted of Coastal, Regional Cabled, and Global Observatories, which would be later called CSN, RSN, and GSN, respectively (JOI 2006b, c, d).

2.1.1.1 Coastal-Scale Nodes (CSN)

The CSN proposed in the June 2006 CND included the West Coast Endurance Array, the East Coast Endurance Array, and the Mid-Atlantic Bight Pioneer Array.

West Coast Endurance Array. This proposed array consisted of the following (in order of priority):

1. Central Oregon Line of profiler moorings at 25, 50, 80, 150, and 500 meters (m). Paired surface-subsurface profiler moorings and benthic nodes at 25, 80, and 500 m with cable connections to the RSN, and a surface mooring with profiler at 50 and 150 m.
2. Central Washington Line of profiler moorings at 25, 50, 80, 150, and 500 m. Paired surface-subsurface profiler moorings and benthic nodes at 25, 80, and 500 m, and surface moorings with profiler at 50 and 150 m.
3. Fleet of 12 instrumented gliders.
4. Central California single profiler mooring at 900 m cabled to the Monterey Accelerated Research System.
5. Southern California Bight Line of paired surface-subsurface profiler moorings at 80 and 500 m.

East Coast Endurance Array. This array was proposed for the South Atlantic Bight, offshore of Georgia. It was to be based on running a seafloor electrical-optical-mechanical (EOM)[1] cable from a shore station to an inner shelf seafloor node (approximate depth 15-20 m) then to two existing surface-piercing towers on the middle shelf (owned by the U.S. Navy). The seafloor node was to be equipped with a profiler mooring. The cabled towers, along with two additional uncabled towers, were to be equipped with high frequency radar, meteorological instrumentation, benthic nodes, and profiler moorings. A fleet of six instrumented gliders was included.

Mid-Atlantic Bight Pioneer Array. This proposed array would be located at the shelf-break front south of Massachusetts and consisted of fixed surface moorings, profiling moorings, gliders, and AUVs:

- 4 EOM paired surface-subsurface profiler moorings, 2 moorings with AUV docking stations;
- 4 subsurface profiler moorings;
- a fleet of 3 long-range, instrumented AUVs and 10 instrumented gliders.

2.1.1.2 Regional-Scale Nodes (RSN)

Planning for a regional cabled observatory spanned a decade of effort, including 10 workshops and meetings to define the many scientific and technical issues that could be addressed with a network of cabled sensors (see Table 2-3). An NSF-supported workshop held in 2003 considered the choice of location as a balance among science themes served and the logistical issues of the engineering, construction, and maintenance of a cabled observatory. The Northeast Pacific in the region of the Juan de Fuca Plate was recommended as having the greatest potential benefit to broad research themes, to span coastal to global scales of observation, to link with other observing programs (e.g., NEPTUNE Canada, EarthScope), and to take advantage of proximity to domestic ports to support operations.

The RSN design was proposed as a network of instrumented seafloor nodes connected to each other and to shore by a backbone EOM cable providing power and data communications. The initial design proposed ~1,500 kilometers (km) of backbone cable connecting five primary nodes and three branching units (to allow for future expansion) in a ring configuration. Extension cables from the primary nodes

1 For the purposes of this EA, EOM will refer to electrical, optical, or electrico-optic mechanical cables proposed for use in the OOI.

would connect secondary infrastructure to allow for instrumentation to be placed 20–100 km away from the primary nodes. There would be an extension cable connection to the Central Oregon Line of moorings. In addition to seafloor instrumentation, eight subsurface profiler moorings were proposed. One mooring cabled to each primary node and three moorings located north of the RSN (i.e., one mooring cabled to NEPTUNE Canada's cabled observatory and two uncabled moorings in the Alaska Current, offshore of northern Vancouver Island).

2.1.1.3 Global-Scale Nodes (GSN)

The criteria for the location of Global Sites included high scientific value with impact to a broad range of disciplines (e.g., prominence and suitability of a site for studies of carbon cycle processes, ocean-atmospheric interactions during extreme events, climate influences on ecosystem change, and seafloor and Earth structure processes). Other considerations in site selection and prioritization included the location's contribution to a global network of ocean buoys (e.g., the international OceanSITES system, and the National Oceanographic and Atmospheric Administration's [NOAA's] Deep-ocean Assessment and Reporting of Tsunamis [DART] and Tropical Atmosphere Ocean [TAO] Arrays), prioritizations from previous community planning efforts, and occupation of sites beyond the reach of present technology. High-latitude, remote sites where less observing capability exists are also considered a priority, as are sites considered representative of ocean basins and biogeographic provinces. The initial GSN included 10 proposed sites plus a to-be-determined location for a Global Pioneer Array (Table 2-2).

Table 2-2. Global Sites as Proposed in the June 2006 OOI Conceptual Network Design

Location	*Proposed Infrastructure*
Station Papa (50^{o}N, 145^{o}W) Depth = 4,250 m	1 acoustically linked surface discus buoy 1 subsurface profiler mooring
Irminger Sea (60^{o}N, 39^{o}W) Depth = 2,800 m	1 acoustically linked surface discus buoy 1 subsurface profiler mooring
Southern Ocean (55^{o}S, 90^{o}W) Depth = 4,800 m	1 spar buoy with EOM cable and seafloor junction box 1 subsurface profiler mooring
East Pacific Rise (10^{o}N, 104^{o}W) Depth = 2,500 m	1 spar buoy with EOM cable and seafloor junction boxes 1 subsurface mooring
Pacific Antarctic Ridge (55^{o}S, 150^{o}W) Depth = 4,250 m	1 acoustically linked surface discus buoy 1 subsurface profiler mooring
Mid-Atlantic Ridge (23^{o}N, 44^{o}W) Depth = 4,460 m	1 surface discus buoy with EOM cable and benthic node 1 subsurface profiler mooring
ALOHA (23^{o}N, 158^{o}W) Depth = 4,755 m	1 EOM subsurface mooring with acoustic source
Argentine Basin (42^{o}S, 42^{o}W) Depth = 5,200 m	1 acoustically linked discus buoy 1 subsurface profiler mooring
South Pacific Subtropical Gyre (28^{o}S, 120^{o}W) Depth = 3,400 m	1 acoustically linked surface discus buoy 1 subsurface mooring
Peru Basin (18^{o}S, 85^{o}W) Depth = 4,250 m	1 surface discus buoy with EOM cable and benthic node 1 subsurface EOM profiler mooring
Global Pioneer Array (TBD)	4 subsurface profiler moorings 4 instrumented gliders

2.1.2 Revisions to the CND – June 2006 to Present

During the year following the CDR, the NSF issued financial and design guidance to the OOI Project Office, necessitating further revisions to the CND. The June 2006 CND was developed using the funding profile and total issued by NSF. In fall of 2006, NSF indicated that funding profile for construction would need to include inflation (using the Office of Management and Budget inflation rates) and that the annual operations and management (O&M) funding for OOI would be capped. Meeting these two fiscal guidelines necessitated revision of the June 2006 CND, specifically a reduction in the proposed infrastructure.

The OOI Observatory Steering Committee (OSC), formerly called the ORION Executive Steering Committee, then tasked the OOI STAC with reevaluating the CND and recommending changes to the proposed OOI infrastructure to satisfy the fiscal constraints while maintaining the transformative capabilities to advance understanding of ocean processes. In addition to NSF's fiscal guidance, the OSC developed scientific criteria for the STAC to use in its considerations of the CND. Those criteria stated that high priority be given to:

- New and transformative technologies for both physical- and cyber-infrastructure.
- Science requiring OOI infrastructure.
- Retaining all three elements - coastal, regional, and global, even if the scope of individual elements is reduced.
- Retaining an appropriate balance between fixed (moorings, seafloor nodes, cables) and mobile (AUVs and gliders) assets.
- Minimizing life cycle costs (i.e., maintenance costs and frequency).

Based on the combined guidance from NSF, OSC, and recommendations made in the CDR Report, the STAC, with assistance from the OOI Engineering Committee, developed recommendations and de-scoped scenarios for revising the OOI conceptual design. Those recommendations were presented to the OSC in early December 2006. Among its recommendations were the elimination of the Central and Southern California moorings, and the East Coast Endurance Array. The former was based on comments of the CDR Panel, who expressed concern with the science justification for the California moorings and felt the assets could be better applied to other parts of the CSN. The East Coast Endurance Array was eliminated because it was no longer clear the U.S. Navy would continue to maintain the infrastructure that was proposed for use in the array. The STAC also proposed reductions to the number of cabled and uncabled moorings in the remaining Endurance Array and Pioneer Array elements.

The STAC recommended reductions in the number of expansion nodes and secondary infrastructure on the RSN, including reducing the number of subsurface profiler moorings, as a means to meet the fiscal targets and retain the plate-scale science capability. Retaining the backbone infrastructure and primary nodes would still allow for future expansion.

The STAC's recommendation for revising the GSN design was to reduce the number of sites from 10 to 7 sites and retain the Global Pioneer Array (however, the Global Pioneer Array was subsequently eliminated during discussions at the January 2007 OSC meeting). In addition to the elimination of three global sites, the STAC recommended that some of the high risk, high maintenance infrastructure at the remaining sites be reduced to lower the O&M costs.

The OSC met again in late January 2007 to consider the STAC recommendations and finalize the revisions to the CND. With assistance from the STAC, the OOI Project Office developed the revised OOI CND, which was presented in March 2007 (JOI 2007a). The OOI Project Office then posted this revised CND for comment by the scientific community. At that time the NSF's Division of Ocean Sciences also submitted further guidance to the OOI Project Office in the form of recommended changes. The recommendations were based on NSF programmatic research priorities and the need to maintain the broad scientific utility of the OOI infrastructure. The OOI Project Office assembled *ad hoc* "tiger teams" to consider both scientific community comments and the additional NSF guidance. These teams were composed of members of the OSC, other outside ocean scientists, and NSF program directors. The following tiger teams met 2-3 times each via teleconference from April to June: Coastal Dynamics Team, Mixing and Climate Team, Plate Geophysics Team, and Science and Planning Team. The tiger teams' recommendations were presented to the OSC in June 2007.

The OSC issued recommendations to guide the preparation of the Preliminary Network Design (PND). With a recognition that further revisions would likely occur as more detailed engineering cost estimates and risk assessments became available, the OSC also formulated guiding principles to provide a framework for future revisions of the PND. Those principles assigned priority to the following:

- Power and communications capabilities exceeding those of traditional ocean observing platforms are the leading aspect of the transformative characteristics of the OOI Network;
- An emphasis on fewer, more capable nodes over more numerous, less capable nodes;
- A mix of fixed platform and mobile assets;
- The integration across the three observatory scales (coastal, regional, global) should be exploited to the extent possible to address high priority science questions;
- The OOI as a research platform that would enable future experiments/capabilities beyond those included in the initial configuration;
- The OOI Network should achieve a balance between enabling science "out of the box," and designing infrastructure to also support separately funded investigator's experiments.

During the period of revision of the PND, JOI (which later became the Consortium for Ocean Leadership) issued Requests for Proposals to identify and select the Implementing Organizations (IOs). Upon recommendation of the National Research Council, the IOs are academically based consortia, competitively selected and contracted to manage the design, construction, and operation of the proposed OOI infrastructure elements. As NSF MREFC projects are intended to serve scientific research needs, academic institutions are traditionally chosen to oversee design, construction, and operation. The lead IOs for the proposed OOI are Woods Hole Oceanographic Institution (WHOI) and Oregon State University for the CSN; the University of Washington for the RSN; and WHOI and Scripps Institution of Oceanography for the GSN. The OOI Project Office then worked with the OOI IOs to review the OSC's recommendations and guiding principles, along with the planning considerations required of all NSF Large Facility projects.

An *ad hoc* Coastal-Global Scale Nodes (CGSN) Team was formed in September 2007 with scientists and engineers from the CGSN IO group and members of the OSC and OOI Project Office. The CGSN Team was tasked to re-examine the CND in light of the OSC's recent recommendations and the updated cost estimates available from the CGSN IO. Those costs were far higher than the estimates used in the previous CNDs. The OSC's recommendation for fewer, more capable nodes (while still meeting fiscal constraints) could only be accommodated by reducing the number of GSN sites (from the March 2007 CND) in order to add more sensors and flanking moorings to increase the footprint at each site. Three additional GSN sites were dropped in order to enhance the four remaining sites; priority was given to three high-latitude sites (Station Papa, Irminger Sea, and Southern Ocean) and the Mid-Atlantic site (the latter to accommodate the mid-latitude design Extended Draft Platform [EDP]).

Considerations for the CSN followed similar criteria (i.e., accommodate the new cost estimates and make the infrastructure more capable). The latter meant cabling as many sites on the Oregon Line as possible and increasing the sensor suite at all remaining mooring sites. The CGSN Team's recommendations were to eliminate the 50-m mooring and cable the 150-m mooring in addition to the cabled 80- and 500-m moorings. Also, all moorings would now have winched, surface-piercing profilers and benthic nodes to accommodate instruments. The Washington Line was reduced from four uncabled mooring locations to two, but with increased sensor packages, benthic nodes, and winched profilers. The CGSN Team's recommendations for the Pioneer Array were to add two subsurface profiler moorings, winched profilers on four moorings, and benthic nodes at two moorings in addition to the existing AUV docking stations.

Design revisions of the RSN were also informed by a series of technical studies carried out by the RSN IO. These studies evaluated different ways of implementing the science-based locations and objectives established in the CND.

- *RSN Wet Plant Primary Infrastructure White Paper* – This study evaluated nine possible configurations for the RSN cable geometry and functionality by assessing cost, reliability, efficiency, and risk, with ramifications for achievable science (University of Washington 2007a). As a result, the RSN was able to maintain all of the science node locations and add a mid-plate node as advised by NSF, by changing from a ring configuration of the cable to a star configuration. In addition, the star configuration was less expensive and allowed additional sensors to be included in the initial construction, which helped broaden the scientific utility of the OOI.
- *RSN Shore Station Options White Paper* – This study reviewed seven possible cable-landing sites in Oregon and Washington. The study determined that using existing commercial cable station facilities on the Oregon coast rather than constructing and maintaining new facilities would result in less potential environmental impacts and significant cost savings (University of Washington 2007b). In addition, rather than a single shore station, this study recommended using two existing shore stations in order to eliminate 26 crossings of existing commercial undersea cables.
- *RSN Secondary Infrastructure White Paper* – The RSN infrastructure described in this study included all of the components required to connect the scientific instruments to the shore station(s) through various levels of nodes and the underwater backbone cable. The components included the Primary Nodes, Secondary Nodes, Low-voltage Nodes, Junction Boxes, vertical moorings, and the connectors and cables needed to interconnect them. For each of these items, the study provided an overview of the functionality, conceptual physical implementation, a summary of technical specifications, and a short description of some of the major system components (University of Washington 2007c).

As can be seen from the discussion presented above, numerous alternative configurations were considered for the CSN, RSN, and GSN components of the proposed OOI. Based on the extensive technical reviews of the June 2006 CND by the OSC, various tiger teams, the *ad hoc* CGSN Team, and STAC, and technical supporting studies of alternative configurations, the resulting Revised CND is described as the Proposed Action; this design and the associated science justification are described in detail in the October 2007 OOI Science Prospectus (JOI 2007b). The science justification was reviewed by an NSF Blue Ribbon Panel in October 2007; the panel endorsed the proposed OOI as a worthy investment in science infrastructure.

Based on the OSC's recommendations to the CND, the OOI Project Office and IOs developed the integrated PND. In December 2007, the NSF conducted a 4-day Preliminary Design Review (PDR) with a panel composed of scientists, engineers, and large project managers. The proposed OOI successfully passed this review by the PDR Panel. The PND is described more fully as the Proposed Action in Section 2.2.

2.2 PROPOSED ACTION

Under the Proposed Action, the CSN, RSN, and GSN would consist of the following elements:

- CSN – the Endurance Array (Newport and Grays Harbor lines) and the Pioneer Array,
- RSN – a configuration with five Primary Nodes and two shore stations, and
- GSN – four sites.

The following sections present a detailed description of all assets, platforms, or infrastructure that would be physically placed on the seafloor or in the water column under the Proposed Action.

2.2.1 Coastal-Scale Nodes (CSN)

The coastal zone, with heat, nutrient, and saline fluxes, mass input, and topographical changes, plays a critical role in ocean physics, ecology, and biogeochemistry, and it is where human impact is felt most strongly. Yet, the coastal ocean is undersampled in space and time and across a range of physical, chemical, and biological variables. Sustaining an advanced observing capability in coastal waters remains a challenge. The OOI's proposed CSN would fill this gap by providing sustained, but adaptable, access to complex coastal systems. The CSN would support long-term and high space-time resolution observations to understand the physics, chemistry, ecology, and climate science of key regions of the complex coastal ocean. The scientific goals include providing observations of phenomena such as variability in complex eastern and western boundary current systems; coupling between coastal physics and biology, including nearshore fisheries and biological regime shifts; coastal carbon budgets; terrestrial-oceanic transport of carbon, nutrients, sediments, and fresh water; shelf, shelfbreak, and slope exchanges; and coastal hazards such as storms, tsunamis, and hypoxia.

Coastal margins are subject to a range of forcing and transport mechanisms such as storms, river plumes, offshore jets, upwelling/downwelling events, and density flows. Many of these are focused or aligned by local topography, and variability in coastal systems is pronounced in the direction perpendicular to the shore. The challenges in locating CSN infrastructure are to adequately sample across the shelf while assessing along-shore variability and to incorporate specific localized effects and still characterize regional, margin-scale phenomena and transports. There are also regional differences in shelf width and geomorphology, wind regime, buoyancy and sediment inputs, tidal characteristics, boundary currents, and anthropogenic pressures. Placing the assets of the CSN in locations with contrasting characteristics would maximize its utility and engender greater interest in the research community. Deploying the CSN infrastructure along the U.S. coasts in the coming decades would transform our observing capabilities and understanding of the coastal ocean.

The proposed CSN consists of two elements: a long-term Endurance Array off Washington and Oregon and a relocatable Pioneer Array in the Mid-Atlantic Bight south of Massachusetts. The Endurance Array would be a long-term observatory of moored and mobile assets deployed across the continental shelf and slope to provide continuous observations at key locations, documenting episodic events and longer-term changes. The Endurance Array would complement existing and planned observatory and infrastructure in the region. The Pioneer Array would provide a more detailed, 3-dimensional view of key biophysical interactions at the shelf break using a flexible, multiplatform array combining moored and mobile assets with high spatial and temporal resolution.

2.2.1.1 Endurance Array

The coastal ocean off Oregon and Washington is characterized by a relatively narrow shelf, an energetic eastern boundary current, persistent wind-driven upwelling, a large buoyancy source (fresh water from the Columbia River), a number of distinct biogeographical regimes, mesoscale variability forced by bathymetry and fluid instabilities, and interannual variability forced by fluctuations in the tropical Pacific (e.g., El Niño Southern Oscillation), as well as variations in the large-scale circulation of the North

Pacific (e.g., Pacific Decadal Oscillation). Over this shelf, water properties and biological community size and composition vary most strongly in the cross-shelf direction. A well-instrumented array spanning the continental shelf is key to sorting out ecosystem responses across this strong gradient. The Endurance Array would also complement observing efforts of the local Regional Ocean Observing Systems of IOOS, such as members of the Northwest Association of Networked Ocean Observing Systems (NANOOS), including the Oregon Coastal Ocean Observing System (OrCOOS), the Columbia River Environment forecasting system, and Central and Southern California Ocean Observing System.

The Endurance Array would be comprised of two lines of moorings, one located off the coast of central Oregon (Newport Line), and a second at a contrasting site in central Washington (Grays Harbor Line) (Figure 2-1). Both lines would consist of surface and subsurface moorings and would employ gliders. The 80-, 150-, and 500-m moorings on the Newport Line would be cabled and connected to the backbone cable of the RSN via NP2 (Figure 2-2; refer to Section 2.2.2 for a detailed discussion of the RSN); the Grays Harbor Line would not be connected to the RSN. Specifically, each line would contain:

Newport Line

- three paired surface/subsurface moorings at 25, 80, and 500 m; and
- one subsurface mooring at 150 m (Figure 2-2).

Grays Harbor Line

- two paired surface/subsurface moorings at 25 and 80 m, and
- one subsurface mooring at 150 m (Figure 2-3).

Vertical moorings would provide long-term observations of shelf processes, extending from the air-sea interface through the water column to the bottom, and benthic instrumentation packages or nodes would provide sampling on and near the seafloor. Some surface moorings (e.g., 80- and 500-m sites in Figure 2-2) would generate power and support two-way telemetry. These surface moorings would also provide the capability to collect surface meteorology and air-sea flux data and would support high-power, high-bandwidth, multidisciplinary science instrumentation in the buoy well and at 5 m beneath the surface.

Sensors may be located in the water column between the seafloor and surface, or on the buoy tower. Control and data signals to and from sensors below the buoy flow along copper conductors built into the mooring strength member elements.

Vertical profiling moorings would carry multidisciplinary core sensor suites, and the profilers would have additional payload and power capacity for future sensor additions. With connection to the RSN cable, vertical profiling can be made continuously. All profilers are winched to the surface with the exception of the deep-ocean profiler at the 500-m site. Profilers not attached to the cable would draw from a bottom-mounted battery reservoir and be capable of profiling four times per day for 6 months.

Benthic junction boxes at the nodes tied in to the RSN cable would support high-power, high-bandwidth instruments with interactive, real-time communications. A multidisciplinary benthic instrument package would be deployed to sample the bottom boundary layer. Where the benthic sensor package is hooked to the RSN cable, high power and bandwidth would enable the construction of a benthic sensor network.

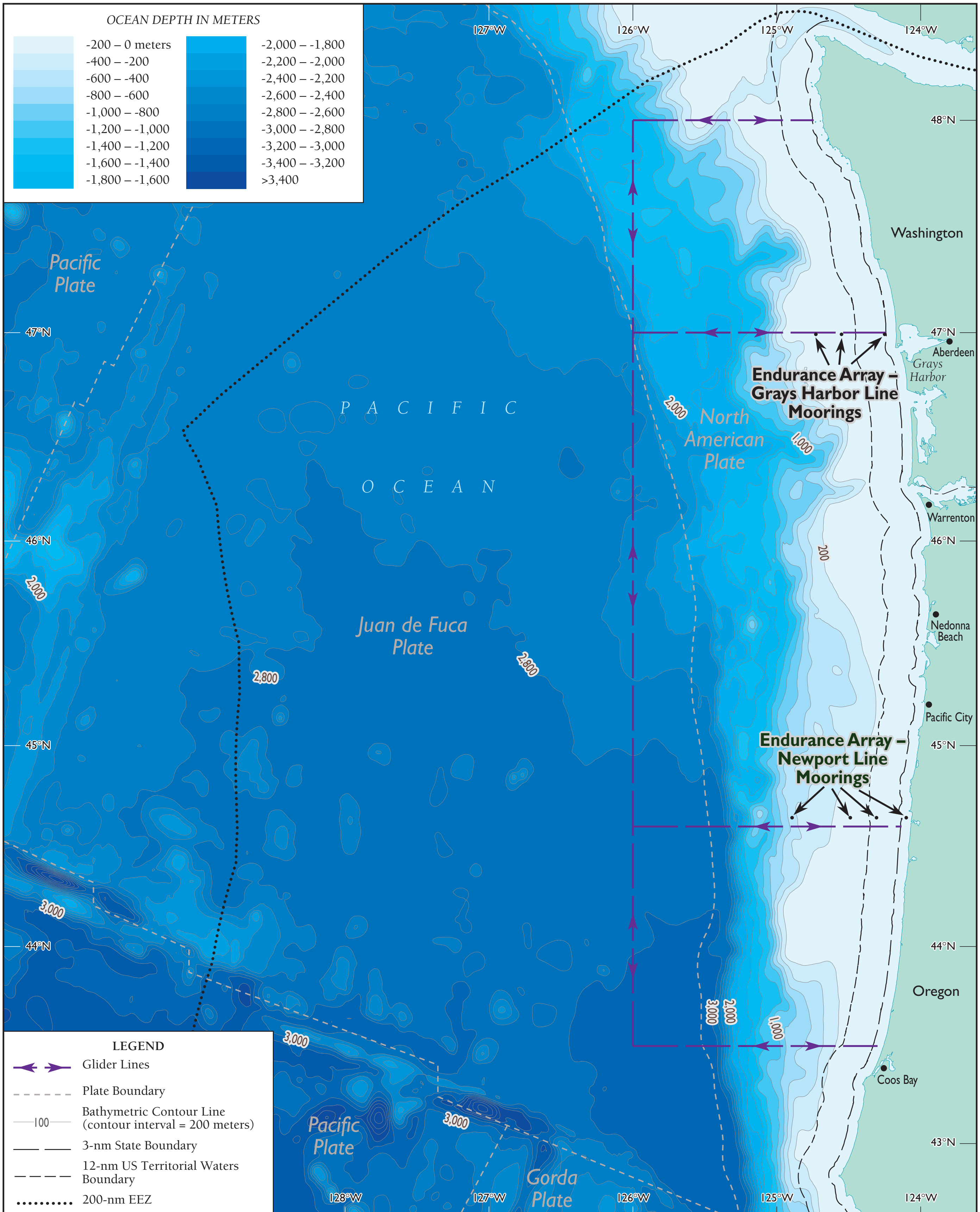

Figure 2-1
Proposed Location of the Pacific Northwest CSN (Endurance Array) and Associated Glider Mission Boxes

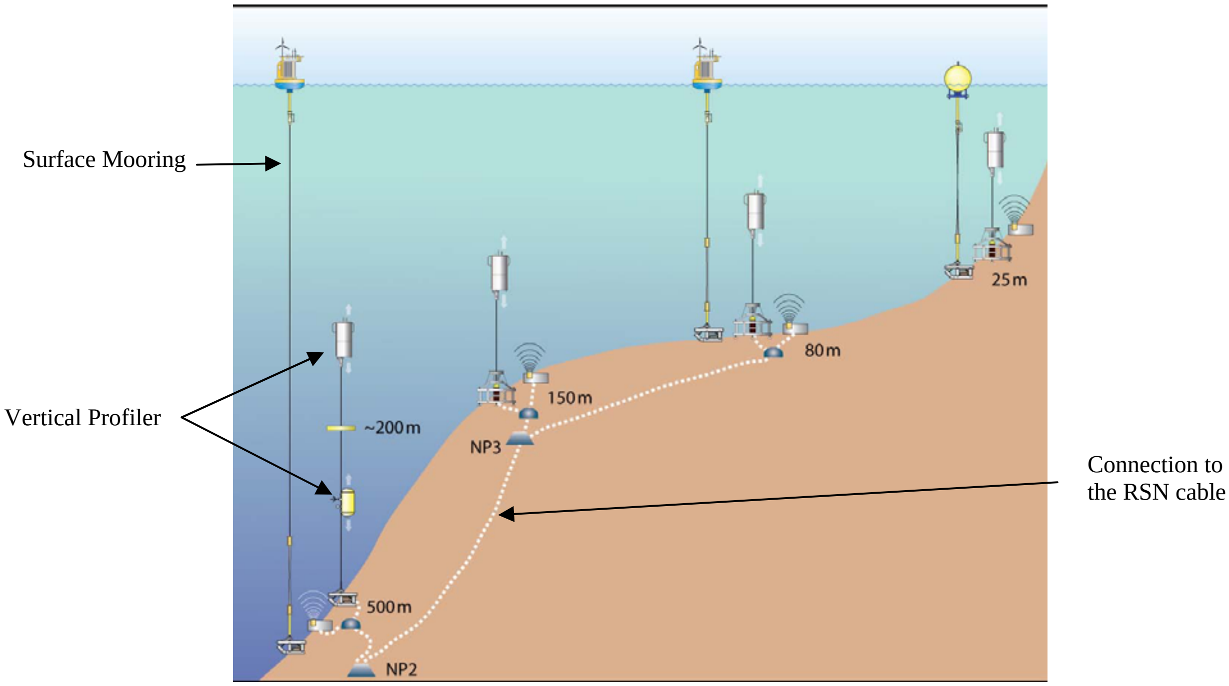

Figure 2-2 Generalized Example of the Endurance Array (Newport Line)

Note: The 80-, 150-, and 500-m sites are shown cabled to RSN Secondary Nodes NP3 and NP2, which eventually are cabled to RSN Primary Node N1. (Not to scale)

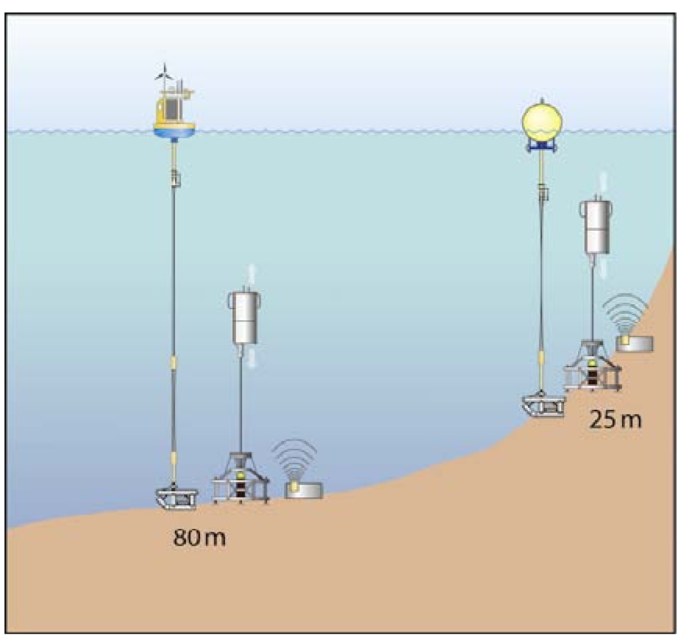

Figure 2-3 Generalized Example of the Endurance Array (Grays Harbor Line)

Note: The 150-m mooring site is not depicted in this example. (Not to scale)

The surface buoy would consist of a welded aluminum core structure and a closed-cell polyethylene foam buoyancy module in the shape of a cylinder about 1 m high and 3 m in diameter. The buoy would have a welded aluminum tower structure that may support meteorological sensors, antennas, solar panels, and wind turbine(s). The top of the buoy tower would rise ~4 m above the sea surface. The buoy would contain an electronics controller consisting of a microcomputer running code designed to control power supplied to sensors, acquire and log data, and transmit recorded data to shore via satellite and/or radio links. The power generation system would consist of photovoltaic cells and wind turbine(s). Power would be stored in absorbed glass mat (AGM) sealed lead/acid batteries housed in a chamber within the buoy hull structure. An alkaline battery pack may be used for backup power supply in the event of a power system failure. Telemetry to and from the mooring would be via satellite and/or radio links including Iridium, Freewave, WiFi, etc.

All buoys would be equipped with a radar reflector and amber flashing light and is marked for identification within the array and for visibility per U.S. Coast Guard (USCG) guidelines for Oceanographic Data Acquisition Systems (ODAS). Notification of deployment of scientific buoys falls under the governance of USCG Private Aids to Navigation (PATON). In addition, the USACE regulates the placement of mooring buoys in all navigable U.S. waters. Prior to deployment of all proposed buoys associated with the OOI, the IO would contact the appropriate Coast Guard District PATON Manager and the USACE for guidance on required buoy color, markings, lights (including color and flash code), reflective material, etc., and any other state or local authority requirements.

At the seafloor, a Multi Function Node (MFN) or benthic “sled”, terminates the bottom of the mooring and would provide the necessary anchoring weight. The weight is provided by a releasable cast steel anchor fitted with a secondary anchor recovery line pack. The MFN has a metal frame with an approximate 4-m^2 footprint, is 1 m high, and houses a rechargeable battery pack to provide power for intermittent seafloor needs. The MFN would provide data and power ports for benthic instrumentation. Batteries and electronics are housed in one or more aluminum pressure-tolerant housings.

Up to six autonomous underwater gliders would also carry multidisciplinary sensor suites along cross-shelf glider lines (Figure 2-1). Measurements would be obtained with submeter vertical resolution on missions that range from 1 to 6 months. The glider array would sample both across-shelf lines and north-south seaward lines totaling ~500 km in length. Refer to Section 2.2.4 for a detailed discussion of gliders.

2.2.1.2 Pioneer Array

The Mid-Atlantic Bight of eastern North America is characterized by a relatively broad shelf, a persistent equator-ward current originating from the north, a well-defined shelfbreak front separating shelf and slope waters, distributed buoyancy inputs from rivers, variable wind forcing, and intermittent offshore forcing by Gulf Stream rings and meanders. The Pioneer Array would be designed to resolve transport processes and ecosystem dynamics within the shelf-slope front, which is a region of complex dynamics, intense mesoscale variability, and enhanced biological productivity. It would collect high-resolution, multidisciplinary, synoptic measurements spanning the shelf break on horizontal scales from a few kilometers to several hundred kilometers. The Pioneer Array would consist of:

- 4 EOM paired surface/subsurface moorings with local power generation, satellite communications capabilities, and benthic nodes;
- 4 subsurface profiling moorings that would be internally powered and communicate acoustically with the EOM moorings;
- 3 AUVs with two docking stations for power transfer and communications; and
- 10 gliders.

The Pioneer Array would extend ~40 km across the shelf, centered at the climatological location of the shelf-break front (Figure 2-4). The array would employ surface moorings, subsurface profiler moorings, gliders, and AUVs to sample on multiple horizontal scales from the air-sea interface to the seafloor (Figure 2-5). The surface moorings would be equipped to measure surface meteorology and air-sea fluxes, fitted with power generation capability, and moored with EOM cable to the seafloor, allowing incorporation of a benthic node for science user instrumentation. Eight additional moorings would support water column profilers.

The Pioneer Array moorings would share their surface buoy design, and most of their subsurface mechanical design, with the Endurance Array (see Section 2.2.1.1). However, the Pioneer Array surface buoys would be capable of being upgraded to a methanol-based fuel cell power generation system. The surface buoys would provide 50–100 Watts (W) of power, Ethernet and acoustic communication with subsurface sensors, and three different types of airside communication systems (Iridium, FreeWave, and WiFi).

Profiler moorings would be of two types (Figure 2-6). The first would be a surface piercing, winched profiler design shared with the Endurance Array. There would be up to four of these, paired with the four EOM surface moorings. The other four profiler moorings would be equipped with a wire-crawler type profiler that would sample all but the upper 15 m of the water column, and an Acoustic Doppler Current Profiler (ADCP) situated near the bottom. The profiler and ADCP are the primary tools for collecting time series data in the water column, providing interdisciplinary observations resolving the semi-diurnal tidal band and longer periods. These observations would be supplemented by multidisciplinary sensor packages at fixed depths on the EOM moorings to capture the near-surface and near-bottom part of the water column. Instruments on both types of profiler would transmit data to shore via Iridium modem, which would also permit command and control from shore. The profiler and ADCP would be powered by internal battery packs.

The Pioneer Array would include four MFNs, benthic platforms at the base of EOM moorings that supply communications and power. The MFN power system is geared towards a single platform with large, episodic power requirements such as an AUV, but could also support multiple, lower power instrumentation for investigator-supplied sensors. AUVs would be used to study cross- and along-front "eddy fluxes" due to frontal instabilities, wind forcing, and mesoscale variability, with the glider array surveying the outer shelf and slope around the moored array to resolve features of the Gulf Stream as they impinge on the shelf break front. The AUVs and gliders would carry a multidisciplinary sensor payload similar to the Endurance Array gliders. Two EOM moorings would incorporate AUV docking stations near their bases to recharge batteries, offload and store AUV data, and transfer commands. AUVs would run user-controllable missions surrounding the moored array, extending coverage of the frontal region to 100–200 km along and across shelf (Figure 2-4). AUVs may also be deployed periodically (e.g., monthly) from a small vessel and subsequently recovered from that vessel, allowing freshly calibrated sensors to do a comparison check on the quasi-permanent sensors on the moorings and the continuously deployed AUVs. A fleet of 10 gliders would sample the mesoscale field within a region of about 300 x 300 km in the slope water offshore of the moored array (Figure 2-4). Repeat glider missions would last for several months until the instruments are recovered for servicing and replaced by another set.

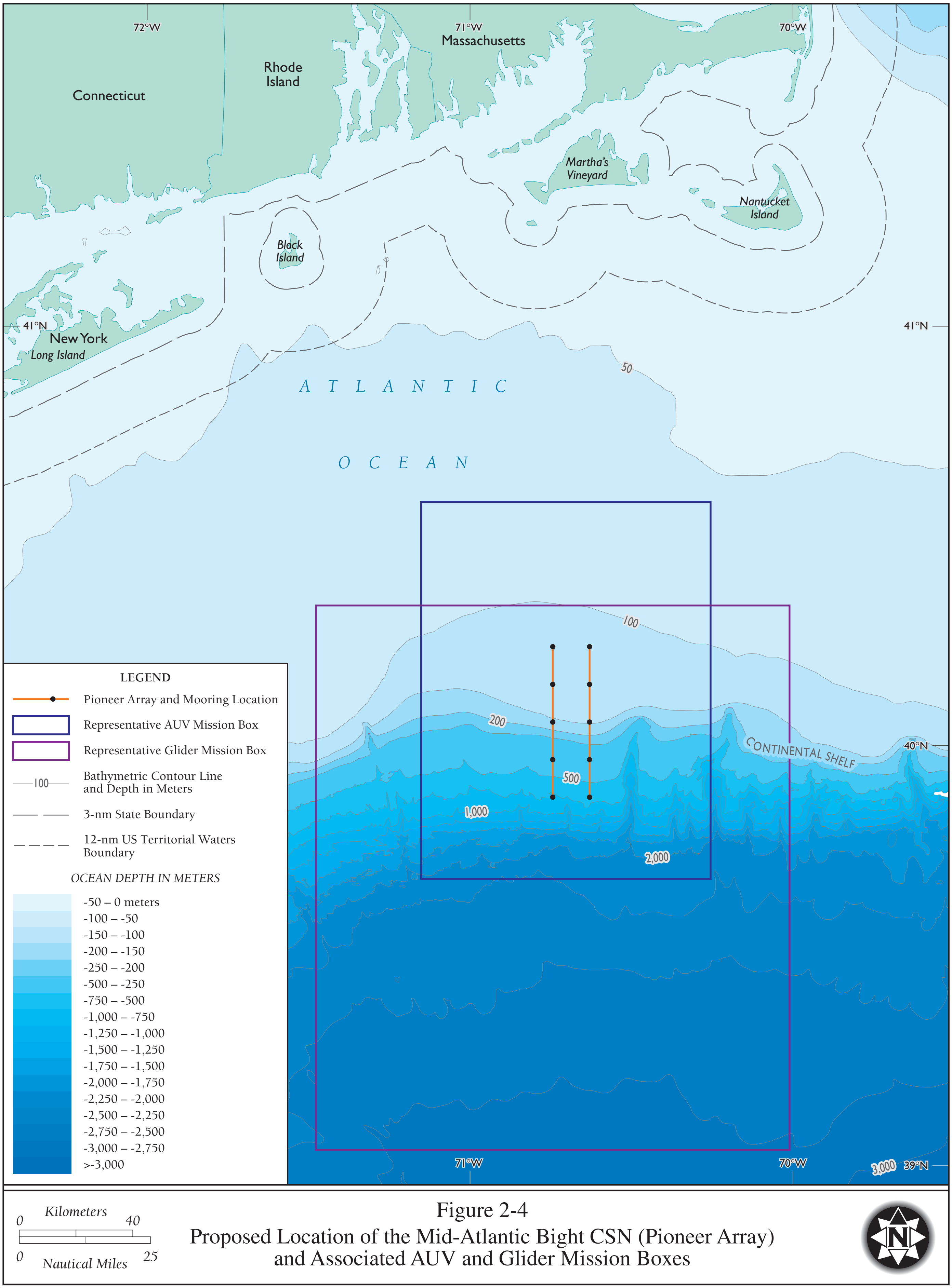

Figure 2-4
Proposed Location of the Mid-Atlantic Bight CSN (Pioneer Array) and Associated AUV and Glider Mission Boxes

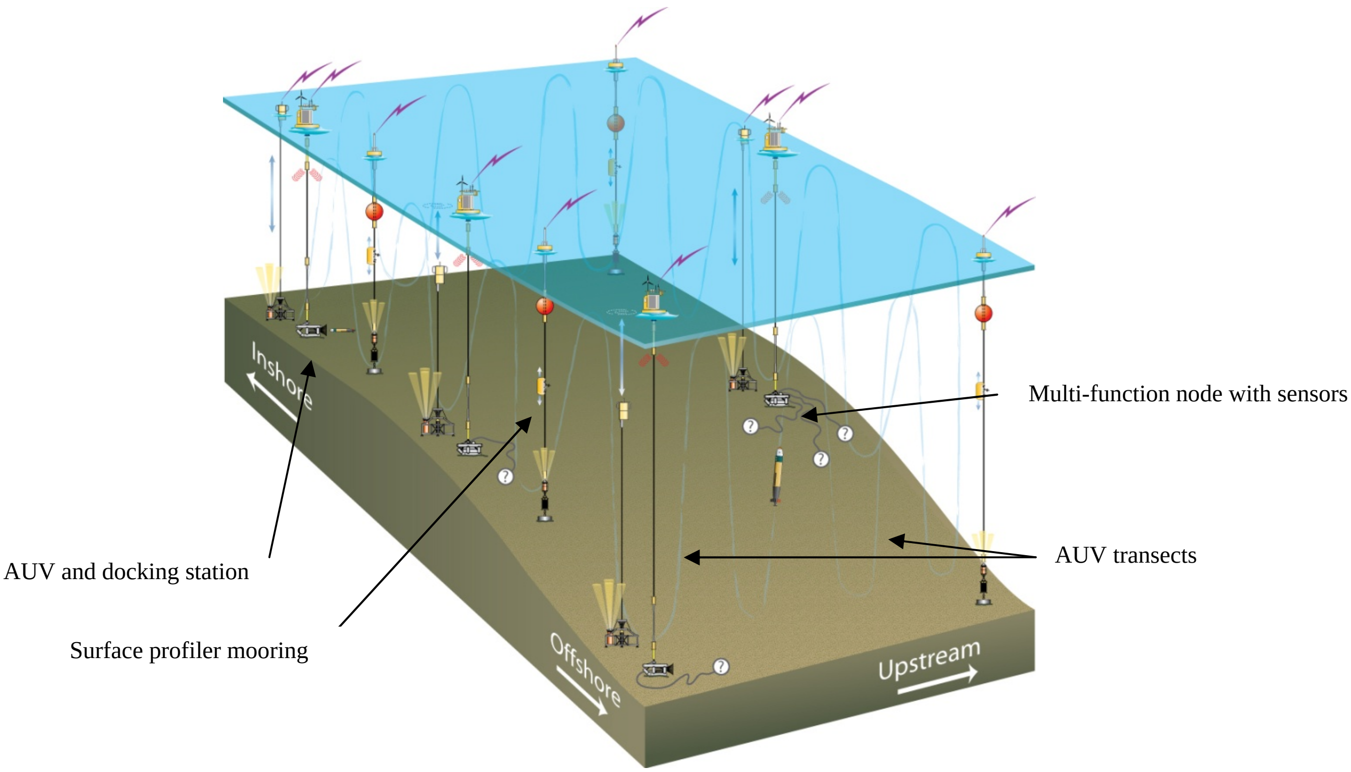

Figure 2-5 Schematic Diagram of the Pioneer Array
(Not to scale)

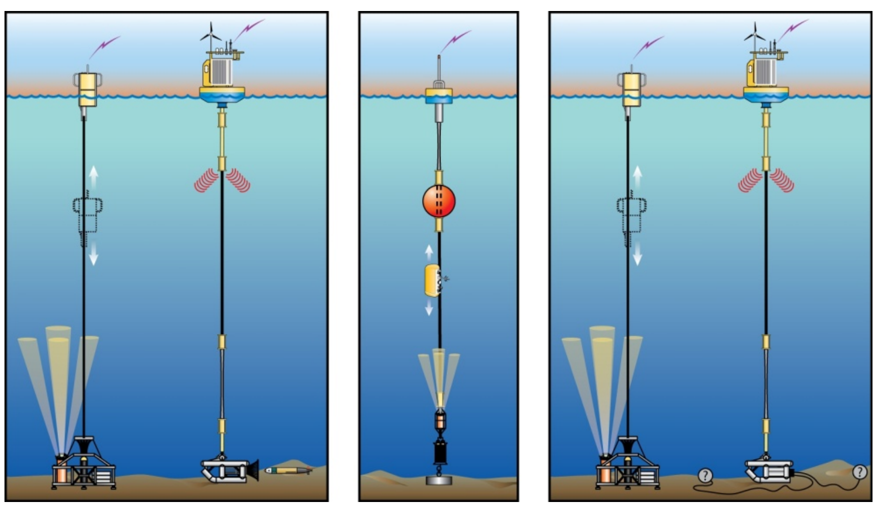

Figure 2-6 Schematic Diagrams of Pioneer Array moorings
Inshore and offshore sites would pair EOM/AUV-dock moorings with surface-piercing winched profilers (left). Central sites would pair EOM/MFN moorings with winched profilers and seafloor sensors (right). The array would also include stand-alone moorings with a wire-crawler profiler and an ADCP coupled inductively to a telemetry buoy (center). (Not to scale)

In contrast to the Endurance Array, the Pioneer Array would be able to be moved to a new location approximately every 3-5 years to compare and contrast different shelf-break systems. This Programmatic EA only addresses the proposed initial location of the Pioneer Array in the Mid-Atlantic Bight. The removal and installation of the Pioneer Array to a new location would be covered by subsequent environmental documentation.

2.2.2 Regional-Scale Nodes (RSN)

The proposed RSN would enable oceanic plate-scale studies of water column, seafloor, and sub-seafloor processes using high-powered, high-bandwidth instrument arrays cabled to shore. The science goals of the RSN are to support investigations of (1) the structure of Earth's crust; (2) the interaction of the Juan de Fuca Plate with its neighbors; (3) geophysics of subduction zones and transform faults; (4) seismicity, magmatism, and deformation across the Plate and Cascadia Subduction Zone; (5) water, heat, and chemical fluxes of hydrothermal systems connecting the sub-seafloor with the water column above; (6) gas hydrate formation and life in extreme environments; (7) benthic ecosystems; (8) ocean circulation and current systems at gyre boundaries; (9) turbulence and mixing; and (10) biogeochemistry and ecosystem dynamics.

The cabled RSN would provide the ocean sciences community with virtually unlimited bandwidth and considerable electrical power that would enable collection of decadal-scale time-series measurements over a tectonic plate, a major coastal upwelling system, a highly variable divergence zone between two North Pacific gyres, one of the most productive fishing areas in the world's oceans, boundary currents on the west coast, and hundreds of kilometers of volcanically and seismically active plate boundaries.

Five Primary Nodes were chosen based on their proximity to diverse tectonic features and water column settings. These nodes would be installed in the North East Pacific Ocean off the coast of southern Washington and northern Oregon at locations spatially coincident with the Juan de Fuca Plate and a suite of mesoscale oceanographic processes that operate in a 300–400-km wide swath that extends from south of Vancouver Island to southern Oregon.

Under the Proposed Action, the RSN would be comprised of four components (Figures 2-7 and 2-8):

1. *Shore Stations* – The shore stations are the cable-landing sites that house the Power Feed Equipment and Network Termination Equipment for the submarine telecommunications backbone cable. The shore stations provide power to the RSN and are network gateways between the Primary Nodes and the terrestrial data center.
2. *Wet Plant or Primary Infrastructure* – From the shore stations, main branches of the backbone cable span long distances to the Primary Nodes, which are located in areas of high scientific interest on the Juan de Fuca Plate. The Primary Nodes convert the high voltage from the shore stations to a lower, useable voltage for distribution to the Secondary Infrastructure. The Primary Nodes and backbone cable make up the Primary Infrastructure.
3. *Secondary Infrastructure* – The Primary Nodes distribute low voltage and data at a lower rate to a group of Low-voltage Nodes (LVNs) positioned geographically around a Primary Node. In addition, Primary Nodes are able to distribute the higher voltage and higher data rates directly to Secondary Nodes, which in turn can distribute power and data to LVNs. The LVNs, Secondary Nodes, and the cables that connect them to the Primary Nodes make up the Secondary Infrastructure.
4. *Tertiary Infrastructure* – The LVNs are connected to either a Medium-Power Junction Box (MPJbox) or a Low-Power Junction Box (LPJbox). The Jboxes then provide the correct power and data interface to small groups of scientific instruments or sensors. The Jboxes and sensors make up the Tertiary Infrastructure.

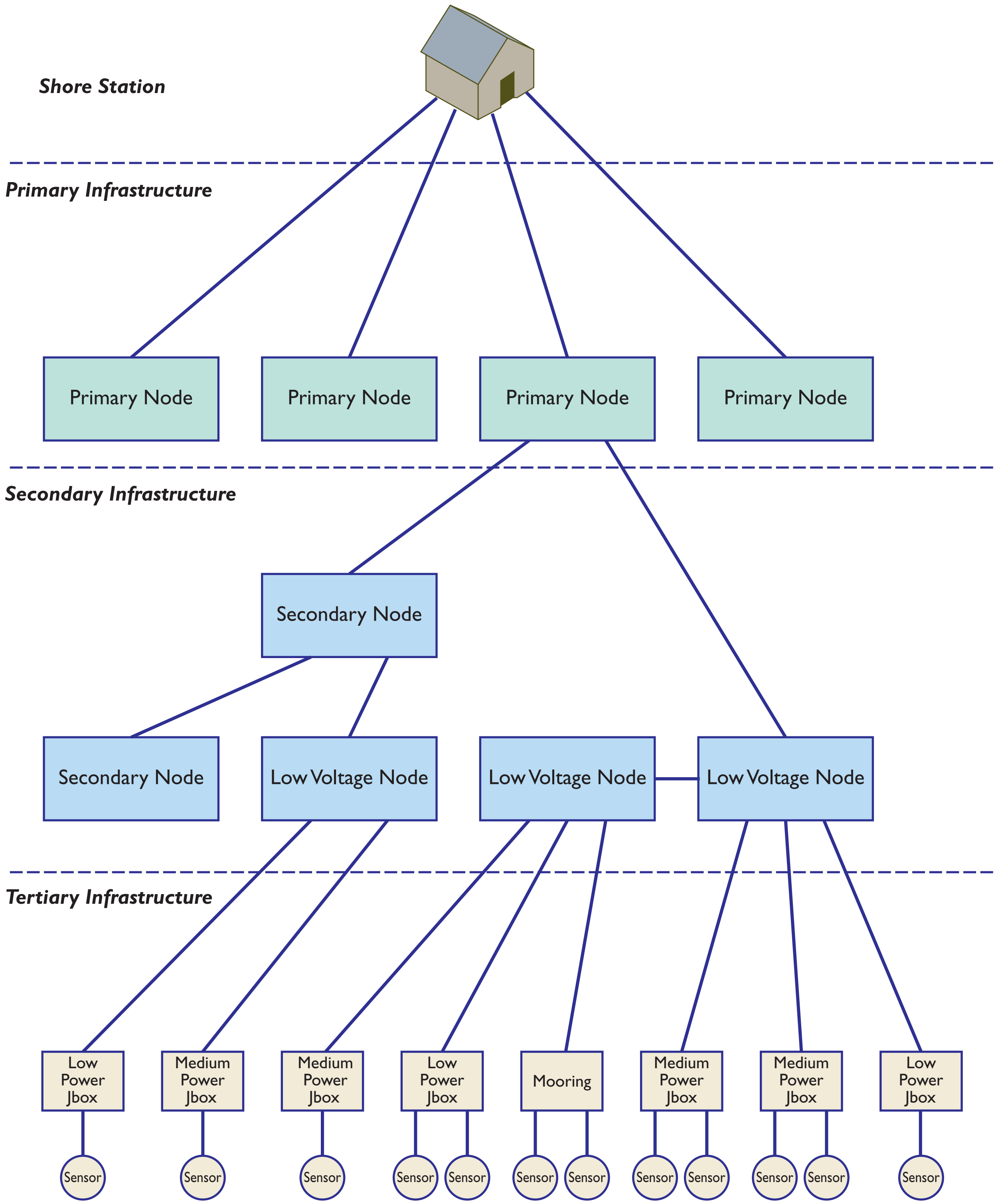

Figure 2-7
Simplified Schematic Illustrating the Linked Relationships
of the Primary, Secondary, and Tertiary Infrastructure of the RSN

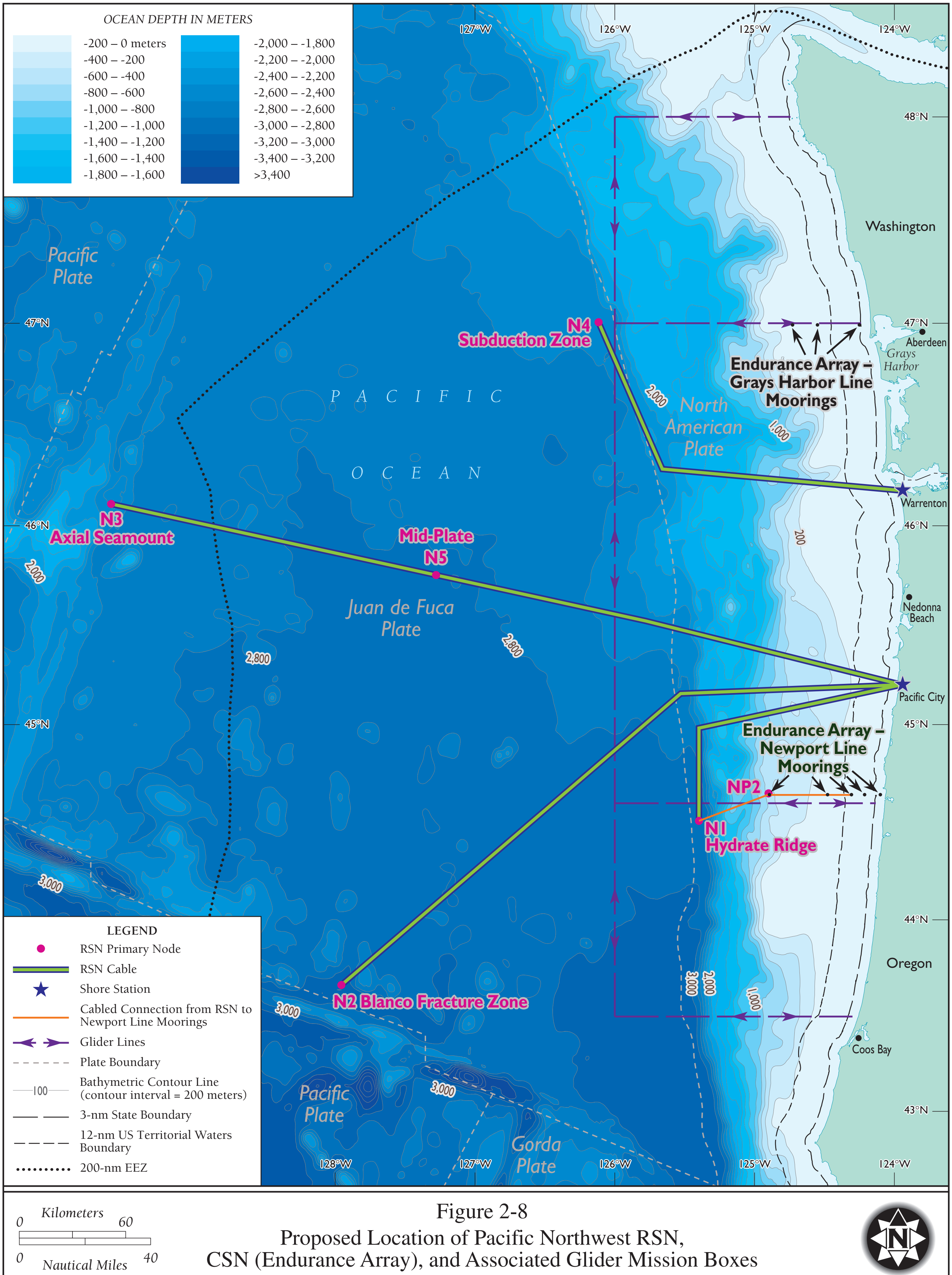

Figure 2-8
Proposed Location of Pacific Northwest RSN,
CSN (Endurance Array), and Associated Glider Mission Boxes

2.2.2.1 Shore Stations

Two existing submarine telecommunications shore stations have been identified for potential use as RSN cable landing sites: Warrenton and Pacific City, Oregon.

Warrenton

The Warrenton cable station is owned by GCI – a publicly traded, full service, commercial and residential communications company serving the major metropolitan areas of Alaska. The Warrenton Cable Station was specifically constructed in 2005 by GCI as the landing point for an undersea cable link between Oregon and Alaska. The Station is located within a residential area and is of wood-frame construction. A duct is available for at least one cable between the beach manhole and the station. A new duct from the station to the beach manhole would use existing rights of way and the existing beach manhole is large enough to accommodate RSN needs. Since no bore pipes are available to land new cables across the beach, horizontal directional drilling (HDD) would be required from the beach manhole to a water depth of 15 m.

Pacific City

MetLife, as the debt holder of the bankrupt North Pacific Cable (NPC), owns the Pacific City cable station. The station was closed in 2005 at the time of the NPC bankruptcy and the building has sat unoccupied since. The station has sufficient space to support all possible RCN configurations. At least two ducts are available from the station to the existing beach manhole. Since no bore pipes are available to land new cables across the beach, HDD would be required from the beach manhole to a water depth of 15 m.

2.2.2.2 Primary Infrastructure (Backbone Cable and Primary Nodes)

The Primary Infrastructure would include:

- 1,238 km of backbone cable (472 km of which would be buried and 766 km would be laid on the seafloor), and
- five Primary Nodes (N1, N2, N3, N4, and N5) (Figure 2-8).

Backbone/Submarine Cable

The backbone infrastructure of the RSN would initially comprise 1,238 km of up to four types of standard submarine telecommunications electrical-optical cable: Lightweight (LW), Special Applications (SPA), Light-Wire Armored (LWA), and Double Armored (DA) (Table 2-3). The cable types and proposed lengths are based on a preliminary analysis of the proposed cable route, seafloor substrate characteristics, and potential environmental activities (e.g., commercial fishing). As part of the OOI planning process, a Desktop Study will be prepared to examine in detail the proposed route and provide recommendations for cable types, locations for placement, and if burial or surface placement is necessary.

The basic underlying component of all cable types is the LW cable comprised of:

- the unit fiber structure supporting the electical-optic fibers protected by two layers of high-strength, steel-stranded wires;
- a copper sheath; and
- a medium-density polyethylene jacket.

The remaining three cable types utilize the LW cable as the base cable and simply add additional protection for various applications. The final outside protective cover for the SPA cable is a high-density polyethylene jacket. The LWA and DA are covered with a tar-soaked nylon yarn.

Table 2-3. Summary of RSN Primary Infrastructure Cable Types and Proposed Amount for Installation

Cable Type	*Outside Diameter (mm)*	*Applications*	*Features*	*Length to Install (km) (% of Total)*
Lightweight (LW)	17	Benign, sandy bottom; deploy to 8,000 m.	Core cable; light protection	369 (30%)
Special Applications (SPA)	22.4	Rough seabed; risk of moderate abrasion and/or attack by marine life; used as spare for LW; deploy to 6,500 m.	Metallic tape and second polyethylene outer jacket applied over core; additional abrasion and hydrogen sulfide protection.	384 (31%)
Light-Wire Armored (LWA)	28.9	Rocky terrain; some risk of fishing damage; used for burial in areas of decreased risk of external damage; deploy to 2,000 m.	Light-wire armored layer applied to core cable.	257 (21%)
Double Armored (DA)	35.9	Very rocky terrain; high risk of fishing damage; pipeline crossings; deploy to 800 m.	Second armored wire layer applied to LWA for additional protection.	228 (18%)
			Total	**1,238**

<u>Primary Nodes</u>

The Primary and Secondary Nodes function as gateways between the backbone cable and the Secondary Infrastructure. Based on the Monterey Accelerated Research System (MARS) design, each node would be enclosed in a trawl-resistant frame (TRF), which protects the electronic equipment of each node from fishing activities (Figure 2-9). The TRF is 4.5 m long, 3.6 m wide, 1.3 m high and weighs 4,800 kilograms (kg) in air.

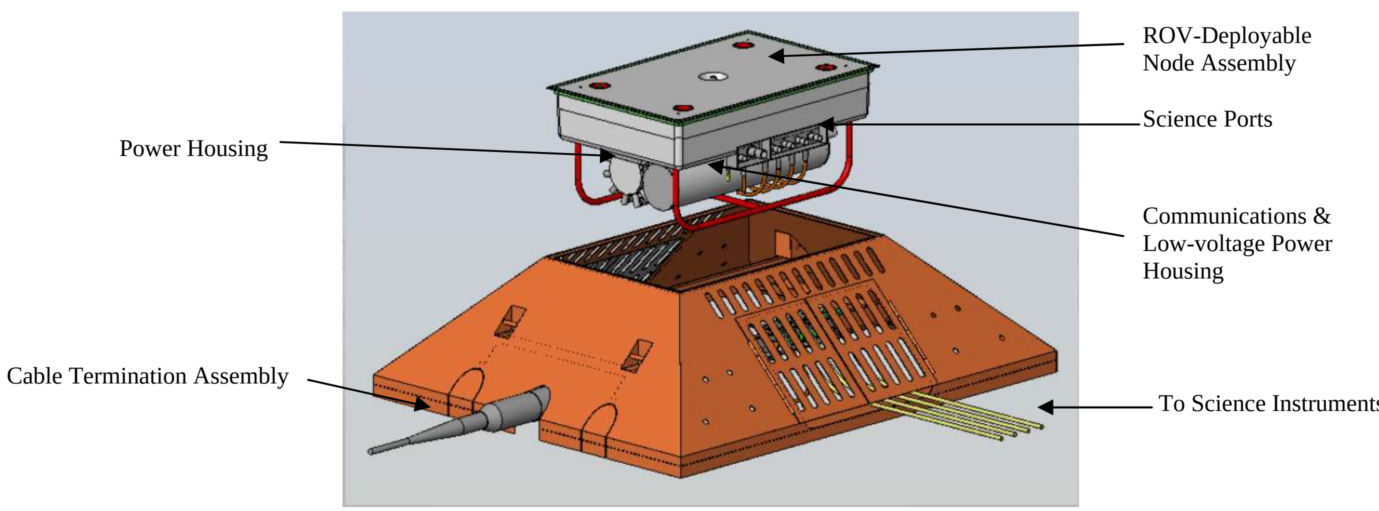

Figure 2-9 Trawl-resistant Frame (TRF) for Primary and Secondary Nodes

The following is a brief summary of the five Primary Node locations (Figure 2-8). All sites would host an initial suite of basic sensors, most likely an ocean bottom seismometer (OBS) coupled to a hydrophone, a differential pressure gauge, a pressure sensor, and a current meter. All Primary Nodes would potentially host water column moorings. Further initial instrumentation suites specific to science topics at specific nodes are summarized below.

Node 1: Hydrate Ridge (N1). N1 would be a focus for numerous interdisciplinary studies that address process linkages associated with gas hydrate formation, the flow of carbon from the crust and from the coast to the deep sea, and the connections between biogeochemical processes and climate change in a zone of high biological productivity. RSN cabled infrastructure at this site would include over 200 km of backbone cable and two Secondary Nodes, NP1 (900-m depth) and NP2 (500-m depth). NP1 would provide access to the gas hydrate site via two LVNs for future experiments and NP2 is the cable connection to the Newport Line of the Endurance Array (see Section 2.2.1.1) (Figure 2-8).

Node 2: Blanco Transform Fault (N2). Proposed cabled infrastructure at the Blanco Transform Fault would represent the best opportunity within the RSN for capturing large earthquakes, and examining deformation at a transform plate boundary and its relation to deformation and seismicity mid plate, at the subduction zone, and at the spreading center. The cable is required to provide real-time observations of the impact of seismic events at the other nodes as events unfold. A daisy-chained array of eight low-voltage nodes and ~100 km of extension cable would provide access to a suite of broadband seismometers at the Blanco Ridge.

Node 3: Axial Seamount (N3). As confirmed in more than 20 years of interdisciplinary studies, the Axial Seamount is seismically, volcanically, and hydrothermally active, having erupted at least three times in the last 12 years. Infrastructure would include the backbone N3, well away from recent eruptions, an LVN that would provide communication to the core suite of geophysical instruments, and a 40-km extension cable connecting to a Secondary Node located on the southeast summit flank providing access to the Axial Seamount Hydrothermal Emissions Study (ASHES) vent field and the caldera. A series of five LVNs and six MPJboxes would support a diverse array of core sensors designed to examine linkages among seismic activity, summit inflation, hydrothermal flow, fluid chemistry, and microbial output and temporal changes in assemblages.

Node 4: Subduction Zone (N4). Science at this site would be focused on earthquake and tsunami generation, plate-scale strain, and hydrological connectivity. The Cascadia subduction zone generated a magnitude 9+ earthquake in 1700, causing a large tsunami that was recorded in Japan. Correlations between fore-arc basin structure and the slip history of large earthquakes would inform the design of a future seismic and geodetic network at this node. In addition to the core geophysical sensors at N4, the site would host 40 km of extension cable and an LVN upslope to the east to support a suite of core geophysical instruments. A water column mooring at this location would provide observations in the "upstream" California Current and along-shelf gradients of properties with respect to the Newport Line of the Endurance Array (see Section 2.2.1.1).

Node 5: Mid-Plate (N5). N5, located between the Axial Seamount (N3) and the coast of Oregon, would provide a reference site that would allow study of stress propagation through the plate, as well as intraplate deformation and its relation to plate boundary failure. This site would allow future water column studies of the subtropical gyre and provide insights into seasonal, interannual, and interdecadal climate change and the impact of these changes on regional physics and ecology. The mid-plate node would also serve as an important site for studying the flux of carbon from the shelf across the slope to deep water.

2.2.2.3 Secondary Infrastructure

Cables

The electrical and EOM cables connecting the Primary Infrastructure to the Secondary Infrastructure would be ~25 mm in diameter and would be placed on the seafloor.

Secondary Nodes

Since the Secondary Nodes differ from Primary Nodes only in the number of expansion ports and the presence of an optical amplifier in the Primary Node, the Secondary Nodes would have the same physical characteristics as the Primary Nodes and would be contained in a TRF. Refer to Section 2.2.2.2 and Figure 2-9 for details.

Low-voltage Nodes (LVNs)

The LVNs interconnect sensors, their associated Jboxes, and Primary and Secondary nodes. Connections to an LVN are made using remotely operated vehicle (ROV) wet-mateable connectors so that the LVN can be brought to the surface for maintenance and repair without having to recover the cables or other attached infrastructure. The LVN would include a pressure housing attached to a frame (trawl resistant if required) that would sit on the seafloor. The ROV wet-mateable connectors would be on the outside of the frame for access by an ROV. A typical LVN would have a 1 x 1 m base and be 2 m high (Figure 2-10).

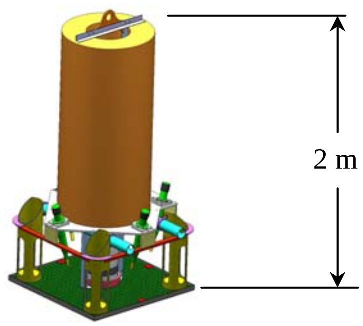

Figure 2-10 Representative Low-Voltage Node (LVN)

2.2.2.4 Tertiary Infrastructure

Cables

The electrical and EOM cables connecting the components within the Tertiary Infrastructure (e.g., Jboxes to sensors) and the Secondary Infrastructure to the Tertiary Infrastructure would be ~25 mm in diameter and would be placed on the seafloor.

Junction Boxes (Jboxes)

The ultimate connection to the sensors would be through a JBox. The JBox has specific power and protocol converters for each sensor type that would be attached to it. Typically the JBox would be configured for a cluster of sensors that are mechanically attached together and would be deployed at the same time. One ROV wet-mateable connector can be used to plug the entire sensor cluster into the system at one time. There would be two versions of the JBox: MPJBox and a LPJbox. Each would be placed on the seafloor and the footprint could range from four ~0.1-m^2 plates (Figure 2-11) or one 1.5 x 2.5 m plate depending on the sediment and type of sensors attached to it.

Figure 2-11 Representative Junction Box (Jbox)

2.2.2.5 Summary of Proposed RSN Primary, Secondary and Tertiary Infrastructure

The total Primary, Secondary, and Tertiary infrastructure that would be installed under the Proposed Action is listed in Table 2-4.

Table 2-4. Summary of Installation Requirements for RSN Primary, Secondary, and Tertiary Infrastructure

Equipment	*Amount*					
PRIMARY INFRASTRUCTURE						
Cable Landings (ea)	4					
Primary Nodes (ea)	5					
Total Cable to Install (km)	1,238					
By Cable Type						
DA (km)	228					
LWA (km)	257					
SPA (km)	384					
LW (km)	369					
Mode of Cable Installation						
Buried (km)	472					
Surface (km)	766					
	Node					Total
	N1	N2	N3	N4	N5	
SECONDARY INFRASTRUCTURE						
Secondary Nodes (ea)	2	0	1	0	0	3
LVNs (ea)	4	2	7	3	2	18
Cable (km)	53.75	5.5	53.7	45.5	5.5	163.95
TERTIARY INFRASTRUCTURE						
LPJboxes (ea)	1	2	2	2	2	9
MPJboxes (ea)	2	8	5	1	0	16
Sensors (including vertical moorings)	43	48	51	37	34	213
Cable (km)	0.890	117	0.835	0.880		119.605

2.2.3 Global-Scale Nodes (GSN)

The GSN would support air-sea, water-column, and seafloor sensors operating in remote, scientifically important locations and provide data and near-real time interaction to diverse communities of scientific and educational users. The scientific goals are to provide sustained atmospheric, physical, biogeochemical, ecological, and seafloor observations at high latitudes. These observations are required to understand critical influences on the global ocean-atmosphere system such as air-sea interactions and gas exchange; the global carbon cycle; ocean acidification; and global geodynamics. Currently, no capability exists to collect these coincident, multidisciplinary time-series data.

Long-term continuous open-ocean observations are essential for quantifying and understanding interannual-to-decadal (and longer) changes in an array of processes, ranging from biogeochemistry to ocean circulation and geodynamics. Moored buoy, open-ocean observatories are well suited to address these requirements, especially in remote areas where cabled observatories are unavailable or prohibitively expensive to install. Thus, moored buoy observatories are an important complement to other components of the global ocean observing system that includes satellite remote sensing, cabled ocean observatories, coastal arrays, gliders and AUVs, and research vessels.

The OOI's design process has identified three strategic high-latitude sites and one mid-latitude site as comprising the initial GSN under the Proposed Action (Figure 2-12):

1. Station Papa in the southern Gulf of Alaska – 50° N, 145° W; depth = 4,250 m
2. Southern Ocean off Chile – 55° S, 90° W; depth = 4,800 m
3. Irminger Sea southeast of Greenland – 60° N, 39° W; depth = 2,800 m
4. Mid-Atlantic Ridge – 23° N, 43.5° W; depth = 4,460 m

Station Papa, Southern Ocean, and Irminger Sea would all have an acoustically linked discus buoy, one subsurface and two flanking subsurface moorings, and five gliders. The Mid-Atlantic site would have the EDP with a benthic node, one subsurface and two flanking subsurface moorings, and five gliders.

Station Papa. This northern, high-latitude site is characterized as a region of net carbon dioxide (CO_2) uptake and a productive ecosystem regime; it would provide an upstream physical and biological reference for OOI's Washington/Oregon RSN and the Pacific Coastal array; it would extend long-term historical time-series obtained by ship occupation of the site and by occasional process mooring deployments; it would provide air-sea flux forcing information; and it would exploit future synergy with a DART buoy in the vicinity.

Southern Ocean. This southern, high-latitude site is an important water-mass formation site, a strong localized southern CO_2 uptake region, a productive ecosystem regime, has virtually unobserved processes, and provides critical Southern Ocean air-sea flux forcing information. Real-time access and control of the simultaneous multidisciplinary observations would for the first time permit investigation of the forcing of processes leading to climate-related changes in the Southern Ocean and potentially reveal new phenomena. Large-scale ocean heat content and circulation measurements using acoustic thermometry would be conducted by this site.

Irminger Sea. This high-latitude site in the North Atlantic is located in a region of strong total and anthropogenic CO_2 uptake coupled with water-mass formation, and is a productive ecosystem and fisheries regime responding strongly to climate variations. This area would also provide a site to study air-sea flux forcing in an extreme environment. As with the Southern Ocean site, real-time access and control of the simultaneous multidisciplinary observations would for the first time permit investigations of the processes leading to climate-related changes in the ecosystem, CO_2 dynamics, watermass formation, and potentially reveal new phenomena, including those related to atmospheric forcing.

Figure 2-12
Proposed Location of the GSN

Mid-Atlantic Ridge. This mid-latitude site would be located at Deep Sea Drilling Project (DSDP) Hole 396 B immediately west of the Mid-Atlantic Ridge. The equatorial Atlantic is the optimum region to observe seismic waves that impact the outer core and core-mantle boundary. A broadband borehole seismic station at this site would record these phases; permit measurement of the structure and heterogeneity of the oceanic upper mantle; and provide long-term observations of earthquake rupture along a large oceanic transform fault. Seismic measurements would be augmented by seafloor electromagnetic and magnetic field measurements. In addition to the geophysical drivers, the Mid-Atlantic site is located at the edge of a sub-tropical gyre, in a region characterized by low productivity and high iron flux (from Saharan dust). The location of this site would enable studies of the biogeochemical fluxes of CO_2, oxygen, nutrients, and trace metals; some of the latter measurements requiring above-water platform stability and power not easily provided by conventional buoy designs.

2.2.3.1 GSN Infrastructure and Platforms

OOI infrastructure would provide the power, bandwidth, and platform space to support more capable sensor packages, bring back as much data in near real time as possible from these under-sampled regions, and permit two-way communications to control and change sampling strategies in response to contextual information. OOI's GSNs would serve as a foundation and proof of concept of new technology, encourage the development of sophisticated, multidisciplinary sensor suites, and become the basis for future expansions and national and international partnerships that would establish truly global ocean coverage.

The planned GSN infrastructure would provide comprehensive surface-to-seafloor observing capability at fixed locations; additional moorings and gliders would provide information on the site's mesoscale context. Paired surface and subsurface moorings would resolve surface forcing, and water column, benthic, and seafloor processes in time and in the vertical, the latter dimension with two profilers spanning the water column. Flanking moorings and gliders would collect data on spatial gradients and advective influences. The global platform design is initially proposing the use of two types of surface platforms: (1) moored discus buoy acoustically linked to subsurface instrumentation, and (2) tri-moored EDP that would provide substantial power and bandwidth to the seafloor instrumentation.

Surface and Subsurface Moorings

Acoustically Linked Discus Buoy. The simplest moored buoy observatory that is proposed for three high-latitude GSN sites (Station Papa, Irminger Sea, and Southern Ocean) is the acoustically linked discus buoy (Figure 2-13). The buoy and mooring are a mature and reliable technology that has been utilized for decades for ocean research. The 8-m long discus buoy consists of a welded aluminum core structure and a closed-cell polyethylene foam buoyancy module in the shape of a cylinder about 2 m high and 3 m in diameter. The buoy has a welded aluminum tower structure that supports meteorological sensors, antennas, solar panels, and wind turbine(s). The top of the buoy tower is ~5 m above the sea surface and the draft is 3 m.

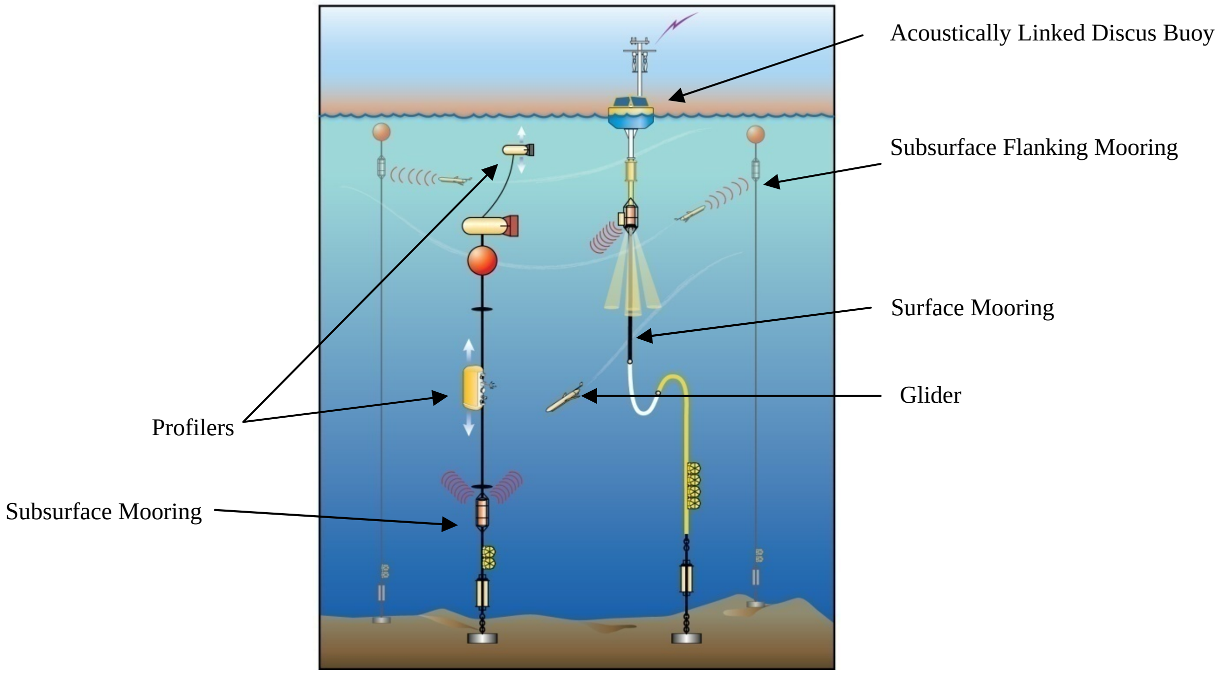

Figure 2-13 Representation of an Acoustically Linked Discus Buoy and Subsurface Moorings Proposed for Use at the High-Latitude GSN Sites

Per USCG guidelines for ODAS, the buoy is equipped with a radar reflector and amber flashing light and is marked for identification and visibility. The buoy is anchored to the seafloor using an 11-mm diameter steel and synthetic mooring line, with 10 m of 15-cm diameter EOM urethane-molded chain directly below the buoy. Actual time on station to deploy a discus surface mooring is ~12-24 hours. The discus mooring would have a ~36-in diameter anchor weighing 1,800 to 3,200 kg, depending on water depth. The flanking moorings would be similarly anchored as the moorings in the Endurance and Pioneer arrays.

As illustrated in Figure 2-13, an acoustically linked surface mooring provides the platform for meteorology and air-sea flux sampling, power generation, and satellite communication. A downward-looking ADCP and other sensors would sample physical, chemical, and biological variability in the upper ocean. An adjacent subsurface mooring would have an upper profiler capable of penetrating the surface, and a lower, “wire-crawler” profiler for sampling the rest of the water column. Two flanking subsurface moorings and gliders would sample mesoscale variability around the node (see additional discussion below). The acoustically linked discus mooring would have inductive communications available from the surface to a depth of several hundred meters. Below that, acoustic modems would provide communications to the discus buoy from sensors deeper in the water column and on the seafloor.

The discus buoy would be designed to self-right and carry electronics and storage batteries. It contains an electronics controller consisting of a microcomputer running code designed to control power supplied to sensors, acquire and log data, and transmit recorded data to shore via satellite and/or radio links (e.g., Iridium, Freewave, WiFi). The power generation system consists of solar cells and wind turbine(s) that would provide 40-50 W continuous power generation. The proposed Southern Ocean discus buoy would be capable of being upgraded to a methanol-based fuel cell power generation system. Power is stored in AGM sealed lead/acid batteries housed in a chamber within the buoy hull structure. An alkaline battery pack may be used for backup power supply in the event of a power system failure.

The innovative aspect of this design as envisioned for OOI is that high data rate, power-efficient acoustic modems would be used to retrieve data from sensors in the water column and on the seafloor out to ranges of ~3 km from the buoy. The data are subsequently transmitted to shore via an Iridium satellite link. A key feature of this system is the ability to add or remove sensors from the observatory without recovery of the buoy or mooring, providing considerable flexibility in the operation and maintenance of the sensor network. However, the acoustically linked system does not provide power to a benthic node.

An "enhanced" EOM moored buoy may be deployed at Southern Ocean GSN site (Figure 2-14). The surface mooring would be cabled to a seafloor junction box (benthic node) providing power and telemetry for a greater diversity of sensors. A subsurface profiler mooring may be linked by cable (dashed line in Figure 2-14) to the surface mooring rather than acoustically, thereby providing a path for data from the subsurface mooring to the satellite relay hardware on the surface mooring. As discussed previously, this enhanced mooring would include subsurface flanking moorings and gliders to sample mesoscale physical, chemical, and biological variability within the water column.

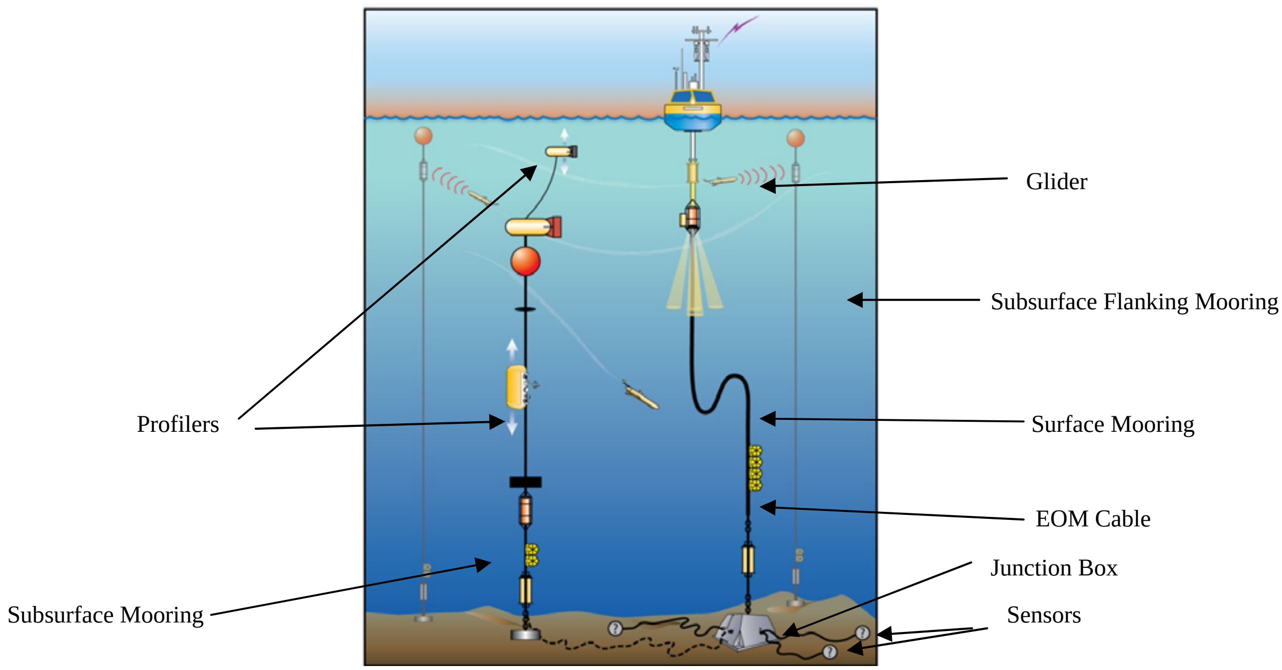

Figure 2-14 Enhanced EOM-Moored Discus Buoy with Benthic Node and Subsurface Moorings

Subsurface Profiler Mooring. Each GSN would have a subsurface profiler mooring close to the surface mooring (i.e., discus buoy or EDP). The subsurface profiler mooring would have two profilers. An upper profiler would operate from ~150 m to the surface, providing a platform for high vertical-resolution sampling up to and including at the sea surface. A lower profiler would sample down to the seafloor. Communication within the subsurface mooring and the upper part of the surface mooring would be inductive, while acoustic modems would be used for communication between the subsurface mooring and the surface buoy and to sensors deeper in the water column or on the seafloor. The upper profiler would penetrate the surface, allowing satellite data telemetry.

Mesoscale Flanking Mooring. Two additional, less-sophisticated subsurface moorings may be deployed to form a triangular array with the central site (~100 km on a side). These flanking moorings are subsurface moorings and have no surface expression or satellite telemetry. They are supported by a syntactic foam subsurface float ~2 m in diameter, below which is a mechanical wire rope mooring to releases at the bottom and a deadweight cast steel anchor. The wire rope is ~8 mm in diameter and is typically broken up into 500-m segments (or shots) for ease of handling and shipping. At sea the shots are assembled as the mooring is deployed, using shackles and sling links. The bottom of the mooring above the releases typically has an array of 43-cm glass spheres that provide sufficient flotation to bring the entire mooring to the surface even if the main flotation sphere is lost.

The mooring would support self-powered and internally recording instrumentation that can be located at any mooring break, allowing for the configuration to be easily changed for a given deployment. The moorings would contain acoustic modems that can collect and compress some data from instrumentation and transmit data intermittently to acoustically equipped gliders when they are in the vicinity or regular data capsule releases from the moorings. In addition, sampling within and around the triangular array would be done using several gliders. These gliders would carry multidisciplinary sensor suites and sample for a year and can be commanded to alter their sampling patterns.

Extended Draft Platform (EDP). The EDP is a deep draft semi-submersible type platform comprised of a 2.5-m tall upper deck box, three 33-m tall and 4.3-m diameter columns, and a submerged lower pontoon (Figures 2-15 and 2-16). The deck is ~33 m from column to column with 26.5 m spacing between columns. Compartments in the three extensions of the deck box are designed to hold all the power, communications, and instrumentation equipment. Each mooring line consists of an upper segment of wire rope, a middle section of 3-inch (-in) diameter polyester line and a lower segment of chain. The platform would be anchored by three 10-foot (ft) diameter anchors each weighing 76 metric tons. The anchors are steel-reinforced concrete and are attached to 300 ft of 2-in diameter chain.

The EDP would provide a stable platform more than 10 m above the sea surface, with large deck space (300 m^2), diesel/solar electric power generation of ~10 kilowatts, with an EOM cable. An EOM cable from the EDP to the seafloor would provide power and two-way communications to a junction box for benthic and borehole sensors and experiments and then to the subsurface mooring and oceanographic sensors, and a data link back to the surface.

These capabilities would also allow atmospheric sampling, including remote sensing (lidar, radar), automated radiosonde launching, aerosol sampling, and measurement of the surface radiation budget. As with other GSN sites, the proposed EDP site would have a profiler-equipped subsurface mooring, two subsurface flanking moorings, and gliders.

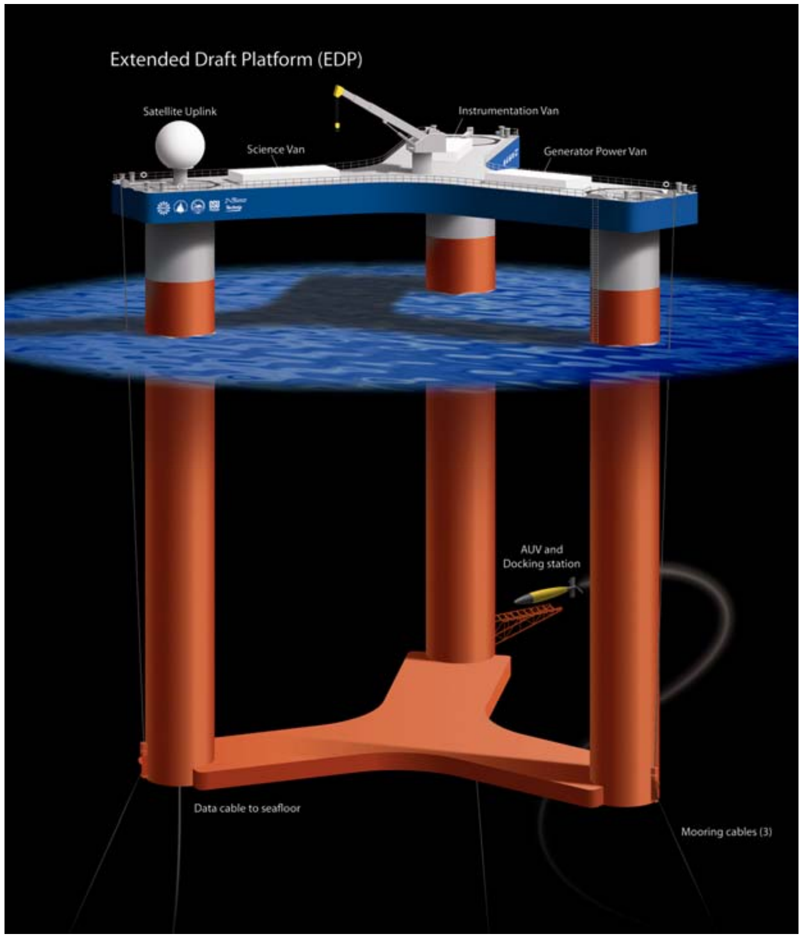

Figure 2-15 Extended Draft Platform (EDP)

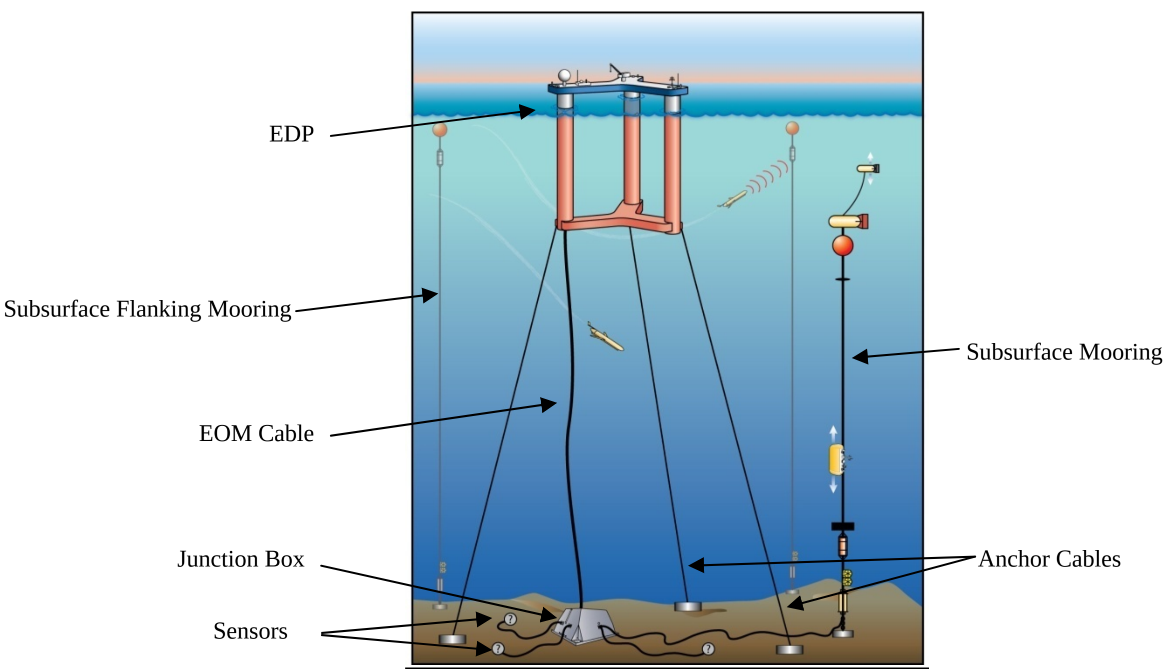

Figure 2-16 Representation of the EDP with Subsurface Moorings

2.2.4 Gliders and AUVs

Gliders and AUVs would carry multidisciplinary sensor suites and sample at the mesoscale field within the GSN and CSN. They would sample autonomously for up to 1 year along pre-programmed sampling patterns.

2.2.4.1 Gliders

A glider is a type of unmanned and untethered underwater vehicle that navigates autonomously without any physical connection to a research vessel at the surface. The Spray glider is representative of the class of gliders that is proposed for use in the OOI. The Spray glider is 2 m in length, has a wingspan of 1.2 m, weighs 51 kg, and has an operating speed of about 0.5 knot (Figure 2-17). Except for the external bladder and measurement sensors, located in a plastic tail section, the glider has no external moving parts or motors and all parts are encased inside an 8-mm thick aluminum hull. It moves on a pre-programmed course vertically and horizontally in the water by pumping mineral oil between two bladders, one internal and the other external to the hull. This action changes the volume of the glider, making it denser or lighter than the surrounding water.

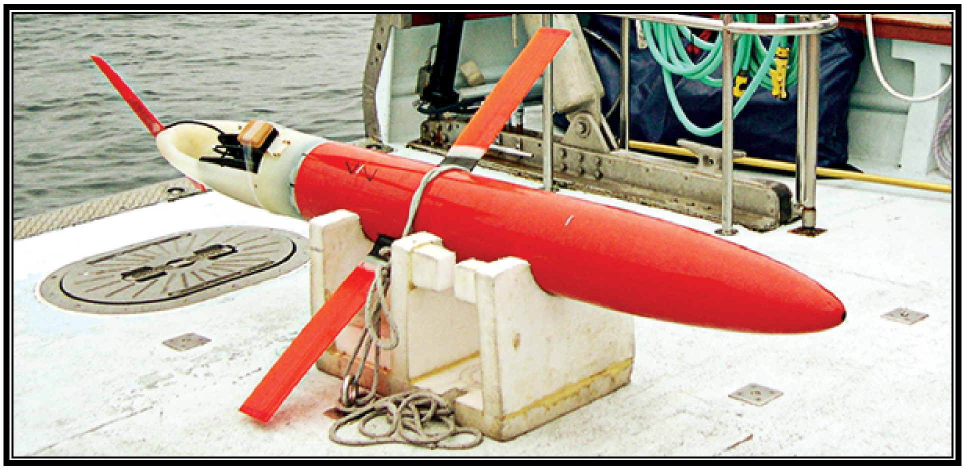

Figure 2-17 Spray Glider

On a mission, a Spray glider resembles a whale moving through the water as it repeatedly submerges and resurfaces. It takes 3.5 hours for the glider to reach a depth of 1 km before it ascends to the surface, gathering data as it rises. During that time it would travel a horizontal distance of 5 km (Figure 2-18). At the beginning and the end of each dive, the glider obtains and records its position by rolling on its side to expose a Global Positioning System (GPS) antenna embedded in the right wingtip. Researchers obtain data from the glider and send new instructions to it using a satellite phone system and an antenna embedded in the left wingtip. In addition, the glider may also communicate acoustically to vertical moorings associated with the GSN and CSN. Currently Spray gliders operate at depths less than 1,500 m and can carry out missions lasting as long as 6 months.

Proposed for use in the GSN and CSN, gliders can carry an entire suite of oceanographic sensors that can measure temperature, salinity, pressure, turbidity, currents, dissolved oxygen, CO_2, acidity/alkalinity, and nutrients.

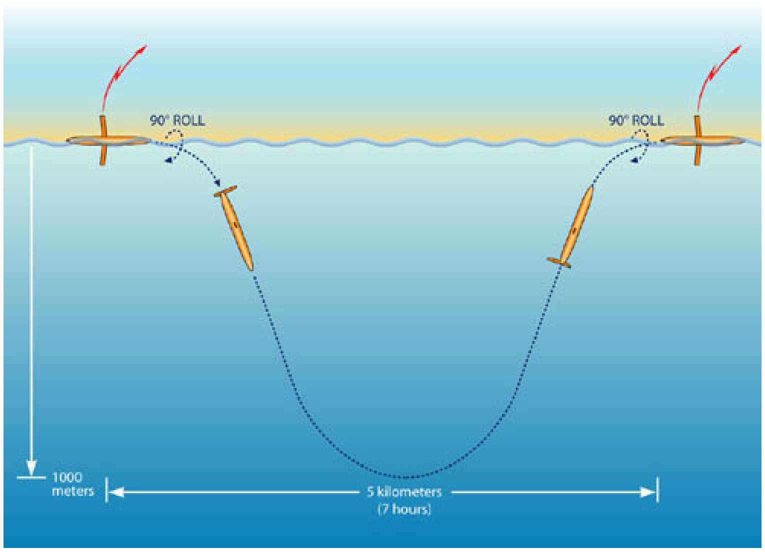

Figure 2-18 Example of a Glider Mission

2.2.4.2 Autonomous Underwater Vehicles (AUVs)

Unlike the long missions, deep-diving abilities, and slow speeds of gliders, a powered AUV travels faster, but for a shorter duration. The Remus 600 AUV is representative of the class of AUVs that is proposed for use in the OOI. The Remus 600 AUV can operate for up to 70 hours on rechargeable lithium ion batteries, can operate at depths to 600 m, and has a speed of up to 5 knots. It is 3.25 m long, has a diameter of 32.4 cm, and weighs 240 kg. AUVs would conduct missions in support of the Pioneer Array. As discussed previously, the base of some of the vertical profiler moorings would be equipped with AUV docking stations, which would allow an AUV to dock and recharge its batteries, thereby extending its at-sea mission. It may be equipped with a number of sensors including conductivity-temperature-depth (CTD), ADCP, pressure sensors, fluorometers, video camera, still camera, and acoustic imaging.

2.2.5 Sensors

To measure changes and variability in the chemical, biological, and geological processes in the ocean, the proposed OOI would be equipped with a complex suite of sensors. These sensors would be deployed from a number of platforms including water column moorings and on the seafloor. Table 2-5 provides a list of potential sensors that may be utilized within the OOI. It is important to note that the actual sensors to be deployed as part of the OOI program would be determined based on scientific objectives, costs, and the on-going discussions between engineers and investigators. It is expected that additional sensors would be added as the OOI program proceeds and the scientific objectives change based on researcher needs and priorities. Although these sensors would be largely commercial off-the-shelf sensors, some would require some modification for extended deployment and a small number would require further development to meet the scientific objectives and requirements of the proposed OOI. This would maximize the utility of the proposed OOI to the broader ocean research community. As additional sensors are proposed, they would be examined for potential environmental impacts, either during their installation or operation, and additional environmental documentation would be prepared, if necessary, that would be tiered off of this Programmatic EA.

Table 2-5. Representative Non-Acoustic Sensors Proposed for Use in the OOI

Sensor	*Measurement*	*Platform(s)*
CTD	Water conductivity, temperature, and depth	Mooring, glider, AUV, benthic
Photosynthetically active radiation (PAR)	Light radiation	Mooring, glider, AUV
Nitrate sensor	Nitrates	Mooring
Broadband seismometers	Seismicity	EDP: benthic (borehole)
Short-period seismometers	Seismicity	Benthic
Pressure	Tidal and storm influence on seismicity and hydrothermal flow	Mooring, AUV, glider, benthic
Temperature-resistivity-H_2	Temperature-chlorinity and dissolved hydrogen	Mooring, benthic, AUV, glider
Fluid-particulate DNA	Fluid-particulate DNA	Benthic
High-definition camera	Imaging of biology and fluid flow at vents	Benthic, mooring
Gravity meter	Gravity field	Mooring
Surface meteorology	Air temperature, barometric pressure, relative humidity, wind velocity, short- & long-wave radiation, precipitation	Surface mooring
Microbial incubators	Environmental conditions within vent walls, co-registered microbe-temperature-fluid sampling	Benthic
pH	Acidity/alkalinity	Mooring, benthic, AUV, glider
Chl-a and colored dissolved organic matter (CDOM) fluorescence	Chlorophyll a and dissolved organic matter	Mooring, glider, AUV, benthic
Optical backscatter	Turbidity and sediment concentration	Mooring, glider, AUV, benthic
Oxygen	Oxygen	Glider, AUV, benthic, mooring
Partial pressure of CO_2	Partial pressure of CO_2	Mooring

The active acoustic sources proposed for use in the proposed OOI include (Table 2-6):

- Acoustic Doppler Velocimeter (ADV). ADVs are active sensors with an operating frequency of 5-6 megahertz (MHz), a source level of ~220 dB reference 1 micropascals at 1 m (re 1µPa @ 1 m), and a pulse length of 600 microseconds (µs). They would be placed on moorings or on the seafloor to investigate turbulence, boundary layers, directional waves, and sediment transport.
- ADCP. An ADCP can calculate the speed of the water current, direction of the current, and the depth in the water column of the current. This instrument can be placed on the seafloor, attached to a buoy or mooring cable, or mounted on an AUV or glider. The ADCP measures water currents with sound, using a principle of sound waves called the Doppler effect and works by transmitting high frequency (~150-1,200 kHz) very short pings (0.6-1.5 milliseconds [ms]) of sound into the water. The source level would be ~220 dB re 1µPa @ 1 m.
- Bio-acoustic Profilers (BAPs). BAPs monitor the presence and location of zooplankton within the water column by transmitting short (~300 µs) narrow-beam (10°) signals at ultrasonic frequencies (200 kHz), which measure acoustic backscatter returns. The source level is 213 dB re 1µPa @ 1 m. Other targets detected include fish and suspended sediments. Much like a downward looking fish-finder, this tool measures the vertical distribution of plankton and fish.
- Altimeters. Altimeters would be used to assist AUVs and gliders with determining their altitude above the sea floor. They generally use generally high frequency (170 kHz) sources that emit a narrow (<5^{o}), downward directed beam with a source level of 206 dB re 1µPa @ 1 m.
- Multibeam Echosounder (MBES). During research activities, the ocean floor would be mapped with an MBES. The MBES emits brief pulses of high-frequency (100 kHz) sound in a narrow (1-2^{o}) fan-shaped beam at a source level of 225 dB re 1µPa @ 1 m.
- Acoustic Modems. Acoustic modems would be used for communication between mooring profilers, benthic sensors, and surface and subsurface buoys. They would operate as a narrow-beamed (<5^{o}), 20-30 kHz signal with a pulse duration of 1-2,000 ms.

- Tracking Pingers. These pingers would enable the tracking of AUVs and gliders once they are deployed. These pingers operate at a frequency of 10-30 kHz and emit a very brief (7 ms) pulse at source levels of 180-186 dB re 1µPa @ 1 m.
- Horizontal Electrometer-Pressure-Inverted Echosounder (HPIES). The HPIES is proposed as a core sensor on the RSN located on the seafloor near the full water column moorings. This instrument package combines a bottom pressure sensor, 12-kHz inverted echosounder, and a horizontal electrometer. Together these sensors allow measurement of bottom pressure, seafloor to sea surface acoustic travel time, and motionally induced electric fields. These properties provide insights into the vertical structure of current fields and water properties including temperature, salinity, and specific volume anomaly, separation of sea surface height variation and temperature, and near-bottom water currents. The echosounder would operate at a source level 172, 177, 182 dB re 1µPa @ 1 m at depths of 1,000, 2,000 and 3,000 m, respectively. There would be 24 narrow beamed ($<5^{o}$), 6-ms pings per hour.
- Sub-bottom Profiler (SBP). The SBP is normally operated to provide information about the near-surface features and bottom topography that is simultaneously being mapped by the MBES. It operates at mid-frequencies (2-7 kHz) with a source level of 203 dB re 1µPa @ 1 m.

Table 2-6. Representative Active Acoustic Sensors Proposed for Use in the OOI

Acoustic Source	*Frequency*	*Source Level (re 1µPa @ 1 m)*	*Pulse Length*	*Purpose/Platform(s)*
ADV	1-6 MHz	~220	600 µs	Current velocity/Mooring, benthic
ADCP	75-1,200 kHz	~220	0.6-1-5 ms	Current velocity across the water column/Mooring profilers, gliders, AUVs, benthic sensors
BAPs	200 kHz	213	150-350 µs	Presence and location of biological parameters (e.g., zooplankton)/Mooring profilers
Altimeters	170 kHz	206	4 sec	Height above seafloor/glider
MBES	100 kHz	225	*	Bottom mapping/AUVs, gliders, mooring profilers
Acoustic modems	20-30 kHz	180	1-2,000 ms	Communication/Moorings, AUVs, gliders, mooring profilers
Tracking pingers	10-30 kHz	180-186	~7 ms	Location/AUVs, gliders
HPIES	12 kHz	172, 177, 182 (depending on depth)	6 ms	Water column velocity, pressure, temperature/Mooring, benthic sensors
SBP	2-7 kHz	203	*	Bottom mapping/AUVs

Notes: *Unlike conventional continuous waveform sonar systems that transmit a short-duration, constant-frequency pulse, the proposed MBES and SBP would transmit a chirp pulse (i.e., a long, linearly swept pulse that changes in frequency linearly over time).

2.2.6 Installation and Operation & Maintenance (O&M)

The following sections describe the general methods that would be used to install the infrastructure of the proposed OOI and conduct routine O&M activities. Proposed installation and O&M activities would use standard methods and procedures currently used by the undersea telecommunications industry. However, methods may change based upon site-specific surveys, ship schedules, and final determination of types of equipment to be installed (e.g., sensor types, models, etc.). If subsequent proposed installation and O&M activities are significantly different than the proposed installation or O&M methods described in this Programmatic EA, then additional environmental documentation would be prepared to assess any potential impacts to the environment.

2.2.6.1 RSN Primary Infrastructure Submarine Cable

A 450-500 ft cable-laying ship is proposed for cable deployment. The cable laying and plowing operation, conducted from the cable laying ship, constitutes the primary construction activity.

As part of the OOI planning process, a Desktop Study will be prepared to provide pertinent information on seabed depths, geological conditions, and hazards along the proposed RSN cable route, as well as information on existing cables and pipelines, permitting concerns, and fisheries and weather considerations offshore the landing site. Cable engineering information will be based on bathymetric charts and other data currently available. The route is subject to modification when additional information is collected during the marine route survey to be conducted prior to any proposed installation activities. In the meantime, for the purposes of this Programmatic EA, information on the proposed RSN cable route is being derived from a Desktop Study prepared for a previously considered RSN cable route alternative that was dismissed during the review process (University of Washington 2007d).

Cable Laying and Burial Operations

Prior to the cable laying operation, a grapnel run would be carried out along the route to ensure that it is free from debris that could interfere with the cable burial operation. A grapnel run involves dragging a small, anchor-like hook on the seafloor along the proposed cable route, to insure that no obstructions or debris are present along the path. The disturbance area is 8 in wide by 12 in deep. Although the sensitivity of the instruments used during the cable route survey ordinarily detects the presence of obstacles, there is a possibility during the period between the cable route survey and actual deployment, that intervening events have deposited debris on the seafloor. All detected debris is removed from the cable path to avoid interference with the burial plow. The grapnel would not be pulled through rocky areas, since the cable plow would not be used along these portions of the route.

Cable burial would be accomplished using a submarine cable plow (Figure 2-19), an existing tool used by the undersea telecommunications industry. The ship would tow the plow, which would dig a narrow trench into the seafloor and insert the cable into the trench. The trench would be ~6-8 in wide, and would refill immediately when the seabed material slumps back due to the surrounding hydrostatic pressure, which pushes into the temporary suction vacuum created by the trenching-blade. No dredging or other removal of material is required. Cameras on the sea plow are used to give the operator warning of any visible obstacles. The plow rides lightly on skids and wheels that limit the temporarily disturbed area to two narrow swaths (3 ft each) in soft mud, the most easily disturbed bottom type. The plow would be lifted well off the sea floor when it is traveling over areas of hard bottom to avoid impacts to hard-bottom communities. Temporary increases in turbidity are expected to last only a few minutes, depending on currents and sediment type, and would occur within only a few feet of the plow.

The cable deployment and plowing would be carried out by the cable ship in a tandem operation at a speed in the range of 0.5 to 1.5 knots depending on bottom type and would lay ~1-2 km of cable per hour. This corresponds to about 20 days total to bury the estimated 472 km of cable (refer to Table 2-4). When the ship is laying cable on the seafloor without burying it would travel at ~7 knots, would lay 10-14 km of cable per hour, and would take about 3 days to lay the remaining cable on the seafloor. Therefore, it would take ~23 days to lay the entire proposed 1,238 km of cable. However, 30 days has been allowed in the schedule to allow for the possibility of weather days (during which installation cannot proceed) or other delays.

The cable laying operation in the vicinity of the landing sites would take ~2 working days. This includes time for the ship to establish position dynamically, for divers to jet the conduit exit point clear, float the cable to the exit point, winch the cable through the conduit to the manhole and bury the cable from the exit point to the ship's location.

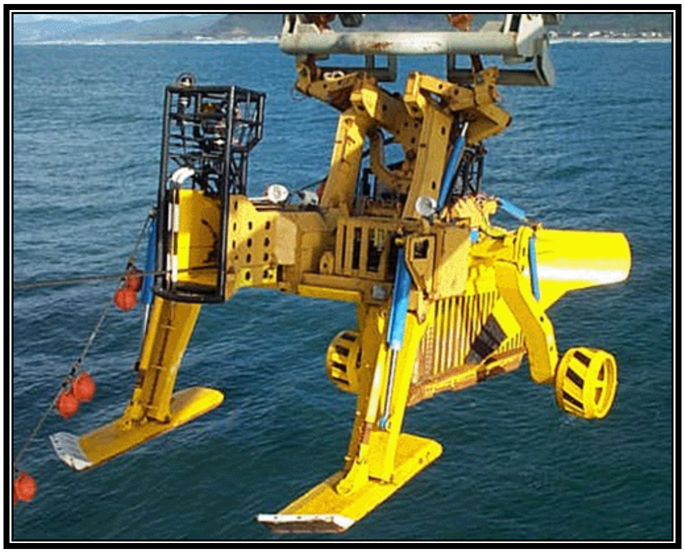

Figure 2-19 Example of a Submarine Cable Plow

<u>Controlled Slack to Avoid Cable Suspensions</u>

Cable suspensions can occur in hard-bottom areas with an uneven surface. The route has been proposed to avoid hard-bottom areas. Two important parameters determine the degree and amount of cable suspensions in hard-bottom regions along the proposed route: (1) the flexibility of the cable, and (2) the control of cable slack during deployment. The small-diameter cable proposed for the RSN is the same as that employed for transoceanic systems and therefore has the same flexibility. Cable flexibility is the key characteristic that determines whether the cable will readily conform to the seafloor contours, provided that sufficient cable slack is introduced to enable conformation. Cable slack is the excess length of cable needed to conform to variable bottom conditions along the seafloor. The exact degree of slack required will be estimated during the preparation of the Desktop Study and ultimately determined from the detailed seabed survey, real-time data collection in the course of installation, and by experience of the cable-laying contractor gained on similar route sections on similar transoceanic cable laying projects.

Extremely rocky areas and regions with rapidly changing slopes (i.e., greater than or equal to 15 degrees) would be avoided by refining the proposed cable path after analysis of the cable route survey data. While surface laying the cable, the laying vessel travels at slow speeds, so the cable will have time to settle to the seabed with the required slack.

<u>Cable Burial Considerations</u>

In the areas where the cable will be buried, the equipment that digs the trench also lays the cable in the trench in one continuous operation. The primary consideration in cable burial is to avoid the potential "conflict of use" of the seabed with local fishermen. The required burial depth is a function of the seafloor bottom conditions and the seafloor penetration depth of fishing trawler equipment. The burial depth required to protect the cable from fishing trawlers and ship anchor hits is based on previous, standard transoceanic cable burying operations in the area and the Desktop Study. This information would be used to determine a burial depth that can reasonably be expected to avoid such conflicts and is also practically and economically feasible.

During cable deployment, cable burial consists of plowing a trench into the seabed and placing the cable into the bottom of the trench along the predetermined route. The required cable burial depth is determined by taking into account the relation between the bottom soil materials (i.e., the corresponding hardness vs.

softness), and the known penetrating depth under the seabed of fishing gear or ship's anchors. The bottom soil materials such as coarse sand, fine sand, sand mixed with shell, mud and clay, will allow various degrees of cable burial; however, the cable cannot be buried into a solid rock bottom.

Ordinary fishing gear that is most likely to become entangled in the cable and become damaged or cause damage to the cable, would be otter-boards of trawling boats, and other fishing gear having long hooks. Trawlers represent the greatest threat to and from the cable, because of the relatively wide areas of the seafloor over which trawling equipment is engaged to catch fish. Long hooks and various types of anchors used to set gillnets or lobster pots are not as significant a threat, due to the low probability they are cast in precisely the small region occupied by the cable. In addition, because of their shape and comparatively lesser weight, these types of fishing gear are less likely to penetrate the seabed to the same depths as trawling gear. Various types of ship's anchors are also a potential hazard to the cable. For this reason, much time has been spent to determine a planned cable route that avoids known anchorages, and to a lesser extent, shipping lanes. Ordinarily, anchorages are limited to the shallow water depths in the range of 50 to 60 m.

Post-Lay Inspection and Burial

Video cameras mounted on the plow would be used to monitor the burial process. Areas where difficulties are encountered in fully burying the cable to the target depth of 1 m, as well as rocky areas, would be recorded and/or the positions noted. A post lay inspection would be performed using an ROV at the locations noted above. The ROV would be equipped with water jets that would be used to complete the burial operation to the extent possible.

Crossing Other Cables or Pipelines

The proposed cable route would cross other cables already in place. The proposed route, however, is not known to cross any pipelines. Special attention and effort has been paid to cable crossings. Databases that identify existing cables, pipelines, and sewage outfalls were used during the planning phase of the RSN to determine a route that avoids crossings to the maximum extent practicable. In addition, a route-specific survey will be performed in order to "fine-tune" the cable route in the intersecting areas. The survey and subsequent data analysis would be performed to detect and identify cable crossings and to select the safest cable route through areas of potential crossings. Based on the preliminary analysis of existing cable locations, the only cables that would be crossed are certain trans-Pacific cables. Consistent with standard industry practice, the owners of cables that must be crossed would be contacted. Industry-standard crossing techniques would be performed.

Periodic Re-inspection of the Installed Cable

The installed cable would be re-inspected at least every 5 years to ensure that buried portions of the cable remain buried.

Primary Nodes and TRFs

Installation of the TRF could be phased such that the TRF would be installed first using a cable-laying ship, with follow-on installation of electronics module (node assembly) using an ROV.

2.2.6.2 Secondary and Tertiary Infrastructure Cables

Two methods could be used for the installation of the secondary and tertiary cables. The preferred method would be the use of a cable-laying module mounted beneath an ROV. The ROV first connects the cable to the appropriate infrastructure using a wet mateable connector, and then begins laying cable to the next piece of infrastructure where the connection would once again be made with a wet mateable connector. ROV cable-laying modules are limited in the diameter and weight of cable that they can carry.

The secondary method would be for an ROV to carry the cable end with a wet mateable connector from the surface vessel to the seafloor and connected to the infrastructure. The ROV is then recovered and using precision cable laying software, the cable is laid by the surface vessel to the next piece of infrastructure. Upon arrival at the final connection point, a slack loop of cable with a wet mateable connector is lowered to the seafloor with a lowering line and ROV/acoustic release. Once the connector is on the seafloor the lowering line is released. The ROV is launched and proceeds to connect the wet mateable connector to the infrastructure.

2.2.6.3 Other Infrastructure (LVNs, Jboxes, Sensors)

Installation of infrastructure such as LVNs, Jboxes, and sensors would be dependent on the weight of the component. In cases where the weight is within the specification of the ROV, the vehicle would carry and place the equipment on the seafloor. Infrastructure that exceeds the weight limits of the ROV would be lowered into place from the surface vessel using lowering lines and ROV/acoustic releases.

2.2.6.4 CSN Moorings

Surface moorings would be installed and maintained using a University-National Oceanographic Laboratory System (UNOLS) vessel. The cabled connection of the 80-m, 150-m, and 500-m moorings of the Newport Line of the Endurance Array to the RSN at NP2 would be laid in concert with the RSN cable after site surveys are completed. These cabled connections of the Endurance Array would be buried either in the same manner as the RSN cable or by an ROV from a UNOLS vessel. Deployments of cabled infrastructure (LVNs, junction boxes, benthic sensor packages, the hybrid profiler, and winched profilers) would be coordinated with the installation of the RSN, using the same ship and ROV. Sensors on surface moorings would be installed before deployment using dry-mated connectors.

2.2.6.5 GSN Moorings

Flanking moorings would be installed and maintained using a UNOLS vessel. Sensors on surface moorings would be installed before deployment using dry-mated connectors.

An offshore supply vessel assisted by an anchor-handling tug would install the EDP and anchors, while a UNOLS vessel with an ROV would install the EOM cable and seafloor instrumentation associated with the EDP.

2.2.6.6 Summary of Installation and Annual O&M Activities for Proposed CSN, RSN, and GSN

Under the Proposed Action, the installation of the CSN, RSN, and GSN components of the proposed OOI Network is expected to take ~201 days at sea (DAS) and involve five classes of vessels (Table 2-7). Annual O&M operations for the OOI Network would take an estimated 230 DAS for all locations.

Table 2-7. Estimated DAS for Installation and Annual O&M of Proposed CSN, RSN, and GSN

Infrastructure	*Vessel Class*[1]	*Total Install DAS*[2]	*Total O&M DAS*
Regional-Scaled Nodes	Cable Laying/Repair	30	20
	Global	30[3]	60[3]
Coastal-Scaled Nodes			
Pioneer Array	Intermediate	13	12
	Intermediate	8	18
Endurance (Newport Line)	Global	7[3]	7[3]
	Intermediate	10	15
Endurance (Grays Harbor Line)	Intermediate	5	10
Global-Scaled Nodes			
Station Papa	Global	19	19
Southern Ocean	Global	23	23
Irminger Sea	Global	23	23
Mid-Atlantic Ridge	Global	19[3]	23[3]
	Supply/Tug	14	0
Subtotals by vessel class	Cable Laying/Repair	30	20
	Supply/Tug	14	0
	Global	121	155
	Intermediate	54	53
	Intermediate	23	43
	Total DAS	**201**	**230**

Note: [1]The approximate range for length overall of the classes of vessels: Cable-laying 450-500 ft.; Global 235-280 ft.; Anchor Handling/Supply Tug 120-220 ft.; Intermediate 170-200 ft.
[2]DAS includes transit time to and from the CSN, RSN, or GSN site and proposed activities at each site.
[3]An ROV would be used for the same number of days during the install and O&M activities.

2.2.7 Summary of Infrastructure under the Proposed Action

The infrastructure and siting characteristics for the proposed CSN, RSN, and GSN associated with the Proposed Action are summarized in Table 2-8.

2.2.8 Special Operating Procedures (SOPs) for Installation and O&M of the Proposed OOI

Table 2-9 lists the SOPs that would be implemented as part of the Proposed Action to avoid and minimize any potential impact to biological resources and commercial fishing activities.

2.3 No-Action Alternative

Under the No-Action Alternative, NSF-funded research integrated across multiple geographic scales using a suite of infrastructure assets would not occur. The oceanographic data from the proposed OOI have important implications for scientific research and, in some cases, human safety and well-being. The No-Action Alternative, through the loss of oceanographic research funding, would result in a loss of important scientific data and knowledge relevant to a number of research fields. While the No-Action Alternative is not considered a reasonable alternative because it does not meet the purpose and need for the Proposed Action, as required under CEQ regulations (40 CFR 1502.14[d]), the No-Action Alternative is carried forward for analysis.

Table 2-8. Summary of the Infrastructure of the Proposed OOI Network

COASTAL SCALE NODES (CSN)	
Endurance Array –	
Grays Harbor Line Moorings	- 3 paired surface/subsurface (@ 25, 80, and 150 m)
Newport Line Moorings	- 1 paired surface/subsurface (25 m) - 2 paired surface/cabled subsurface (80 and 500 m) - 1 cabled subsurface (150 m) to RSN @ NP2
AUVs and Gliders	6 gliders
Pioneer Array	
Moorings	- 4 paired surface/subsurface - 4 subsurface
AUVs and Gliders	3 AUVs and 10 gliders
REGIONAL SCALE NODES (RSN)	
Cable Configuration	Mid-plate star
Primary Infrastructure Cable Length	1,238 km
Shore Stations	Warrenton and Pacific City, OR
Primary Nodes	5
Moorings	5 subsurface
GLOBAL SCALE NODES (GSN)	
Station Papa	
Buoys	1 acoustically linked discus buoy
Moorings	1 subsurface & 2 flanking subsurface
AUVs and Gliders	5 gliders
Southern Ocean	
Buoys	1 acoustically linked discus buoy
Moorings	1 subsurface & 2 flanking subsurface
AUVs and Gliders	5 gliders
Irminger Sea	
Buoys	1 acoustically linked discus buoy
Moorings	1 subsurface & 2 flanking subsurface
AUVs and Gliders	5 gliders
Mid-Atlantic Ridge	
Buoys	1 EDP with 1 benthic node
Moorings	1 subsurface & 2 flanking subsurface
AUVs and Gliders	5 gliders

Table 2-9. SOPs to be Implemented under the Proposed Action

SOP	*Applicability*
1. Cable and equipment locations for all components of the proposed OOI would be published on NOAA Charts, through Notices to Mariners (NOTMARs), and accurate locational information will be made available to fishers to assist their avoidance of the instruments. A contact phone number will be established where fishers can report possible entanglements.	CSN RSN GSN
2. Onshore construction activities would avoid sensitive coastal dune, bluff, and wetland habitats, scenic locations, or public access points, and be sited on relatively level ground and to the maximum extent practicable on previously disturbed or developed land.	RSN
3. For onshore construction activities, appropriate best management practices (BMPs), based on the Oregon Department of Environmental Quality's Erosion and Sediment Control Manual (Oregon Department of Environmental Quality [ODEQ] 2005), would be incorporated into a stormwater pollution prevention plan (SWPPP) and submitted to the ODEQ in partial fulfillment of the CWA Section 301 National Pollutant Discharge Elimination System (NPDES) permit.	RSN
4. The shallow water exit points for HDD would be sited in sandy bottom areas. Pre-	RSN

Table 2-9. SOPs to be Implemented under the Proposed Action

SOP	*Applicability*
installation cable route surveys would be performed to identify bottom conditions, plan cable burial accordingly, and to minimize the crossing of rocky and/or geologically unstable areas.	
5. The Oregon Fishermen's Cable Committee (OFCC) will be notified regarding the proposed submarine cable, moorings, and associated sensors. An agreement would be negotiated with the OFCC to minimize risks to, interference with, and/or interruption of commercial fishing activities and of submarine cable operations.	CSN (Endurance Array) RSN
6. The cables would be buried ~1 m deep where substrate conditions allow, using a combination of plow and/or ROV. In so far as practicable, cables would be buried to water depths of ~1,100 m. In addition to complying with any permit conditions, it is expected that the cable routes will be inspected at 5-year intervals after the installation to determine whether there are exposed sections of cable that could be snagged by fishing gear, and such areas will be reburied to the extent possible.	RSN
7. During initial installation, where it is anticipated that burial cannot be achieved, the cable would be armored and fishers notified of the location of the exposed cable.	RSN
8. The RSN cable route and locations of moorings would be submitted to the U.S. Navy for comment/approval.	RSN
9. Owners of all existing and proposed cables would be contacted to coordinate crossings, if necessary. To the extent possible, all crossings would meet the recommendations of the International Cable Protection Committee (ICPC).	RSN
10. As much as possible, cables would be laid perpendicular, rather than parallel to, steep offshore slopes. Perpendicular placement is more stable and reduces the risks of damage from underwater landslides or differential slippage of cable sections down side slopes.	RSN
11. Site-specific surveys will be completed at the proposed mooring locations for the Pioneer Array; the proposed locations of the Primary Nodes, Secondary Nodes, LVNs, and Jboxes of the RSN; and Endurance Array mooring locations to ensure adequate, acceptable positions for the siting of OOI infrastructure. For a more effective placement of sensors on the seafloor, AUV operations may be conducted at the node locations.	CSN (Endurance and Pioneer Arrays) RSN
12. For HDD operations, an HDD Monitoring and Spill Contingency Plan would be prepared and submitted to the USACE and ODEP as appropriate in conjunction with CWA Section 404/401 permitting for the Proposed Action. The plan would include, but not necessarily be limited to the following: • description of surficial and bedrock geological conditions and the proposed bore profile at each HDD location; • assessment of the likelihood of a "frac-out" involving the release of drilling fluids from the bore hole into the overlying ocean waters; • procedures to monitor drilling fluid returns, regulate drilling pressure, and add loss circulation materials as necessary to plug fractures along the bore path and minimize the possibility of a frac-out; • to minimize the release of drilling mud when the drill punches through on the seabed, operators will switch from drilling mud to water only to lubricate the bore during the last stage of the operation before the drill reaches its exit point; • procedures for monitoring the bore path between the bore entry and the planned exit point to detect a release of drilling mud; • a Contingency Plan for the containment and cleanup of a discharge of drilling mud onto the shore or seabed; and • reporting procedures to document the implementation of the plan and its effectiveness.	RSN

2.4 SCOPE OF ENVIRONMENTAL REVIEW

The major environmental compliance requirement for the analysis of potential impacts from the installation and operation of the OOI is NEPA and the preparation of an EA. Within an EA, potential impacts to the natural and human environment must be considered for a number of resource areas such as biological resources, cultural resources, socioeconomics, transportation, water quality, geology, etc.

The geographic extent for the Proposed Action is based upon three geographic scales for proposed activities: CSN, RSN, and GSN. Based upon a preliminary analysis of the potential impacts of the proposed activities associated with the installation and subsequent O&M of the proposed OOI, some resource areas typically analyzed in an EA will not be addressed in this Programmatic EA because impacts to these resource areas are considered unlikely. A detailed discussion of the reasons for not carrying these resource areas forward for analysis is presented in the *Approach to Analysis* sections for the CSN, RSN, and GSN in Chapters 3, 4, and 5, respectively.

CHAPTER 3
AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES: PACIFIC NORTHWEST CSN (ENDURANCE ARRAY) AND RSN

3.1 APPROACH TO ANALYSIS

This chapter describes the existing environmental conditions in and around the RSN and Endurance Array of the CSN for resources potentially affected by implementation of the Proposed Action as described in Chapter 2. Information presented in this chapter represents baseline conditions against which the Proposed Action is evaluated to identify potential impacts. In the environmental analysis process, the resources analyzed are identified and the expected geographic scope of potential impacts, known as the region of influence (ROI), is defined.

In compliance with NEPA and CEQ regulations, the description of the affected environment focuses only on those resources potentially subject to impacts. In addition, the level of analysis should be commensurate with the anticipated level of environmental impact. Accordingly, the discussion of the affected environment (and associated environmental impact analyses) focuses on marine biological resources, geological resources, water quality, cultural resources, and socioeconomics (fisheries) within the ROI for the CSN (Endurance Array) and RSN.

3.1.1 Air Quality

For the purposes of this analysis, air quality is defined as the ambient air concentrations of specific pollutants determined by the USEPA to be of concern to the health and welfare of the general public. These seven pollutants (the criteria pollutants) include ozone, carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter less than 10 microns in diameter (PM_{10}), particulate matter less than 2.5 microns in diameter ($PM_{2.5}$), and lead. National Ambient Air Quality Standards (NAAQS) have been established by the USEPA for these criteria pollutants (USEPA 2007). The NAAQS define the maximum concentrations of the criteria pollutants that are considered safe, with an additional adequate margin of safety, to protect human health and welfare. Oregon and Washington have adopted the NAAQS for all criteria pollutants except for SO_2, for which both states have adopted slightly more stringent requirements (WDOE 2007; ODEQ 2008). Depending on the type of pollutant, these maximum concentrations may not be exceeded at any time, or may not be exceeded more than once per year (USEPA 2007; WDOE 2007; ODEQ 2008).

As required by the Clean Air Act (CAA) Amendments of 1990, Oregon and Washington have each prepared a State Implementation Plan (SIP). The SIP is a compilation of goals, strategies, schedules, and enforcement actions that help lead a state into compliance with the NAAQS. Areas not in compliance with the NAAQS can be declared nonattainment areas by the USEPA or by the appropriate state or local agency. Areas in compliance with the NAAQS are defined as being in attainment. Areas that have been reclassified from nonattainment to attainment are designated as attainment/maintenance areas. Areas that lack the monitoring data to demonstrate attainment or nonattainment status are designated as unclassified and are treated as attainment areas for regulatory purposes.

As described in 40 CFR Part 51, *Determining Conformity of General Federal Actions to State or Federal Implementation Plans* (the "General Conformity Rule"), all federal actions occurring in air basins designated in nonattainment or in a maintenance area must conform to an applicable implementation plan. Should a proposed action result in emissions that exceed *de minimis* levels (based on the nonattainment status for each applicable criteria pollutant in the area of concern), a conformity determination would be required.

Emission thresholds associated with CAA conformity requirements are the primary means of assessing potential air quality impacts. A formal conformity determination is required for federal actions occurring in nonattainment or maintenance areas when the total direct and indirect stationary and mobile source emissions of nonattainment pollutants or their precursors exceed applicable *de minimis* thresholds. Effects to air quality are evaluated based on estimated direct and indirect emissions associated with the action alternatives.

The Proposed Action is located within the jurisdiction of Grays Harbor County, Washington; and Clatsop, Tillamook, and Lincoln counties, Oregon. All affected counties are in attainment of the NAAQS as well as state and regional air quality standards (USEPA 2008). Therefore, a CAA conformity determination is not required. The Proposed Action would result in minor temporary emissions from surface vessels during installation and O&M activities of the RSN and CSN. However, these vessel emissions would not represent a substantial increase above existing conditions, as only a small number would be used and for only a few weeks per year. The Proposed Action would not compromise air quality attainment status in Washington and Oregon or conflict with attainment and maintenance goals established in their SIPs. Therefore, the Proposed Action would have a negligible impact on air quality.

3.1.2 Terrestrial Biological Resources

Under the Proposed Action, existing shore stations and beach manholes would be used for the landing of the RSN submarine cable. Although the exact location of the proposed HDD activities has not been determined at this time, preliminary analysis indicates that there would be no significant impacts to terrestrial biological resources at the proposed Warrenton and Pacific City shore station sites. A site-specific evaluation would be done prior to any HDD activities and if necessary, additional environmental documentation would be completed to assess the potential impacts to terrestrial resources. The CSN would not have a terrestrial component and therefore there would be no significant impacts to terrestrial biological resources from implementation of the Grays Harbor and Newport lines of the Endurance Array.

3.1.3 Transportation

Generally only two to three vessels would be used during installation and O&M activities associated with the proposed OOI, and then only for a few weeks per year. Projected increases in vessel traffic due to implementation of the Proposed Action would constitute a negligible portion of the total existing vessel traffic in the ROI. In addition, proposed activities associated with the installation and annual O&M of the proposed OOI would not restrict or change existing vessel traffic patterns within the ROI. All eight mooring buoys of the Endurance Array would be marked in accordance with USCG requirements and locations of all buoys would be published on NOAA charts. Therefore, there would be no significant impacts to transportation within the ROI with implementation of the Proposed Action.

3.1.4 Land Use

Proposed terrestrial activities associated with the proposed cable landings at Warrenton and Pacific City, Oregon would be sited in accordance with established land use guidelines addressing safety, functionality, and environmental protection zones where appropriate. The proposed shore stations are existing facilities and no additional construction is required. With implementation of SOPs during RSN HDD activities (see Section 2.2.8), there would be no significant impacts to terrestrial resources. In addition, no changes to existing land use would occur with implementation of the Proposed Action.

3.2 MARINE BIOLOGICAL RESOURCES

3.2.1 Affected Environment

3.2.1.1 Marine Habitats and Invertebrates

The bottom environment of the Pacific Northwest is complex due to the variety of bottom substrates and the complicated system of water circulation and bathymetry. The distribution of the benthos is determined by a vertical zonation pattern that is mainly a function of depth (i.e., light penetration, temperature, and wave action) and substrate (i.e., availability and type of substrate and movement and accumulation of sediments). Marine benthic assemblages are extremely diverse and include representatives of nearly all phyla. With increasing depth, light intensity declines and eventually algae and plants are unable to survive; therefore, benthic algae and reef-building corals decrease in abundance and size. Below 100 m only a few, small, stony corals are found. At greater depths, animals, including non-reef-building corals, obtain their food through suspension feeding (DoN 2006b; NOAA 2004).

Benthic flora is nearly ubiquitous in the photic zone from depths ranging from the spray zone, well above high tide level, to depths approaching 270 m. Macroflora (large plants) forms significant habitat along most shorelines and shallow water environments and serve as an important food source, a means of substrate for attachment, and a source of shelter for many grazing invertebrates and vertebrates (DoN 2006b; NOAA 2004).

The most conspicuous benthic macroflora in the Pacific Northwest are the brown algae commonly known as kelp. Kelp attach to rocky substrates at subtidal depths and form the distinctive "kelp forests" familiar to the Pacific Northwest region. They extend from seafloor to surface and form a vertically structured habitat that is the fundamental element to many important ecosystems in the Pacific Northwest. Kelp usually grow attached to rocky substrate and can grow up to 50 m in length in nearshore areas of 2 to 60 m depth. The typical kelp habitat is multilayered; it is composed of canopy, understory, turf, and crustose layers. Kelp can grow up to 10 cm per day and is among the most productive of marine plants (DoN 2006b; NOAA 2004).

The nature of the faunal (invertebrate) communities of the Pacific Northwest depends on various local conditions including substrate type, water depth, the associated macrofloral communities, and geographical locations (DoN 2006b; NOAA 2004).

Rocky substrate can provide support to extensive communities of marine plants and animals that require attachment for survival. For example, rocky substrates provide attachment sites for macroflora, which in turn provide habitat for a diverse ecosystem of fish and invertebrates. These areas can also be termed live bottoms or live hardbottom habitat (DoN 2006b; NOAA 2004).

Invertebrate communities that exist in the soft sediments of the Pacific Northwest are almost as rich as those that exist on the hard substrate. Many important commercial and recreational fisheries are dependent upon the soft substrate habitats. For example, adult Dungeness crabs can be found in waters as deep as 90 m and on substrates consisting of mud, rock, and gravel bottoms; however, they prefer soft substrates. In addition, five species of shrimp are associated with softbottom benthic habitats, although some species move up into the water column at night to feed (DoN 2006b; NOAA 2004).

Habitat-forming deep-sea corals occur on the continental shelf and the slope off Oregon. For the purposes of this discussion, the deep-sea environment extends from the shelf break (150 to 200 m) to the abyssal plain (4,000+ m). Deep-sea corals of the Pacific Northwest occur in water depths ranging from 9 to 3,450 m. True deep-sea coral communities live in complete darkness, in temperatures as low as 4°C and in waters as deep as 6,000 m. Such communities of the Pacific Northwest include sessile stony corals (Order Scleractinia), soft corals (Sub Class Octocorallia), black corals (Order Antipatharia), and lace corals. Deep-sea coral communities are typically found from the edge of the continental shelf to the continental rise, on banks, and on seamounts. The biological diversity of deep-sea coral communities is high; from an economic perspective, this diversity creates valuable habitat for several commercially fished species. Corals are found along the entire shelf slope (predominantly within the 500 to 1,500 m water-depth range) of the Pacific Northwest (DoN 2006b; NOAA 2004).

3.2.1.2 Fish

Habitat parameters affecting fish distribution throughout the Pacific Northwest include both physical (depth, substrate, temperature, salinity, and dissolved oxygen) and biological (competitors, predators, and facilitators) variables. Habitat types along the west coast can be separated into two large zoogeographic provinces: the Oregonian (north of Point Conception) and the Californian (south of Point Conception). The Pacific Northwest falls entirely within the Oregonian Province. The Oregonian province can further be broken down into the following habitat types utilized by managed fishes and found within the project area (NMFS 2005b).

Nearshore (Estuarine and Intertidal Habitats)

- Nearshore biogenic habitats: includes kelp, seagrass, and sponges. The biological component (kelp, seagrass, or sponges) associated with the habitat is generally the feature that makes that habitat suitable for a particular species or life stage (e.g., groundfish).
- Nearshore unconsolidated bottom (silt, mud, gravel, or mixed): composed of small particles (gravel, sand, mud, silt, or mixtures of these particles), which contains little to no vegetation due to the lack of stable surfaces for attachment.
- Nearshore hardbottom: composed of bedrock, boulders, cobble, or gravel/cobble. One of the least abundant benthic habitats, but one of the most important for fishes, especially rockfish, lingcod, and sculpins.
- Nearshore water column: coastal epipelagic zone. Includes egg, juvenile, and larval stages of groundfish commonly associated with macrophyte canopies or drift algae.

Offshore (Shelf and Slope Habitats)

- Offshore biogenic habitats (corals, sponges, etc.): includes structure-forming invertebrates such as corals, basketstars, brittlestars, demosponges, gooseneck barnacles, sea anemones, sea lilies, sea urchins, sea whips, tube worms, and vase sponges.
- Offshore unconsolidated bottom (silt, mud, sand, gravel, or mixed): composed of small particles (gravel, sand, mud, silt, or mixtures of these particles), which contains little to no vegetation due to the lack of stable surfaces for attachment.
- Offshore hardbottom: composed of bedrock, boulders, cobble, or gravel/cobble. Large, mobile, nektobenthic fishes (e.g., rockfish, sablefish, Pacific hake, spotted ratfish, spiny dogfish) are typically associated with this habitat.
- Offshore water column: pelagic zone. This area is home to the highly migratory species, other relatively large pelagics, and early life stages of groundfish inhabiting the epipelagic/mesopelagic area or are in association with fronts, current systems, and marcophyte canopies or drift algae.

Marine fish that utilize the nearshore and offshore environments (depending on life stage) include but are not limited to Pacific cod, Pacific hake, lingcod, sablefish, pollock, spiny dogfish, green and white sturgeon, flounder (starry and arrowtooth), and sole (Petrale, Dover, English). Highly migratory species such as albacore and bluefin tuna are also likely present along the shelf areas. The slope areas serve as habitat for Pacific halibut, skates, and flounder. Coastal pelagic species such as Pacific herring, northern anchovy, and jack mackerel occur throughout the water column. Rockfish species such as thornyhead, bocaccio, greenstriped, redstriped, yellowtail, and chilipepper can be found inhabiting the continental shelf areas (Turk et al. 2001; Builder Ramsey et al. 2002; NOAA 2004).

3.2.1.3 EFH

The MSA requires federal agencies to consult with NMFS on activities that may adversely affect EFH. The Pacific Fishery Management Council (FMC) manages the fisheries for Groundfish, Coastal Pelagic Species (CPS), Highly Migratory Species (HMS), and Pacific Salmon through the associated Fisheries Management Plans (FMPs) and has defined EFH for these three groups. All waters that support anadromous fish are considered EFH by NMFS (Pacific FMC 2006c).

EFH has been designated for 82 groundfish, 3 CPS, 13 HMS, and 3 salmon species along the Washington, Oregon, and California coasts (Pacific FMC 1998, 2000, 2005, 2006a, 2007). With a few exceptions, groundfish live on or near the bottom of the ocean and are made up of the following species:

- ***Rockfish*.** The FMP covers 55 different species of rockfish including widow, yellowtail, canary, and vermilion rockfish.
- ***Flatfish*.** The FMP covers 13 species of flatfish, including various soles, starry flounder, turbot, and sanddab.
- ***Roundfish*.** The seven species of roundfish included in the FMP are lingcod, cabezon, kelp greenling, Pacific cod, Pacific hake, Pacific flatnose, and Pacific grenadier.
- ***Sharks, skates and chimaeras*.** The seven species within this group include leopard shark, soupfin shark, spiny dogfish, big skate, California skate, longnose skate, and spotted ratfish.

Groundfish EFH is defined as all waters from the high tide line (and parts of estuaries) to 3,500 m in depth. Groundfish and CPS species are likely to occur in some form of life stage (egg, larval, juvenile, or adult) along the coasts either in nearshore or offshore areas. The east-west geographic boundary of EFH for each individual CPS finfish and market squid is defined to be all marine and estuarine waters from the shoreline along the coasts of California, Oregon, and Washington offshore to the limits of the EEZ (200 nmi) and above the thermocline where sea surface temperatures range between 10 and 26 ^{o}C. EFH for HMS is defined by temperature ranges, salinity, oxygen levels, currents, shelf edges, and seamounts. These species are highly mobile and not usually associated with features that are considered typical fish habitat (i.e., seagrass beds or estuaries). Salmon EFH defined for estuaries and marine areas, extends from the shoreline to the 200-nm limit of the EEZ and beyond (Pacific FMC 2000). Salmon typically occupy the coastal areas in juvenile or adult stages. Designated EFH for 64 groundfish, 3 CPS, 5 HMS, and 3 salmon species are likely to occur within the vicinity of the CSN (Endurance Array) and RSN (Table 3-1).

Habitat Areas of Particular Concern (HAPCs) are a subset of EFH. Fishery Management Councils are encouraged to designate HAPCs under the MSA. HAPCs are identified based on habitat level considerations rather than species life stages as are identified with EFH. EFH guidelines published in Federal regulations identify HAPCs as types or areas of habitat within EFH that are identified based on one or more of the following considerations:

- The importance of the ecological function provided by the habitat.
- The extent to which the habitat is sensitive to human-induced environmental degradation.
- Whether, and to what extent, development activities are or will be stressing the habitat type.
- The rarity of the habitat type (50 CFR 600.815(a)(8)).

Table 3-1. Fish Species with Designated EFH within the Vicinity of the Proposed CSN (Endurance Array) and RSN

Species	*Life Stage*	*Comment*
GROUNDFISH		
Arrowtooth flounder	A, J, L, E	Present
Aurora rockfish	A, J, L	L habitat more abundant
Big skate	A, J, E	Present
Black rockfish	A, J	Very sparse
Blue rockfish	A, J, L	A and J very sparse habitat, L present
Bocaccio rockfish	A, J, L	L habitat more abundant
Brown rockfish	A	Present
Butter sole	A	Present
Cabezon	A	Very sparse
California skate	A, J, E	Present
Canary rockfish	A, J	Very sparse
Chilipepper rockfish	J	Present
China rockfish	A, J	Very sparse
Copper rockfish	A	Very sparse
Cowcod	A, J	Very sparse
Curlfin sole	A	Present
Darkblotched rockfish	A, J, L	Present
Dover sole	A, J	Present
English sole	A, J, L	Present
Flathead sole	A, J	Present
Greenspotted rockfish	J	Present
Greenstriped rockfish	A, J	Present
Kelp greenling	A, J	A very sparse; J abundant
Lingcod	A, J, L, E	A very sparse; J, L, and E habitat present
Longnose skate	A, J, E	Present
Longspine thornyhead	A, J	Present but located further offshore
Pacific ocean perch	A, J, L	A and J habitat located further offshore; L present
Pacific cod	A, J, L, E	A very sparse; J, L, and E habitat present
Pacific flatnose	A	Very sparse-located offshore
Pacific hake	A, E	Present
Pacific grenadier	A, J, L, E	A and J habitat located further offshore; L and E present
Pacific sanddab	A	Present
Petrale sole	A, J	Present
Quillback rockfish	J	Very sparse
Ratfish sp.	A, J, E	Present
Redbanded rockfish	A	Present but located further offshore
Redstripe rockfish	A	Very sparse
Rex sole	A, J	Present
Rock sole	A	Present
Rosethorn rockfish	A	Very sparse
Rosy rockfish	A, J	Very sparse
Rougheye rockfish	A, J	Present
Sablefish	A, J, L, E	A and J present; L and E habitat located further offshore
Sand sole	A, J, L	Present
Sharpchin rockfish	A, J, L	Present
Shortbelly rockfish	A	Located further offshore
Shortraker rockfish	A	Located further offshore
Shortspine thornyhead	A, J	Present but located further offshore
Soupfin shark	A, J	Present
Spiny dogfish	A, J	Present
Splitnose rockfish	A, J, L	Present
Starry flounder	A, J, E	Present
Stripetail rockfish	A, J	A habitat located further offshore; J present
Tiger rockfish	A	Very sparse

Table 3-1. Fish Species with Designated EFH within the Vicinity of the Proposed CSN (Endurance Array) and RSN

Species	*Life Stage*	*Comment*
Vermillion rockfish	A	Very sparse
Widow rockfish	J	Present
Yelloweye rockfish	A, J	Very sparse
Yellowmouth rockfish	J	Present
Yellowtail rockfish	A	Very sparse
COASTAL PELAGICS		
Jack mackerel	A	Present
Pacific sardine	A, L, E	Present
Market Squid	A, E	Present
HIGHLY MIGRATORY		
Common Thresher shark	A	Present
Bigeye thresher shark	A	Present
Blue shark	A, J	Present
Albacore tuna	A	Present
Northern bluefin tuna	J	Present
PACIFIC SALMON		
Chinook	A, J	Present
Coho	A, J	Present
Pink	A, J	Present

Notes: A = adult, E = eggs. J = juvenile, L = larvae.
Sources: Pacific FMC 2006c.

Based on these considerations, the Pacific FMC has designated both 'areas' and 'habitat types' as HAPCs. In some cases, HAPCs identified by means of specific habitat type may overlap with the designation of a specific area. Designating HAPCs facilitates the consultation process by identifying ecologically important, sensitive, stressed, or rare habitats that should be given particular attention when considering potential nonfishing impacts. Their identification is the principal way in which the Pacific FMC can address these impacts (Pacific FMC 2005).

HAPCs are designated for the following areas off the Washington, Oregon coast for Pacific groundfish: estuaries, canopy kelp, seagrass, and rocky reefs. In addition, HAPCs are designated for Daisy Bank/Nelson Island (located just south of the proposed Newport Line), Thompson Seamount (located just to the north of the proposed RSN cable route between N3 and N5), and President Jackson Seamount (located south of RSN cable and N2) (Pacific FMC 2006).

All waters and sea bottom in Washington State waters shoreward from the 3-nm boundary of the State Territorial Waters to mean higher high water have been designated as an HAPC for groundfish. The Washington State waters HAPC encompasses a variety of habitats important to groundfish, including other HAPCs such as rocky reef habitat supporting juvenile rockfish (primarily north of Grays Harbor) and estuary areas supporting numerous economically and ecologically important species, including juvenile lingcod and English sole. Sandy substrates within state waters (primarily south of Grays Harbor) are important habitat for juvenile flatfish (Pacific FMC 2005). There are currently no HAPCs designated for CPS, HMS, or salmon (Pacific FMC 1998, 2000, 2007).

3.2.1.4 Marine Mammals

Approximately 26 marine mammal species occur within the nearshore and deep open ocean habitats along the Oregon Coast. Cetaceans (whales, dolphins, and porpoises) account for a majority of marine mammals occurring in the area, whereas there are only five pinniped species. Baleen whales occurring in the area include humpback, minke, and gray. Minke whales tend to reside in the area year-round unlike other baleens whales, such as humpback, that typically make long migrations from summer foraging grounds to warm wintering/breeding grounds. Gray whales have the greatest occurrence along the coast of all whales that visit the area, particularly during winter. They are often seen year-round occurring in the continental shelf areas and foraging in waters less than 70 m. Their migration paths typically take them over nearshore submarine canyons, passing by the coast mainly January through April (DoN 2006b).

Toothed whales (odontocetes) occurring in the area include beaked whales (Cuvier's, Hubbs, Stejneger's, and Baird's); short beaked, Pacific white-sided, and Risso's dolphins; and harbor and Dall's porpoises. Most of the odontocetes occurring along the coast do so year-round with general peak abundance during the summer months. Exceptions are with respect to short-beaked and Northern right-whale dolphin that has a more temperature driven distribution in that they occur mostly during the summer beyond the 200-m isobath and are rarely seen during the remainder of the year. Foraging depths for odonotocetes generally occur between the 200 and 1,000 m isobaths with porpoises feeding primarily between nearshore and 200 m (DoN 2006b).

Pinnipeds occurring along the coast include harbor, elephant, and Northern fur seal as well as California sea lion. They are all year-round residents with multiple haul outs utilized along the coast (shorelines, estuaries, man-made structures, and rock islands). Three Arch Rocks is the only haul out area for California sea lions between Warrenton and Pacific City. Harbor and elephant seals tend to stay within 200 m depths whereas sea lions can venture out beyond 2,000 m. Seals and sea lions occurring in the area are most abundant during summer and less abundant during winter except for Northern fur seals that are at their peak abundance during spring along the Oregon coast (DoN 2006b).

3.2.1.5 ESA-Listed Species

Eight marine mammals, one sea turtle, and four Evolutionary Significant Units (ESUs) and one Distinct Population Segment (DPS) of anadromous fish species are federally listed as threatened or endangered under the ESA and potentially occur in the vicinity of the proposed CSN and RSN (Table 3-2).

Table 3-2. ESA-listed Species Potentially Occurring within the Vicinity of the Proposed CSN and RSN

Species	*ESA Status*
MARINE MAMMALS	
Blue whale	E
Fin whale	E
Humpback whale	E
Killer whale (Southern Resident)	E
North Pacific right whale	E
Sei whale	E
Sperm whale	E
SEA TURTLES	
Leatherback	E
FISH	
Lower Columbia River Chinook ESU	T
Lower Columbia River Coho ESU	T
Lower Columbia River Steelhead ESU	T
Columbia River Chum ESU	T
Coastal-Puget Sound Bull Trout DPS	T, CH

Notes: CH = critical habitat, E = endangered, T = threatened.
Sources: DoN 2006b; NMFS 2008b.

Marine Mammals

Blue whale. Blue whales are found in oceans worldwide and are separated into populations by ocean basin in the North Atlantic, North Pacific, and Southern Hemisphere. They typically migrate between summering and wintering areas; however some populations can reside year-round in areas. Blue whales feed almost exclusively on krill in the North Pacific region. Blue whales are more common during the summer months and are still sighted in the Pacific Northwest as late as October along coastal and shelf areas (DoN 2006b). Therefore, blue whales may be present within the vicinity of the proposed RSN from summer through early fall.

Humpback whale. Humpbacks typically spend winters in tropical waters of the Northern and Southern Hemispheres and summers are spent foraging in the Gulf of Alaska and Bering Sea. There is a smaller stock of humpbacks (Eastern North Pacific stock) that spend winter/spring in Central America and Mexico mating and calving and then migrate to the coastal waters of California and up through to British Columbia feeding on krill and small schools of fish. Humpbacks occur off the Washington and Oregon coast during winter migrations, mostly occurring in the nearshore areas (DoN 2006b). Humpbacks may be present within the vicinity of the proposed CSN and RSN during summer months and between January and March during migrations (DoN 2006b).

North Pacific right whale. Right whales occur in subpolar to temperate waters. Their distribution ranges from the eastern Bering Sea to Baja, California. They occur in coastal and shelf waters and tend to migrate between summer feeding grounds in temperate or high latitudes and winter calving areas in warmer waters. Right whales feed throughout the water column almost exclusively on copepods (zooplankton) (DoN 2006b). North Pacific right whales may potentially occur very rarely within the vicinity of the CSN and RSN during summer months.

Southern Resident Killer Whale. Killer whales have a wide distribution and are found in all parts of the ocean. In the North Pacific, killer whales occur in the eastern Bering Sea to the Aleutian Islands; southeastern Alaska to intercoastal waterways of British Columbia and Washington State; along the coasts of Washington, Oregon, and California; along the Russian coast; eastern side of Sakhalin and the Kuril Islands; and the Sea of Japan. There are three genetically distinct populations of killer whales that occur in the project area: transient, offshore, and resident killer whales. The resident population is broken up into four smaller sub-populations: Southern, Northern, Southern Alaska, and Western Alaska-North Pacific residents. Only the Southern Resident population is federally listed as endangered under ESA. The majority of animals potentially occurring in Oregon waters are members of the offshore population. Transient killer whales feed on other marine mammals such as porpoises, sea lions, seals, and the occasional baleen whale; residents are exclusively salmon eaters, while the offshore population is also suspected of feeding exclusively on fish (DoN 2006b).

Killer whales tend to occur further offshore along the Oregon coast, and are probably members of the offshore population (DoN 2006b). They may be present within the vicinity of the CSN and RSN during summer months. Southern residents would occur rarely within Oregon waters and only during winter.

Sperm whale. Sperm whales occur in all oceans of the world ranging from 60° N to 60° S latitudes. They spend a majority of their time at depths of between 400 and 1,000 m feeding on prey residing at that depth range such as large squid and demersal sharks, skates, and fish. Sperm whales occur off the Oregon coast in all seasons except for winter, and primarily outside the 1,000 m isobath and less likely, although they have been sighted, along the 200 m isobaths (DoN 2006b). They are expected to be present within the vicinity of the CSN and RSN March through November.

Leatherback Sea Turtle

Leatherback sea turtles are the largest of all sea turtles, reaching 2.4 m and weighing 725 kg. Leatherbacks range widely through the tropics and subtropics, migrate seasonally into Arctic and Antarctic waters, and typically nest between 40º N to 35º S latitudes; no nesting occurs on beaches under U.S. jurisdiction. They feed mainly on jellyfish near the surface or within the water column. Sea surface temperatures where leatherback turtles have been observed are usually in the 15-16 °C range, suggesting that leatherbacks can range as far north as Oregon and Washington waters when sea surface temperatures are highest in the summer and fall. During vessel and aerial surveys in 1990, leatherback turtles were observed in both Oregon and Washington waters, but most sightings were along the coast of Washington. Turtles were observed between June and September with most sightings in July in continental slope waters, while fewer occur over the continental shelf (DoN 2006b). Leatherback turtles may potentially occur during the summer in small numbers in the deeper, offshore waters of the proposed CSN and RSN.

Fish

Five ESA-listed anadromous fish species potentially occur within the vicinity of the proposed CSN and RSN off the coast of Oregon and Washington: Coastal-Puget Sound Bull Trout DPS, Lower Columbia River Coho Salmon ESU, Lower Columbia River Chinook Salmon ESU, Columbia River Chum ESU, and Lower Columbia River Steelhead Trout DPS. Only the bull trout is expected to occur as a resident within the area and only in the nearshore areas north of the Columbia River, including Grays Harbor. All other species, including juvenile and adult salmonids from the Columbia River stocks, would only occur as migrating individuals during their marine lifestage and data on their occurrence within the area is not available.

Critical habitat for the Coastal-Puget Sound Bull Trout DPS has been designated within the nearshore marine/estuarine waters of coastal Washington, from Grays Harbor north. Critical habitat extends offshore to a depth of 10 m (USFWS 2005).

3.2.2 Environmental Consequences

3.2.2.1 Proposed Action

Installation and O&M Activities

The vessels and activity associated with installation of RSN cable, surface and subsurface moorings, and associated scientific sensors on the sea floor may cause marine species to temporarily avoid the immediate vicinity of the proposed CSN (Endurance Array) and RSN, but this impact would not be significant due to the small scale and temporary nature of the proposed activities. The vessel used for cable and mooring deployment would move very slowly during the activity and would not pose a collision threat to marine mammals.

There are no documented incidents of marine mammal entanglement in a submarine cable during the past 50 years (Norman and Lopez 2002). The cables would be taut against the seafloor, without loose slack,. Entanglement of marine species is not likely because the submarine cable would be buried in water depths less than 1,100 m. For water depths greater than 1,100 m, where the cable is not buried, the rigidity of the cable would cause the cable to lie extended on the sea floor and not coil thereby eliminating the potential for entanglement. Entanglement of marine species within mooring cables in the water column is considered highly unlikely because of the rigidity of the mooring cables and the ability of marine species to detect and avoid the mooring lines.

Once installed on the seabed, the proposed mooring anchors and scientific sensors would be equivalent to other hard structures on the seabed, again posing no risk of adverse effect on marine organisms. Based on observations of underwater cables (Office of Naval Research 2001; Monterey Bay Aquarium Research Institute [MBARI] 2003; DoN 2004; Dollar and Brock 2006), the cables, anchors, and scientific sensors would be covered with marine growth or buried by sand. The presence of cables and other man-made structures may enhance the physical complexity of the marine habitats and provide settling or sheltering locations for marine organisms, a beneficial impact.

EFH. Under the provisions of the MSA, federal agencies must consult with NMFS prior to undertaking any actions that may adversely affect EFH. Federal agencies retain the discretion to determine what actions fall within the definition of "adverse affect." Temporary or minimal impacts, as defined by NMFS regulations and below, are not considered to "adversely affect" EFH (50 CFR Part 600). "Temporary impacts" are those that are limited in duration and that allow the particular environment to recover without measurable impact. "Minimal impacts" are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

In considering the potential impacts of a proposed action on EFH, all designated EFH must be considered. Impacts on EFH would entail temporary mechanical disturbance of the substrate, and long-term coverage of relatively small areas of substrate by RSN cable, TRFs, mooring anchors, LVNs, Jboxes, and cabled scientific sensors. As described previously, the substrate in the affected area offshore consists of sand, sand and mud, and mud. The cables, anchors, and instruments themselves would constitute ~4 hectares (ha) of new hard substrate. Use of the sea plow and/or ROV to install the RSN cables would impact an approximately 2-m wide swath of substrate during installation, and a total area of 94 ha. Therefore, a total of 98 ha of EFH would be impacted by proposed CSN and RSN installation activities. Over time, the natural movement of sediments by ocean currents and burrowing organisms would reestablish natural bottom topography. The short-term and minor increases in turbidity and sedimentation would not affect the ability of EFH to support healthy fish populations and affected areas are expected to recover quickly. Repair activities and/or future removal of the proposed cable, moorings, and associated infrastructure would have impacts on seafloor geology similar to those of installation at the affected locations. Therefore, the implementation of the proposed Endurance Array and RSN would not have an adverse affect on EFH in the area.

<u>Gliders and AUVs</u>

The use of up to six gliders within a survey area of ~16,000 nmi^2 around the Endurance Array (Figure 2-1) is not expected to affect marine species, as the proposed gliders would move within the water column similar to a dolphin or whale. Gliders are sealed, contain no motors, fuels, or hazardous materials; and move at very slow speeds (~0.5 knot), thereby eliminating the potential for collisions with marine mammals.

<u>Active Acoustic Sources</u>

Due to the potential for active acoustic sources to impact fish and marine mammals, the following section is a brief summary of the hearing abilities of these groups.

Hearing Abilities of Fish. Although studies of fish hearing capabilities are limited to very few of the more than 29,000 existing fish species, there are data on representative species of a number of diverse fish taxa (see Fay 1988; Popper et al. 2003; Ladich and Popper 2004). Thus, what is known about hearing capabilities across the very diverse fish taxa is based on a rather sparse sampling of species. Although a few species can hear at high frequencies (see below), for the majority of fish species hearing is restricted to rather low frequencies. Most fish species can hear sounds from a few cycles per sec (Hertz or Hz) up to 300 to 1,000 cycles per sec (1,000 Hz or 1 kHz). Fish of a few species are known to detect sounds less than 1 Hz (Sand and Karlsen 1986, 2000; reviewed in Popper et al. 2003).

There are several recent reviews on fish hearing that provide a detailed discussion of the issues raised here. Most notably, see Fay and Simmons (1999), Fay and Popper (2000), Popper et al. (2003), and Ladich and Popper (2004). Differences between hearing generalists and hearing specialists are described in the following subsections.

Many species of fish primarily detect the direct stimulation of particle motion and have very little input to the ear from the swim bladder, or they may not have a swim bladder. These fish are often referred to as *hearing generalists*. Most bony fishes (the species most often thought of as “fish,” from the class Osteichthys) and cartilaginous fishes (the sharks, skates, rays, and chimeras of the Class Chondrichthys), are classified as hearing generalists. They detect sounds from somewhat below 50 Hz (though some may detect sounds to as low as 1 Hz) to anywhere from 500 to 1,500 Hz, depending upon the species. Salmon are hearing generalists (Hawkins and Johnstone 1978), as are flatfishes (Chapman and Sand 1974) and many other fish species.

In contrast, other fish have evolved mechanisms that enhance the detection of the pressure component of the sound field, and this enhances their hearing sensitivity and their range of hearing. These fish, which are referred to as *hearing specialists,* have some kind of mechanical connection between the air bubble and the inner ear, resulting in the re-radiated signal being efficiently carried to the inner ear. Generalists do not have this efficient coupling of sound from the pressure detector to the ear.

Hearing specialists are found in a diverse assortment of fish groups, and rather than being limited to a kHz or less in hearing, can hear up to several kHz. Hearing specialists detect sounds from below 50 Hz (and perhaps as low as 1 Hz in some species) to several thousand Hz, and their sensitivity in the frequency range that overlaps with generalists is far greater (Ladich and Popper 2004). For example, the hearing specialist, the goldfish, can detect sounds to above 3 kHz. Moreover, one group of fish in the anadromous herring sub-family Alosinae (shads and menhaden) can detect sounds to well over 180 kHz (Mann et al. 1997, 1998, 2001). It should be noted that not all Clupeiformes can detect ultrasound, but all that have been studied are hearing specialists and able to detect sounds to over 4 kHz (Mann et al. 2001).

Hearing Abilities of Marine Mammals. Marine mammal hearing has been reviewed by Kastelein et al. (1995), Richardson et al. (1995), Kastak and Schusterman (1998), Ketten (1998, 2000), Au et al. (2000), and Nedwell et al. (2004). Fay (1988) tabulated and graphed most pre-1988 data and compared them with audiometric (measured sensitivity of hearing) data from other vertebrates. Ketten (2000) categorized cetaceans into functional groupings based on their auditory anatomy.

For many marine mammal species, no direct behavioral or physiologic audiometric data exist, especially mysticete whales. Hearing ranges for species with no audiograms are estimated with mathematical models based on ear anatomy, inferred from the range of vocalizations, or by a variety of experimental techniques (Ketten 1997; Houser et al. 2007). The hearing ability of mammals is a complex of biotic (e.g., structure of inner ear) and abiotic factors (e.g., water temperature, depth, weather). For instance, the “absolute threshold” is the level of sound at a specific frequency that is barely audible in the absence of significant ambient noise. Data on hearing are available for a few odontocetes and pinnipeds, but not for mysticetes although various authors have speculated about hearing abilities based on the anatomy of their ears, the frequencies of their own calls, and their known reactions to sounds of certain frequencies and levels.

Marine mammals as a group have functional hearing ranges of 10 Hz to 180 kHz with best sensitivity thresholds near 40 dB re 1 µPa @ 1 m (Ketten 1998; Gentry et al. 2004; Kastak et al. 2005). They can be divided into groups based on their probable functional ranges: (a) species with a probable range of 15 Hz to 20 kHz, (b) species with a probable range of 100 Hz to 100 kHz, and (c) species with a probable range of 500 Hz to 180 kHz. The larger species of whales and pinnipeds (e.g. blue whale and elephant seal) have best hearing sensitivity in the lower frequency ranges (i.e., less than 1 kHz).

Overall, current information suggests that mysticete hearing includes frequencies of 10-15 Hz (or lower) at the lower end and up to 20-30 kHz (Frisk et al. 2003). Behavioral and anatomical evidence indicates that they hear well at frequencies below 1 kHz (Richardson et al. 1995, Ketten 2000). Functional hearing for mysticetes as a group extends from 7 Hz to 22 kHz, though the hearing range of individual species may not be as wide (Southall et al. 2007). The auditory threshold for mysticetes is unknown, but is speculated to be approx 60-80 dB re 1 µPa within the frequency range of best hearing (Ketten 2004). However, the absolute sound levels that they can detect below 1 kHz are probably limited by increasing levels of natural ambient noise at decreasing frequencies. At frequencies below 1 kHz, natural ambient levels tend to increase with decreasing frequency (Hildebrand 2004).

Based on field and anatomical evidence, it is assumed that mysticete whale hearing is similar at frequencies less than 1 kHz, then deteriorates with increasing frequency. At frequencies in the 1 to 8 kHz range, ambient noise levels occurring under the quietest natural conditions (and in the absence of man-made sound) are rarely less than 60 dB (Richardson et al. 1995). Therefore, the minimum hearing sensitivity for mysticetes is likely about 50 dB at their best frequencies.

The hearing range of at least some odontocete species ranges from 40 Hz to 150 kHz and is most sensitive in the range of 10-100 kHz. The hearing abilities of some odontocetes have been studied in detail and hearing sensitivity has been determined to be a function of frequency (Richardson et al. 1995; Au et al. 2000; Southall et al. 2007). The small to moderate-sized toothed whales whose hearing has been studied have relatively poor hearing sensitivity at frequencies below 1 kHz, but extremely good sensitivity at and above several kHz. There are at present no specific data on the absolute hearing thresholds (the minimum level at which the animal can hear at each frequency) of the larger, deep-diving toothed whales, such as sperm and beaked whales.

Based on studies of a small number of species of small to medium-sized odontocetes including the Risso's dolphin (Nachtigall et al. 1995), odontocetes hear sounds over a wide range of frequencies (Richardson et al. 1995). Hearing extends at least as low as 40-75 Hz in the bottlenose dolphin (Johnson 1967; Turl 1993). However, the hearing sensitivity of small to medium odontocetes at low frequencies is generally poor. In contrast, the high-frequency hearing ability of most small to medium-sized odontocetes is good, likely related to these cetaceans' use of high-frequency sound for echolocation. The hearing range extends up to 80-150 kHz in at least some individuals of all of the species tested to date. Sound data for Dall's porpoise suggest that they produce sounds in the 0.04-160 kHz range. .

The hearing range of seals and sea lions is generally from 100 Hz to 60 kHz. Underwater audiograms have been obtained for several species of phocids (true or earless seals). At least some of the phocid seals have better auditory sensitivity at lower frequencies (less than 1 kHz) than do odontocetes (Kastak and Schusterman 1999). Below 30-50 kHz, the minimum hearing sensitivity of most pinniped species tested ranges between 60 and 85 dB re 1 µPa.

Potential Impact of Proposed OOI Active Acoustic Sources. In general, the majority of fish are believed to hear within the frequency range of 500 Hz to ~3 kHz. The frequency range over which mysticetes as a group are believed to hear sounds is ~7 Hz to 22 kHz. The frequency range of odontocete hearing is considered ~150 Hz to 180 kHz and the frequency range of pinnipeds is 1-180 kHz (Richardson et al. 1995; Southall et al. 2007). The proposed active acoustic sources associated with the Endurance Array and RSN would generally operate at frequencies much higher than those frequencies considered audible by fish and marine mammals. The ADV, BAP, and the ADCP would all operate at frequencies greater than 180 kHz, with most operating at frequencies greater than 200 kHz (see Table 2-6). For the HPIES, MBES, SBP, altimeters, acoustic modems, and tracking pingers operating at frequencies between 2 and 170 kHz, fish and marine mammals would not be disturbed by any of these proposed acoustic sources given their low duty cycles, the brief period when an individual animal would potentially be within the very narrow beam of the source, and the relatively low source levels of the HPIES, pingers, and acoustic modems. Therefore, implementation of the proposed deployment of the Endurance Array and RSN is not expected to result in significant acoustic impacts to fish and marine mammals, including ESA-listed species.

3.2.2.2 No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the CSN (Endurance Array) and RSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to marine biological resources with implementation of the No-Action Alternative.

3.3 GEOLOGICAL RESOURCES

3.3.1 Affected Environment

For the purposes of this Programmatic EA, the discussion of the geology of the CSN (Endurance Array) and RSN project area will be based on the Desktop Study prepared for a previous alternative alignment that was subsequently dismissed (i.e., the use of a Nedonna Beach, Oregon shore station and a ringed cable design for the RSN) (University of Washington 2007d). A Desktop Study will be prepared to assess the route-specific characteristics of the proposed RSN and CSN alignments addressed in this EA. Therefore, route-specific geological characteristics cannot be determined at this time. However, given the project area of the previous Desktop Study is the same as the current RSN and CSN project area, one can make general inferences as to sediment and substrate types potentially found along the proposed route.

Sediment types found along the proposed Grays Harbor Line of the Endurance Array are expected to be primarily sand at the 25-m mooring, sand and mud at the 80-m mooring, and mud at the 150-m mooring. The proposed Newport Line is expected to have sand at the 25-, 50-, and 80-m moorings and mud at the 150- and 500-m moorings. For the RSN route, sand is the dominant sediment out to ~12 nmi, with sand and mud comprising a narrow band from 12 to 16 nmi from shore, and the mud being dominant along the remaining route. Based on the previous proposed cable alignment assessed in the 2007 Desktop Study, rocky or other hardbottom areas would be avoided to the maximum extent practicable, particularly out to ~1,800 m depth (University of Washington 2007d).

3.3.2 Environmental Consequences

3.3.2.1 Proposed Action

<u>CSN (Endurance Array)</u>

Under the Proposed Action, potential impacts to geological resources from the proposed (CSN) Endurance Array (Grays Harbor and Newport lines) would only be associated with the placement of 14, 2 m^2 mooring anchors and associated sensors on the seafloor (at 25, 50, 80, 150, and 500 m). Impacts would include temporary mechanical disturbance of soft sediments, and long-term coverage of relatively small areas of substrate by the anchors and scientific sensors. Over time, the natural movement of sediments by ocean currents and burrowing organisms would reestablish natural bottom topography. These impacts on soft-bottom substrates are considered minor and would result in short-term insignificant impacts to geological resources.

RSN

Impacts to geological resources onshore would include temporary soil disturbance by grading, excavation, and equipment operations to support HDD activities at two locations: Pacific City and Warrenton, Oregon. At each site, it is anticipated that HDD activities would temporarily disturb approximately 0.2 ha in close proximity to existing beach manholes for existing cables.

As stated in the SOPs (section 2.2.8), the onshore drilling sites would be configured to avoid impacting sensitive coastal habitats that would be especially vulnerable to erosion. In accordance with CWA NPDES requirements, the OOI would obtain coverage under the State of Oregon's general permit for construction stormwater discharges. This would include the preparation and implementation of a stormwater pollution prevention plan (SWPPP) with BMPs to minimize erosion and sediment transport from construction sites, and to restore disturbed areas to a stable condition after construction. As a result, no significant impacts to onshore geologic resources would occur.

Impacts on offshore geology would entail temporary mechanical disturbance of the substrate, and long-term coverage of relatively small areas of substrate by TRFs, mooring anchors, LVNs, Jboxes, and cabled scientific sensors. As described previously, the substrate in the affected area offshore consists of sand, sand and mud, and mud. The cables, anchors, and instruments themselves would constitute ~4 ha of new hard substrate. Soft sediments would be excavated and dispersed a short distance around the bore exits, sites where equipment would be placed, and cable burial corridors. Use of the sea plow and/or ROV to install the cables would impact an approximately 2-m wide swath of substrate during installation, and a total area of 94 ha. Over time, the natural movement of sediments by ocean currents and burrowing organisms would reestablish natural bottom topography. If necessary, the placement of cables on rock substrate would cause minor physical abrasion (grooving) of the substrate (MBARI 2003). Repair activities and/or future removal of the proposed cable, moorings, and associated infrastructure would have impacts on seafloor geology similar to those of installation at the affected locations. These impacts on soft- and hard-bottom substrates are considered minor and not significant.

3.3.2.2 No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the CSN (Endurance Array) and RSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to geological resources with implementation of the No-Action Alternative.

3.4 WATER QUALITY

This section describes the chemical and physical composition of water-related resources as affected by natural conditions and human activities. For the purposes of this analysis, water quality is evaluated with respect to possible release of hazardous constituents and sedimentation resulting from proposed CSN and RSN installation and O&M activities. Water resource regulations focus on the right to use water and protection of water quality. The principal federal laws protecting water quality are the CWA, as amended (33 USC §1251 et seq.) and the Safe Drinking Water Act (42 USC §300f et seq.). Both laws were previously enforced by the USEPA but have subsequently been delegated to the State of Washington and State of Oregon for enforcement. The CWA provides protection of surface water quality and preservation of wetlands. The Safe Drinking Water Act is directed at protection of drinking water supplies.

3.4.1 Affected Environment

3.4.1.1 General Marine Environment

Hydrology. The waters along the Washington and Oregon coast are dominated by the California Current, Davidson Current, and California Undercurrent, and are considered to have the greatest volume of upwelling in North America. Upwelling occurs from February to September due to currents and wind driven factors, resulting in nutrient-rich waters. The California Current flows southward beyond the continental shelf year-round, bringing with it low temperature and salinity, high oxygen, and high phosphate sub-arctic water. The Davidson Current flows over the slope and outer shelf in winter and early spring bringing the same water characteristics as the California Current. The California Undercurrent flows northward along the upper slope at a depth of ~200 m, bringing with it warmer water with a lower salinity, low oxygen, and low phosphates. In winter, the Washington Undercurrent flows deeper (~400 m) along the slope. Bottom currents and winter storms aid in sediment transfer throughout the year (NOAA 1993; University of Washington 2007d).

General circulation over the shelf is northward during winter and southward during summer. During the southward flow in spring and summer, northwesterly winds in combination with the earth's rotation cause surface waters to be deflected offshore (NOAA 1993; University of Washington 2007d).

Sea State. The outer coast is known for its rough seas and large waves. The height and direction of waves vary seasonally. During summer, waves are lower in height, predominantly from the northwest, causing longshore currents and sediment transport to the south. These types of sea conditions are often about 4 or less on the Beaufort scale. In winter, waves are generally higher than in the summer, and sea conditions can commonly be at 6 or higher on the Beaufort scale. Waves are often from the southwest, causing northerly longshore currents and sediment transport. Data from a station off Grays Harbor show nearshore wave heights averaging 4.0 m November through January, with maximum heights of almost 7.9 m October through December. Wave heights farther offshore can regularly be about 4.9 m in December through January. Wave heights in excess of 15.2 m have been recorded on and beyond the continental shelf (NOAA 1993; University of Washington 2007d).

3.4.1.2 Sediment Composition

Highly variable types of sediments occur over the continental margin of the Pacific Northwest, such as coarse sands, very soft to hard clays, sandy clays and clayey sands, gravel, and turbidites. Glacial deposits comprise the underlying sediments of the continental shelf. Sediments along the northern portion of the shelf are deposited by the Columbia River. Sandy silt accumulates along the shelf, while the inner shelf near the coast is mainly composed of sand, while the outer shelf is primarily silt and clay. Sediment types within the project area (Grays Harbor line to the north, Newport Line to the south, and extending further offshore) include, moving west from the coast, sand, sand and mud, and mud. There are areas of rock and rock and sand near the Newport Line (NOAA 1993; University of Washington 2007d).

3.4.2 Environmental Consequences

3.4.2.1 Proposed Action

The onshore portion of the Proposed Action would not affect water quality. Project activities are expected to occur on level sites without surface water features or direct drainage to the ocean. A project-specific SWPPP incorporating BMPs for erosion and sedimentation control would be prepared and implemented to prevent the discharge of sediment or pollutants or runoff from the sites.

The offshore cables consist of metallic and synthetic, essentially inert materials (glass fibers, plastic (polyethylene), copper, steel, waterproof nylon yarn). Based on observations of underwater cables off Kauai (Office of Naval Research 2001) and elsewhere (MBARI 2003; DoN 2004), the cables would soon be covered with marine growth or buried by sand, and would not break down for a very long period of time. The available information, although limited, suggests that cable constituents (such as copper and zinc) are not normally leached into surrounding waters unless the cable is damaged, and that in any case, the amounts are small and unlikely to affect the organisms that grow on the cables (ICPC 2007). Ultimately, as cable components disintegrate, decompose, or corrode, the constituent elements would be dispersed into surrounding media, with no significant effect on sediment or water quality.

The HDD process would not directly or cumulatively introduce toxic or hazardous substances or chemicals, organic substances, or solid wastes into bodies of water or on land to cause the level of these substances to exceed regulatory standards. The bentonite clay used in the drilling process is a non-toxic clay that is not a hazardous substance. It is possible that drilling mud could escape from the bore into the surrounding geologic formation. Any material migrating to the surface would be rapidly dispersed by wave and current action and would not be expected to persist or accumulate in appreciable amounts. During the final stage of drilling, bentonite addition to the drilling fluid would be discontinued, and only water would be used, thus minimizing the release of the clay sediment when the bore exits the seabed. The drilling contractor would follow procedures established in a project-specific Drill Monitoring and Cleanup Plan to minimize the possibility of a release of drilling mud into the ocean, and to remove any accumulation of drilling mud on the seafloor.

The only hazardous substances that would be used in the proposed project are lubricants and fuel contained in marine vessels and equipment. Vessels would adhere to federal, state, and IO requirements (i.e., UNOLS 2003; University of California-San Diego [UCSD] 2007; University of Washington 2007e, f; WHOI 2008) for the management of hazardous materials and hazardous waste. Vessels engaged in installation would adhere to all USCG (CWA §311) requirements regarding the containment, cleanup, and reporting of spills, which would assure that the effects are minimized. Therefore, there would be no significant impacts to marine water quality with implementation of the Proposed Action.

Small-scale increases in turbidity would occur due to installation of the cables and instruments on the seafloor. Turbidity would be minor and temporary throughout the installation activities. Sediments would rapidly disperse and/or settle back to the seabed. Coarse sediments (sand or larger) would resettle within seconds in the immediate area, whereas fines (silt to clay) would tend to drift and remain in suspension for minutes to hours, depending on particle sizes and bottom currents (Minerals Management Service 1999). There would be no permanent or significant effect on marine water quality due to suspended sediments. The outer layers of submarine cables are insoluble and readily become encrusted with marine organisms and are not expected to break down for decades. Inner metallic components are sealed from the surrounding media. Any by-products of corrosion or dissolution of cable components in seawater would be rapidly dispersed and diluted in the water column and as such would have no significant effect on water quality.

Repair activities and/or future removal of the instruments would have impacts on marine water quality similar to those of installation at the affected locations.

No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the CSN (Endurance Array) and RSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to water quality with implementation of the No-Action Alternative.

3.5 CULTURAL RESOURCES

Cultural resources are defined as any prehistoric or historic sites, buildings, districts, structures, traditional use areas, or objects considered important to a culture, subculture, or community for scientific, traditional, religious, or any other reasons. Cultural resources are generally divided into three groups: *archaeological resources* (both historic and prehistoric), *architectural resources*, and *traditional cultural resources*. Since there would be no terrestrial construction and all proposed activities would occur within the offshore (i.e., underwater or on the water's surface) or nearshore environment, the following discussion focuses on those cultural resources that occur in the offshore or nearshore environment. These resources include submerged sites, shipwrecks, shell middens, and traditional resources related to fishing and other marine or nearshore resources.

Archaeological Resources. Prehistoric and historic archaeological resources are locations (sites) where human activity measurably altered the earth or left deposits of physical remains. Prehistoric sites consist of various forms of evidence indicative of human activities that spanned the time from about 9,000 years ago until the time of the first European contact in 1635. Most frequently, such sites contain both surface and subsurface elements.

Traditional Cultural Resources. Traditional cultural resources are resources associated with cultural practices and beliefs of a living community that are rooted in its history and are important in maintaining the continuing cultural identity of the community. Traditional cultural resources may include archaeological sites, locations of historic events, sacred areas, sources of raw materials used to produce tools and sacred objects, traditional hunting or gathering areas, and usual and accustomed Tribal fishing grounds. The community may consider these resources essential for the persistence of their traditional culture.

A 1974 federal court ruling granted Western Washington Native American Indian Tribes and Nations access to "usual and accustomed fishing grounds and stations" (U.S. District Court 1974). The "Boldt Decision" allocated 50% of the annual catch to treaty tribes, thus allowing Western Washington tribes the right to fish at usual and accustomed grounds and stations identified by federal treaties signed in 1854 and 1855.

Information on the locations of cultural resources and the probability of affecting currently unknown resources was derived from previous environmental documents from the area and the *Northern Shipwrecks Database* (Northern Maritime Research 2002).

3.5.1 Affected Environment

3.5.1.1 CSN (Endurance Array – Grays Harbor Line)

Archaeological Resources. The reported but not confirmed locations for five shipwrecks are within approximately 3 nmi of the proposed Grays Harbor Line (USACE 1986; Northern Maritime Research 2002; University of Washington 2007d). All of these are closer to shore and to the north or south of the proposed mooring locations. Although not listed on the NRHP, these shipwrecks are potentially eligible for listing.

Traditional Cultural Resources. The Quinault Nation has usual and accustomed fishing rights within the area of the proposed Grays Harbor Line. The area of usual and accustomed fishing rights extends from just north of Kalaloch, Washington to just south of Grays Harbor, Washington (NMFS 2004; 50 CFR 660.324).

3.5.1.2 CSN (Endurance Array – Newport Line)

Archaeological Resources. No known shipwrecks are located within 5 nmi of the proposed Newport Line (Northern Maritime Research 2002; University of Washington 2007d).

Traditional Cultural Resources. There are no Native American tribes or nations with usual and accustomed fishing rights off the coast of Oregon (50 CFR 660.324).

3.5.1.3 RSN

Archaeological Resources. No known shipwrecks are located within 1 nmi of the proposed RSN cable route (Northern Maritime Research 2002; University of Washington 2007d).

Traditional Cultural Resources. There are no Native American tribes or nations with usual and accustomed fishing rights off the coast of Oregon (50 CFR 660.324).

3.5.2 Environmental Consequences

3.5.2.1 Proposed Action

Under the Proposed Action, potential impacts to cultural resources from the proposed (CSN) Endurance Array would only be associated with the placement of two mooring anchors (at 25 m or approximately 3 nmi from shore) on the seafloor for the Grays Harbor Line, four mooring anchors (two each at 25 and 50 m) on the seafloor for the Newport Line, and associated scientific sensors on the seafloor in the immediate vicinity of the moorings. The proposed RSN cable route would be sited to avoid all known cultural resource sites. Site-specific surveys would be conducted prior to placement of any RSN cable and mooring anchors to determine if any undiscovered cultural resources are within the immediate vicinity of the proposed RSN cable and Endurance Array moorings. With the implementation of pre-cable laying surveys and the routing of the RSN cable and placement of Endurance Array moorings to avoid known cultural resources, there would be no significant impacts to cultural resources with implementation of the CSN (Endurance Array) and RSN components of the Proposed Action.

NSF and the CSN IOs would establish a communication process with the Quinault Nation to establish points of contact to exchange information on proposed OOI activity and Tribal fishing regulations in order to avoid disruption of Tribal usual and accustomed fishing patterns. Therefore, implementation of the Proposed Action would not result in adverse effects to historic resources, cultural resources, or to usual and accustomed fishing rights.

No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the CSN (Endurance Array) and RSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to cultural resources with implementation of the No-Action Alternative.

3.6 SOCIOECONOMICS (FISHERIES)

3.6.1 Affected Environment

The main socioeconomic resource along the Oregon and Washington coasts is commercial fishing fish and shellfish. Fishing typically occurs from the shoreline to approximately 1,850 m depth and most effort takes place between January and September, with less from October through December. There are four main gear types used along the Oregon and Washington coasts: bottom trawl, near-bottom trawl, longlines, and pot gear. Scallop dredges are also used, but rarely as there are very few scallop areas remaining off of Oregon and Washington (Natural Resources Consultants [NRC] 2007). Fisheries targeted by gear type is provided in Table 3-3 and a brief description of each method is summarized below.

Table 3-3. Gear Type and Fisheries within the Proposed CSN and RSN ROI

Gear Type	*Fisheries*
Bottom trawl	Flatfish, rockfish, roundfish, shrimp, prawns
Near-bottom trawl and pelagic trawl	Whiting, rockfish
Longlines	Halibut, sablefish, rockfish
Pot	Dungeness crab, sablefish, slime eels

Bottom Trawl

Bottom trawling is the method most often used off Washington and Oregon coasts. Bottom trawling gear that targets flatfish on muddy/sandy bottom sediment consists of wire bridles that connect a heavy chaffing web net to the trawl doors. The bridles are positioned so that they can penetrate 2-3 centimeters (cm) into the soft bottom for the purpose of kicking up fish that are lying on the bottom. The bottom of the net nearest the codend stays in contact with the soft bottom as trawling activity occurs and may dig into the soft bottom several centimeters. The leading edge of the doors are bowed up to allow for bouncing up and over obstructions. Most flatfish fishing occurs January through September (NRC 2007).

Gear used to target shrimp is similar to that used to target flatfish except that gear consists of two net bottom trawls used simultaneously along areas of soft bottom sediments at an average depth of 150 m. The net itself is not designed to contact the bottom; however, wire footropes may dig into the bottom as deep as 5 cm. Most trawling effort for shrimp occurs during the summer months at 100 – 200 m depths near Tillamook Bay (NRC 2007). Figure 3-1 depicts the bottom trawl fishing effort in the vicinity of the proposed CSN (Endurance Array) and RSN.

Near-bottom Trawl and Pelagic Trawl

Gear used to target rockfish consists of similar gear as described above for bottom trawling. However, trawling areas contain a rocky bottom with drop offs and canyons rather than sand and muddy sediments. Therefore, the gear is set to remain just off of the bottom. Due to reduced rockfish stocks, bottom-trawling effort has been restricted between 100 and 200 m off of Oregon and Washington with restrictions expecting to continue until stocks increase. Mid-water or pelagic trawling has no contact with the bottom and often takes place from 15 to 1,000 m depths with most fishing effort occurring 20 to 30 nmi offshore. The target fish for pelagic trawling is primarily Pacific hake (NRC 2007).

Long Lines

Long line gear used to target halibut consists of a 10- to 16-mm diameter three-strand twisted poly rope with each end attached to a 20-35 kg anchor. Baited circle hooks are attached along the line where it is positioned along the bottom sediment. Braided poly or nylon rope are attached to the groundline and extend up to the surface, attaching to a buoy and light/radar reflector poles. Long line gear targeting sablefish is similar to halibut except that only one end of the long line is anchored to the bottom while the other extends up to the surface and attaches to a buoy, flags, lights, and radar detectors.

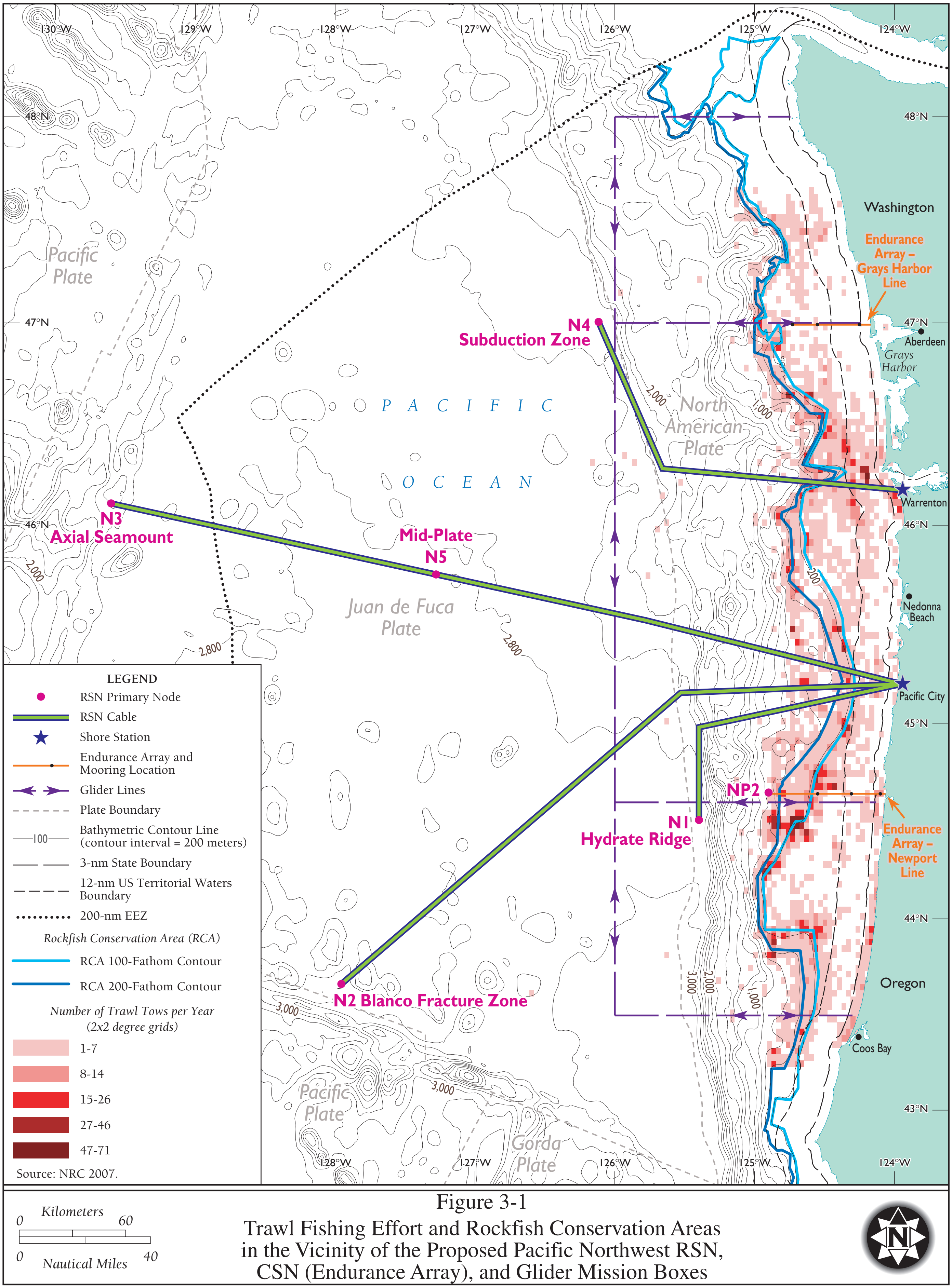

Figure 3-1
Trawl Fishing Effort and Rockfish Conservation Areas in the Vicinity of the Proposed Pacific Northwest RSN, CSN (Endurance Array), and Glider Mission Boxes

Pot

Pot gear targeting crab is composed of a 1.5 m circular or rectangular steel frame and weigh 35 to 70 kg each. Pots are baited and set over soft bottoms at relatively shallow depths (5 to 40 m) and are attached to a long line up to the surface held in place by a buoy. Pots can penetrate the bottom but rarely and no more than 5 cm deep. Pots are typically checked every 12 to 48 hours. Most fishing effort occurs between the Columbia River and Tillamook (NRC 2007).

Pots are also used for sablefish. Gear consists of 50 to 200 pots attached to 20- to 25-mm diameter groundline. The groundline is set and marked at the surface as described for the halibut longline fishery above (NRC 2007).

3.6.2 Environmental Consequences

3.6.2.1 Proposed Action

Bottom trawl fisheries targeting flatfish, rockfish, roundfish, shrimp, and prawns represent the greatest threat of damage to submarine fiber optic cables in the project area. Near-bottom and pelagic trawl fisheries targeting whiting and rockfish offer less of a threat since they only rarely contact the seabed but may impact scientific instrument packages that extend upward into the water column. Bottom contact longline gear targeting halibut, sablefish, and rockfish offers yet a lower level of threat to cables and scientific instrument packages from entanglement in terminal anchors and mainline. Pot gear targeting Dungeness crab, sablefish, and slime eels offer a similar low level of threat to project cables and equipment on the seabed.

The three proposed cable routes extending out from the Pacific City shore station bisect flatfish/round fish bottom trawl areas as well as near-bottom rockfish and pelagic trawl pacific hake areas (Figure 3-1). However, restrictions imposed that eliminate trawl effort between 100 and 200 m offshore of the Oregon Coast provides an area at which impact to trawling from cables are insignificant. Crab fisheries occur in the nearshore depths of the cable route from Pacific City, however, crab pot gear is not anticipated to have issues with snagging on cables. The proposed cable route extending off the proposed Warrenton Shore Station also bisects a very popular crab pot fishing location with the Columbia River immediately north of the Warrenton shore station. Bottom trawl effort is generally low along the proposed cable route and the Grays Harbor and Newport lines of the Endurance Array (Figure 3-1).

The proposed installation and O&M activities of the CSN (Endurance Array) and RSN would have two potential impacts to commercial fisheries operations in the ROI: 1) presence of the cable installation vessel would preclude fishing activities within a limited area (~1.6 km) for a temporary period (a few hours to several days), and 2) commercial fisheries that use equipment that contacts the bottom could potentially snag unburied portions of the cable or scientific sensors, causing damage to or loss of their fishing gear, or damage to the cable or scientific sensors on the seafloor.

Notice would be given to fishing vessels regarding the proposed CSN and RSN installation operations to prevent contact that could potentially damage fishing gear. No exclusions are proposed along the cable route, so interference would not occur between the cable installation vessel and commercial fisheries. Potential interference with commercial fishing activities could occur during cable and mooring installation operations, but these would be temporary and localized. As the cable vessel and installation operations progress, fishing activities would not be precluded along the entire proposed cable route or Endurance Array lines. Only small areas would not be available for fishing while the cable plow and cable-laying vessel are in a specific area.

The IOs for the proposed CSN and RSN and representatives from the OFCC have been in preliminary discussions about a formal agreement that would address concerns of the fishing industry regarding installation of the cable and potential impacts on fishing revenues from potential loss of gear. Such agreements have been incorporated into the considerations and approvals of previous commercial fiber optic cable projects in Oregon coastal waters. These earlier agreements have provided a model for the preliminary discussions. With the implementation of SOPs (Section 2.2.8) and the incorporation of an agreement between the OFCC and the OOI owner, there would be no significant impacts to commercial fisheries with implementation of the Proposed Action.

3.6.2.2 No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the CSN (Endurance Array) and RSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to fisheries with implementation of the No-Action Alternative.

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CHAPTER 4
AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES: MID-ATLANTIC BIGHT CSN (PIONEER ARRAY)

4.1 APPROACH TO ANALYSIS

This chapter describes the existing environmental conditions in the vicinity of the Pioneer Array for resources potentially affected by implementation of the Proposed Action as described in Chapter 2. Information presented in this chapter represents baseline conditions against which the Proposed Action is evaluated to identify potential impacts. In the environmental analysis process, the resources analyzed are identified and the expected geographic scope of potential impacts, known as the ROI is defined.

In compliance with NEPA and CEQ regulations, the description of the affected environment focuses only on those resources potentially subject to impacts. In addition, the level of analysis should be commensurate with the anticipated level of environmental impact. Accordingly, the discussion of the affected environment (and associated environmental impact analyses) focuses on marine biological resources within the ROI for the Pioneer Array. Several additional resources that are generally evaluated in the preparation of an EA were not evaluated in this Programmatic EA because it was determined that implementation of the Proposed Action would be unlikely to have any effect on these resources. The reason why each resource has been exempted from analysis or is not analyzed in detail in this Programmatic EA is provided below.

4.1.1 Geological Resources

Under the Proposed Action, potential impacts to geological resources from the proposed Pioneer Array would only be associated with the placement of 12 mooring anchors and associated sensors on the seafloor ~75 nmi from shore. The placement of these anchors and sensors would result in short-term insignificant impacts to surface sediments in the immediate vicinity of the proposed Pioneer Array assets, and there would be no significant impacts to marine geological resources.

4.1.2 Air Quality

The Proposed Action is not located within the jurisdiction of any state and is also outside U.S. Territory. There are no emissions standards for vessels or activities operating beyond 12 nmi of shore. Proposed activities would result in minor temporary emissions from surface vessels or surface buoys during installation and O&M activities of the Pioneer Array. However, these emissions would not represent a substantial increase above existing conditions as only a small number of vessels and surface buoys would be used. The proposed installation and O&M activities associated with the Pioneer Array would take place more than 75 nmi from the shoreline of any state and therefore would not compromise air quality attainment status in New York, Rhode Island, Connecticut, and Massachusetts. Therefore, the Proposed Action would have a negligible impact on air quality within the ROI.

4.1.3 Water Quality

Proposed installation and O&M activities at the proposed Pioneer Array would not introduce any materials or substances into the marine environment that would adversely affect marine water quality. The only potential sources of hazardous materials would be unanticipated accidents or spills that resulted in a discharge of fuel, lubricants, or sensor components (e.g., batteries) from a project vessel or associated OOI equipment and sensors. Based on existing IO requirements (i.e., UNOLS 2003; UCSD 2007; University of Washington 2007e, f; WHOI 2008) and procedures for management of such materials on board vessels and the design of scientific equipment and sensors, such events are extremely unlikely to occur. If such a spill were to occur, it would be a localized occurrence, and adherence to standard containment, cleanup, and reporting requirements would assure that the effects are minimized. In addition, residual material would be dispersed by natural processes.

The proposed Pioneer Array would be capable of being upgraded to a methanol-based fuel cell power generation system. Pure 100% methanol (M100) would be used in the proposed fuel cells. An alcohol, methanol is a clear, odorless, volatile liquid, and mixes completely in water. Based on a review of existing information on the fate and transport of methanol in the environment (American Methanol Institute 1999), it was determined that methanol was unlikely to accumulate in surface water in the event of an accidental spill of a fuel cell. In surface water, the complete solubility of methanol would result in rapid wave-, wind-, and tide-induced dilution to low concentrations. Relative to conventional gasoline and diesel fuel, methanol is significantly less toxic to marine life than oil or gasoline and is considered a safer and more environmentally benign fuel (American Methanol Institute 1999).

The project would not alter currents or circulation regimes. A minor and localized area for which the anchors, scientific sensors, and connecting cables would be placed would likely have some re-suspension of sediment, but these effects would be temporary. Therefore, there would be no impacts to water quality with implementation of the Pioneer Array component of the proposed OOI.

4.1.4 Cultural Resources

The Automated Wreck and Obstruction Information System (AWOIS) is a catalogue of reported submerged shipwrecks and obstructions in U.S. coastal waters. This database indicates numerous shipwrecks and obstructions are within the vicinity of the proposed Pioneer Array (NOAA 2007).

Under the Proposed Action, potential impacts to cultural resources from the proposed Pioneer Array would only be associated with the placement of 12 mooring anchors and associated sensors on the seafloor beyond 75 nmi of shore. Prior to deployment of the proposed moorings and anchors, a site survey would be conducted within an approximate 1-km radius of each proposed anchor site to determine if any known or unknown cultural resources (e.g., shipwrecks) are within the vicinity. All obstructions and/or cultural resources would be avoided based on these surveys and after consulting the AWOIS. Therefore, the placement of the proposed Pioneer Array would not result in significant impacts to cultural resources.

4.2 MARINE BIOLOGICAL RESOURCES

4.2.1 Affected Environment

In general the habitat within the area is composed of a mix of live and hard bottom communities. Sand, silt-clay, sand ridges, and glacially exposed rock form the seafloor. The inner continental shelf is shaped by submarine canyons and seamounts. The shelf is a vibrant habitat for algae growth and benthic and demersal species such as sea fans and hard and soft corals. Common coral communities (northern star coral) inhabit the low tide area and extending out to just beyond the 200 m depth. Soft corals occupy the continental shelf and slope areas from 200 to 500 m. The bottom habitat between 500 and 4,000 m contains deepwater hard coral communities. The proposed Pioneer Array is ~10 nmi east of Alvin Canyon at the shelf break, which has abundant deepwater corals (Alcyonaria) (DoN 2005).

Abundant plankton communities drive the productive ecosystem that functions along the continental shelf and Mid-Atlantic Bight. Plankton communities include phytoplankton (plant) and zooplankton (animal and larval fish). Temperature, light, and nutrient concentration influence the growth of phytoplankton in the area. Generally, summer months have an increase of phytoplankton within the continental shelf and slope areas with a presence of chlorophyll residing as deep as 150 m from the surface due to increased light penetration. Zooplankton rely in large part on ocean currents and nutrients in the water column. Seasonal changes in currents and mixing, creating stratification within the water column, typically result in increased plankton species. Zooplankton, specifically copepods, are dominant within the shelf area during spring and summer (DoN 2005).

4.2.1.1 Marine Invertebrates and Fish

Invertebrate species are primarily influenced by the availability of benthic habitat. Species such as American lobster and red deepsea crab and molluscs such as Atlantic surf clam, sea scallop, and ocean quahog may occur within the benthic habitat of the shelf areas throughout the year. Distribution of squid species and highly migratory species such as tunas and sharks are driven by ocean fronts and are expected to be present along the shelf areas during winter and coastal areas in spring or summer. Marine fish utilizing the U.S. Northeastern continental shelf include but are not limited to Atlantic sea herring, black sea bass, Atlantic tunas (bluefin, yellowfin), butterfish, and scorpionfish. Numerous species of flounder, skates, and sharks occur along the continental shelf as well. Temperate fish species (inhabiting temperatures below 15 °C), particularly cod, haddock, and hake species, primarily reside along Georges Bank along banks and ledges. Haddock will inhabit shelf waters in fall, but move to shallower waters in spring (SAUP 2007).

4.2.1.2 EFH

EFH is broadly defined to include "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." In addition, the regional FMCs further define EFH for each species and each life stage to correspond with specific habitat, temperature, salinity, and depth. For the Northeast Region, EFH has been identified for 59 species covered by 14 FMPs, under either the New England FMC or Mid-Atlantic FMC (NMFS 2007). Within the New England Region, FMPs have been prepared for Atlantic salmon, Northeast Multispecies, sea scallop, Atlantic herring, and monkfish. Of those managed species, 34 species have designated EFH within the general vicinity of the proposed Pioneer Array (Table 4-1). No HAPCs have been designated within the vicinity of the Pioneer Array.

Table 4-1. Fish Species with Designated EFH within the Vicinity of the Proposed Pioneer Array

Species	*Life Stage*
American plaice	L
Atlantic bluefin tuna	J, A
Atlantic butterfish	L, J, A
Atlantic cod	E, L
Atlantic mackerel	L
Atlantic sea herring	L, J, A
Atlantic yellowfin tuna	J, A
Barndoor skate	A
Basking shark	J, A
Black sea bass	J
Blue shark	J, A
Bluefish	A
Cobia	E, L, J, A
Dusky shark	J
Haddock	L, A
King mackerel	E, L, J, A
Long finned squid	J, A
Monkfish	E, L, J, A

Table 4-1. Fish Species with Designated EFH within the Vicinity of the Proposed Pioneer Array

Species	*Life Stage*
Ocean pout	E, L, J, A
Offshore hake	L
Red hake	E, L, J, A
Sandbar shark	J, A
Scup	J
Shortfin mako	L, J, A
Spanish mackerel	E, L, J, A
Spiny dogfish	J, A
Summer flounder	E. L, A
Thresher shark	L, J, A
Tiger shark	J
Whiting	E, L, J, A
Windowpane flounder	L, J, A
Winter flounder	E, L, J, A
Witch flounder	E, L, A
Yellowtail flounder	E, L, J, A

Notes: A = adult, E = eggs. J = juvenile, L = larvae.
Source: NMFS 2008c.

4.2.1.3 Marine Mammals

Approximately 40 marine mammal species occur within the nearshore and deep open ocean habitats surrounding the proposed location of the Pioneer Array. Baleen whales or mysticetes occurring in the area include humpback, minke, dwarf minke, and sei. Minke whales tend to reside in the area year-round unlike other baleens whales that typically make long migrations from summer foraging grounds to warm wintering/breeding grounds. Toothed whales or odontocetes occurring in the area include dwarf and pygmy sperm whales, short-finned pilot whales, long-finned pilot whales, beaked whales (Cuvier’s, Trues, and Gervais); common bottlenose, Atlantic spotted, Atlantic white-sided, and Risso’s dolphins; and harbor porpoise. Most of the toothed whales occur within the area year-round with an increased abundance over continental shelf waters during spring and summer months. Harbor and gray seals are year-round residents in the area although they typically stay within the coastal areas and do not generally venture beyond 10 nmi from shore (DoN 2005; SAUP 2007).

4.2.1.4 ESA-listed Species

One fish species, three sea turtles, and six marine mammals are ESA-listed as threatened or endangered and may occur in the vicinity of the proposed Pioneer Array (Table 4-2).

<u>Fish</u>

Atlantic Salmon. Juvenile Atlantic salmon rear in rivers for ~3 years. Smolts then migrate out to sea where they will forage and mature to adults for 2-3 years before returning to freshwater to spawn (Fay et al. 2006). Although spawning rivers are found predominantly to the north of Massachusetts, Atlantic salmon have extensive marine-phase feeding migrations and are likely to be present within the vicinity of the proposed Pioneer Array.

Table 4-2. ESA-Listed Species Potentially Occurring within the Vicinity of the Proposed Pioneer Array

Species	*ESA Status*
FISH	
Atlantic Salmon	E
SEA TURTLES	
Kemp's ridley	E
Loggerhead	T
Leatherback	E
MARINE MAMMALS	
Blue whale	E
Fin whale	E
Humpback whale	E
North Atlantic right whale	E
Sei whale	E
Sperm whale	E

Notes: E = endangered, T = threatened.
Source: NMFS 2008b.

Sea Turtles

Kemp's Ridley Sea Turtle. Kemp's ridleys are distributed throughout the Gulf of Mexico and U.S. Atlantic seaboard, from Florida to New England. They feed primarily on crabs, and to a lesser extent, fish, jellyfish, and molluscs. Breeding and nesting beaches for Kemp's ridley are primarily located within the Gulf of Mexico (NMFS 2008b). Although Kemp's ridleys adults rarely inhabit waters deeper than 50 m, post-hatchling oceanic juveniles are common along shelf areas, primarily east and west of the proposed Pioneer Array (DoN 2005).

Loggerhead Sea Turtle. Loggerheads inhabit both temperate and tropical regions. In the Atlantic, they range from Newfoundland to Argentina, with nesting concentrated in the U.S. on beaches from North Carolina to Florida. They feed on crabs, shrimp, jellyfish, and a variety of molluscs. Main feeding areas are along the continental shelf areas (NMFS 2008b). Post-hatchling oceanic juveniles and returning adults may be present within the vicinity of the Pioneer Array at any time of the year.

Leatherback Sea Turtle. Leatherbacks are the most migratory and wide-ranging sea turtle species, foraging on jellyfish and other soft-bodied prey in both coastal and pelagic waters. Because they are capable of tolerating a wide range of temperatures, sightings have occurred along the entire continental coast of the US as far north as the Gulf of Maine. U.S. nesting locations include the U.S. Caribbean and southeast Florida (NMFS 2008b). Leatherbacks are likely to occur within the vicinity of the Pioneer Array during summer months.

Marine Mammals

Blue Whale. The blue whale is considered an occasional visitor in the U.S. EEZ, which may represent the limits of its feeding range. Thus, a small number of blue whales may occasionally occur in the vicinity of the Pioneer Array during the summer (Waring et al. 2004; DoN 2005).

Fin Whale. Fin whales are mainly distributed within the U.S. Atlantic EEZ from Cape Hatteras northward. They primarily forage on schooling fish within New England waters with many sightings within Massachusetts Bay and the Gulf of Maine. Approximately 50 percent of aerial survey sightings have been along the continental shelf. Calving takes place from October to January in the US Mid-

Atlantic region (DoN 2005). Fin whales are likely to be present year around within the vicinity of the Pioneer Array.

Humpback Whale. Humpback whales that inhabit the western North Atlantic are primarily found foraging on herring in the Gulf of St. Lawrence, Newfoundland, western Greenland, and Gulf of Maine during the summer. Sightings of humpbacks have also occurred in the Georges Bank. Humpbacks that spend summers within the Northeastern Atlantic typically migrate to the West Indies during wintertime (DoN 2005). Humpback whales are likely to be present within the vicinity of the Pioneer Array during summer months.

North Atlantic Right Whale. North Atlantic right whales in the western North Atlantic typically migrate along the US coast from Nova Scotia to Florida. Year around sightings of these right whales have been within the Mid-Atlantic Bight north to the Gulf of Maine. New England waters are the primary foraging location for right whales during the late winter where they feed on various zooplankton species. Occurrences of right whales increase within the Georges Bank during summer months, predominately in August. Critical habitat is designated for North Atlantic right whale in Massachusetts Bay and Cape Cod Bay and along the Great South Channel, ~60 nmi to the northeast of the proposed Pioneer Array and associated glider box (NMFS 2008b). North Atlantic right whales are likely to occur within the vicinity of the Pioneer Array at any time of the year with more abundance during summer months.

Sei Whale. Sei whales occurring in the Atlantic inhabit the waters of the Scotian shelf and the deeper waters of the continental shelf (2,000 m). They are mostly planktivorous and spend spring and summer months within the northern U.S. Atlantic EEZ, specifically Gulf of Maine and Georges Bank. Sei whales are the most abundant during spring along the eastern and southwestern edge of the Georges Bank in the area of the Hydrographer Canyon. Sei whales are likely to occur within the vicinity of the Pioneer Array, particularly during spring and summer (NMFS 2008b).

Sperm Whale. Sperm whales occurring in the Atlantic region spend winters east and northeast of Cape Hatteras. They are distributed widely throughout the center portion of the mid-Atlantic Bight and Georges Bank during spring, summer, and fall. They spend a majority of their time at depths of between 400 and 1,000 m feeding on large squid and demersal sharks, skates, and fish (NMFS 2008b). Sperm whales are likely to occur within the vicinity of the Pioneer Array, particularly during spring, summer, and fall.

4.2.2 Environmental Consequences

4.2.2.1 Proposed Action

Installation and O&M Activities

The vessels and activity associated with installation of 12 surface and subsurface moorings and associated scientific sensors on the sea floor may cause marine species to temporarily avoid the immediate vicinity of the proposed Pioneer Array, but this impact would not be significant due to the small scale and temporary nature of the proposed activities (estimated time to deploy a mooring with one vessel is 12-24 hours). The vessel used for mooring deployment would move very slowly (1-2 knots) during the activity and would not pose a collision threat to marine mammals. Entanglement of marine species is not likely because the rigidity of the mooring cables and the ability of marine species to detect and avoid the mooring lines. Once installed on the seabed, the proposed mooring anchors and scientific sensors would be equivalent to other hard structures on the seabed, again posing no risk of adverse effect on marine organisms.

EFH. Under the provisions of the MSA, federal agencies must consult with NMFS prior to undertaking any actions that may adversely affect EFH. Federal agencies retain the discretion to determine what actions fall within the definition of "adverse affect." Temporary or minimal impacts, as defined by NMFS regulations and below, are not considered to "adversely affect" EFH (50 CFR Part 600). "Temporary impacts" are those that are limited in duration and that allow the particular environment to recover without measurable impact. "Minimal impacts" are those that may result in relatively small changes in the affected environment and insignificant changes in ecological functions.

In considering the potential impacts of a proposed action on EFH, all designated EFH must be considered. Impacts from the placement of proposed mooring anchors or MFN, and cabled scientific sensors on the seafloor would include temporary mechanical disturbance of soft sediments, and long-term coverage of relatively small areas of substrate by the anchors and scientific sensors. Based on the expected size and number of anchors and scientific sensors on the seafloor, ~30 m^2 of EFH would potentially be impacted during installation activities. Over time, the natural movement of sediments by ocean currents and burrowing organisms would reestablish natural bottom topography. The short-term and minor increases in turbidity and sedimentation would not affect the ability of EFH to support healthy fish populations and affected areas are expected to recover quickly. Therefore, the implementation of the proposed Pioneer Array would not have an adverse affect on EFH in the area.

Gliders and AUVs

The use of up to 10 gliders and 3 AUVs within a survey area of ~9,000 nmi^2 around the Pioneer Array (Figure 2-4) is not expected to affect marine species as the proposed gliders and AUVs would move within the water column similar to a dolphin or whale. Gliders are sealed, contain no motors, fuels, or hazardous materials; and move at very slow speeds (~0.5 knot), thereby eliminating the potential for collisions with marine mammals. AUVs also move at low speeds (~3.5 knots) with little potential for collisions with marine species. AUV batteries are sealed with little potential for leakage. Therefore, the use of gliders and AUVs associated with the proposed Pioneer Array would not have an adverse affect on marine species in the ROI.

Active Acoustic Sources

Potential Impact of Proposed OOI Active Acoustic Sources. In general, the majority of fish are believed to hear within the frequency range of 500 Hz to ~3 kHz. The frequency range over which mysticetes as a group are believed to hear sounds is ~7 Hz to 22 kHz. The frequency range of odontocete hearing is considered ~150 Hz to 180 kHz and the frequency range of pinnipeds is 1-180 kHz (Richardson et al. 1995; Southall et al. 2007). The proposed active acoustic sources associated with the Pioneer Array would generally operate at frequencies much higher than those frequencies considered audible by fish and marine mammals. The ADV, BAP, and the ADCP would all operate at frequencies greater than 180 kHz, with most operating at frequencies greater than 200 kHz (see Table 2-6). For the HPIES, MBES, SBP, altimeters, acoustic modems, and tracking pingers operating at frequencies between 2 and 170 kHz, fish and marine mammals would not be disturbed by any of these proposed acoustic sources given their low duty cycles, the brief period when an individual animal would potentially be within the very narrow beam of the source, and the relatively low source levels of the HPIES, pingers, and acoustic modems. Therefore, implementation of the proposed deployment of the Pioneer Array is not expected to result in significant acoustic impacts to fish and marine mammals, including ESA-listed species.

4.2.2.2 No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the CSN (Pioneer Array) component, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to marine biological resources with implementation of the No-Action Alternative.

CHAPTER 5
AFFECTED ENVIRONMENT AND ENVIRONMENTAL CONSEQUENCES: GSN

5.1 APPROACH TO ANALYSIS

This chapter describes the existing environmental conditions in the vicinity of the proposed GSN sites for resources potentially affected by implementation of the Proposed Action as described in Chapter 2. Information presented in this chapter represents baseline conditions against which the Proposed Action is evaluated to identify potential impacts. In the environmental analysis process, the resources analyzed are identified and the expected geographic scope of potential impacts, known as the ROI is defined.

In compliance with NEPA and CEQ regulations, the description of the affected environment focuses only on those resources potentially subject to impacts. In addition, the level of analysis should be commensurate with the anticipated level of environmental impact. Accordingly, the discussion of the affected environment (and associated environmental impact analyses) focuses on marine biological resources within the ROI for the GSN sites. Several additional resources that are generally evaluated in the preparation of an EA were not evaluated in this Programmatic EA because it was determined that implementation of the Proposed Action would be unlikely to have any effect on these resources. The reason why each resource has been exempted from analysis or is not analyzed in detail in this Programmatic EA is provided below.

5.1.1 Geological Resources

Under the Proposed Action, potential impacts to geological resources from the proposed four GSN sites would only be associated with the placement of 12 mooring anchors and associated scientific sensors on the seafloor in International Waters. Impacts would include temporary mechanical disturbance of sediments, and long-term coverage of relatively small areas of substrate by the anchors, scientific sensors, and connecting cables. Over time, the natural movement of sediments by ocean currents and burrowing organisms would reestablish natural bottom topography. These impacts on bottom substrates are considered minor and would result in short-term insignificant impacts to geological resources at these remote and isolated locations.

5.1.2 Air Quality

The proposed GSN sites are not located within the jurisdiction of any state and are also outside U.S. Territory in International Waters. There are no emissions standards for vessels or activities operating beyond 12 nmi of shore. The Proposed Action would result in minor temporary emissions from surface vessels during installation and O&M activities of the GSN sites. However, these vessel emissions would not represent a substantial increase above existing conditions, as only a small number would be used and for only a few weeks per year. The proposed installation and O&M activities associated with the GSN sites would take place more than 75 nmi from the shoreline and therefore would not compromise the air quality of any country. Therefore, the Proposed Action would have a negligible impact on air quality.

5.1.3 Water Quality

Proposed installation and O&M activities at the proposed GSN sites would not introduce any materials or substances into the marine environment that would adversely affect marine water quality. The only potential sources of hazardous materials would be unanticipated accidents or spills that resulted in a discharge of diesel fuel, lubricants, or sensor components (e.g., batteries) from a project vessel or associated OOI equipment and sensors. Based on existing IO requirements (i.e., UNOLS 2003; UCSD

2007; University of Washington 2007e, f; WHOI 2008) and procedures for management of such materials on board vessels and the design of scientific equipment and sensors, such events are extremely unlikely to occur. If such a spill were to occur, it would be a localized occurrence, and adherence to standard containment, cleanup, and reporting requirements would assure that the effects are minimized. In addition, residual material would be dispersed by natural processes.

Although currently proposed as being powered by solar or wind power, the proposed Southern Ocean and Irminger Sea discus buoys would be capable of being upgraded to a methanol-based fuel cell power generation system. Pure 100% methanol (M100) would be used in the proposed fuel cells. An alcohol, methanol is a clear, odorless, volatile liquid, and mixes completely in water. Based on a review of existing information on the fate and transport of methanol in the environment (American Methanol Institute 1999), it was determined that methanol was unlikely to accumulate in surface water in the event of an accidental spill of a fuel cell. In surface water, the complete solubility of methanol would result in rapid wave-, wind-, and tide-induced dilution to low concentrations. Relative to conventional gasoline and diesel fuel, methanol is significantly less toxic to marine life than oil or gasoline and is considered a safer and more environmentally benign fuel (American Methanol Institute 1999).

The project would not alter currents or circulation regimes. A minor and localized area for which the anchors, scientific sensors, and connecting cables will be placed would likely have some re-suspension of sediment, but would be temporary. Therefore, there would be no impacts to water quality with implementation of the GSN component of the proposed OOI.

5.2 STATION PAPA

5.2.1 Marine Biological Resources

The proposed Station Papa GSN site is located approximately 500 nmi west of the Queen Charlotte Islands, British Columbia, Canada and 600 nmi south of Cordova, Alaska in waters 4,250 m deep (Figure 2-12). Site-specific information on the potential occurrence of marine biological resources within the vicinity of the GSN does not exist. Therefore, the following discussion provides a very general background regarding marine biological resources potentially found in the vicinity based on inferences from documents describing marine resources within the Gulf of Alaska.

5.2.1.1 Affected Environment

Fish

Medium to large pelagic fishes and sharks most likely dominate the pelagic fish assemblage within the vicinity of the proposed Station Papa GSN; deepwater benthic and bathypelagic fish species also occur.

Marine Mammals

Approximately 20 marine mammal species are known to occur within the Gulf of Alaska, occupying both nearshore and open ocean habitats. Most of the marine mammals potentially occurring within the Station Papa GSN ROI are expected to be cetaceans (whales and dolphins). Baleen whale species (Mysticetes) that potentially occur in the area include humpback, minke, and sei. Typical prey species for baleen whales include zooplankton and schooling fish. Toothed whales (Odontocetes) occurring in the area include Cuvier's, Stejneger's, and Baird's beaked whales; sperm whale; killer whale; Pacific white-sided dolphin; and both harbor and Dall's porpoise. Wintering and breeding time varies between species. In general, whales tend to migrate out during winter to warmer tropical waters whereas species such as dolphins and porpoises typically reside in the area or show very little change in distribution between summer and winter. Pinniped species potentially occurring in the area include northern fur seal and northern elephant seal. They feed on various fish species and potentially occur in the project area during all seasons of the year (DoN 2006a; Angliss and Outlaw 2007).

<u>ESA-Listed Species</u>

Three salmonid ESUs, seven marine mammals, and the leatherback sea turtle are federally listed as threatened or endangered and may potentially occur at the proposed Station Papa GSN site (NMFS 2008a). Because occurrences of bowhead, fin, and sei whales as well as leatherback sea turtles are expected to be extremely rare in the project area and thus impacts to these species would be insignificant, brief life history and distribution for more common visitors are included for blue, humpback, and sperm whale (DoN 2006a; Angliss and Outlaw 2007).

Salmonids. Of the ESA-listed salmon ESUs, only one Chinook salmon ESU (Snake River Fall Chinook ESU) and two steelhead ESUs (Upper and Lower Columbia River Steelhead ESUs) are thought to range into marine waters off Alaska during the ocean migration portion of their life history. In the Gulf of Alaska, ESA-listed salmon ESUs are mixed with hundreds to thousands of other salmon stocks originating from the Columbia River in Washington and Oregon and river drainages in British Columbia, Alaska, and Asia. ESA-listed fish are visually indistinguishable from these unlisted stocks (NMFS 2005a).

Humpback whale. Humpback whales inhabit all but the Arctic waters of the North Pacific region. Winters are spent mainly in the tropical and subtropical waters, while summers are spent foraging along the coast and inland waters of the Pacific Rim from California into the Gulf of Alaska and as far as the Sea of Okhotsk (DoN 2006a; Angliss and Outlaw 2007). Humpback whales may be present within the vicinity of the GSN location during summer months.

Blue whale. Blue whales range throughout the North Pacific Ocean, from Kamchatka to southern Japan in the west, and from the Gulf of Alaska and California south to Costa Rica in the east. The Gulf of Alaska group of blue whales are typically observed along the eastern Gulf. Blue whales may be present in the vicinity of the proposed GSN station during summer months when they are feeding (DoN 2006a; Angliss and Outlaw 2007).

Sperm whale. Sperm whales have a wide distribution within the Pacific region. Females and calves typically remain in tropical and temperate waters year-round, while males are thought to move north in the summer to feed in the Gulf of Alaska, Bering Sea, and waters around the Aleutian Islands (DoN 2006a; Angliss and Outlaw 2007). Sperm whales may be present within the vicinity of the proposed Station Papa GSN site during summer months.

5.2.1.2 Environmental Consequences

<u>Proposed Action</u>

Installation and O&M Activities. The vessels and activity associated with installation of the Station Papa GSN discus buoy, three subsurface moorings, and associated scientific sensors on the sea floor may cause marine species to temporarily avoid the immediate vicinity, but this impact would not be significant due to the small scale and temporary nature of the proposed activities (estimated time to deploy a discus surface mooring with one vessel is 12-24 hours). The vessel used for mooring deployment would move very slowly during the activity and would not pose a collision threat to marine mammals. Entanglement of marine species is not likely because the rigidity of the mooring cables and the ability of marine species to detect and avoid the mooring lines. Once installed at ~4,250 m on the seabed, the proposed discus buoy anchor, flanking mooring anchors, and scientific sensors would be equivalent to other hard structures on the seabed, again posing no risk of adverse effect on marine organisms.

Gliders. The use of up to five gliders within a survey area of hundreds of square km around the Station Papa GSN is not expected to affect marine species as the proposed gliders move within the water column similar to a dolphin or whale. Gliders are sealed, contain no motors, fuels, or hazardous materials; and move at very slow speeds (~0.5 knot), thereby eliminating the potential for collisions with marine mammals and sea turtles.

Active Acoustic Sources. In general, the majority of fish are believed to hear within the frequency range of 500 Hz to ~3 kHz. The frequency range over which mysticetes as a group are believed to hear sounds is ~7 Hz to 22 kHz. The frequency range of odontocete hearing is considered ~150 Hz to 180 kHz and the frequency range of pinnipeds is 1-180 kHz (Richardson et al. 1995; Southall et al. 2007). The proposed active acoustic sources associated with the Station Papa GSN would generally operate at frequencies much higher than those frequencies considered audible by fish and marine mammals. The ADV, BAP, and the ADCP would all operate at frequencies greater than 180 kHz, with most operating at frequencies greater than 200 kHz (see Table 2-6). For the MBES, SBP, altimeters, acoustic modems, and tracking pingers operating at frequencies between 2 and 170 kHz, fish and marine mammals would not be disturbed by any of these proposed acoustic sources given their low duty cycles, the brief period when an individual animal would potentially be within the very narrow beam of the source, and the relatively low source levels of the pingers and acoustic modems. Therefore, implementation of the proposed deployment of the Station Papa GSN is not expected to result in significant acoustic impacts to fish and marine mammals, including ESA-listed species.

No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the GSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to marine biological resources with implementation of the No-Action Alternative.

5.3 SOUTHERN OCEAN

The proposed Southern Ocean GSN site is located approximately 600 nmi west of Chile in waters 4,800 m deep (Figure 2-12). Site-specific information on the potential occurrence of marine biological resources within the vicinity of the GSN does not exist. Therefore, the following discussion provides a very general background regarding marine biological resources potentially be found in the vicinity based on inferences from sources describing marine resources within the vicinity.

5.3.1 Marine Biological Resources

5.3.1.1 Affected Environment

Fish

Due to the location of the proposed Southern Ocean GSN at a water depth of 4,800 m, medium to large pelagic, deepwater benthic, and bathypelagic fishes and sharks are expected to dominate the fish assemblage in the vicinity including longnose lancetfish, slender tuna, yellowfin tuna, yellowtail amberjack, thintail thresher, black scabbardfish, razorback scabbardfish, largehead conger, elongate frostfish, striped marlin, shortbill spearfish, tope shark, basking shark, blue shark, and whale shark (Sea Around Us Project [SAUP] 2007).

Marine Mammals

Marine mammals expected to occur in the vicinity of the Southern Ocean GSN site include Antarctic and dwarf minke whales, pygmy right whale, long-finned pilot whale, southern bottlenose dolphin, killer whale, spectacled porpoise, and dusky dolphin (SAUP 2007).

ESA-Listed Species

Six whale species listed as endangered under ESA may potentially occur within the vicinity of the proposed Southern Ocean GSN: blue, fin, humpback, sei, southern right, and sperm.

Blue whale. Blue whales occur in the North Atlantic, North Pacific, and Southern Hemisphere. They typically have seasonal summer and winter migration areas although some smaller populations are thought to remain in certain areas year-round. Blue whales occurring in the Southern Hemisphere tend to inhabit north and south of the Antarctic Convergence which is an area of which northward-flowing cold Antarctic waters dip below warmer sub-Antarctic waters located approximately between 48° S and 61° S latitude (NMFS 2008b). Blue whales may be present within the vicinity of the proposed Southern Ocean GSN at any time of the year.

Fin whale. Fin whales have a wide distribution, occurring in all oceans. Fin whales occurring in the Antarctic tend to have open ocean migration paths and typically travel to the high-latitude Antarctic feeding areas in the summer and low-latitude areas for breeding and calving in the winter (NMFS 2008b). Fin whales may be present within the vicinity of the proposed Southern Ocean GSN during summer months.

Humpback whale. Humpback whales occur in all oceans with the exception of the Arctic. They generally inhabit waters of continental shelves and around some oceanic islands. There are approximately seven populations of humpbacks occurring in the Southern Hemisphere. These populations feed in Antarctic waters in the austral summer and migrating up the western coast of South America to breeding grounds off Colombia, Ecuador and into Central America (Reeves et al. 2002). Humpback whales are likely to be present within the vicinity of the proposed Southern Ocean GSN during summer months.

Southern right whale. Southern right whales occur throughout the Southern Hemisphere between 20° and 60° S latitude. Feeding grounds are within the higher latitudes (South of 50° S) from spring through fall. Southern right whales migrate to low-latitude areas in winter for breeding, calving, and nursing (NMFS 2008b). Southern right whales are likely to be present within the vicinity of the proposed Southern Ocean GSN during spring, summer, and fall months.

Sei whale. Sei whales occur in all oceans of the world, primarily occupying open ocean areas. They spend summers feeding in subarctic and subantarctic waters and are the most common in the southern hemisphere. Winters are spent in warmer lower latitudes (NMFS 2008b). Sei whales are likely to be present within the vicinity of the proposed Southern Ocean GSN during summer months.

Sperm whale. Sperm whales occur in all oceans of the world, primarily in the open ocean areas between 60° N and 60° S. They are more common in deep waters. Females are more abundant at the deep depths than males. Summers are spent feeding in the high latitude polar regions and wintering in the warmer low latitude regions (NMFS 2008b). Sperm whales are likely to be present within the vicinity of the proposed Southern Ocean GSN during summer months.

5.3.1.2 Environmental Consequences

Proposed Action

Installation and O&M Activities. The vessels and activity associated with installation of the Southern Ocean GSN discus buoy, three subsurface moorings, and associated scientific sensors on the sea floor may cause marine species to temporarily avoid the immediate vicinity, but this impact would not be significant due to the small scale and temporary nature of the proposed activities (estimated time to deploy a discus surface mooring with one vessel is 12-24 hours). The vessel used for mooring deployment would move very slowly during the activity and would not pose a collision threat to marine mammals. Entanglement of marine species is not likely because the rigidity of the mooring cables and the ability of marine species to detect and avoid the mooring lines. Once installed at ~4,800 m on the seabed, the proposed discus buoy anchor, flanking mooring anchors, and scientific sensors would be equivalent to other hard structures on the seabed, again posing no risk of adverse effect on marine organisms.

Gliders. The use of up to five gliders within a survey area of hundreds of square km around the Southern Ocean GSN is not expected to affect marine species as the proposed gliders move within the water column similar to a dolphin or whale. Gliders are sealed, contain no motors, fuels, or hazardous materials; and move at very slow speeds (~0.5 knot), thereby eliminating the potential for collisions with marine mammals.

Active Acoustic Sources. In general, the majority of fish are believed to hear within the frequency range of 500 Hz to ~3 kHz. The frequency range over which mysticetes as a group are believed to hear sounds is ~7 Hz to 22 kHz. The frequency range of odontocete hearing is considered ~150 Hz to 180 kHz and the frequency range of pinnipeds is 1-180 kHz (Richardson et al. 1995; Southall et al. 2007). The proposed active acoustic sources associated with the Southern Ocean GSN would generally operate at frequencies much higher than those frequencies considered audible by fish and marine mammals. The ADV, BAP, and the ADCP would all operate at frequencies greater than 180 kHz, with most operating at frequencies greater than 200 kHz (see Table 2-6). For the MBES, SBP, altimeters, acoustic modems, and tracking pingers operating at frequencies between 2 and 170 kHz, fish and marine mammals would not be disturbed by any of these proposed acoustic sources given their low duty cycles, the brief period when an individual animal would potentially be within the very narrow beam of the source, and the relatively low source levels of the pingers and acoustic modems. Therefore, implementation of the proposed deployment of the Southern Ocean GSN is not expected to result in significant acoustic impacts to fish and marine mammals, including ESA-listed species.

No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the GSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to marine biological resources with implementation of the No-Action Alternative.

5.4 IRMINGER SEA

The proposed Irminger Sea GSN site is located approximately 125 nmi east of Greenland in waters 2,800 m deep (Figure 2-12). Site-specific information on the potential occurrence of marine biological resources within the vicinity of the GSN does not exist. Therefore, the following discussion provides a very general background regarding marine biological resources potentially be found in the vicinity based on inferences from sources describing marine resources within the vicinity.

5.4.1 Marine Biological Resources

5.4.1.1 Affected Environment

Fish

Due to the location of the proposed Irminger Sea GSN at a water depth of 2,800 m, medium to large pelagic, deepwater benthic, and bathypelagic fishes and sharks are expected to dominate the fish assemblage in the vicinity including black scabbardfish, meager, blackfish, orange roughy, porbeagle, opah, angler, onion-eyed grenadier, ocean sunfish, slander snipe eel, sea trout, ocean perch, king of herrings, Greenland shark, and deal fish (SAUP 2007).

Marine Mammals

Marine mammals expected to occur in the vicinity of the Irminger Sea GSN site include dwarf minke whale, long-finned pilot whale, Atlantic white-sided dolphin, northern bottlenose whale, white-beaked dolphin, Sowerby's beaked whale, and killer whale (SAUP 2007).

ESA-Listed Species

Five mysticetes (North Atlantic right, humpback, sei, fin, and blue whales) and one odontocete (sperm whale) potentially occur in the vicinity of the Irminger Sea GSN site and are listed as endangered under the ESA.

North Atlantic Right Whale. The population of right whales in the N Atlantic are still considered depleted off Greenland as a result of commercial whaling. North Atlantic right whales were historically common off Greenland but until the 1990s had not been observed since the late 1800s. Knowlton et al. (1992) reported several long-distance movements of N Atlantic right whale**s** as far north as the southeast coast of Greenland. In addition, photo-identified whales from the W Atlantic stock have been resighted off Iceland and arctic Norway (Waring et al. 2005b), but sightings are considered rare.

Humpback whale. Humpback whales that inhabit the western North Atlantic are primarily found foraging on herring in the Gulf of St. Lawrence, Newfoundland, western Greenland, and Gulf of Maine during the summer (NMFS 2008b). Humpback whales feed in shallow waters around Greenland during the summer months, often into the fjords and bays in search of food (International Council for the Exploration of the Sea [ICES] 2006). Humpbacks may be present within the vicinity of the Irminger Sea GSN during summer months.

Sei Whale. Sei whales occurring in the Atlantic typically inhabit the waters of the Scotian shelf and the deeper waters of the continental shelf (2,000 m). They are mostly planktivorous and spend spring and summer months within the northern U.S. Atlantic EEZ (NMFS 2008b). Sei whales occurring east of Greenland typically inhabit the offshore areas along the continental shelf and beyond (ICES 2006). Sei whales may be present within the vicinity of the Irminger Sea GSN during summer months.

Fin Whale. The fin whale is the second-most-common mysticete in Greenland and adjacent waters after the minke whale. According to a sightings survey conducted in summer 2001, the abundance of fin whales in the East Greenland-Iceland stock was estimated at 23,000 and may be approaching its carrying capacity. In Greenland waters, fin whales feed predominantly on krill. Fin whales mainly occur in the offshore areas of the North Atlantic, along the continental slope and beyond (ICES 2006). Fin whales may be present within the vicinity of the Irminger Sea GSN during summer months.

Blue Whale. Blue whales migrate to Greenland-Iceland where they spend the entire summer feeding on krill. In September, they migrate south to unknown breeding grounds. They are the least abundant of the large whales regularly seen in the area (ICES 2006). Blue whales may be present within the vicinity of the Irminger Sea GSN during summer months.

Sperm whale. Sperm whales spend a majority of their time at depths of between 400 and 1,000 m feeding on prey residing at that depth range such as large squid and demersal sharks, skates, and fish (NMFS 2008b). Sperm whales are common in Greenland waters and may be present within the vicinity of the Irminger Sea GSN (ICES 2006).

5.4.1.2 Environmental Consequences

Proposed Action

Installation and O&M Activities. The vessels and activity associated with installation of the Irminger Sea GSN discus buoy, three subsurface moorings, and associated scientific sensors on the sea floor may cause marine species to temporarily avoid the immediate vicinity, but this impact would not be significant due to the small scale and temporary nature of the proposed activities (estimated time to deploy a discus surface mooring with one vessel is 12-24 hours). The vessel used for mooring deployment would move very slowly during the activity and would not pose a collision threat to marine mammals. Entanglement of marine species is not likely because the rigidity of the mooring cables and the ability of marine species to detect and avoid the mooring lines. Once installed at ~2,800 m on the seabed, the proposed discus buoy anchor, flanking mooring anchors, and scientific sensors would be equivalent to other hard structures on the seabed, again posing no risk of adverse effect on marine organisms.

Gliders. The use of up to five gliders within a survey area of hundreds of square km around the Irminger Sea GSN is not expected to affect marine species as the proposed gliders move within the water column similar to a dolphin or whale. Gliders are sealed, contain no motors, fuels, or hazardous materials; and move at very slow speeds (~0.5 knot), thereby eliminating the potential for collisions with marine mammals.

Active Acoustic Sources. In general, the majority of fish are believed to hear within the frequency range of 500 Hz to ~3 kHz. The frequency range over which mysticetes as a group are believed to hear sounds is ~7 Hz to 22 kHz. The frequency range of odontocete hearing is considered ~150 Hz to 180 kHz and the frequency range of pinnipeds is 1-180 kHz (Richardson et al. 1995; Southall et al. 2007). The proposed active acoustic sources associated with the Irminger Sea GSN would generally operate at frequencies much higher than those frequencies considered audible by fish and marine mammals. The ADV, BAP, and the ADCP would all operate at frequencies greater than 180 kHz, with most operating at frequencies greater than 200 kHz (see Table 2-6). For the MBES, SBP, altimeters, acoustic modems, and tracking pingers operating at frequencies between 2 and 170 kHz, fish and marine mammals would not be disturbed by any of these proposed acoustic sources given their low duty cycles, the brief period when an individual animal would potentially be within the very narrow beam of the source, and the relatively low source levels of the pingers and acoustic modems. Therefore, implementation of the proposed deployment of the Irminger Sea GSN is not expected to result in significant acoustic impacts to fish and marine mammals, including ESA-listed species.

No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the GSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to marine biological resources with implementation of the No-Action Alternative.

5.5 MID-ATLANTIC RIDGE

The proposed Mid-Atlantic Ridge GSN site is located approximately 1,300 nmi northeast of Venezuela and 1,500 nmi west of Africa in waters 4,460 m deep (Figure 2-12). Site-specific information on the potential occurrence of marine biological resources within the vicinity of the GSN does not exist. Therefore, the following discussion provides a very general background regarding marine biological resources potentially be found in the vicinity based on inferences from sources describing marine resources within the vicinity.

5.5.1 Marine Biological Resources

5.5.1.1 Affected Environment

Fish

As with the other previously discussed GSN sites, due to the location of the proposed Mid-Atlantic Ridge GSN at a water depth of 4,460 m, medium to large pelagic, deepwater benthic, and bathypelagic fishes and sharks are expected to dominate the fish assemblage in the vicinity.

Marine Mammals

Available data are insufficiently detailed to allow meaningful estimates of species presence of marine mammals for this remote region along the Mid-Atlantic Ridge. No marine mammals were seen by dedicated observers during ~1,000 km of observation effort during an NSF-funded seismic survey in this region from October – November 2003, including transits to and from the site (Holst 2004). However, it has been hypothesized that large baleen whales use the Mid-Atlantic Ridge as a migration corridor between low-latitude breeding grounds and high-latitude feeding grounds during fall and spring (Olsen et al. 2005). Low densities may be related to the considerable distance from coastlines and shelf-breaks and low productivity in the waters. In the oceanic waters of the Atlantic, primary production is relatively low compared to coastal waters (Parsons et al. 1977; Waring et al. 2005). Mysticetes expected to occur within the vicinity of the GSN include Bryde's and minke whales.

Because the GSN area is characterized by deep water (4,500 m) and is not near land, odontocetes inhabiting deep, temperate waters are most likely to occur, but generally in low densities. Such species include the pygmy and dwarf sperm whales, Cuvier's beaked whale, Blainville's beaked whale, melon-headed whale, short-finned pilot whale, rough-toothed dolphin, pantropical spotted dolphin, spinner dolphin, striped dolphin, Clymene dolphin, and Risso's dolphin (Reeves et al. 2002).

ESA-Listed Species

Five whale and one sea turtle species are federally listed as endangered under the ESA and may occur in the proposed location of the Mid-Atlantic Ridge GSN site.

The ESA-listed whale species that may potentially occur within the vicinity of the Mid-Atlantic Ridge GSN site include humpback, sei, fin, blue, and sperm whales. These species are expected to occur rarely and may only use the area in small numbers during spring and fall migration. Summer feeding habitat for these species occurs farther north in the Atlantic, and winter breeding habitat presumably occurs further south based on available information (e.g., Reeves et al. 2002).

The Mid-Atlantic Ridge GSN is within the range of several sea turtle species: loggerhead, green, hawksbill, Kemp's ridley, and leatherback turtles. Because of the largely coastal nature of most of these species, only the leatherback turtle is likely to occur in area of the GSN. During a fall 2003 marine seismic cruise along the Mid-Atlantic Ridge, no sea turtles were observed (Holst 2004).

5.5.1.2 Environmental Consequences

Proposed Action

Installation and O&M Activities. Due to the size of the proposed EDP at the Mid-Atlantic Ridge GSN site, additional measures would be taken for the purposes of safety, protecting the environment, and enhancing security. All federal USCG regulations would be complied with during EDP towing operations from a U.S. port to the proposed Mid-Atlantic GSN site. The International Maritime Organization (IMO) does not specifically regulate un-manned buoys in the middle of the ocean. However, it is expected that IMO collision avoidance measures would be implemented to provide increased safety to other ships, particularly if the EDP is located near shipping lanes. Additionally, the IMO pollution regulations of the International Convention for the Prevention of Marine Pollution from Ships, 1973, as modified by the Protocol of 1978 (known as MARPOL) would be met because there is fuel on board, and there will be at-sea fuel oil transfer operations. IMO issues Safety of Navigation Circular Letters to the member governments that are typically promulgated among the various national NOTMARs. The location of the EDP would be identified as a navigational warning in this manner through the USCG. For the initial concept level design and at this time for the purposes of this Programmatic EA, the following equipment and regulations would be provided to meet the intent of the IMO regulations:

- Collision Avoidance: SART Radar Transponder, white strobe lights on each leg, anchor light, and sound signals for use during periods of restricted visibility.
- Pollution: MARPOL Regulations related to fuel storage and fuel transfer at sea.

The use of surface vessels and ROVs and activities associated with installation of the EDP, three anchor cables, three subsurface moorings, Jbox, and associated scientific sensors on the sea floor may cause marine species to temporarily avoid the immediate vicinity, but this impact would not be significant due to the temporary nature of the proposed activities. The vessel used for EDP deployment would move very slowly during the activity and would not pose a collision threat to marine mammals or sea turtles. Entanglement of marine species is not likely because the rigidity of the mooring and anchor cables and the ability of marine species to detect and avoid the cables. Once installed at ~4,460 m on the seabed, the proposed EDP anchors, Jbox, flanking mooring anchors, and scientific sensors would be equivalent to other hard structures on the seabed, again posing no risk of adverse effect on marine organisms.

Gliders. The use of up to five gliders within a survey area of hundreds of square km around the Mid-Atlantic Ridge GSN is not expected to affect marine species as the proposed gliders move within the water column similar to a dolphin or whale. Gliders are sealed, contain no motors, fuels, or hazardous materials; and move at very slow speeds (~0.5 knot), thereby eliminating the potential for collisions with marine mammals.

Active Acoustic Sources. In general, the majority of fish are believed to hear within the frequency range of 500 Hz to ~3 kHz. The frequency range over which mysticetes as a group are believed to hear sounds is ~7 Hz to 22 kHz. The frequency range of odontocete hearing is considered ~150 Hz to 180 kHz and the frequency range of pinnipeds is 1-180 kHz (Richardson et al. 1995; Southall et al. 2007). The proposed active acoustic sources associated with the Mid-Atlantic Ridge GSN would generally operate at frequencies much higher than those frequencies considered audible by fish and marine mammals. The ADV, BAP, and the ADCP would all operate at frequencies greater than 180 kHz, with most operating at frequencies greater than 200 kHz (see Table 2-6). For the MBES, SBP, altimeters, acoustic modems, and tracking pingers operating at frequencies between 2 and 170 kHz, fish and marine mammals would not be disturbed by any of these proposed acoustic sources given their low duty cycles, the brief period when an individual animal would potentially be within the very narrow beam of the source, and the relatively low source levels of the pingers and acoustic modems. Therefore, implementation of the proposed deployment of the Mid-Atlantic Ridge GSN is not expected to result in significant acoustic impacts to fish and marine mammals, including ESA-listed species.

No-Action Alternative

Under the No-Action Alternative, the NSF-funded OOI, including the GSN components, would not be implemented. Therefore, baseline conditions would remain unchanged and there would be no impacts to marine biological resources with implementation of the No-Action Alternative.

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CHAPTER 6
CUMULATIVE IMPACTS

CEQ regulations (40 CFR §§1500 – 1508) implementing the provisions of NEPA, as amended (42 USC §§4321 *et seq*.) provide the definition of cumulative impacts. Cumulative impacts are defined as:

> "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions." (40 CFR §1508.7)

Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. A cumulative impact results from the additive effect of all projects in the same geographical area. Generally, an impact can be considered cumulative if: a) effects of several actions occur in the same locale, b) effects on a particular resource are the same in nature, and c) effects are long-term in nature. The common factor key to cumulative assessment is identifying any potential temporally and/or spatially overlapping or successive effects that may significantly affect individual or populations of marine resources occurring in the analysis areas.

6.1 RESOURCE CONSIDERATIONS

Certain resources do not need to be considered for cumulative impacts at this programmatic level because either a) the effects of the proposed action would be so small and localized that the potential additive effects with other actions would be negligible; or b) the effects of the proposed action would be limited sufficiently by statutory or regulatory requirements and procedures that again, potential additive effects would be negligible. These include the following:

- *Air Quality*. Emissions from the Proposed Action would be minimal in comparison with other local and regional sources and would be transitory during installation and use of the proposed systems. Local air basin jurisdictions establish emissions thresholds for significance and mitigation that help ensure that individual project emissions do not individually or cumulatively have a significant impact on air quality. Emissions from the Proposed Action would be below levels of significance and do not involve permanent stationary sources. In the offshore waters, emissions from proposed activities would involve relatively small quantities of pollutants produced by project vessels; such emissions would be transient and rapidly dispersed. Therefore, cumulative impacts on air quality would not occur.
- *Geology and Water Quality*. Effects of the Proposed Action are sufficiently small in magnitude and limited in extent that potential additive effects are negligible. Potential water quality impacts are also limited by CWA requirements for permitting, which would be followed for onshore and in-water construction. Therefore, cumulative impacts on geological resources and water quality would not occur.
- *Transportation*. Marine transportation effects would be minimized by coordination with local coastal authorities and the avoidance of heavily used vessel transit corridors, the latter by design of the system. NOTMARs would be used to minimize the potential conflicts with other vessels, during installation, and the depiction of the structures on NOAA navigation charts would minimize conflicts thereafter. Surface buoys or other structures would be marked in accordance with USCG regulations and readily avoidable.
- *Hazardous Materials***.** The only potential sources of hazardous materials would be unanticipated accidents or spills that resulted in a discharge of fuel, lubricants, or sensor components (e.g.,

batteries) from a project vessel or associated OOI equipment and sensors. Based on existing requirements and procedures for management of such materials on board vessels and the design of scientific equipment and sensors, such events are extremely unlikely to occur. If such a spill were to occur, it would be a localized occurrence, and adherence to standard containment, cleanup, and reporting requirements would assure that the effects are minimized. In addition, residual material would be dispersed by natural processes, but the potential for additive effects with other discharges of hazardous materials in the same location(s) is considered negligible. Cumulative impacts would not occur.

- *Cultural Resources*. Site-specific evaluations and compliance with the requirements of the NHPA would ensure that the Proposed Action avoids impacting properties listed or potentially eligible-for-listing on the NRHP. Therefore, cumulative impacts to cultural resources would not occur.
- *Terrestrial Resources at Shore Stations*. Project SOPs (Section 2.2.8) would ensure that any new onshore construction would have minimal or no impact on sensitive natural resources. Since the proposed shore stations are on previously developed and disturbed sites on the immediate coast, the impacts on land are essentially contained within an existing “footprint” and there is little to no potential for cumulative effects with development or other activities onshore. Implementation of BMPs in conjunction with obtaining coverage under the NPDES general permit for construction would effectively avoid potential cumulative effects on surrounding lands and waters. Finally, the permitting for the new infrastructure onshore would address consistency with zoning requirements, local land uses, and resources of the adjacent coastal areas. Therefore, cumulative impacts would not occur at any of the proposed shore station locations.

The remaining resources that require further consideration for cumulative impacts include the following:

- *Marine Biology*. Marine biological resources, including the species and communities of marine benthic, water column, and surface water habitats affected by the Proposed Action, are subject to potential cumulative impacts through the incremental effects of multiple actions on habitats, species’ populations, or ecological processes. Cumulative effects on habitats can result from incremental degradations and losses that ultimately diminish the capacity of the habitat to support species, communities, and ecological processes. Owing to the dispersal of populations, incremental effects on species at one location can interact with effects occurring elsewhere to affect the overall distribution and abundance of the species. A detailed discussion for these types of potential cumulative effects on marine biological resources is provided below.
- *Socioeconomics (Fisheries)*. Potential cumulative effects on Socioeconomics (Fisheries) reflect primarily the potential for structures installed on the seabed and within the water column to interfere with commercial fishing. These potential impacts would be reduced, but not eliminated, through coordination with local fishing groups, such as the OFCC, and the implementation of agreements regarding damage to fishing gear and preclusion from fishing areas, as part of the Proposed Action.

6.2 ACTIONS CONSIDERED

Other past, present, and reasonably foreseeable future actions that warrant consideration for potential cumulative impacts when added to the impacts of the Proposed Action include the installation and use of submarine cables, moorings, scientific instruments, or anchored structures such as wind or wave energy generators, in the same affected areas; and commercial fishing and fisheries management, especially as it pertains to bottom trawling. These types of activities could interact or combine with components of the Proposed Action to affect marine resources and/or their use. On land, other development activities at the shore station locations could in principle affect coastal resources and their use in the same manner as the Proposed Action. Actions relevant to the analysis of cumulative effects of each element of the Proposed Action are presented below.

6.2.1 CSN (Endurance Array) and RSN

<u>Submarine Cables</u>

Several submarine cable systems have been previously installed off the coasts of Oregon and Washington; some are in-service, some have been retired and left in place. Active systems include but are not necessarily limited to three landings of Videsh Sanchar Nigam Limited (VSNL) cables (TGN Pacific Segments G1 and G6, which are trans-Pacific, and G5, which goes to California); TPC-5; PC-1; Southern Cross; Northstar; and China-US systems. Further information on these and some of the out-of-service cables is available at www.iscpc.org. Pending projects include the proposed ACS Cable Systems project off of Florence, Oregon (ACS Cable Systems 2007), the FLAG NGN project which would land at Twin Rocks, Astoria, or Bandon, Oregon (Federal Communications Commission 2007), and Verizon's Trans-Pacific Express cable from China to Nedonna Beach, Oregon, which is expected to be completed by the end of 2008 (TeleGeography 2006). These projects involve a single cable landing in Oregon and cable routes that traverse the offshore waters where the Proposed Action would occur.

<u>Wave Energy Projects</u>

Wave energy projects are designed to capture wave and tidal energy using surface buoys, which are anchored to the ocean bottom and connected by cables to shore. The Federal Energy Regulatory Commission (FERC) has regulatory oversight responsibility for wave energy projects. A review of FERC's recently issued and pending permits indicates numerous projects currently proposed off of the Oregon coast, including but not necessarily limited to the Coos County Offshore Wave Energy Power Project, Coos Bay OPT Wave Park, Reedsport OPT Wave Energy Park, Oregon Coastal Wave Energy Project, Florence Wave Park, and Newport OPT Wave Park (FERC 2008). Off of Washington, the proposed Grays Harbor Ocean Energy Project is directly inshore of the Grays Harbor Line (Washington Wave Company 2007). These projects are generally within 3 nmi of shore and so have limited overlap with the proposed CSN and RSN components, but may affect marine biological communities and fishing activities in a similar manner as the Proposed Action.

<u>Other Regional Ocean Observing Systems</u>

Other ocean observing systems include the coastal buoys installed and maintained by NOAA, and ocean observing systems with goals and architecture similar to those of the Proposed Action, with similar potential environmental effects. A number of collaborative scientific efforts are in progress, including the OrCOOS, which has assets in the general vicinity of the Proposed Action (OrCOOS 2008). OrCOOS is a recent partner in the Nation's ongoing efforts to develop the IOOS. OrCOOS, which is funded primarily through NOAA's National Ocean Service (NOS), is partnered with NANOOS (http://www.nanoos.org/).

<u>Commercial Fishing and Fisheries Management</u>

As described in the Socioeconomics (Fisheries) section (3.6), the Pacific Northwest coastal region supports a large and diversified commercial fishing industry. Fishing impacts bottom, water column, and surface habitats, affecting both target and non-target species, especially in areas subject to bottom trawling. Key developments affecting fisheries resources have been the finalization of FMPs and EFH, including HAPCs, for Groundfish, Highly Migratory Species, Coastal Pelagics, and Salmon. Pursuant to the sustainable use of fishery resources, the FMPs identify and protect areas that are especially vulnerable to certain types of fishing, especially bottom trawling. The implementation of FMPs is generally beneficial to the resource species, but regulates commercial fishing activity. Hence cumulative effects to both fishery resources and commercial fishers need to be considered.

6.2.2 CSN (Pioneer Array)

Submarine Cables

Dozens of submarine cables have been previously installed off the southern New England coast, which has been a major landing site for trans-Atlantic cables. Information on these cables can be found at www.iscpc.org.

Tidal and Wind Energy Projects

Many tidal energy projects are pending (i.e., permits from FERC have been issued or are pending) in the nearshore waters of southern coastal New England (FERC 2008). All of these projects are well inshore of the proposed Pioneer Array, resulting in no potential for cumulative impacts. A major wind energy project currently proposed in U.S. Territorial waters north of Nantucket is the Cape Wind Project (USACE 2008). This project is well outside the area of the proposed Pioneer Array, resulting in no potential for cumulative impacts.

Other Regional Ocean Observing Systems

Other ocean observing systems include the coastal buoys installed and maintained by NOAA, and ocean observing systems with goals and architecture similar to those of the Proposed Action, with similar potential environmental effects. The proposed Pioneer Array would span the continental slope, more than 75 nmi offshore of Massachusetts. As a result, it is remote from the coastal ocean observatories that are located closer to shore, such as the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA, http://www.macoora.org/) and the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS, http://www.neracoos.org/), and would not result in any cumulative effects in conjunction with the Proposed Action.

6.2.3 GSN

The remote locations of the GSN buoys are traversed by ocean-going vessels and have been the subject of previous and ongoing oceanographic research, such as profiling floats of Project Argo in the vicinity of the proposed Station Papa GSN site (Department of Fisheries and Oceans Canada ([DFOC] 2006) and deep sea drilling near the proposed Mid-Atlantic Ridge and Station Papa GSN sites (Integrated Ocean Drilling Program [IODP] 2007).

6.3 ANALYSIS OF PROJECT ELEMENTS

It is expected that additions (e.g., sensors, moorings, cables) to some or all elements of the proposed OOI (i.e., CSN, RSN, and GSN) may be proposed in the future. These additions to the OOI that are not covered under this Programmatic EA would be analyzed under future NEPA documents, including the potential for any cumulative effects.

6.3.1 CSN (Endurance Array) and RSN

As described in Chapter 3, installation and use of the Grays Harbor and Newport lines of the Endurance Array would entail relatively small, localized areas of disturbance to the seabed during installation. The extent of disturbance to the seabed associated with the RSN is of wider extent, but still affects a very small area of the seabed in any particular location. Disturbance would be predominantly in soft-sedimentary habitats, which are subject to natural disturbances (bioturbation by fishes and invertebrates) and strong sediment deposition and transport in the dynamic cross-shelf environment. These natural phenomena ensure that alterations of the soft-bottom habitat are temporary. Once in place, the permanent structures of the RSN would either remain buried or provide hard surfaces for attachment and sheltering of fishes and invertebrates, a beneficial effect. Overall, cumulative effects on marine biological resources would be insignificant.

The CSN and RSN structures could potentially interfere with commercial fishing to varying degrees, depending on gear type, and in conjunction with restrictions imposed under the FMPs. Coordination with the local fishing community would reduce these potential impacts, and it is possible that the presence of structures may contribute to resource sustainability by providing localized refuges from fishing. Overall, however, because of the expanding, incremental loss of access to fishing grounds due to the placement of structures on the seabed and in the water column, the potential exists for the proposed action to have cumulative effects on commercial fishing. Such impacts could be mitigated by the finalization of fishing agreements with the affected parties (i.e., OFCC).

6.3.2 CSN (Pioneer Array)

For the same reasons discussed above for the Endurance Array, the proposed Pioneer Array would have negligible cumulative effects on marine biological resources. Potential effects would be negligible due to the extremely small "footprints" of the array components (surface and subsurface mooring buoys).

The Pioneer Array is proposed as a relocatable array that may be moved to another location 3-5 years after its initial proposed deployment as covered under the Proposed Action. The movement of the Pioneer Array, including the retrieval of assets from the proposed location south of Massachusetts, would be covered under a separate NEPA document. However, it is not expected that the retrieval or redeployment of the Pioneer Array would have any cumulative effects based on the current analysis.

6.3.3 GSN

Use of the proposed GSN sites would impact relatively small areas of the seabed, water column, and ocean surface of relatively remote areas. With the wide dispersion of research and other activities across these areas, no cumulative effects are anticipated.

6.4 Relationship between Short-Term Uses and Long-Term Productivity

NEPA requires consideration of the relationship between short-term use of the environment and the impacts that such use could have on the maintenance and enhancement of long-term productivity of the impacted environment. The proposed OOI would allow academic scientists to investigate the geology, geophysics, ecology, oceanography, etc. of the world's oceans. This research would require both short-term and long-term commitments of human labor and financial resources. Nonrenewable resources that would be consumed during the installation and operation of the proposed OOI include primarily fuel and oil associated with the installation of the CSN, RSN, and GSN components and the routine maintenance of this infrastructure. The proposed protective measures or standard operating procedures to be implemented during the installation of the proposed OOI, which include avoiding sensitive habitats and/or seasons, avoiding submerged cultural resources, etc., would all serve to minimize the effects of the proposed marine research. The majority of effects from the installation of the OOI and associated marine research would be temporary in nature. As a result, implementation of the proposed OOI would not result in any environmental impacts that would significantly affect the maintenance and enhancement of long-term productivity of the marine environment.

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CHAPTER 7
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7 January 2008

MEMORANDUM FOR: Mr. Dale Blanton
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635 Capitol St., NE, Suite 150
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ON BEHALF OF: National Science Foundation (NSF)
Division of Ocean Sciences
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SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Mr. Blanton,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the proposed project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. The OOI would build upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI, if approved, would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. The OOI would be a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The proposed OOI infrastructure would include cables, buoys, underwater vehicles, moorings, junction boxes, power generation (solar, wind, fuel cell, and/or diesel), and two-way communications systems. This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The OOI would also support related elements, such as data dissemination and archiving, modeling of oceanographic processes, and education and outreach activities essential to the long-term success of ocean science.

The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node cabled observatory; fixed and relocatable coastal arrays coupled with mobile assets; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Program Office is managed by the Consortium for Ocean Leadership (Ocean Leadership), in conjunction with three academic-based Implementing Organizations, and funded via a cooperative agreement with NSF by the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

<u>Global-, Regional-, and Coastal-Scale Nodes</u>

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

<u>Environmental Compliance and Interagency Coordination</u>

On behalf of the NSF, TEC is preparing a Programmatic EA/OEA pursuant to the requirements of the National Environmental Policy Act (NEPA) (42 United States Code [USC] §4321, *et seq*.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations §§1500-1508); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. This Programmatic EA/OEA is also intended to assist NSF's compliance with the Coastal Zone Management Act (CZMA) (16 USC §1451, *et seq*.).

During its preparation of the Programmatic EA/OEA and in accordance with the CZMA, NSF has considered whether the proposed OOI is likely to have any effect on coastal uses or resources of the State of Oregon. Because it is anticipated that, if approved, the OOI would not place infrastructure in any marine protected areas and would not interfere with activities in recreation areas or fisheries within or adjacent to Oregon's coastal zone, the proposed OOI would not have any effects on the coastal uses or resources of the state of Oregon. As part of its current NEPA and CZMA compliance processes, NSF has initiated discussions with the Oregon Fishermen's Cable Committee and the Oregon Ocean Policy Advisory Council regarding the proposed OOI project, which have been positive and are ongoing. If, at the conclusion of the Programmatic EA/OEA process, a decision is made to move forward to the site-specific stage, the issue of whether the proposed OOI would have any site-specific effects on coastal uses or resources would be re-examined in light of the availability of more detailed information. NSF anticipates that this secondary review of effects, including the preparation of a consistency determination, if required, would be based, in large part, on the Programmatic EA/OEA and on any site-specific environmental review document prepared to address any outstanding issues.

In accordance with the CZMA and EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed at this programmatic review stage of the proposed OOI. In addition, to encourage efficiencies in completing the environmental reviews associated with the proposed OOI, we ask that you also include potential issues that you believe may be applicable if the proposed OOI moves to the site-specific stage. A decision regarding whether to move forward with the installation and operation of the proposed OOI will not be made until all required environmental reviews, including NSF's compliance with the CZMA, are completed.

On behalf of NSF, TEC requests your comments at this programmatic stage no later than 21 January 2008; however, comments received at any time throughout the NEPA process will be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF will analyze at that stage whether the proposed project is likely to have effects on any of the state of Oregon's coastal uses or resources. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.

Rick Spaulding
Sr. Biologist/Project Manager
TEC Inc.

cc: Dr. Shelby Walker, Project Officer, NSF
Rosie Lunde, Project Manager, Ocean Leadership

Figure 1
Geographic Locations of the Proposed OOI Infrastructure

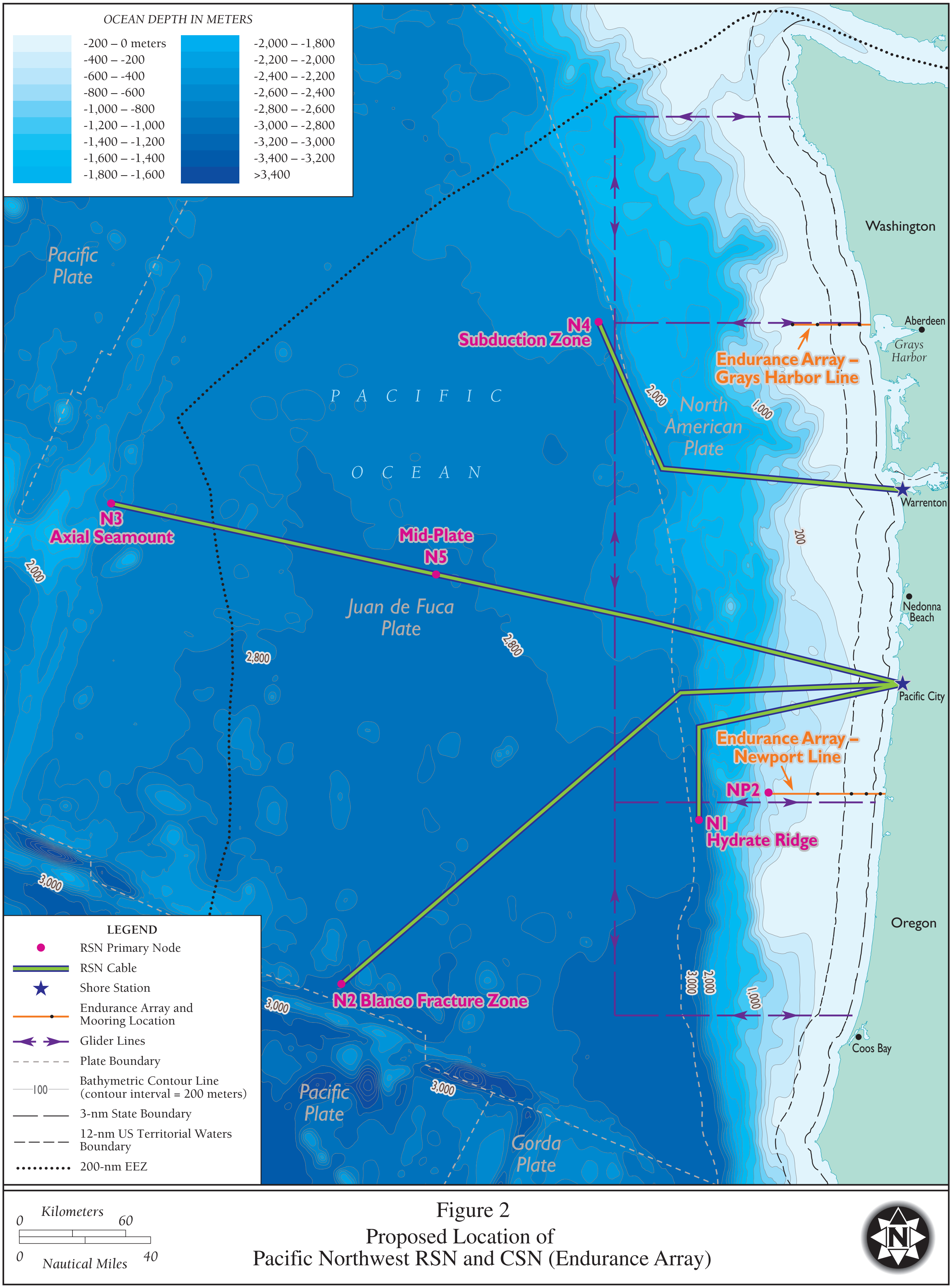

Figure 2
Proposed Location of
Pacific Northwest RSN and CSN (Endurance Array)

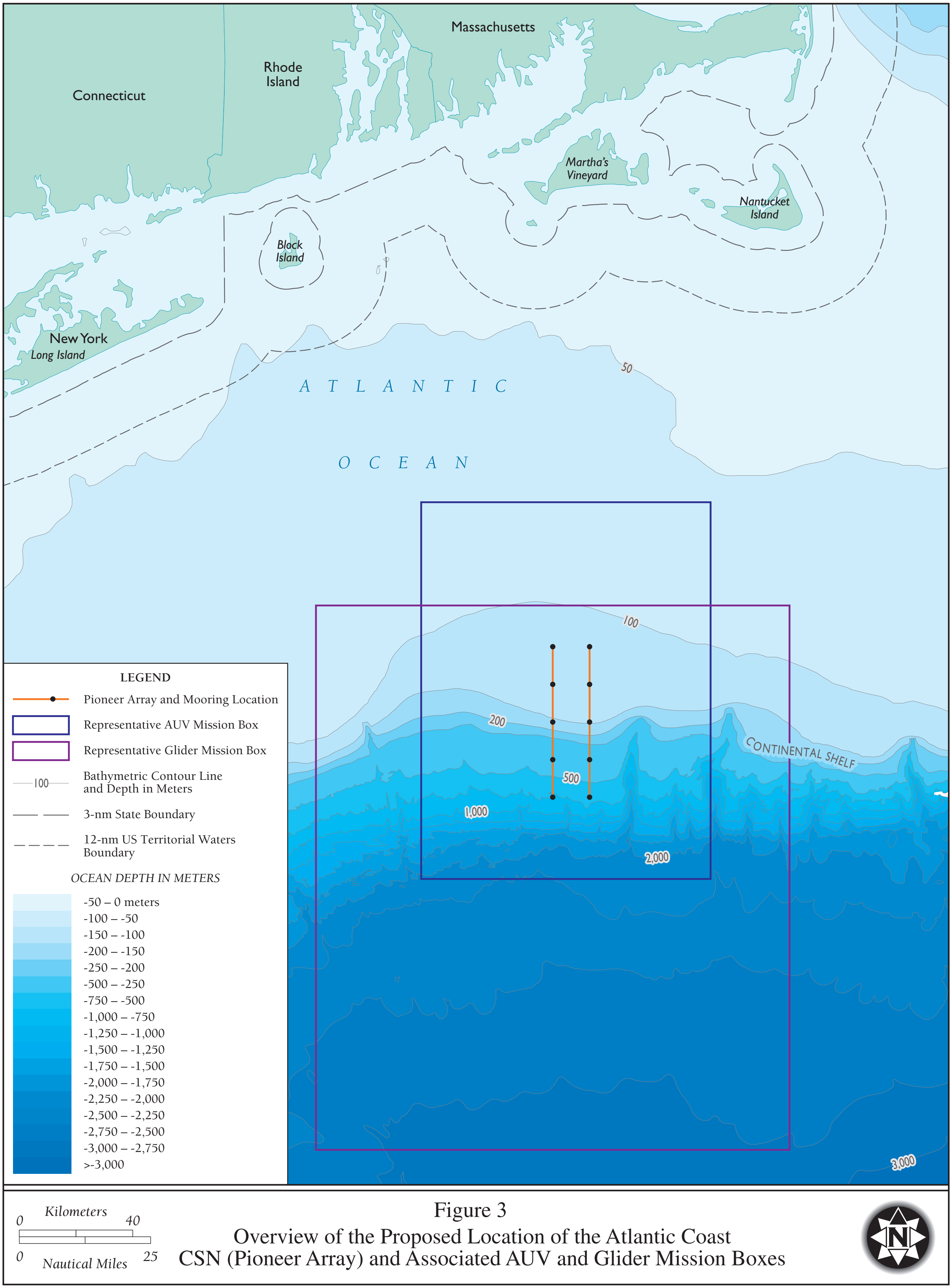

Figure 3
Overview of the Proposed Location of the Atlantic Coast
CSN (Pioneer Array) and Associated AUV and Glider Mission Boxes

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7 January 2008

MEMORANDUM FOR: Mr. Craig Zora
Aquatic Area Manager
Washington Department of Natural Resources
601 Bond Rd.
Castle Rock, WA 98611-0190

ON BEHALF OF: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Mr. Zora,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. The OOI would build upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI, if approved, would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. The OOI would be a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The proposed OOI infrastructure would include cables, buoys, underwater vehicles, moorings, junction boxes, power generation (solar, wind, fuel cell, and/or diesel), and two-way communications systems.

This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The OOI would also support related elements, such as data dissemination and archiving, modeling of oceanographic processes, and education and outreach activities essential to the long-term success of ocean science.

The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node cabled observatory; fixed and relocatable coastal arrays coupled with mobile assets; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Program Office is managed by the Consortium for Ocean Leadership (Ocean Leadership), in conjunction with three academic-based Implementing Organizations, and funded via a cooperative agreement with NSF by the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

Global-, Regional-, and Coastal-Scale Nodes

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

Environmental Compliance and Interagency Coordination

On behalf of the NSF, TEC is preparing a Programmatic EA/OEA pursuant to the requirements of the National Environmental Policy Act (NEPA) (42 United States Code [USC] §4321, *et seq*.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations §§1500-1508); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. This Programmatic EA/OEA is also intended to assist NSF's compliance with the Coastal Zone Management Act (CZMA) (16 USC §1451, *et seq*.).

During the preparation of the Programmatic EA/OEA and in accordance with the CZMA, NSF has considered whether the proposed OOI is likely to have any effect on coastal uses or resources of the State of Washington. At this programmatic stage of the environmental review process it is not anticipated that, if approved, the OOI would have effects on Washington's coastal uses or resources; the proposed OOI, as currently envisioned, would not place infrastructure in any marine protected areas and would not interfere with activities in fisheries within or adjacent to Washington's coastal zone, nor is it anticipated that it would impede any recreation areas. If, at the conclusion of the Programmatic EA/OEA process, a decision is made to move forward to the site-specific stage, the issue of whether the proposed OOI would have any site-specific effects on coastal uses or resources would be re-examined in light of the availability of more detailed information. NSF anticipates that this secondary review of effects, including the preparation of a consistency determination, if required, would be based, in large part, on the Programmatic EA/OEA and on any site-specific environmental review document prepared to address any outstanding issues.

In accordance with the CZMA and EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed at this programmatic review stage of the proposed OOI. In addition, to encourage efficiencies in completing the environmental reviews associated with the proposed OOI, we ask that you also include potential issues that you believe may be applicable if the proposed OOI moves to the site-specific stage. A decision regarding whether to move forward with the installation and operation of the proposed OOI will not be made until all required environmental reviews, including NSF's compliance with the CZMA, are completed.

On behalf of NSF, TEC requests your comments at this programmatic stage no later than 21 January 2008; however, comments received at any time throughout the NEPA process would be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF will analyze at that stage whether the proposed project is likely to have effects on any of the State of Washington's coastal uses or resources. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.

Rick Spaulding
Sr. Biologist/Project Manager
TEC Inc.

cc: Dr. Shelby Walker, Project Officer, NSF
Ms. Rosie Lunde, Project Manager, Ocean Leadership

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7 January 2008

MEMORANDUM FOR: Mr. Steven Resler
Deputy Bureau Chief
Division of Coastal Resources
Department of State
41 State Street
Albany, NY 12231-0001

ON BEHALF OF: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Mr. Resler,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. The OOI would build upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI, if approved, would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. The OOI would be a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The proposed OOI infrastructure would include cables, buoys, underwater vehicles, moorings, junction boxes, power generation (solar, wind, fuel cell, and/or diesel), and two-way communications systems. This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The OOI would also support related elements, such as data dissemination and archiving, modeling of oceanographic processes, and education and outreach activities essential to the long-term success of ocean science.

The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node cabled observatory; fixed and relocatable coastal arrays coupled with mobile assets; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Program Office is managed by the Consortium for Ocean Leadership (Ocean Leadership), in conjunction with three academic-based Implementing Organizations, and funded via a cooperative agreement with NSF by the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

Global-, Regional-, and Coastal-Scale Nodes

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

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During the preparation of the Programmatic EA/OEA and in accordance with the CZMA, NSF has considered whether the proposed OOI is likely to have any effect on coastal uses or resources of the State of New York. Because it is anticipated that, if approved, the OOI would not place infrastructure in any marine protected areas and would not interfere with activities in fisheries within or adjacent to New York's coastal zone, the proposed OOI would not have any effects on the coastal uses or resources of the State of New York. If, at the conclusion of the Programmatic EA/OEA process, a decision is made to move from the programmatic stage to the site-specific stage, the issue of whether the proposed OOI would have any site-specific effects on coastal uses or resources would be re-examined in light of the availability of more detailed information. NSF anticipates that this secondary review of effects, including the preparation of a consistency determination, if required, would be based, in large part, on the Programmatic EA/OEA and on any site-specific environmental review document prepared to address any outstanding issues.

In accordance with the CZMA and EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed at this programmatic review stage of the proposed OOI. In addition, to encourage efficiencies in completing the environmental reviews associated with the proposed OOI, we ask that you also include potential issues that you believe may be applicable if the proposed OOI moves to the site-specific stage. A decision regarding whether to move forward with the installation and operation of the proposed OOI will not be made until all required environmental reviews, including NSF's compliance with the CZMA, are completed.

On behalf of NSF, TEC requests your comments at this programmatic stage no later than 21 January 2008; however, comments received at any time throughout the NEPA process would be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF will analyze at that stage whether the proposed project is likely to have effects on any of the State of New York's coastal uses or resources. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.

Rick Spaulding
Sr. Biologist/Project Manager
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cc: Dr. Shelby Walker, Project Officer, NSF
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7 January 2008

MEMORANDUM FOR: Mr. Jeff Willis
Coastal Resources Management Council
Stedman Office Building
4808 Tower Hill Rd.
Wakefield, RI 02879-1900

ON BEHALF OF: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Mr. Willis,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. The OOI would build upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI, if approved, would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. The OOI would be a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

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The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

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During the preparation of the Programmatic EA/OEA and in accordance with the CZMA, NSF has considered whether the proposed OOI is likely to have any effect on coastal uses or resources of the State of Rhode Island. Because it is anticipated that, if approved, the OOI would not place infrastructure in any marine protected areas and would not interfere with activities in fisheries within or adjacent to Rhode Island's coastal zone, the proposed OOI would not have any effects on the coastal uses or resources of the State of Rhode Island. If, at the conclusion of the Programmatic EA/OEA process, a decision is made to move from the programmatic stage to the site-specific stage, the issue of whether the proposed OOI would have any site-specific effects on coastal uses or resources would be re-examined in light of the availability of more detailed information. NSF anticipates that this secondary review of effects, including the preparation of a consistency determination, if required, would be based, in large part, on the

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In accordance with the CZMA and EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed at this programmatic review stage of the proposed OOI. In addition, to encourage efficiencies in completing the environmental reviews associated with the proposed OOI, we ask that you also include potential issues that you believe may be applicable if the proposed OOI moves to the site-specific stage. A decision regarding whether to move forward with the installation and operation of the proposed OOI will not be made until all required environmental reviews, including NSF's compliance with the CZMA, are completed.

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Rick Spaulding
Sr. Biologist/Project Manager
TEC Inc.

cc: Dr. Shelby Walker, Project Officer, NSF
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Bainbridge Island, WA 98110
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7 January 2008

MEMORANDUM FOR: Mr. Robert Boeri
Acting Project Review Coordinator
Office of Coastal Zone Management
Executive Office of Environmental Affairs
251 Causeway Street, Suite 800
Boston, MA 02114

ON BEHALF OF: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Mr. Boeri,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

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The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node cabled observatory; fixed and relocatable coastal arrays coupled with mobile assets; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Program Office is managed by the Consortium for Ocean Leadership (Ocean Leadership), in conjunction with three academic-based Implementing Organizations, and funded via a cooperative agreement with NSF by the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

Global-, Regional-, and Coastal-Scale Nodes

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

Environmental Compliance and Interagency Coordination

On behalf of the NSF, TEC is preparing a Programmatic EA/OEA pursuant to the requirements of the National Environmental Policy Act (NEPA) (42 United States Code [USC] §4321, *et seq*.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations §§1500-1508); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. This Programmatic EA/OEA is also intended to assist NSF's compliance with the Coastal Zone Management Act (CZMA) (16 USC §1451, *et seq*.).

During the preparation of the Programmatic EA/OEA and in accordance with the CZMA, NSF has considered whether the proposed OOI is likely to have any effect on coastal uses or resources of the State of Massachusetts. Because it is anticipated that, if approved, the OOI would not place infrastructure in any marine protected areas and would not interfere with activities in fisheries within or adjacent to Massachusetts' coastal zone, the proposed OOI would not have any effects on the coastal uses or resources of the State of Massachusetts. If, at the conclusion of the Programmatic EA/OEA process, a decision is made to move from the programmatic stage to the site-specific stage, the issue of whether the proposed OOI would have any site-specific effects on coastal uses or resources would be re-examined in light of the availability of more detailed information. NSF anticipates that this secondary review of effects, including the preparation of a consistency determination, if required, would be based, in large part, on the Programmatic EA/OEA and on any site-specific environmental review document prepared to address any outstanding issues.

In accordance with the CZMA and EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed at this programmatic review stage of the proposed OOI. In addition, to encourage efficiencies in completing the environmental reviews associated with the proposed OOI, we ask that you also include potential issues that you believe may be applicable if the proposed OOI moves to the site-specific stage. A decision regarding whether to move forward with the installation and operation of the proposed OOI will not be made until all required environmental reviews, including NSF's compliance with the CZMA, are completed.

On behalf of NSF, TEC requests your comments at this programmatic stage no later than 21 January 2008; however, comments received at any time throughout the NEPA process would be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF will analyze at that stage whether the proposed project is likely to have effects on any of the State of Massachusetts' coastal uses or resources. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.

Rick Spaulding
Sr. Biologist/Project Manager
TEC Inc.

cc: Dr. Shelby Walker, Project Officer, NSF
Ms. Rosie Lunde, Project Manager, Ocean Leadership

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7 January 2008

MEMORANDUM FOR: Mr. Tom Ouellette
Office of Long Island Sound Programs
Department of Environmental Protection
79 Elm Street, 3rd Floor
Hartford, CT 06106-5127

ON BEHALF OF: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Mr. Ouellette,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. The OOI would build upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI, if approved, would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. The OOI would be a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The proposed OOI infrastructure would include cables, buoys, underwater vehicles, moorings, junction boxes, power generation (solar, wind, fuel cell, and/or diesel), and two-way communications systems.

This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The OOI would also support related elements, such as data dissemination and archiving, modeling of oceanographic processes, and education and outreach activities essential to the long-term success of ocean science.

The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node cabled observatory; fixed and relocatable coastal arrays coupled with mobile assets; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Program Office is managed by the Consortium for Ocean Leadership (Ocean Leadership), in conjunction with three academic-based Implementing Organizations, and funded via a cooperative agreement with NSF by the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

Global-, Regional-, and Coastal-Scale Nodes

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

Environmental Compliance and Interagency Coordination

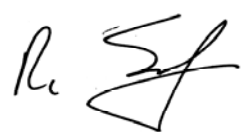
On behalf of the NSF, TEC is preparing a Programmatic EA/OEA pursuant to the requirements of the National Environmental Policy Act (NEPA) (42 United States Code [USC] §4321, *et seq*.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations §§1500-1508); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. This Programmatic EA/OEA is also intended to assist NSF's compliance with the Coastal Zone Management Act (CZMA) (16 USC §1451, *et seq*.).

During the preparation of the Programmatic EA/OEA and in accordance with the CZMA, NSF has considered whether the proposed OOI is likely to have any effect on coastal uses or resources of the State of Connecticut. Because it is anticipated that, if approved, the OOI would not place infrastructure in any marine protected areas and would not interfere with activities in fisheries within or adjacent to Connecticut's coastal zone, the proposed OOI would not have any effects on the coastal uses or resources of the State of Connecticut. If, at the conclusion of the Programmatic EA/OEA process, a decision is made to move from the programmatic stage to the site-specific stage, the issue of whether the proposed OOI would have any site-specific effects on coastal uses or resources would be re-examined in light of the availability of more detailed information. NSF anticipates that this secondary review of effects, including the preparation of a consistency determination, if required, would be based, in large part, on the

Programmatic EA/OEA and on any site-specific environmental review document prepared to address any outstanding issues.

In accordance with the CZMA and EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed at this programmatic review stage of the proposed OOI. In addition, to encourage efficiencies in completing the environmental reviews associated with the proposed OOI, we ask that you also include potential issues that you believe may be applicable if the proposed OOI moves to the site-specific stage. A decision regarding whether to move forward with the installation and operation of the proposed OOI will not be made until all required environmental reviews, including NSF's compliance with the CZMA, are completed.

On behalf of NSF, TEC requests your comments at this programmatic stage no later than 21 January 2008; however, comments received at any time throughout the NEPA process would be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF will analyze at that stage whether the proposed project is likely to have effects on any of the State of Connecticut's coastal uses or resources. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.



Rick Spaulding
Sr. Biologist/Project Manager
TEC Inc.

cc: Dr. Shelby Walker, Project Officer, NSF
Ms. Rosie Lunde, Project Manager, Ocean Leadership

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7 January 2008

MEMORANDUM FOR: Dr. Allyson Brooks
Department of Archaeology and Historic Preservation
1063 South Capitol Way, Suite 106
Olympia, WA 98501

FROM: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Dr. Brooks,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. The OOI would build upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. OOI is a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The proposed OOI infrastructure would include cables, buoys, underwater vehicles, moorings, junction boxes, power generation (solar, wind, fuel cell, and/or diesel), and two-way communications systems. This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The OOI would also support related elements, such as data dissemination and archiving, modeling of oceanographic processes, and education and outreach activities essential to the long-term success of ocean science.

The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node cabled observatory; fixed and relocatable coastal arrays coupled with mobile assets; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Program Office is managed by the Consortium for Ocean Leadership (Ocean Leadership), in conjunction with three academic-based Implementing Organizations, and funded via a cooperative agreement with NSF by the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

Global-, Regional-, and Coastal-Scale Nodes

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

Environmental Compliance and Interagency Coordination

On behalf of the NSF, TEC is preparing a Programmatic EA/OEA pursuant to the requirements of the National Environmental Policy Act (NEPA) (42 United States Code [USC] §4321, *et seq*.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations §§ 1500-1508); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. The Programmatic EA/OEA is also intended to assist NSF's compliance with Section 106 of the National Historic Preservation Act (NHPA) (16 USC §470).

The preliminary records search for the project area indicates that all recorded submerged cultural resources would be avoided by the proposed RSN submarine cables, anchored buoys of the CSN, and associated scientific instruments on the seafloor. The proposed RSN shore station would be within an existing facility and no impacts to terrestrial cultural resources are anticipated. These findings would be reviewed again if a decision were made to move forward to the site-specific stage. In accordance with Section 106 of the NHPA, if the proposed OOI project moves to the site-specific stage and potential impacts to historic resources were found, Section 106 consultation would move forward. It is anticipated that any such Section 106 consultation process would occur in conjunction with the preparation of any supplementary environmental document and would be tiered off of the Programmatic EA/OEA.

In accordance with the NHPA and EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed in the Programmatic EA/OEA and for purposes of conducting Section 106 consultations. When all environmental review processes, including NSF's Section 106 requirements are complete, the decision maker would be in a position to make an informed decision regarding the installation and operation of the proposed OOI.

On behalf of NSF, TEC requests your comments no later than 21 January 2008; however, comments received at any time throughout the NEPA process would be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF would re-initiate its NHPA Section 106 consultation process. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.

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cc: Dr. Shelby Walker, Project Officer, NSF
Ms. Rosie Lunde, Project Manager, Ocean Leadership

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7 January 2008

MEMORANDUM FOR: Mr. Stephen Poyser
Review and Compliance Specialist
Oregon Parks and Recreation Department
State Historic Preservation Office (SHPO)
725 Summer St., NE, Suite C
Salem, OR 97301

FROM: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Mr. Poyser,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. The OOI would build upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. OOI is a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The proposed OOI infrastructure would include cables, buoys, underwater vehicles, moorings, junction boxes, power generation (solar, wind, fuel cell, and/or diesel), and two-way communications systems.

This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The OOI would also support related elements, such as data dissemination and archiving, modeling of oceanographic processes, and education and outreach activities essential to the long-term success of ocean science.

The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node cabled observatory; fixed and relocatable coastal arrays coupled with mobile assets; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Program Office is managed by the Consortium for Ocean Leadership (Ocean Leadership), in conjunction with three academic-based Implementing Organizations, and funded via a cooperative agreement with NSF by the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

Global-, Regional-, and Coastal-Scale Nodes

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

Environmental Compliance and Interagency Coordination

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The preliminary records search for the project area indicates that all recorded submerged cultural resources would be avoided by the proposed RSN submarine cables, anchored buoys of the CSN, and associated scientific instruments on the seafloor. The proposed RSN shore station would be within an existing facility and no impacts to terrestrial cultural resources are anticipated. These findings would be reviewed again if a decision were made to move forward to the site-specific stage. In accordance with Section 106 of the NHPA, if the proposed OOI project moves to the site-specific stage and potential impacts to historic resources were found, Section 106 consultation would move forward. It is anticipated that any such Section 106 consultation process would occur in conjunction with the preparation of any supplementary environmental document and would be tiered off of the Programmatic EA/OEA.

In accordance with the NHPA and EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed in the Programmatic EA/OEA and for purposes of conducting Section 106 consultations. When all environmental review processes, including NSF's Section 106 requirements are complete, the decision maker would be in a position to make an informed decision regarding the installation and operation of the proposed OOI.

On behalf of NSF, TEC requests your comments no later than 21 January 2008; however, comments received at any time throughout the NEPA process would be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF would re-initiate its NHPA Section 106 consultation process. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.

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7 January 2008

MEMORANDUM FOR: Mr. Steve Leathery
NOAA-Fisheries/SF3
Room 14434
1315 East-West Highway
Silver Spring, MD 20910

FROM: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the NSF Ocean Observatories Initiative (OOI)

Dear Mr. Leathery,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. OOI builds upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. OOI is a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

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<u>Global-, Regional-, and Coastal-Scale Nodes</u>

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

<u>Environmental Compliance and Interagency Coordination</u>

On behalf of the NSF, TEC is preparing a Programmatic EA/OEA pursuant to the requirements of NEPA (42 United States Code §4321 et seq.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations §§ 1500-1508); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*. This Programmatic EA/OEA is also intended to assist NSF in its compliance with other environmental statutes, such as the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA).

This Programmatic EA/OEA would analyze the potential impacts on the human and natural environment associated with the installation and operation of the OOI. The NEPA process ensures that environmental impacts of proposed major federal actions are considered in the decision-making process. EO 12114 requires environmental consideration (i.e., preparation of an OEA) for actions that may affect the environment outside United States (U.S.) Territorial Waters. The Draft Programmatic EA/OEA would be filed with the U.S. Environmental Protection Agency and announced in a Notice of Availability (NOA) published in the Federal Register (anticipated release in late winter 2008).

Based on a preliminary analysis of the potential impacts to marine resources under the jurisdiction of the National Marine Fisheries Service (NMFS), implementation of the Proposed Action is not, at this programmatic stage, anticipated to result in adverse impacts to species or habitats covered under the ESA, Magnuson-Stevens Fishery Conservation and Management Act, and MMPA. If a decision were made to move from the programmatic stage to the site-specific stage, any supplementary environmental document would be tiered off of the Programmatic EA/OEA to analyze any remaining issues.

In accordance with EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed in the Programmatic EA/OEA. In addition, to encourage efficiencies in completing the environmental reviews associated with the proposed OOI, we ask that you also include potential issues that you believe may be applicable at the site-specific stage. The environmental issues analyzed would identify the potential impacts of implementing the OOI and lead to a Finding of No Significant Impact (FONSI) or a decision to prepare an Environmental Impact Statement (EIS). When all environmental reviews are complete, the decision maker would be in a position to make an informed decision regarding whether to move forward to the site-specific stage involving the installation and operation of the proposed OOI.

On behalf of NSF, TEC requests your comments no later than 21 January 2008; however, comments received at any time throughout the NEPA process would be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF will analyze at that stage whether the proposed project is likely to raise any additional issues requiring further compliance with environmental statutes. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.

Rick Spaulding
Sr. Biologist/Project Manager
TEC Inc.

cc: Dr. Shelby Walker, Project Officer, NSF
Ms. Rosie Lunde, Project Manager, Ocean Leadership
Mr. Bob Lohn, Regional Administrator, NW Regional Office, NMFS
Mr. Michael Tehan, Oregon State Habitat Director, NW Regional Office, NMFS
Ms. Patricia Kurkul, Regional Administrator, NE Regional Office, NMFS

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7 January 2008

MEMORANDUM FOR: Dr. Mark Sudol
Regulatory Branch
Headquarters, U.S. Army Corps of Engineers (USACE)
441 G Street, NW
Washington, DC 20314

FROM: National Science Foundation (NSF)
Division of Ocean Sciences
Suite 725
4201 Wilson Blvd.
Arlington, VA 22230

SUBJECT: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Ocean Observatories Initiative (OOI)

Dear Dr. Sudol,

On behalf of NSF, TEC Inc. (TEC) is preparing a Programmatic EA/OEA for the proposed installation and operation of the OOI. The purpose of this letter is to introduce the Proposed Action to state and federal agencies with regulatory jurisdiction within the project areas early in the environmental compliance process, and assist in the identification of potential issues during the preparation of the Programmatic EA/OEA.

Overview of the OOI

To provide the U.S. ocean sciences research community with the basic sensors and infrastructure required to make sustained, long-term, and adaptive measurements in the oceans, the NSF's Ocean Sciences Division is developing the OOI from community-wide, national, and international scientific planning efforts. The proposed OOI would build upon recent technological advances, experience with existing ocean observatories, and lessons learned from several successful pilot and test bed projects. The proposed OOI would be an interactive, globally distributed and integrated network of cutting-edge ocean observing capabilities. This network would enable the next generation of complex ocean studies at the coastal, regional, and global scale. The OOI would be a key NSF contribution to the broader effort to establish the proposed operationally focused national system known as the Integrated Ocean Observing System (IOOS). As these efforts mature, the research-focused observatories envisioned by the OOI would be networked to become an integral part of the IOOS and in turn would be a key and enabling U.S. contribution to the international Global Ocean Observing System (GOOS) and the Global Earth Observation System of Systems (GEOSS).

The OOI infrastructure would include cables, buoys, underwater vehicles, moorings, junction boxes, power generation (solar, wind, fuel cell, and/or diesel), and two-way communications systems. This large-scale infrastructure would support sensors located at the sea surface, in the water column, and at or beneath the seafloor. The OOI would also support related elements, such as data dissemination and archiving, modeling of oceanographic processes, and education and outreach activities essential to the long-term success of ocean science.

The OOI represents a significant departure from traditional approaches in oceanography and a shift from expeditionary to observatory-based research. It would include the first U.S. multi-node cabled observatory; fixed and relocatable coastal arrays coupled with mobile assets; and advanced buoys for interdisciplinary measurements, especially for data-limited areas of the Southern Ocean and other high-latitude locations. The OOI Program Office is managed by the Consortium for Ocean Leadership (Ocean Leadership), in conjunction with three academic-based Implementing Organizations, and funded via a cooperative agreement with NSF by the NSF's Major Research Equipment and Facilities Construction (MREFC) account.

Global-, Regional-, and Coastal-Scale Nodes

The OOI design is based upon three main components at global, regional, and coastal scales (Figure 1). At the global and coastal scales, mooring observatories would provide locally generated power to seafloor and platform instruments and sensors for data collection, and use a satellite link for data transmission and communication to shore and the Internet. Up to six Global-scale Nodes (GSN) or buoy sites are proposed for ocean sensing in the Eastern Pacific and Atlantic oceans (Figure 1). The Regional-scale Nodes (RSN) off the coasts of Washington and Oregon would consist of seafloor observatories with various chemical, biological, physical, and geological sensors linked to shore by submarine cables that provide power and Internet connectivity (Figure 2). Coastal-scale Nodes (CSN) would be represented by the Endurance Array off the coast of Washington and Oregon (Figure 2) and the relocatable Pioneer Array off the coast of Massachusetts (Figure 3). In addition, there would be an integration of mobile assets such as autonomous underwater vehicles (AUVs) and gliders with the GSN, RSN, and CSN observatories.

Environmental Compliance and Interagency Coordination

On behalf of the NSF, TEC is preparing a Programmatic EA/OEA pursuant to the requirements of the National Environmental Policy Act (NEPA) (42 United States Code §4321, *et seq*.); the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of NEPA (Title 40 Code of Federal Regulations §§ 1500-1508); and Executive Order (EO) 12114, *Environmental Effects Abroad of Major Federal Actions*.

In accordance with Section 10 of the River and Harbors Act (RHA) and Section 404 of the Clean Water Act (CWA), it is anticipated that the associated regulatory requirements under those statutes would be fulfilled by NSF at the site-specific stage of the OOI installation process if a decision were made to move from the programmatic stage to the site-specific stage. It is anticipated that any supplementary environmental document would be tiered off of the Programmatic EA/OEA at the site-specific stage to analyze any remaining issues.

In accordance with EO 12372, *Inter-governmental Review of Federal Programs*, we request your assistance in identifying potential issues to be addressed in the Programmatic EA/OEA. In addition, to encourage efficiencies in completing the environmental reviews associated with the proposed OOI, we ask that you also include potential issues that you believe may be applicable at the site-specific stage. A decision regarding whether to move forward with the installation and operation of the proposed OOI would not be made until all required environmental reviews, including NSF's compliance with the RHA and CWA, are completed.

On behalf of NSF, TEC requests your comments no later than 21 January 2008; however, comments received at any time throughout the NEPA process would be considered to the extent possible in the preparation of the Programmatic EA/OEA. Again, should the proposed OOI be approved to move forward to the site-specific stage, NSF would analyze at that stage whether the proposed project is likely to have remaining issues that require additional compliance with environmental statutes. Should you have any questions or desire additional information, please feel free to contact Rick Spaulding, Project Manager, TEC at (206) 855-4997, rlspaulding@tecinc.com or Dr. Shelby Walker, Project Officer, Division of Ocean Sciences, NSF at (703) 292-4568.

Rick Spaulding
Sr. Biologist/Project Manager
TEC Inc.

cc: Dr. Shelby Walker, Project Officer, NSF
Ms. Rosie Lunde, Project Manager, Ocean Leadership
Ms. Jennifer McCarthy, Regulatory Branch, HQ USACE
Ms. Karen Kochenbach, Northwestern Division, USACE

STATE OF CONNECTICUT
DEPARTMENT OF ENVIRONMENTAL PROTECTION

January 21, 2008

Rick Spaulding
Sr. Biologist/Project Manager
TEC Inc.
6765 NE Day Road
Bainbridge Island, WA 98110

Re: Programmatic Environmental Assessment/Overseas Environmental Assessment (EA/OEA) for the Oceanic Observatories Initiative (OOI)

Dear Mr. Spaulding:

Thank you for the opportunity to comment on the preparation of a Programmatic EA/OEA for the proposed installation and operation of an Oceanic Observatories Initiative (OOI). The State of Connecticut supports the deployment of ocean observing systems for the purposes of monitoring ambient environmental conditions and aiding in the study and management of ocean resources.

Your memorandum of January 7, 2007 requested that we identify potential issues of concern to Connecticut that should be addressed at this programmatic review stage of the proposed OOI. As an initial question, we would want to know what coordination has taken place or is proposed to take place between OOI and two existing initiatives: the Mid-Atlantic Coastal Ocean Observing Regional Association (MACOORA) and the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS). You stated that OOI would contribute to the national Integrated Ocean Observing System (IOOS). However, your letter includes no reference to NERACOOS, whose mission includes the establishment of operating principles for regional ocean observing systems in accordance with IOOS standards. Similarly, MACOORA oversees and manages the design and operation of ocean observing systems within the OOI Pioneer Array project area, thus warranting coordination of any interrelated efforts.

The Pioneer Array project site identified in the memorandum does not in itself encompass Connecticut waters. However, in contrast to your stated position, we believe that there could be potential resource and use impacts of concern to this state associated with the siting and operation of that array. The general description of proposed project infrastructure raises questions about the potential disturbance of migratory species (marine mammals, sea turtles and shorebirds) that either do or may frequent Connecticut waters and that may pass near or through the project site. Connecticut fishermen fish for scallops on the Continental Shelf, and for lobster and tuna in Block Canyon and Hudson Canyon located on the Shelf south of Long Island. Trawling also takes place in the same areas for squid and a variety of finfish species. Those fishing grounds are relatively proximal to the proposed Pioneer Array site, hence we would be concerned about the socioeconomic consequences of any disruption of such fishing activities.

Given the lack of specificity in your memorandum regarding the scale and operation of the Pioneer Array as well as the activities that would take place in the associated AUV and Glider Mission Boxes, it is not possible at this juncture to judge the appropriate level of the concerns expressed above. Therefore, we wish to insure by this letter that we will receive and have the opportunity to review and comment on the Programmatic EA/OEA and all other future documentation related to this initiative. We look forward at that time to evaluating in greater detail the nature of any specific impacts of concern to Connecticut. Please be advised that the identification of resource or use impacts such as those described above would require federal consistency review pursuant to the federal consistency regulations at 15 CFR Part 930.

If you have any questions about Connecticut's review of proposed activities as the OOI initiative progresses, please contact Tom Ouellette of this Office at 860-424-3612 or tom.ouellette@po.state.ct.us.

Sincerely,

Brian P. Thompson
Director
Office of Long Island Sound Programs

BPT/TO/o
cc: Julie Victoria, DEP Wildlife Div.
David Simpson, DEP Marine Fisheries Div.

APPENDIX B:
COMMON AND SCIENTIFIC NAMES OF SPECIES DISCUSSED IN THE TEXT

Appendix B
Common and Scientific Names of Faunal Species Discussed in the Text

Common Name	Scientific Name
INVERTEBRATES	
American lobster	*Homarus americanus*
Atlantic surf clam	*Spisula solidissima*
Dungeness crab	*Cancer magister*
Long finned squid	*Loligo pealei*
Market squid	*Loligo opalescens*
Ocean quahog	*Arctica islandica*
Red deepsea crab	*Geryon quinquedins*
Sea scallop	*Placopecten magellanicus*
FISH	
Albacore tuna	*Thunnus alalunga*
American plaice	*Hippoglossoides platessoides*
Angler	*Lophius piscatorius*
Arrowtooth flounder	*Atheresthes stomias*
Atlantic bluefin tuna	*Thunnus thymus*
Atlantic butterfish	*Peprilus triacanthus*
Atlantic cod	*Gadus morhua*
Atlantic herring	*Clupea harengus*
Atlantic mackerel	*Scomber scombrus*
Atlantic salmon	*Salmo salar*
Aurora rockfish	*Sebastes aurora*
Barndoor skate	*Dipterus laevis*
Basking shark	*Cetorohinus maximus*
Bigeye thresher shark	*Alopias superciliosus*
Big skate	*Squalus acanthias*
Blackfish	*Centrolophus niger*
Black rockfish	*Sebastes melanops*
Black sea bass	*Centropristis striata*
Black scabbardfish	*Aphanopus carbo*
Blue rockfish	*Sebastes mystinus*
Blue shark	*Prionace glauca*
Bluefish	*Pomatomus saltatrix*
Bocaccio rockfish	*Sebastes paucispinus*
Brown rockfish	*Sebastes auriculatus*
Bull trout	*Salvelinus confluentus*
Butter sole	*Isopsetta isolepis*
Cabezon	*Scorpaenichthys marmoratus*
California skate	*Raja inornata*
Canary rockfish	*Sebastes pinniger*
Chilipepper rockfish	*Sebastes goodei*
China rockfish	*Sebastes nebulosus*
Chinook salmon	*Oncorhynchus tshawytscha*
Chum salmon	*Oncorhynchus keta*
Cobia	*Rachycentron canadum*
Coho salmon	*Oncorhynchus kisutch*
Copper rockfish	*Sebastes caurinus*
Cowcod	*Sebastes levis*
Curlfin sole	*Pleuronichthys decurrens*
Darkblotched rockfish	*Sebastes crameri*
Deal fish	*Trachipterus arcticus*
Dover sole	*Microstomus pacificus*
Dusky shark	*Carcharhinus obscurus*
Elongate frostfish	*Benthodesmus elongatus*
English sole	*Paraphrys vetulus*
Flathead sole	*Hippoglossoides elassodon*
Green sturgeon	*Acipenser medirostris*
Greenland shark	*Somniosus microcephatus*
Greenspotted rockfish	*Sebastes chlorostictus*
Greenstriped rockfish	*Sebastes elongatus*
Haddock	*Melanogrammus aeglefinus*
Jack mackerel	*Trachurus symmetricus*
Kelp greenling	*Hexagrammos decagrammus*
King of Herrings	*Regalecus glesne*
King mackerel	*Scomberomorus cavalla*
Largehead conger	*Bathycongrus varidens*
Leopard shark	*Triakis semifasciata*
Lingcod	*Ophiodon elongatus*
Longnose lancetfish	*Alepisaurus ferox*
Longnose skate	*Raja rhina*
Longspine thornyhead	*Sebastolobus altivelis*
Meager	*Argyrosomus regius*
Monkfish	*Lophius americanus*
Northern anchovy	*Engraulis mordax*
Northern bluefin tuna	*Thunnus thynnus*
Ocean perch	*Sebastes marinus*
Ocean pout	*Macrozoarces americanus*
Ocean sunfish	*Mola mola*
Offshore hake	*Merluccius albidus*
Onion-eyed grenadier	*Macrourus berglax*
Opah	*Lampris guttatus*
Orange roughy	*Hoplostethus atlanticus*
Pacific cod	*Gadus macrocephalus*
Pacific flatnose	*Antimora microlepis*
Pacific grenadier	*Coryphaenoides acrolepis*
Pacific hake	*Merluccius productus*
Pacific halibut	*Hippoglossus stenolepis*
Pacific herring	*Clupea pallasii pallasii*
Pacific ocean perch	*Sebastes alutus*
Pacific sanddab	*Citharichthys sordidus*
Pacific sardine	*Sardinops sagax*
Petrale sole	*Eopsetta jordani*
Pink salmon	*Oncorhynchus gorbuscha*
Porbeagle	*Lamna nasus*
Quillback rockfish	*Sebastes maliger*
Razorback scabbardfish	*Aphanopus carbo*
Red hake	*Urophycis chuss*
Redbanded rockfish	*Sebastes babcocki*
Redstripe rockfish	*Sebastes proriger*
Rex sole	*Glyptocephalus zachirus*
Rock sole	*Lepidopsetta bilineata and L. polyxystra*
Rockfish	*Sebastes spp.*
Rosethorn rockfish	*Sebastes helvomaculatus*
Rosy rockfish	*Sebastes rosaceus*
Sablefish	*Anoplopoma fimbria*
Sand sole	*Psettichthys melanostictus*
Sandbar shark	*Carcharhinus plumbeus*
Sea trout	*Salmo trutta trutta*
Scorpionfish	*Neomerinthe hemingwayi*
Scup	*Stenotomus chrysops*
Sharpchin rockfish	*Sebastes zacentrus*
Shortbelly rockfish	*Sebastes jordani*
Shortbill spearfish	*Tetrapturus angustirostris*
Shortfin mako	*Isurus oxyrinchus*
Shortraker rockfish	*Sebastes borealis*
Slender snipe eel	*Nemichthys scolupaceus*
Slender tuna	*Allothunnus fallai*
Shortspine thornyhead	*Sebastolobus alascanus*
Slime eel	*Simenchelys parasitica*
Soupfin shark	*Galeorhinus galeus*
Spanish mackerel	*Scomberomorus maculatus*
Spiny dogfish	*Squalus acanthias*
Splitnose rockfish	*Sebastes diploproa*
Spotted ratfish	*Hydrolagus colliei*

Common Name	*Scientific Name*
Starry flounder	*Platichthys stellatus*
Steelhead trout	*Oncorhynchus mykiss*
Striped marlin	*Tetrapturus audax*
Stripetail rockfish	*Sebastes saxicola*
Summer flounder	*Paralichtys dentatus*
Thresher shark	*Alopias vulpinus*
Tiger rockfish	*Sebastes nigrocinctus*
Tiger shark	*Galeocerdo cuvieri*
Tope shark	*Galeorhinus galeus*
Vermillion rockfish	*Sebastes miniatus*
Walleye Pollock	*Theragra chatcogramma*
Whale shark	*Rhincodon typus*
White sturgeon	*Acipenser transmontanus*
Whiting	*Merluccius bilinearis*
Widow rockfish	*Sebastes entomelas*
Windowpane flounder	*Scophthalmus aquosus*
Winter flounder	*Pseudopleuronectes americanus*
Witch flounder	*Glyptecephalus cynoglossus*
Yelloweye rockfish	*Sebastes ruberrimus*
Yellowfin tuna	*Thunnus albacares*
Yellowmouth rockfish	*Sebastes reedi*
Yellowtail amberjack	*Seriola lalandi*
Yellowtail flounder	*Limanda ferruginea*
Yellowtail rockfish	*Sebastes flavidus*
REPTILES	
Green sea turtle	*Chelonia mydas*
Hawksbill sea turtle	*Eretmochelys imbricata*
Kemp's ridley sea turtle	*Lepidochelys kempii*
Leatherback sea turtle	*Dermochelys coriacea*
Loggerhead sea turtle	*Caretta caretta*
MAMMALS	
Antarctic minke whale	*Balaenoptera bonaerensis*
Atlantic spotted dolphin	*Stenella frontalis*
Atlantic white-sided dolphin	*Lagenorhynchus acutus*
Baird's beaked whale	*Berardius bairdii*
Blainville's beaked whale	*Mesoplodon densirostris*
Blue whale	*Balaenoptera musculus*
Bottlenose dolphin	*Tursiops truncatus*
Bowhead whale	*Balaena mysticetus*
California sea lion	*Zalophus californianus*
Clymene dolphin	*Stenella clymene*
Cuvier's beaked whale	*Ziphius cavirostris*
Dall's porpoise	*Phocoenoides dalli*
Dusky dolphin	*Lagenorhynchus obscurus*

Common Name	*Scientific Name*
Dwarf minke whale	*Balaenoptera acutorostrata*
Dwarf sperm whale	*Kogia sima*
Fin whale	*Balaenoptera physalus*
Gervais' beaked whale	*Mesoplodon europaeus*
Harbor porpoise	*Phocoena phocoena*
Harbor seal	*Phoca vitulina*
Hubb's beaked whale	*Mesoplodon carlhubbsi*
Humpback whale	*Megaptera novaeangliae*
Killer whale	*Orcinus orca*
Long-finned pilot whale	*Globicephala melas*
Melon-headed whale	*Peponocephala electra*
Minke whale	*Balaenoptera acutorostrata*
Northern Atlantic right whale	*Eubalaena glacialis*
Northern Pacific right whale	*Eubalaena japonica*
Northern bottlenose whale	*Hyperoodon ampullatus*
Northern elephant seal	*Mirounga angustirostris*
Northern fur seal	*Callorhinus ursinus*
Northern right whale dolphin	*Lissodelphis borealis*
Northern sea otter	*Enhydra lutris kenyoni*
Pacific gray whale	*Eschrichtius robustus*
Pacific walrus	*Odobenus rosmarus divirgens*
Pacific white-sided dolphin	*Lagenorhynchus obliquidens*
Pantropical spotted dolphin	*Stenella attenuata*
Polar bear	*Ursus maritimus*
Pygmy sperm whale	*Kogia breviceps*
Pygmy right whale	*Caperea marginata*
Risso's dolphin	*Grampus griseus*
Rough-toothed dolphin	*Steno bredanensis*
Sei whale	*Balaenoptera borealis*
Short-beaked common dolphin	*Delphinus delphis*
Short-finned pilot whale	*Globicephala macrorhynchus*
Southern bottlenose dolphin	*Hyperoodon planifrons*
Southern right whale	*Eubalaena australis*
Sowerby's beaked whale	*Mesoplodon bidens*
Spectacled porpoise	*Phocoena dioptrica*
Sperm whale	*Physeter macrocephalus*
Spinner dolphin	*Stenella longirostris*
Stejneger's beaked whale	*Mesoplodon stejnegeri*
Striped dolphin	*Stenella coeruleoalba*
True's beaked whale	*Mesoplodon mirius*
White-beaked dolphin	*Lagenorhynchus albirostris*

Sources: Lutz and Musick 1997; Rice 1998; Nelson et al. 2004; FishBase 2008.