U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

MEMORANDUM FOR: Commander Mark Wetzler, NOAA
Commanding Officer, NOAA Ship *Okeanos Explorer*

FROM: Captain Anne K. Lynch, NOAA
Commanding Officer, NOAA Marine Operations Center-Atlantic

SUBJECT: Project Instruction for EX-16-05 Leg 1
CAPSTONE CNMI & Mariana Trench MNM (ROV & Mapping)

Attached is the final Project Instruction for EX-16-05 Leg 1, CAPSTONE CNMI & Mariana Trench MNM (ROV & Mapping), which is scheduled aboard NOAA Ship *Okeanos Explorer* during the period of April 20 – May 11, 2016. Of the 22 DAS scheduled for this project, 22 days are funded by a Line Office Allocation. This project is estimated to exhibit a High Operational Tempo. Acknowledge receipt of these instructions via e-mail to ChiefOps.MOA@noaa.gov at Marine Operations Center-Atlantic.

DRAFT Project Instructions

Date Submitted: April 8, 2016

Platform: NOAA Ship *Okeanos Explorer*

Project Number: EX-16-05 Leg 1

Project Title: CAPSTONE CNMI & Mariana Trench MNM (ROV & Mapping)

Project Dates: April 20 – May 11, 2016

Prepared by:

Approved by: _____ Dated: 4/13/2016

Craig Russell
Program Manager
Office of Ocean Exploration & Research

Approved by: _____ Dated: 4/19/2016

Captain Anne K. Lynch, NOAA
Commanding Officer
Marine Operations Center - Atlantic

I. OVERVIEW

A. Brief Summary and Project Period

From April to July 2016, NOAA and partners will conduct three telepresence-enabled ocean exploration cruises on NOAA Ship *Okeanos Explorer* to collect critical baseline information in and around the Commonwealth of the Northern Marianas Islands (CNMI) and the Marianas Trench Marine National Monument (MTMNM). NOAA will work with the scientific and management community to characterize unknown and poorly-known areas through telepresence-based exploration. This expedition is part of a three year Campaign (CAPSTONE) focused on systematically collecting baseline information to support science and management needs within and around the Monuments and other protected places in the Pacific, and serves as an opportunity for NOAA and the Nation to highlight the uniqueness and importance of these national symbols of ocean conservation.

This document contains project instructions for EX-16-05 Leg 1. Operations for this cruise will include ROV, mapping, telepresence-based remote participation, and CTD rosette operations. The expedition will be commence in Santa Rita, Guam with operations beginning on April 20th and conclude in Saipan, CNMI on May 11th. Operations will use the ship's deep water mapping systems (Kongsberg EM302 multibeam sonar, EK60 split-beam fisheries sonars, ADCPs, and Knudsen 3260 chirp sub-bottom profiler sonar), NOAA's two-body 6000 m remotely operated vehicle (ROVs *Deep Discoverer* and *Seirios*), CTD rosette, and the ship's high-bandwidth satellite connection for real-time ship to shore communications. Daytime ROV dives are planned every day from April 21 –May 10. ROV dives will include high-resolution visual surveys and limited rock and biologic specimen sampling. Mapping operations will be conducted overnight and when the ROV is on deck. CTD casts have been requested during the cruise to collect more environmental information at sites of interest. Exploration operations for this cruise will focus on deep-water areas around CNMI and MTMNM. This expedition will help establish a baseline of information in the region to catalyze further exploration, research and management activities.

NOAA Ship *Okeanos Explorer* systematically explores the ocean every day of every cruise to maximize public benefit from the ship's unique capabilities. With 95% of the ocean unexplored, we pursue every opportunity to map, sample, explore, and survey at planned destinations as well as during transits; "Always Exploring" is a guiding principle. An integral element of *Okeanos Explorer*'s "Always Exploring" model is the ship's seafloor and water column mapping capabilities. A subset or all of the sonars (EM 302, EK 60, Knudsen sub-bottom, ADCPs) on board will be operated at all times when ROV or CTD operations are not taking place, allowing for continued exploration and seabed, water column, and/or sub-bottom data collection and selected processing.

As a telepresence-enabled ROV cruise, EX-16-05 Leg 1 is anticipated to have a robust

complement of shore-based science experts participating from their home institutions and Exploration Command Centers around the country. This shore-based science team will actively engage with the at-sea team in real-time using *Okeanos Explorer*'s state-of-the art telepresence technology, including during ROV dives and daily ship-to-shore science planning meetings. In general, operations will focus in the areas highlighted in Figure 1.

B. Days at Sea (DAS)

Of the 22 DAS scheduled for this project, 0 DAS are funded by an OMAO allocation, 0 DAS are funded by an OAR Line Office Allocation, and 22 DAS are funded by a NMFS Line Office Allocation, 0 DAS are Program Funded, and 0 DAS are other agency funded. This project is estimated to exhibit a High Operational Tempo due to daily ROV operations, nighttime mapping, and possible evening CTD work.

C. Operating Area

EX-16-05 Leg 1 of the CAPSTONE Expeditions is a telepresence-enabled ROV cruise that will focus on sites within CNMI and MTMNM. The overarching themes of CAPSTONE include collecting data to addressing Monument and Sanctuary science and management needs; vulnerable marine habitats; seamounts within the Prime Crust Zone; and collecting information about the geologic history of the Pacific Seamounts. Additional themes for the expedition include deep sea coral and bottom fish habitats; hydrothermal vents; mud volcanoes; trench and subduction zone areas. Operations for this cruise are located in the southern portion of the CNMI and South of Guam.

The ship will conduct 24 hour operations consisting of daytime ROV dives and evening/nighttime mapping operations including during transit. During this cruise we will conduct primarily 8 hour ROV dives with occasional 10 or 12 hour dives on particularly interesting or deep water dive sites, as staffing allows. ROV operations will focus in depths between 250 and 6,000 meters and will include high-resolution visual surveys and limited sample collection. Mapping operations will be conducted in 250m of water and deeper, and include transit and overnight multibeam, water column backscatter, and sub-bottom data collection. CTD rosette operations are requested at several sites to inform ROV dives, and may be requested opportunistically at selected sites where collecting the data is considered important to understanding the physical or chemical properties of the overlying water column.

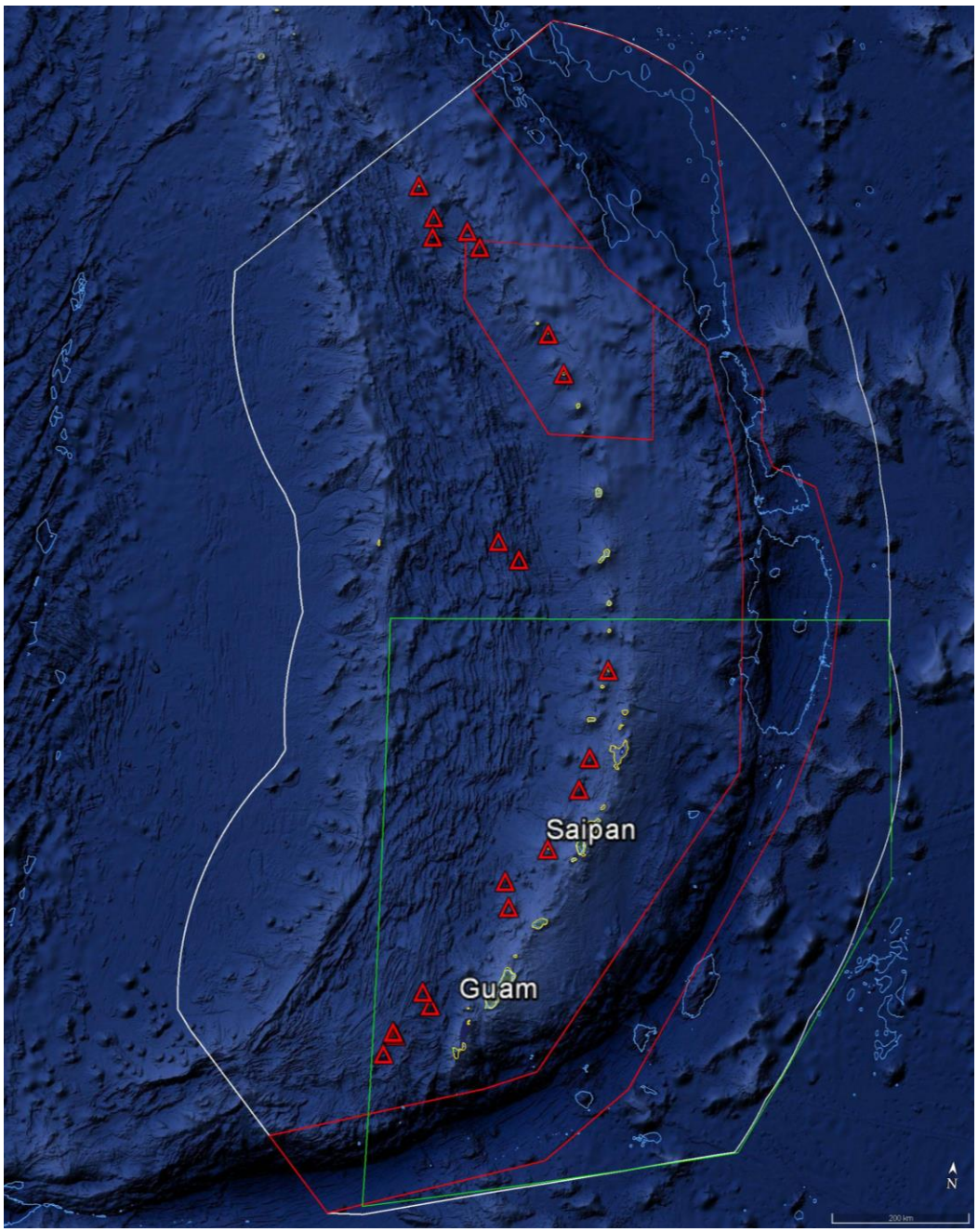

Figure 1: This figure shows the operating area (green box) of the *Okeanos Explorer* for EX-16-05 Leg 1. The white line shows the CNMI/US EEZ, the red lines and triangles are the boundaries of the Trench and Islands Unit of the MTMNM, and the red triangles are the Vents Unit of MTMNM. The yellow contour lines are the 250m contours surrounding Guam and the CNMI, and light blue are 6000m contours.

Operating Area Bounding Coordinates		
ID	**Latitude (N)**	**Longitude (E)**
SE Corner	11.6364	147.7862
Mid-East Node	14.6465	149.4795
NE Corner	17.5088	149.3278
NW Corner	17.3300	143.2906
SW Corner	11.0410	143.4362

Table: Bounding coordinates of the operating area box show in Figure 1.

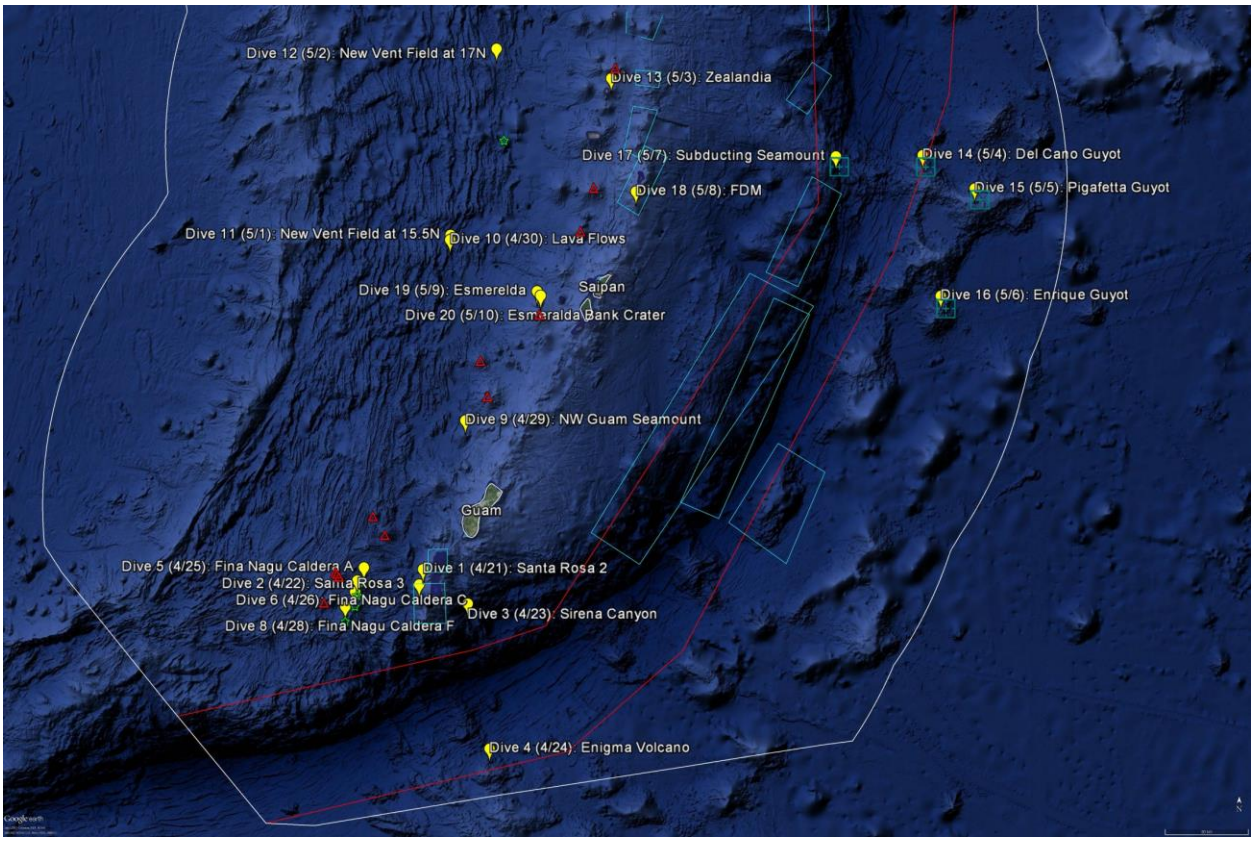

Figure 2: This figure shows the location of planned ROV dives (yellow dots with numbers), mapping area boxes (yellow boxes) and requested CTD rosette operations (green stars). The white boundaries are the CNMI/US EEZ, the red polygon is the boundary of the Trench Unit of MTMNM, and the red triangles compose the Vents Unit of the MTMNM. See the detailed itinerary in table 4 on page 19 for details on the ROV dive sites and an anticipated schedule of operations.

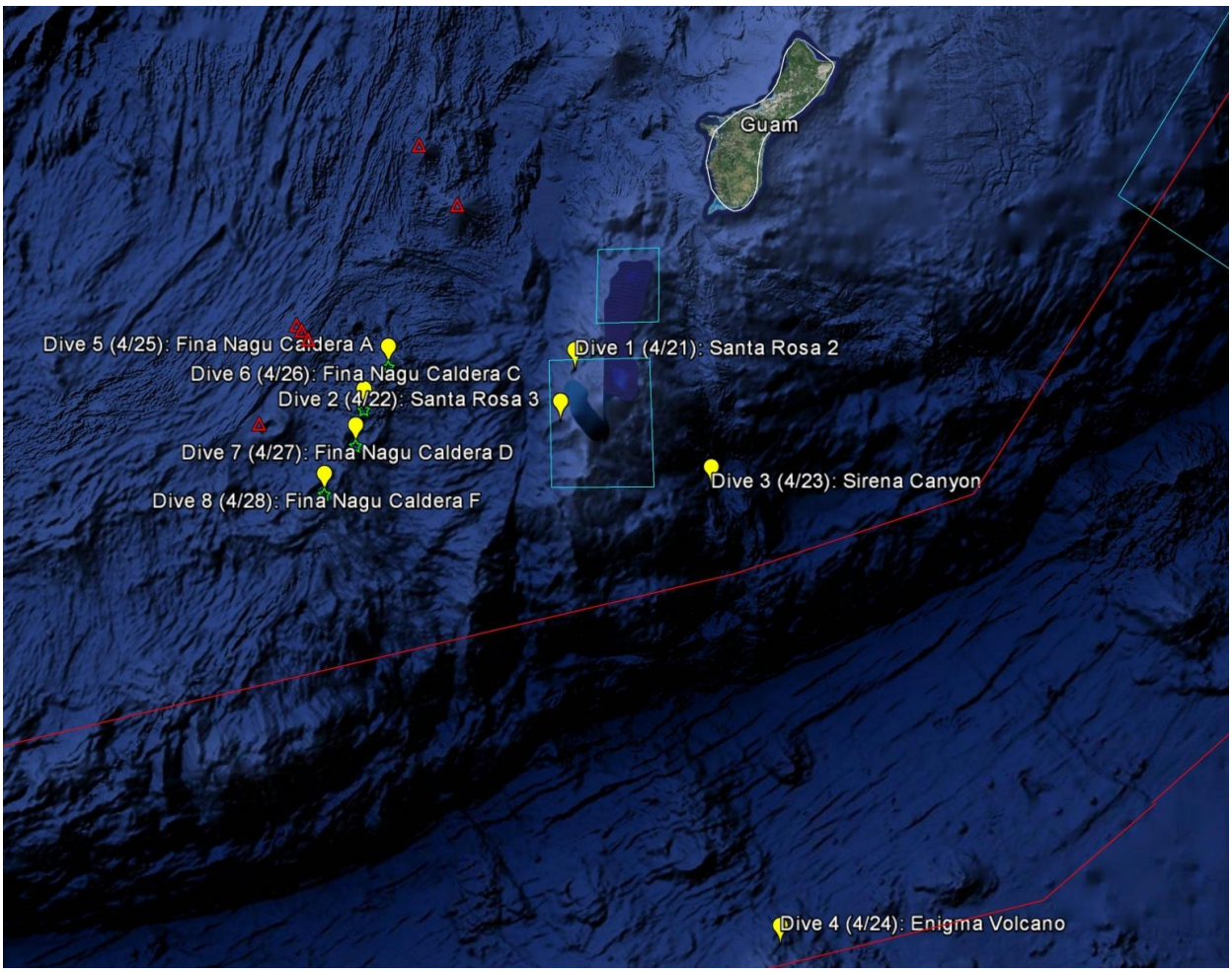

Figure 3: Close-up showing dives planned south of Guam. The yellow balloons are the locations of planned ROV dives, the blue boxes are requested mapping areas, and the green stars are requested CTD operations. The red triangles are the Vents Unit, and the red polygon is the Trench Unit of the Marianas Trench Marine National Monument. The white lines are the CNMI Exclusive Economic Zone.

D. Summary of Objectives

April 20 – May 11 (Santa Rita, Guam to Saipan, CNMI) Telepresence-enabled ROV cruise with mapping and CTD operations

EX-16-05 Leg 1 operations will cover a wide area of the US EEZ in and around the Commonwealth of the Northern Marianas Islands, Guam, and the Marianas Trench Marine National Monument. The

primary goal for this cruise is to collect baseline data and information to support priority NOAA science and management needs.

Mission objectives for EX-16-05 Leg 1 include a combination of operational, science, education, outreach, and data management objectives:

1. Science
    a. Acquire data to support priority Monument and Sanctuaries science and management needs;
    b. Explore the diversity and distribution of benthic habitats – including bottom fish habitats, deep sea and precious coral communities, hydrothermal vent communities, mud volcanoes, trench and subduction zone habitats;
        i. Collect data on: habitat size and extent, animal diversity and density;
        ii. Focus close-up imaging operations on potential new, rare and poorly documented animals as well as dominant members of the communities;
        iii. Collect and preserve biological samples of potential new species, new records, dominant community members if not easily recognized, and other animals to aid in site characterization
    c. Collect biological and geological data and samples on seamounts within the Prime Crust Zone east of the trench, particularly focusing on ridge tops and summit margins;
    d. Collect biological and geological data at sites to aid the understanding of the geologic history of the Pacific seamounts.
    e. Continue to refine specimen collection protocols and processing procedures;
    f. Ground-truth acoustic data using video imagery and characterize associated habitat;
    g. Engage a broad spectrum of the scientific community and public in telepresence-based exploration;
    h. Successfully conduct operations in conjunction with shore-based Exploration Command Centers and remote science team participants;
    i. Create and provide input into standard science products to provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities.

2. Remote Science/Exploration Command Centers
    a. Provide operational support and training to scientists and managers to enable remote participation in at-sea operations;
    b. Provide support and testing to bring new ECC or viewing center online at the University of Guam;
    c. Provide support and testing to bring internet-1 based ECC or viewing center online at Northern Marianas College;

d. Develop and test best practices for hosting internet-1 based live interactions;
e. Facilitate outreach and engagement activities and events at the ECCs;
f. Test and refine ship-to-shore communications procedures that engage multiple ECCs and other remote participants;
g. Test and refine operating procedures and products.

3. ROV Engineering
    a. Daytime ROV dives on exploration targets;
    b. Ongoing training of pilots;
    c. Ongoing system familiarization, documentation, and training;
    d. Test and refine new ROV systems and pilot sampling protocol.

4. Video Engineering (VSAT ~15 mb/sec ship-to-shore; 2.5 mb/sec shore-to-ship)
    a. Test terrestrial and high-speed satellite links (Test high speed at 18 mbps if bandwidth can be procured, to see if this is successful. Will need coordination from OER and KnightSky to do this)
    b. Support telepresence-enabled ROV operations;
    c. Collect/create all standard video products;
    d. Continue to refine new highlight video SOPs;
    e. Facilitate live outreach events between ship and shore;
    f. Continue to refine protocols for using YouTube live to host live video;
    g. Test and refine new video compression and editing hardware;
    h. Formalize / Finalize parallel processing of imagery and video compression routines;
    i. Develop protocols and procedure for using the Telestream video recording suite.

5. Mapping
    a. Collect high resolution mapping data from sonars in priority areas as dictated by operational needs as well as science and management community needs;
    b. Support ROV operations with mapping products and expertise;
    c. Conduct mapping operations during transit, with possible further development of exploration targets;
    d. Collect XBT/ UnderwayCTD casts at regular intervals no longer than 6 hours, as data quality requires, during mapping operations;
    e. Create daily standard mapping products;
    f. Collection of sun photometer measurements as part of survey of opportunity;
    g. Continue to test the integration of the new EK60 frequencies and the ADCPs. Overnight mapping operations will focus on refining protocols for the new sonars.

6. Data Management

a. Provide a foundation of publicly accessible data and information products to spur further exploration, research, and management activities;
b. Provide daily products to shore for operational decision making purposes;
c. Test SOP for providing sample data management support from shore;
d. Continue to test the ability to record high definition video footage of a full dive onboard the ship;
e. Develop and test protocols and procedures for handling the data from the Telestream video recording system;
f. Develop and test protocols and procedures for handling data from pilot sampling efforts
g. Cross train existing ROV dedicated personnel;
h. Formalize Data Management SOPs;
i. Continue development on real time data visualization of ROV geospatial and environmental parameters;
j. Ensure Marine Archology data protection protocols are followed, if relevant.

7. Outreach
    a. Engage the general public in ocean exploration through live video and timely content (daily updates, topical essays and web logs, highlight videos, video clips, still imagery and mapping products) posted on the Ocean Explorer website;
    b. Provide support and testing to enable live-streaming and context for the Marians "mock command center" public exhibit at UnderWater World Guam.
    c. Conduct live interactions and UnderWater World Guam;
    d. Conduct live interactions with schools on Saipan;
    e. Host live events with VIPs;
    f. More TBD.

8. Ship
    a. Continue to refine SOPs for the new VSAT;
    b. Provide high a high quality stable internet connection with the new VSAT;
    c. Continue training new deck department personnel in ROV launch and recovery.

E. Participating Institutions

National Oceanic and Atmospheric Administration (NOAA), Office of Ocean Exploration and Research (OER)–1315 East-West Hwy, Silver Spring, MD 20910

Global Foundation for Ocean Exploration, 75 Greenmanville Ave., Mystic, CT 06355

NOAA, National Oceanographic Data Center, National Coastal Data Development Center, Stennis Space Center MS, 39529

NOAA, Office of Coast Survey, Hydrographic Surveys Division, Atlantic Hydrographic Branch, 439 W. York St., Bldg 2, Norfolk, VA 23510

University Corporation for Atmospheric Research Joint Office for Science Support (JOSS), PO Box 3000 Boulder, CO 80307

University of Hawai'i at Manoa- 2500 Campus Rd, Honolulu, HI 96822

University of New Hampshire (UNH) Center for Coastal and Ocean Mapping (CCOM) Jere A. Chase Ocean Engineering Lab, 24 Colovos Rd, Durham, NH 03824 USA

NOAA National Marine Fisheries Service, Pacific Islands Regional Office, 1845 Wasp Blvd, Honolulu, HI 96818

NOAA National Marine Fisheries Service, Marine National Monuments Program, 1845 Wasp Blvd, Honolulu, HI 96818

NOAA National Marine Fisheries Service, Pacific Islands Fisheries Science Center, 1845 Wasp Blvd, Honolulu, HI 96818

University of Guam, University Dr., Mangilao, Guam 96923

UnderWater World Guam, 1245 Pale San Vitores Rd, Tamuning, Guam 96911

Northern Marianas College, P.O. Box 501250, Saipan, MP 96950

F. Personnel (Mission Party)

Table 2: Leg I – Full list of sea going mission party members and their affiliations

Name (First, Last)	Title	Date Aboard	Date Disembark	Gender	Affiliation	Nationality
Kelley Elliott	Expedition Coordinator	4/16	5/14	F	NOAA OER	USA
Lindsay McKenna	Mapping Team Lead	4/18	5/13	F	NOAA OER	USA
Deborah Glickson	Scientist 2	4/17	5/13	F	UCAR/FAU	USA
Diva Amon	Scientist 1	TBD	TBD	F	UCAR/UH	UK, Trinidad

						and Tobago
Kevin Jerram	Mapping Watch Lead	4/19	TBD	M	UCAR	USA
Andy O'Brien	Data Management	4/16	5/13	M	UCAR/GFOE	USA
Karl McLetchie	Engineering Group Lead 1	4/16	5/13	M	UCAR/GFOE	USA
Chris Ritter	Engineering Group 2	TBD	TBD	M	UCAR/GFOE	USA
Jeff Laning	Engineering Group 3	4/16	TBD	M	UCAR/GFOE	USA
Levi Unema	Engineering Group 4	4/17	5/13	M	UCAR/GFOE	USA
Joshua Carlson	Engineering Group 5	4/17	5/13	M	UCAR/GFOE	USA
Andy Lister	Engineering Group 6	4/16	TBD	M	UCAR/GFOE	USA
Sean Kennison	Engineering Group 7	4/16	5/13	M	UCAR/GFOE	USA
Jim Newman	Engineering Group 8	4/18	5/13	M	UCAR/GFOE	USA
Dan Rogers	Engineering Group 9	4/15	5/12	M	UCAR/GFOE	USA
Tara Smithee	Engineering Group 10	4/17	5/13	F	UCAR/GFOE	USA
Brian Kennedy	Engineering Group 11	4/17	5/14	M	UCAR/GFOE	USA
Ed McNichol	Engineering Group 12	4/16	TBD	M	UCAR/GFOE	USA
Roland Brian	Engineering Group 13	4/15	5/14	M	UCAR/GFOE	USA
Caitlin Bailey	Engineering Group 14	4/16	5/13	F	UCAR/GFOE	USA

Table 3: Leg I—Shore-based Operations Team

Last Name	First Name	Organization	Area of interest or expertise.	What is your level of intended/desired participation?	Where are you planning on participating from?
Kelley	Chris	UH Manoa	Deep Sea Taxonomy, sponges	Core	UH Manoa
Liwag	Jonathan	Northern Marianas College		Occasional	Saipan, Northern Marianas College
Gerringer	Mackenzie	University of Hawaii	Deep-sea Fishes, Hadal Trenches	Core	UH ECC
Quattrini	Andrea	Harvey Mudd College	benthic bio	Occasional	HMC
Parrish	Frank	PIFSC		Occasional	IRC
Watling	Les	University of Hawaii at Manoa	benthic biology, octocorals	Core	Hawaii, Maine
Levin	Lisa	Scripps Institution of Oceanography	benthic biology	Occasional	Scripps Institution of Oceanography
Parke	Michael	PIFSC	Benthic eccology	Core	IRC and UH
Zykov	Victor	Schmidt Ocean Institute		Occasional	SF Bay Area
Johnson	Hoku	NOAA/NMFS/PIFSC		Occasional	NOAA - Inouye Regional Center
Fraser	John	APASEEM	GIS, Chemistry	Core	Saipan, CNMI
Hirsh	Heidi	NOAA NMFS Monuments Program	geomorphology, benthic, biology, hydrothermal vents, geology, submarine volcanoes, ocean	Core	NOAA Inouye Regional Center and Residence in Honolulu

			literacy, education and outreach		
Borja	James	Fisherman/Fishermen's Co-Op		Occasional	Guam
Baechler	Neah	College of Charelston	geomorphology, hydrothermal venting	Occasional	Portland, OR
Tibbatts	Brent	Guam DAWR	fisheries, fish taxonomy	Core	Guam DAWR
Oram	Risa	NMFS		Occasional	Honolulu, PIFSC, NMFS
Malay	Maria Celia (Machel)	University of Guam Marine Laboratory	benthic biology, crustaceans, invertebrates in general, biogeography	Occasional	Guam - University of Guam Marine Laboratory
Brooke	Samantha	NOAA		Core	IRC
Greene	Robbie	Pacific Coastal Research & Planning	bathymetry & seafloor mapping, geomorphology	Occasional	CNMI Dept. of Lands & Natural Resources, Saipan, Northern Mariana Islands
Simeon	Anna	Bureau of Statistics and Plans	reef biology and ecology	Occasional	Guam, BSP or Underwater world
Burdick	David	University of Guam Marine Laboratory	mesophotic benthic communities, focus on corals	Occasional	University of Guam Marine Laboratory
Schils	Tom	University of Guam Marine Laboratory	Benthic Ecology; Phycology; Water Quality Monitoring	Core	University of Guam, Guam, Mariana Islands
Heywood	Luan	Western Washington University	Igneous petrology/Volcanology	Occasional	Bellingham, WA, USA; Western Washington University
Kelley	Katherine	University of Rhode Island	igneous petrology	Occasional	University of Rhode Island
Molodtsova	Tina	P.P.Shirshov Institute of Oceanology RAS	deep-sea corals, benthic biology	Core	Moscow, P.P. Shirshov Institute of Oceanology
Coykendall	Katharine	USGS	benthic biology	Occasional	USGS Leetown Science Center
Reed	John	Harbor Branch Oceanographic Institute	geomorphology, benthic biology	Occasional	HBOI-FAU ECC
Carney	Robert	Louisiana State Univ	benthic biology	Occasional	LSU
Morgan	Nicole	Florida State University	benthic biology	Occasional	Florida State Uni, Tallahassee, FL
Austin	James	University of Texas/Austin	marine geology	Doctor-on-call	my office
Wicksten	Mary	TexasA&M University	invertebrate zoology	Occasional	Texas A&M University, College Station, TX

Perfit	Michael	University of Florida	Geology, Petrology, Geochemistry	Occasional	Harbor Branch, Florida Atlantic Univ
Vecchione	Michael	NMFS National Systematics Lab	cephalopods and pelagic biology	Core	Smithsonina, VIMS, and home
Catsambis	Alexis	Naval History & Heritage Command	Archaeology	Occasional	Washington DC
McKinnon	Jennifer	East Carolina University	archaeology	Occasional	East Carolina University
Gruber	David	Baruch College, City University of New York/National Geographic/AMNH	coral reefs, deep reef biology, biofluorescence, bioluminescence	Occasional	Baruch College, City University of New York/New York City
Herrera	Santiago	U Toronto, WHOI	benthic biology	Occasional	U Toronto
Dreyer	Brian	UCSC	petrology	Occasional	UCSC
Chadwick	Bill	NOAA/PMEL	Geology, volcanology	Occasional	Hatfield Marine Science Center, Newport, Oregon
Huber	Julie	Marine Biological Laboratory	microbiology	Core	Woods Hole, Marine Biological laboratory
Ross	Steve	UNC-W	fishes, deep-sea ecology, deep sea corals	Occasional	office
Stephanie	Farrington	Harbor Branch Oceanographic inst. at fau	Biology	Occasional	HBOI ECC
Miller	Allison	National Park Service	invertebrate biology and molecular phylogenetics	Core	Guam
Herter	Jeffrey	NY Department of State, Office of Planning & Development	Offshore Planning, Submarine canyons	Occasional	NY Department of State, Office of Planning & Development, Albany, NY
Moore	James	Bureau of Ocean Energy Management (BOEM)	Archaeology, shipwrecks, geomorphology	Core	NOAA Headquarters in Silver Spring, MD or BOEM Headquarters in Sterling, VA
Baco-Taylor	Amy	Florida State university	Benthic ecology, deep-sea corals and sponges	Core	FSU
Beauregard	Laura	USFWS	Marine National Monument	Occasional	USFWS Honolulu/Guam
Amesbury	Judith	Micronesian Archaeological Research Services	archaeology	Occasional	MARS office, Guam
Jourdan	David	Nauticos	Sonar mapping	Occasional	Nauticos, Cape Porpoise, Maine

Matsumoto	Asako	Chiba Institute of Technology	deep sea biology, deep water coral	Core	Japan
Carrier	Brandi	Bureau of Ocean Energy Management	archaeology, magnetometry	Core	Bureau of Ocean Energy Management, Sterling, Virginia
Jordan	Brian	BOEM	archaeology	Doctor-on-call	Sterling, VA BOEM HQ
Glickson	Deborah	FAU-Harbor Branch Oceanographic Institute	marine geology, hydrothermal vents	Core	HBOI
Embley	Robert	NOAA/PMEL	geology	Core	Newport, OR
Glazer	Brian	University of Hawaii	hydrothermal	Occasional	University of Hawaii Manoa
Mundy	Bruce	NOAA NMFS PIFSC	ichthyology (fish identification and biogeography)	Occasional	IRC ECC
Beaulieu	Stace	Woods Hole Oceanographic Institution	benthic biology	Occasional	Woods Hole Oceanographic Institution
GALLARDO	VICTOR	National Taiwan Ocean University	Benthic communities	Occasional	Taiwan
Amon	Diva	University of Hawaii	benthic biology	Core	Okeanos Explorer (leg 1), University of Hawaii (leg 3)
Drazen	Jeffrey	University of Hawaii	deep sea fishes	Occasional	UH campus
Phil	Alderslade	CSIRO O&A	octocorals	Occasional	CSIRO Hobart Tasmania Australia
Dieter	Bryan	PIFSC	exploration	Occasional	IRC
Baechler	Britta	CNMI Division of Fish & Wildlife	MPAs, fisheries, corals	Occasional	Saipan
Gawel	Mike	US DOI NPS	Octocorals, hard corals, invertebrates, fishes	Doctor-on-call	Guam
Matsumoto	Asako	Chiba Institute of Technology (Chitech)	deep sea biology, deep water coral	Core	Japan
Demopoulos	Amanda	USGS		Occasional	USGS office-Gainesville
Auyong	Marie	University of Guam	Community outreach	Occasional	Guam, University of Guam
Ford	Mike	NOAA Fisheries	jellyfish	Occasional	Silver Spring ECC
Hetti	Diluni	University of Texas at Dallas	Everything about hydrothermal vents	Occasional	Dallas TX, University of Texas at Dallas
Wicksten	Mary	Texas A&M University	invertebrate zoology	Occasional	Texas A&M University
Raineault	Nicole	OET	geomorph, exploration, seafloor mapping	Occasional	OET, GSO-URI
Wagner	Daniel	NOAA	Deep-sea corals	Occasional	IRC ECC and Office

Berntson	Ewann	NOAA Fisheries	deep sea corals	Occasional	NWFSC Manchester Research Station
Mittelstaedt	Eric	University of Idaho	geology and geophysics	Occasional	University of Idaho - my office
Shank	Timothy	WHOI	benthic biology	Core	WHOI command center
Rowley	Sonia	University of Hawai'i at Manoa	biogeography & taxonomy of Octorallia, benthic biology	Occasional	Hawai'i, University of Hawai'i at Manoa
Coykendall	Katharine	USGS	benthic biology	Occasional	USGS-Leetown Science Center
Frable	Ben	Scripps Institution of Oceanography	ichthyology	Occasional	Scripps Institution of Oceanography, La Jolla, CA
Andrews	Allen	NOAA Fisheries	Fishes and corals	Occasional	IRC
Collins	Allen	NOAA National Systematics Lab	Medusozoan Cnidarians, Hexactinellid sponges	Occasional	Washington DC NOAA
Johnston	Lyza	CNMI Bureau of Environmental and Coastal Quality	coral reef ecology	Occasional	BECQ Saipan
Putts	Meagan	Hawaii Pacific University	Benthic biology, deep-water coral	Occasional	Hawaii Pacific University/ University of Hawaii
Harmer Luke	Tara	Stockton University	deep sea biology	Core	Stockton University, Galloway, NJ
ROSE	PAUL	NATIONAL GEOGRAPHIC - PRISTINE SEAS		Occasional	UK and Geneva
France	Scott	University of Louisiana at Lafayette	Benthic biology, deep-sea coral	Core	University of Louisiana at Lafayette
Stern	Bob	U TX Dallas	Marianas	Occasional	UTD and Taos NM
Van Tilburg	Hans	NOAA ONMS	maritime heritage	Occasional	DKIRC
Mooi	Rich	California Academy of Sciences	echinoid systematics	Doctor-on-call	Calif. Acad. of Sciences, San Francisco
Smith	Sallie	Howard B. Owens Science Center			Howard B Owens Science Center
Mah	Christopher	National Museum of Natural History (Smithsonian)	Starfish,echinoderms, deep-sea biology, etc.	Occasional	Washington, D.C.
Nunnally	Clifton	University of Hawaii at Manoa	benthic ecology and biogeochemistry of marine sediments, Hadal ecology and	Core	ECC of Univesity of Hawaii campus

			energetics		
Leitner	Astrid	University of Hawaii Manoa	deep sea fish ecology and biology	Occasional	University of Hawaii Manoa
Miller	Joyce	University of Hawaii	Geology	Occasional	Hawaii -- home
Trusdell	Frank	USGS	Volcanology		Hawaii, HVO, USA
Fryer	Patricia	Univ. Hawai‘i at Mānoa (UHM)	geology/petrology	Core	Okeanos Explorer

Last Name	First Name	Organization	Area of interest or expertise.	Location
Netburn	Amanda	NOAA	Shore-side Ops and Web Coordinator	Hawaii/ TBD
Cantwell	Kasey	NOAA OER (Collabralink)	Shore-side Ops	Silver Spring/ TBD
Kelley	Chris	UH Manoa	CAPSTONE Science Advisor, Shore-side Ops	UH Manoa
Martinez	Catalina	NOAA	Shore-side Ops	Rhode Island
Crum	Emily	NOAA OER	Communications Coordinator	Key West, FL
Wagner	Katie	NOAA OER (Collabralink)	Media specialist	Silver Spring, MD
Russell	Craig	NOAA OER	Program Manager, Operations	Seattle, WA

G. Administrative

1. Points of Contact:

Ship Operations

Marine Operations Center, Atlantic (MOA)
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Mission Operations

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NOAA Ocean Exploration & Research
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Vessel shipping address:

Shipments:

Send an email to the *Okeanos Explorer* Operations Officer at OPS.Explorer@noaa.gov indicating the size and number of items being shipped.

Items sent to Guam should arrive at the below address prior to COB April 13, 2016.

Naval Base Guam
Port Operations
Building 3169
Sumay Dr.
Santa Rita, Guam
96915
Attn: NOAA Ship *Okeanos Explorer*

2. Diplomatic Clearances

N/A

3. Licenses and Permits

A Scientific Research License application to conduct work on the submerged lands extending 3nm surrounding the Northern Marianas Island has been submitted to the Director's Office of CNMI DLNR's Division of Fish and Wildlife. The license is pending approval. Once the license is received, the DFW Fishing, Harvesting and Hunting permit for sample collections can be obtained.

The expedition is being planned and conducted by NOAA as an agency of the U.S. Federal government, in partnership with NOAA NMFS Pacific Islands Regional Office Marine National Monument Program. We do not require a permit to work in the MTMNM.

In order to support or conduct Marine Scientific Research within the U.S. EEZ, work funded, authorized and/or conducted by the NOAA must be compliant with the National Environmental Policy Act (NEPA). NOAA Administrative Order (NAO) 216-6 describes NOAA's specific obligations with regard to NEPA compliance. Among these is the need to review all NOAA-supported projects with respect to their environmental consequences. In compliance with NAO 216-6 and NEPA, a memorandum describing the project's scientific sensors' possible effects on the environment has been submitted for the project. As expected with ocean research with limited time or presence in the marine environment, the project has been determined to not have the potential to result in any lasting changes to the environment. As defined in Sections 5.05 and 6.03.c.3 (a) of NAO 216-6, this is a research project of limited size or magnitude or with only short-term effects on the environment and for which any cumulative effects are negligible, and as such, the project is categorically excluded from the need to prepare a full-scale NEPA environmental assessment. The categorical exclusion met the requirements of NOA 216-6 and

NEPA, and authorizes the Marine Scientific Research conducted for the project.

Additionally, informal consultation was initiated under Section 7 of the Endangered Species Act (ESA), requesting NOAA Fisheries' Protected Resources Division concurrence with our biological evaluation determining that 2016 Marianas Expedition and all other planned *Okeanos* Explorer operations during the 2016-17 field season, may affect, but are not likely to adversely affect, ESA-listed marine species. The informal consultation was completed on February 3, 2016 when NOAA OER received a signed letter from the Regional Administrator of NMFS Pacific Islands Regional Office, stating that NMFS concurs with OER's determination that conducting proposed *Okeanos Explorer* cruises are not likely to adversely affect ESA-listed marine species.

II. OPERATIONS

The Expedition Coordinator is responsible for ensuring the scientific staff are trained in planned operations and are knowledgeable of project objectives, priorities and environmental compliance procedures. The Commanding Officer is responsible for ensuring all operations conform to the ship's accepted practices and procedures.

A. **Project Itinerary** *(All times and dates are subject to prevailing conditions and the discretion of the Commanding Officer)*

We will conduct primarily 8 hour ROV dives with a few longer dives as staffing allows. CTD casts are planned, subject to staffing availability.

Table 4: EX1605 Leg 1 Detailed Itinerary
This is an approximate itinerary and is subject to change

Date	Dive	Activities	Site details
4/16-17		Mission personnel arrive. VIP tours expected.	
4/18		Mobilization. Final mission personnel arrive. Tours for educators.	10:00 AM Tour for Educators who took part in OER's WDWE Professional Development WKSP. 5:00 PM Event at UnderwaterWorld Guam.
4/19		Mobilization. Tours for media and VIPs.	10:00 AM Tour for VIPs. 1:00 PM tour for Media and interviews.
4/20/2016		Depart Guam. CTD operations at Fina Nagu if time allows, overnight mapping at Santa Rosa.	~10:00 AM Depart Guam
4/21/2016	Dive 1	Dive Santa Rosa 2	- Santa Rosa Site 2

		- Overnight mapping at Santa Rosa	- 12° 51.453 N, 144° 18.386 E, 500m - Bottom fish fishery, high density corals, precious corals
4/22/2016	Dive 2	Dive Santa Rosa 3 - Overnight mapping at Santa Rosa - Transit to Sirena Canyon	- Santa Rosa Site 3 - 12° 43.96 N,144° 16.166 E, 500m - Bottom fish fishery, high density corals, precious corals
4/23/2016	Dive 3	Dive Sirena Canyon - Transit to New Plate Seamount	- Sirena Canyon - 12° 34.50’ N, 144° 39.25’ E, 6000m - Trench habitat
4/24/2016	Dive 4	Enigma Seamount	- Enigma Seamount - 11°25'34.35"N, 144°50'8.88"E, 4,300m - Trench habitat, seamount, geologic history of Pacific Seamounts
4/25/2016	Dive 5	Dive Fina Nagu - Evening CTD operations - Overnight mapping operations	- Fina Nagu Caldera D? - 12.67° N, 143.75°E, 3,000m - Hydrothermal vent habitat
4/26/2016	Dive 6	Dive Fina Nagu - Evening CTD operations - Overnight mapping operations	- Fina Nagu Caldera E? - 12.7° N, 145.8°E, 2,970m - Hydrothermal vent habitat
4/27/2016	Dive 7	Dive Fina Nagu - Evening CTD operations - Overnight mapping operations	- Fina Nagu Caldera F? - 12.55° N, 143.67°E, 3,270m - Hydrothermal vent habitat
4/28/2016	Dive 8	Dive Fina Nagu - Transit to NW Guam Seamount	- Fina Nagu Caldera G? - 12.47° N, 143.55°E, 2,830m - Hydrothermal vent habitat
4/29/2016	Dive 9	NW Guam Seamount	- NW Guam Seamount - 14° 1.5' N, 144° 39' E, 1,560m - Extinct hydrothermal vent, fisheries and deep-sea coral habitat?
4/30/2016	Dive 10	Lava Flows	- Lava Flows - 4100-4400m - Hydrothermal vent habitat
5/1/2016	Dive 11	New Hydrothermal Vent Field	- New Hydrothermal Vent Field - 3840m - Hydrothermal vent habitat
5/2/2016	Dive 12	Newly Discovered Hydrothermal Vent Field	- New Hydrothermal Vent Field 2 - 3280m - Hydrothermal vent habitat
5/3/2016	Dive 13	Zealandia (long transit, 14-15 hours?)	- Zealandia - 16° 42.095,145° 49.083, 400m

			- Bottom fish fishery, high density corals, precious corals
5/4/2016	Dive 14	Del Cano Guyot (may start a little late?) - Subbottom after - Map Subducting Seamount overnight - Transit to Pigafetta Guyot	- Del Cano Guyot - 16° 6.375, 148° 22.426, 1930m - High density coral communities, Mn-crusted communities
5/5/2016	Dive 15	Pigafetta Guyot - Subbottom after	- Pigafetta Guyot - 15° 50.965/148° 48.877, 1164m - High density coral communities, Mn-crusted communities
5/6/2016	Dive 16	Enrique Guyot - Subbottom after	- Enrique Guyot - 14° 59.985/148° 31.022, 2200m - High density coral communities, Mn-crusted communities
5/7/2016	Dive 17	Subducting Seamount - Collect mapping data in seep area en route	- Subducting seamount - 16° 06.5’ N, 147° 40’ E, 6,000m - Trench/subduction zone habitat, seamounts
5/8/2016	Dive 18	Dive FDM - Map 400 and 500m contours around FDM - Transit to Esmerelda (map crater en route if there is time)	- FDM - 15° 48.844 N,146° 1.187 E, 450m - Bottom fish fishery, high density corals, precious corals
5/9/2016	Dive 19	Dive Esmerelda - Map Esmerelda Bank Crater	- Esmerelda - 15° 2.049 N, 145° 13.203 E, 500m - Bottom fish fishery, high density corals, precious corals
5/10/2016	Dive 20	Dive Esmerelda Bank Crater	- Esmeralda Bank Crater - 15°N, 145.25°E, 3-500m - Hydrothermal vent site
5/11/2016		Map data gaps around Saipan Pull into port	
5/12/2016		Cruise demobilization. Continuous ship tours in afternoon.	Ship tours for teachers, partners, VIPs and possibly media in afterno.
5/13/2016		Mission personnel depart	Possible additional VIP tours that do not require ship support.

B. Staging and Destaging

A. Minimal mobilization will be required because ROV equipment will be onboard from a previous cruise.

B. Minimal demobilization will be required because nearly all equipment and samples will remain on board.

C. **Operations to be Conducted**

Telepresence Events

A. Dates TBD – Live events are expected during the cruise with schools in Saipan, UnderWater World Guam, and possibly VIP events with the University of Guam and Northern Marianas College. There will be additional live events that come up as the cruise progresses. These events will have little to no effect on the ship's operations and will be raised during daily operations briefings.

In-Port Events

A. Planning is still underway, but limited ship tours for VIP and media are anticipated in Guam on April 18th or 19th prior to cruise departure. These should not require ship personnel.
B. Ship tours for VIPs, teachers, public officials and possibly some members of the public are planned during the Saipan in port for either the afternoon of May 12th or the morning of May 13th and will require ship support. This is still being planned and discussed with the ship.

D. SCUBA Dive Plan

All dives are to be conducted in accordance with the requirements and regulations of the NOAA Diving Program (http://www.ndc.noaa.gov/dr.html) and require the approval of the ship's Commanding Officer. No SCUBA dives are currently planned for this cruise.

E. Applicable Restrictions

Sonar Operations

EM 302, EK 60, ADCP, and sub-bottom profiler data acquisition is planned for this cruise. All data acquisition will be conducted in accordance with established standard operating procedures under the direction of the mapping team lead. These operating procedures will include protection measures when operating in the vicinity of marine mammals, sea turtles or Endangered Species Act-listed species as described in appendices D and E. The final decision to operate and collect 24-hour sub-bottom profiler data will be at the discretion of the Commanding Officer.

III. EQUIPMENT

A. Equipment and capabilities provided by the ship

- Kongsberg Simrad EM302 MultibeamEchosounder (MBES)

- Kongsberg Simrad EK60DeepwaterEchosounders and GPTs (18, 70, 120, 200 kHz)
- Knudsen Chirp 3260 Sub-bottom profiler (SBP)
- Teledyne RDI Workhorse Mariner (300 kHz) ADCP
- Teledyne RDI Ocean Surveyor (38 kHz) ADCP
- Teledyne UnderwayCTD
- LHM Sippican XBT (Deep Blue probes)
- Seabird SBE 911Plus CTD
- Seabird SBE 32 Carousel and 24 2.5 L Niskin Bottles
- Light Scattering Sensor (LSS)
- Oxidation – Reduction Potential (ORP)
- Dissolved Oxygen (DO) sensor
- Altimeter Sensor and battery pack
- CNAV GPS
- POS/MV
- Seabird SBE-45 (Micro TSG)
- Kongsberg Dynamic Positioning-1 System
- NetApps mapping storage system
- CARIS HIPS Software
- IVS Fledermaus Software
- SIS Software
- Hypack Software
- Scientific Computing System (SCS)
- ECDIS
- Met/Wx Sensor Package
- Telepresence System
- VSAT High-Speed link (Comtech 15 Mbps ship to shore; 2.54 Mbps shore to ship)
- Cruise Information Management System (CIMS)
- Three VoIP telephone lines
- NOAA OER 6000 m *Deep Discoverer* ROV
- NOAA *Seirios* Camera Platform

B. Equipment and capabilities provided by the scientists

- Microtops II Ozone Monitor Sunphotometer and handheld GPS required for NASA Marine Aerosols Network supplementary project.
- Equipment associated with new sampling protocol

IV. HAZARDOUS MATERIALS

A. Policy and Compliance

The Expedition Coordinator is responsible for complying with FEC 07 Hazardous

Materials and Hazardous Waste Management Requirements for Visiting Scientific Parties (or the OMAO procedure that supersedes it). The Expedition Coordinator and Science Team Lead will be responsible for transporting all samples and HAZMAT on and off the ship. By Federal regulations and NOAA Marine and Aviation Operations policy, the ship may not sail without a complete inventory of all hazardous materials by name and quantity, MSDS, appropriate spill cleanup materials (neutralizing agents, buffers, or absorbents) in amounts adequate to address spills of a size equal to the amount of chemical brought aboard, and chemical safety and spill response procedures. Documentation regarding those requirements will be provided by the Chief of Operations, Marine Operations Center, upon request.

Per OMAO procedure, the scientific party will include with their project instructions and provide to the CO of the respective ship 30 days before departure:

- List of chemicals by name with anticipated quantity
- List of spill response materials, including neutralizing agents, buffers, and absorbents
- Chemical safety and spill response procedures, such as excerpts of the program's Chemical Hygiene Plan or SOPs relevant for shipboard laboratories
- For bulk quantities of chemicals in excess of 50 gallons total or in containers larger than 10 gallons each, notify ship's Operations Officer regarding quantity, packaging and chemical to verify safe stowage is available as soon as chemical quantities are known.

Upon embarkation and prior to loading hazardous materials aboard the vessel, the scientific party will provide to the CO or their designee:

- An inventory list showing actual amount of hazardous material brought aboard
- An MSDS for each material
- Confirmation that neutralizing agents and spill equipment were brought aboard sufficient to contain and cleanup all of the hazardous material brought aboard by the program
- Confirmation that chemical safety and spill response procedures were brought aboard

Upon departure from the ship, scientific parties will provide the CO or their designee an inventory showing that all chemicals were removed from the vessel. The CO's designee will maintain a log to track scientific party hazardous materials. MSDS will be made available to the ship's complement, in compliance with Hazard Communication Laws.

Scientific parties are expected to manage and respond to spills of scientific hazardous materials. Overboard discharge of hazardous materials is not permitted aboard NOAA ships.

B. Inventory

Item	Use	Approx. locations
95% Denatured Ethanol (10 gallons)	Sample preservation	Wetlab, under the chemical hood
10% Buffered Formalin (3 gallons)	Sample preservation	Wetlab, under the chemical hood
Chaos Buffer (0.5 gallons) (4 M guanidine thiocyanate, 0.5% N-laurosyl sarcosine, 25 mM Tris pH 8.0, 0.1 M beta-mercaptoethanol)	Sample preservation (genetics)	Wetlab, under the chemical hood
Aqua Shield	Underwater Lubricant	ROV Workshop Fire Cabinet, Pit
Dow Corning 4	Electrical insulating compound	ROV Workshop Fire Cabinet, Pit
Fluid Film Spray	Silicone Lubricant	ROV Workshop Fire Cabinet
Isopropanol Alcohol	Solvent	ROV Workshop Fire cabinet
Scotchkote	Electrical insulating compound	ROV Workshop Fire cabinet
3M Silicone Spray	Silicone Lubricant	ROV Workshop Fire cabinet
Synthetic AW Hydraulic Oil, ISO-22	Amsoil (AWG-05)	Hanger, Pit, Vehicles
Tap Magic Cutting Fluid	Cutting/Machining Lubricant	ROV Workshop Fire cabinet
Tap Magic Heavyweight Cutting Fluid	Cutting/Machining Lubricant	ROV Workshop Fire cabinet
Tuff Coat M	Marine Lubricant	ROV Workshop Fire cabinet
Dow Corning Molykote 111	Valve Lubricant and Sealant	ROV Workshop Fire cabinet, Pit
WD40	Lubricant	ROV Workshop Fire cabinet
Loktite	Bolt adhesive	ROV Workshop Fire cabinet

Mineral Oil	Vitrea	Hanger, Vehicles
Por-15	Paint Kit	ROV Workshop Fire cabinet
Univis HVI 13	Hydraulic Fluid	Hanger, ROV D2
Ultratane	Butane fuel	ROV Workshop fire cabinet
Rust-oleum	Protective Enamel	ROV Workshop fire cabinet
Flux-Off	Soldering Flux remover	ROV Workshop fire cabinet
Propane	Torch Fuel	ROV Workshop fire cabinet

C. Chemical safety and spill response procedures

A. All safety and spill response procedures will be handled according to OMAO guidelines and following the manufacturers MSDS which has been provided to the ship's ECO.

D. Radioactive Materials

NOT APPLICABLE TO THIS CRUISE

V. ADDITIONAL PROJECTS

A. Supplementary Projects

NASA Maritime Aerosol Network

During the cruise the marine aerosol layer observations will be collected for the NASA Maritime Aerosol Network (MAN). Observations will be made by mission personnel (as time allows) with a sun photometer instrument provided by the NASA MAN program. Resulting data will be delivered to the NASA MAN primary investigator Alexander Smirnov by the expedition coordinator. All collected data will be archived and publically available at: http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html

Equipment resides on the ship and is stewarded by the Expedition Coordinator.

See Appendix F for full Survey of Opportunity Form.

B. NOAA Fleet Ancillary Projects

No NOAA Fleet Ancillary Projects are planned.

VI. DISPOSITION OF DATA AND REPORTS

A. Data Responsibilities

All data acquired on *Okeanos Explorer* will be provided to the public archives without proprietary rights. All data management activities shall be executed in accordance with NAO 212-15, Management of Environmental and Geospatial Data and Information [http://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_212/212-15.html].

Ship Responsibilities

The Commanding Officer is responsible for all data collected for missions until those data have been transferred to mission party designees. Data transfers will be documented on NOAA Form 61-29. Reporting and sending copies of project data to NESDIS (ROSCOP form) is the responsibility of OER.

NOAA OER Responsibilities

The Expedition Coordinator will work with the *Okeanos Explorer* Operations Officer to ensure data pipeline protocols are followed for final archive of all data acquired on *Okeanos Explorer* without proprietary rights. See Appendix B for detailed data management plans.

Deliverables

a. At sea

- Daily plans of the Day (POD)
- Daily situation reports (SITREPS)
- Daily summary bathymetry data files
- Summary forms for each ROV dive
- Summary files for each sample collection
- Summary forms for each CTD rosette cast

b. Post cruise

- Refined SOPs for all pertinent operational activities
- Assessments of all activities

c. Science

- Multibeam and XBT raw and processed data (see appendix B for the formal cruise data management plan)
- EK 60 raw data
- Knudsen 3260 sub-bottom profiler raw data
- Summary file with all sample data
- Mapping data report
- Cruise Report

Archive

- OER and ship will work together to ensure documentation and stewardship of acquired data sets in accordance with NAO 212-15. The Cruise Information

Management System is the primary tool used to accomplish this activity.

VII. Meetings, Vessel Familiarization, and Project Evaluations

Shipboard Meetings

A safety brief and overview of POD will occur on the Bridge each morning at 0800. Daily Operations Briefing meetings will be held at 1330 in the forward lounge to review the current day, and define operations, associated requirements, and staffing needs for the following day. A Plan of the Day (POD) will be posted each evening for the next day in specified locations throughout the ship. Daily Situation Reports (SITREPS) will be posted as well and shared daily through e-mail.

A. Pre-Project Meeting: The Expedition Coordinator and Commanding Officer will conduct a meeting of pertinent members of the scientific party and ship's crew to discuss required equipment, planned operations, concerns, and establish mitigation strategies for all concerns. This meeting shall be conducted before the beginning of the project with sufficient time to allow for preparation of the ship and project personnel. The ship's Operations Officer usually is delegated to assist the Expedition Coordinator in arranging this meeting.

B. Vessel Familiarization Meeting: The Commanding Officer is responsible for ensuring scientific personnel are familiarized with applicable sections of the standing orders and vessel protocols, e.g., meals, watches, etiquette, drills, etc. A vessel familiarization meeting shall be conducted in the first 24 hours of the project's start and is normally presented by the ship's Operations Officer.

C. Post-Project Meeting: The Commanding Officer is responsible for conducting a meeting no earlier than 24 hrs before or seven days after the completion of a project to discuss the overall success and short comings of the project. Concerns regarding safety, efficiency, and suggestions for future improvements shall be discussed and mitigations for future projects will be documented for future use. This meeting shall be attended by the ship's officers, applicable crew, the Expedition Coordinator, and members of the scientific party and is normally arranged by the Operations Officer and Expedition Coordinator.

D. Project Evaluation Report:
Within seven days of the completion of the project, a Customer Satisfaction Survey is to be completed by the Expedition Coordinator. The form is available at http://www.omao.noaa.gov/fleeteval.html and provides a "Submit" button at the end of the form. Submitted form data is deposited into a spreadsheet used by OMAO management to analyze the information. Though the complete form is not shared with the

ships, specific concerns and praises are followed up on while not divulging the identity of the evaluator.

VIII. MISCELLANEOUS

A. Meals and Berthing

The ship will provide meals for the scientists listed above. Meals will be served 3 times daily beginning one hour before scheduled departure, extending throughout the project, and ending two hours after the termination of the project. Since the watch schedule is split between day and night, the night watch may often miss daytime meals and will require adequate food and beverages (for example a variety of sandwich items, cheeses, fruit, milk, juices) during what are not typically meal hours. Special dietary requirements for scientific participants will be made available to the ship's command at least twenty-one days prior to the survey (e.g., Expedition Coordinator is allergic to fin fish).

Berthing requirements, including number and gender of the scientific party, will be provided to the ship by the Expedition Coordinator. The Expedition Coordinator and Operations Officer will work together on a detailed berthing plan to accommodate the gender mix of the scientific party taking into consideration the current make-up of the ship's complement. The Expedition Coordinator is responsible for ensuring the scientific berthing spaces are left in the condition in which they were received; for stripping bedding and linen return; and for the return of any room keys which were issued. The Expedition Coordinator is also responsible for the cleanliness of the laboratory spaces and the storage areas utilized by the scientific party, both during the cruise and at its conclusion prior to departing the ship.

All NOAA scientists will have proper travel orders when assigned to any NOAA ship. The Expedition Coordinator will ensure that all non-NOAA or non-Federal scientists aboard also have proper orders. It is the responsibility of the Expedition Coordinator to ensure that the entire scientific party has a mechanism in place to provide lodging and food and to be reimbursed for these costs in the event that the ship becomes uninhabitable and/or the galley is closed during any part of the scheduled project.

All persons boarding NOAA vessels give implied consent to comply with all safety and security policies and regulations which are administered by the Commanding Officer. All spaces and equipment on the vessel are subject to inspection or search at any time. All personnel must comply with OMAO's Drug and Alcohol Policy dated May 7, 1999 which forbids the possession and/or use of illegal drugs and alcohol aboard NOAA Vessels.

B. Medical Forms and Emergency Contacts

The NOAA Health Services Questionnaire (NHSQ, NF 57-10-01 (3-14)) must be completed in advance by each participating scientist. The NHSQ can be obtained from the Expedition

Coordinator or the NOAA website http://www.corporateservices.noaa.gov/noaaforms/eforms/nf57-10-01.pdf.

All NHSQs submitted after March 1, 2014 must be accompanied by NOAA Form (NF) 57-10-02 - Tuberculosis Screening Document in compliance with OMAO Policy 1008 (Tuberculosis Protection Program).

The completed forms should be sent to the Regional Director of Health Services at the applicable Marine Operations Center. The NHSQ and Tuberculosis Screening Document should reach the Health Services Office no later than four weeks prior to the start of the project to allow time for the participant to obtain and submit additional information should health services require it, before clearance to sail can be granted. Please contact MOC Health Services with any questions regarding eligibility or completion of either form. Ensure to fully complete each form and indicate the ship or ships the participant will be sailing on. The participant will receive an email notice when medically cleared to sail if a legible email address is provided on the NHSQ.

The participant can mail, fax, or email the forms to the contact information below. Participants should take precautions to protect their Personally Identifiable Information (PII) and medical information and ensure all correspondence adheres to DOC guidance (http://ocio.os.doc.gov/ITPolicyandPrograms/IT_Privacy/PROD01_008240).

The only secure email process approved by NOAA is Accellion Secure File Transfer which requires the sender to setup an account. Accellion's Web Users Guide is a valuable aid in using this service, however to reduce cost the DOC contract doesn't provide for automatically issuing full functioning accounts. To receive access to a "Send Tab," after your Accellion account has been established send an email from the associated email account to accellionAlerts@doc.gov requesting access to the "Send Tab" function. They will notify you via email, usually within one business day of your approval. The "Send Tab" function will be accessible for 30 days.

Contact information:

Regional Director of Health Services
Marine Operations Center – Atlantic
439 W. York Street
Norfolk, VA 23510
Telephone (757) 441.6320
Fax (757) 441.3760
E-mail: MOA.Health.Services@noaa.gov

Please make sure the medical.explorer@noaa.gov email address is cc'd on all medical correspondence.

Prior to departure, the Expedition Coordinator must provide a listing of emergency contacts to the Operations Officer for all members of the scientific party, with the following information: name, address, relationship to member, and telephone number.

Emergency contact form is included as Appendix A.

C. Shipboard Safety

Hard hats are required when working with suspended loads. Work vests are required when working near open railings and during small boat launch and recovery operations. Hard hats and work vests will be provided by the ship when required.

Wearing open-toed footwear or shoes that do not completely enclose the foot (such as sandals or clogs) outside of private berthing areas is not permitted. Steel-toed shoes are required to participate in any work dealing with suspended loads, including CTD deployments and recovery. The ship does not provide steel-toed boots. Hard hats are also required when working with suspended loads. Work vests are required when working near open railings and during small boat launch and recovery operations. Hard hats and work vests will be provided by the ship when required.

Operational Risk Management: For every operation to be conducted aboard the ship (NOAA-wide initiative), risk management procedures will be followed. For each operation, risks will be identified and assessed for probability and severity. Risk mitigation strategies/measures will be investigated and implemented where possible. After mitigation, the residual risk will have to be assessed to make Go-No Go decisions for the operations. Particularly with new operations, risk assessment will be ongoing and updated as necessary. This does not only apply to over-the-side operations, but to everyday tasks aboard the vessel that pose risk to personnel and property.

- CTD, ROV (and other pertinent) ORM documents will be followed by all personnel working onboard *Okeanos Explorer*.
- All personnel onboard are in the position of calling a halt to operations/activities in the event of a safety concern.

D. Communications

A daily situation report (SITREP) on operations prepared by the Expedition Coordinator will be relayed to the program office. Sometimes it is necessary for the Expedition Coordinator to communicate with another vessel, aircraft, or shore facility. Through various modes of communication, the ship is able to maintain contact with the Marine Operations Center on an as needed basis. These methods will be made available to the Expedition Coordinator upon request, in order to conduct official business. The ship's primary means of communication with the Marine Operations Center is via e-mail and the Very Small Aperture Terminal (VSAT) link. VSAT bandwidth at 15Mbps will be paid by OER and provided by OMAO.

Specific information on how to contact NOAA Ship *Okeanos Explorer* and all other fleet vessels can be found at http://www.moc.noaa.gov/MOC/phone.html#EX

Important Telephone and Facsimile Numbers and E-mail Addresses

Ocean Exploration and Research (OER):

OER Program Administration:
Phone: (301) 734-1010
Fax: (301) 713-4252
E-mail: Firstname.Lastname@noaa.gov

University of New Hampshire, Center for Coastal and Ocean Mapping

Phone: (603) 862-3438
Fax: (603) 862-0839

NOAA Ship *Okeanos Explorer* - Telephone methods listed in order of increasing expense:

Okeanos Explorer Cellular: (401) 713-4114
Okeanos Explorer Iridium:(808) 659-9179
OER Mission Iridium (dry lab): (808) 851-3827

EX INMARSAT B
Line 1: 011-870-764-852-328
Line 2: 011-870-764-852-329

Voice Over IP (VoIP) Phone:
(541) 867-8932
(541) 867-8933
(541) 867-8934

E-Mail: Ops.Explorer@noaa.gov - (mention the person's name in SUBJECT field)

expeditioncoordinator.explorer@noaa.gov For dissemination of all hands emails by Expedition Coordinator while onboard. See ET for password.

E. IT Security

1. Any computer that will be hooked into the ship's network must comply with the *OMAO Fleet IT Security Policy* 1.1 (November 4, 2005) prior to establishing a direct connection to the NOAA WAN. Requirements include, but are not limited to: Installation of the latest virus definition (.DAT) file on all systems and performance of a virus scan on each system.
2. Installation of the latest critical operating system security patches.
3. No external public Internet Service Provider (ISP) connections.

Completion of these requirements prior to boarding the ship is required.

Non-NOAA personnel using the ship's computers or connecting their own computers to the ship's network must complete NOAA's IT Security Awareness Course within three days of embarking.

F. Foreign National Guests Access to OMAO Facilities and Platforms

Foreign National Guest, Diva Amon, will sail on EX-16-05 Leg 1. Her FNG sponsor is Kelley Elliott. Notification of Diva's participation in the cruise has been submitted to the NOAA Office of Security. Diva has been cleared against the denied persons list, and the signed CAO endorsement on Appendix B has been received. The CO has been notified of her plans to sail. Final clearance is pending.

Appendix A

EMERGENCY CONTACT DATA SHEET

NOAA OKEANOS EXPLORER

Scientists sailing aboard the *Okeanos Explorer* should fill out the form found at the following link location:
https://docs.google.com/a/noaa.gov/forms/d/1pcoSgPluUVxaY64CM1hJ75l1iIYirTk48G-lv37Am_k/viewformwith their emergency contact information

Appendix B: Data Management Plan

Data Management Plan
Okeanos Explorer (EX1605L1): CAPSTONE CNMI & Mariana Trench MNM (ROV & Mapping)

OER Data Management Assignments:
Shipboard Data Manager: Andy O'Brien, Shoreside Data Manager: Brendan Reser
Sampling Data Manager: Katharine Woodard (shoreside), Stewardship Data Manager: Susan Gottfried

1. General Description of Data to be Managed

1.1 Name and Purpose of the Data Collection Project

Okeanos Explorer (EX1605L1): CAPSTONE CNMI & Mariana Trench MNM (ROV & Mapping)

1.2 Summary description of the data to be collected.

The ship will conduct 24 hour operations consisting of daytime ROV dives and evening/nighttime mapping operations including during transit. During this cruise we will conduct primarily 8 hour ROV dives with occasional 10 or 12 hour dives on particularly interesting or deep water dive sites, as staffing allows. ROV operations will focus on depths between 250 and 6,000 meters and will include high-resolution visual surveys and limited sample collection. Mapping operations will be conducted in 250m of water and deeper, and include transit and overnight multibeam, water column backscatter, and sub-bottom data collection. CTD rosette operations are planned to collect more information about the environmental parameters at ROV dives sites, or opportunistically at selected sites where collecting the data is considered important to understanding the physical or chemical properties of the overlying water column.

1.3 Keywords or phrases that could be used to enable users to find the data.

Davisville, mapping survey, multibeam, multibeam backscatter, multibeam sonar, multi-beam sonar, noaa fleet, okeanos, okeanos explorer, R337, Rhode Island, scientific computing system, SCS, single beam sonar, singlebeam sonar, single-beam sonar, sub-bottom profile, water column backscatter, expedition, exploration, explorer, marine education, noaa, ocean, ocean discovery, ocean education, ocean exploration, ocean exploration and research, ocean literacy, ocean research, OER, science, scientific mission, scientific research, sea, stewardship, systematic exploration, technology, transformational research, undersea, underwater, oceans, Mariana Trench, Mariana Trench Marine National Monument, MTMNM, Commonwealth of the Northern Marianas Islands, CNMI, CAPSTONE, Santa Rita, Guam, Saipan, Central Pacific Seamounts, Prime Crust Zone, deep sea corals, bottom fish habitats, hydrothermal vents, submarine volcanoes, mud volcanoes, trench, subduction zones, biologic sampling, geologic sampling, visual surveys

1.4 If this mission is part of a series of missions, what is the series name?

Okeanos ROV Cruises

1.5 Planned or actual temporal coverage of the data.

Dates: 4/20/2016 to 5/11/2016

1.6 Planned or actual geographic coverage of the data.

Latitude Boundaries: 11 to 16

Longitude Boundaries: 141.75 to 148.2

1.7 What data types will you be creating or capturing and submitting for archive?

Cruise Plan, Cruise Summary, Data Management Plan, Highlight Images, Quick Look Report, ADCP, Bottom Backscatter, CTD (raw), Dive Summaries, EK60 Singlebeam Data, Highlight Video, Images, Mapping Summary, Multibeam (image), Multibeam (processed), Multibeam (product), Multibeam (raw), NetCDF, Raw Video (digital), Sample Logs, SCS Output (compressed), SCS Output (native), Sub-Bottom Profile data, Water Column Backscatter, XBT (raw)

1.8 What platforms will be employed during this mission?

NOAA Ship Okeanos Explorer, Deep Discoverer ROV, SEIRIOS Camera Sled

2. Point of Contact for this Data Producing Project

Overall POC:	Kelley Elliott
Title:	Expedition Coordinator
Affiliation/Dept:	NOAA/OAR/OER
E-Mail:	kelley.elliott@noaa.gov
Phone:	301-734-1024

3. Point of Contact for Managing the Data

Data POC Name:	Susan Gottfried (OER data management coordinator), Brendan Reser (shoreside DM), Katharine Woodard (shoreside sampling DM), and Andrew O'Brien (shipboard data manager)
Title:	OER Data Management
E-Mail:	susan.gottfried@noaa.gov; brendan.reser@noaa.gov, katharine.woodard@noaa.gov, andrewparsonobrien@gmail.com

4. Resources

4.1 Have resources for management of these data been identified? False

4.2 Approximate percentage of the budget devoted to data management. (specify % or "unknown")

unknown

5. Data Lineage and Quality

5.1 What is the processing workflow from collection to public release?

SCS data shall be delivered in its native format as well as an archive-ready, documented, and compressed NetCDF3 format to NCEI-MD; multibeam data and metadata will be compressed and delivered in a bagit format to NCEI-CO

5.2 What quality control procedures will be employed?

Quality control procedures for the data from the Kongsberg EM302 is handled at UNH CCOM/JHC. Raw (level-0) bathymetry files are cleaned/edited into new data files (level-1) and converted to a variety of products (level-2). Data from sensors monitored through the SCS are archived in their native format and are not quality controlled. Data from CTD casts and XBT firings are archived in their native format and are not quality controlled. CTDs are processed into profiles for display only on the *Okeanos* Atlas.

6. Data Documentation

6.1 Does the metadata comply with the Data Documentation Directive? True

6.1.1 If metadata are non-existent or non-compliant, please explain:

6.2 Where will the metadata be hosted?

Organization: An ISO format collection-level metadata record will be generated during pre-cruise planning and published in an OER catalog and Web Accessible Folder (WAF) hosted at NCEI-MS for public discovery and access. The record will be harvested by data.gov.

URL: www.ncddc.noaa.gov/oer-waf/ISO/Resolved/2016/

Meta Std: ISO 19115-2 Geographic Information with Extensions for Imagery and Gridded Data will be the metadata standard employed; a NetCDF3 standard for oceanographic data will be employed for the SCS data; the Library of Congress standard, MAchine Readable Catalog (MARC), will be employed for NOAA Central Library records.

6.3 Process for producing and maintaining metadata:

Metadata will be generated via xml editors or metadata generation tools.

7. Data Access

7.1 Do the data comply with the Data Access Directive? True

7.1.1 If the data will not be available to the public, or with limitations, provide a valid reason.

Not Applicable

7.1.2 If there are limitations, describe how data are protected from unauthorized access.

Account access to mission systems are maintained and controlled by the Program. Data access prior to public accessibility is documented through the use of Data Request forms and standard operating procedures.

7.2 Name and URL of organization or facility providing data access.

Org: National Centers for Environmental Information (NCEI)

URL: explore.noaa.gov/digitalatlas

7.3 Approximate delay between data collection and dissemination. By what authority?

Hold Time: none

Authority: not applicable

7.4 Prepare a Data Access Statement

No data access constraints, unless data are protected under the National Historic Preservation Act of 1966.

8. Data Preservation and Protection

8.1 Actual or planned long-term data archive location:

Data from this mission will be preserved and stewarded through the NOAA National Centers for Environmental Information. Refer to the Okeanos Explorer FY16 Data Management Plan at NOAA's EDMC DMP Repository (EX_FY16_DMP_Final.pdf) for detailed descriptions of the processes, procedures, and partners involved in this

collaborative effort.

8.2 If no archive planned, why?

8.3 If any delay between data collection and submission to an archive facility, please explain.

30-60 days (average 45 days)

8.4 How will data be protected from accidental or malicious modification or deletion?

Data management standard operating procedures minimizing accidental or malicious modification or deletion are in place aboard the *Okeanos Explorer* and will be enforced.

8.5 Prepare a Data Use Statement

Data use shall be credited to NOAA Office of Ocean Exploration and Research.

Appendix C: Categorical Exclusion

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
OCEANIC AND ATMOSPHERIC RESEARCH
Office of Ocean Exploration and Research
Silver Spring, MD 20910

March 7, 2016

MEMORANDUM FOR: The Record

FROM: John McDonough
Deputy Director, NOAA Office of Ocean Exploration and Research (OER)

SUBJECT: Categorical Exclusion for NOAA Ship *Okeanos Explorer* Cruise EX-16-05 Leg 1

NAO 216-6, Environmental Review Procedures, requires all proposed projects to be reviewed with respect to environmental consequences on the human environment. This memorandum addresses NOAA Ship *Okeanos Explorer's* scientific sensors possible effect on the human environment.

Description of the Project
This project is part of the NOAA Office of Ocean Exploration and Research's "Science Program" and entails ocean mapping activities, Remotely Operated Vehicle (ROV) Operations, and water column profiling using CTD casts designed to increase knowledge of the marine environment. This Categorical Exclusion addresses NOAA Ship *Okeanos Explorer* cruise EX-16-05 Leg I "CAPSTONE CNMI & Mariana Trench MNM (ROV & Mapping)" led by Kelley Elliott, Expedition Coordinator for NOAA OER. This expedition serves as an opportunity for NOAA and the Nation to highlight the uniqueness and importance of the Pacific Monuments and Sanctuaries, which are national symbols of ocean conservation. Operations conducted during this expedition and the broader 3-year CAPSTONE campaign support NOAA missions to understand and predict changes in climate, weather, oceans and coasts, and share the knowledge and information with others. Much of this year's work will contribute to and complement NOAA's Deep Sea Coral Research and Technology Program's three-year Pacific Islands Regional Initiative.

EX-16-05 Leg I is a telepresence-enabled ROV cruise that will be conducted from April 20 to May 11, 2016 in the Commonwealth of the Northern Mariana Islands (CNMI) and Marianas Trench Marine National Monument (MTMNM). Operations will be focused primarily on deep water areas 500m and deeper (though may include high priority work up to 250m) in and around the southern half of the CNMI Exclusive Economic Zone. The cruise will start in Guam and end in Guam or

Saipan. A tandem 6,000 meter ROV system will be deployed and CTD rosette casts may be conducted during the expedition. ROV dive targets include seamounts, rift zone ridges, hydrothermal vents, mud volcanoes, trench/subduction zone areas, habitats at the top of the trench, and bottom fish habitats.

The overarching goal of the project is to extend our breadth of knowledge about the distribution and diversity of deep water habitats within the operating area. The information and data generated by this project will lead to a better understanding of the deep water habitats and ecosystems of the MTMNM and the marine environment around the Mariana Islands, providing basic information about the about the rich and unique biological resources and habitats of this region. Ideally, the findings from this cruise will spur further exploration and research and ultimately contribute to effective resource management decisions.

ROV Operations

The purpose of conducting ROV operations is to conduct interdisciplinary site characterization at priority targets in the CNMI and MTMNM. Interdisciplinary site characterization would be achieved by visually surveying priority targets while simultaneously acquiring environmental data with in situ sensors mounted on the ROVs (CTD and DO). ROV targets include seamounts, rift zone ridges, hydrothermal vents, mud volcanoes, trench/subduction zone areas, habitats at the top of the trench, and bottom fish habitats. The combined dives will enable scientists and managers to have a better understanding of the diversity and distribution of deep water habitats in the CNMI and MTMNM, and should contribute to enhanced protection of these resources.

The *Okeanos Explorer* is equipped with OER's dedicated, fully integrated, two-body ROV system. ROV operations are conducted primarily during daylight hours while the vessel is stopped and holds station using dynamic positioning. ROV operations will typically take place within several meters of the seafloor, and are conducted in a way to minimize seafloor disturbances. On occasion, the ROV is set down on the seafloor in order to acquire very close imagery of habitats or features of interest. Common procedure includes visually scanning the seafloor to ensure the area the ROV is set on does not include corals or other animals, however some animals may reside beneath the sediment or may be too small to see. The ROV also has a temperature probe that may be shallowly inserted into the seafloor sediment to measure the depth or temperature of features of interest. Finally, though every effort is made to prevent any unnecessary seafloor disturbance, it is likely that at some point the ROV will inadvertently touch some benthic fauna (e.g., sea whip) or that water moving through the ROV thrusters will stir up small amounts of seafloor sediment. Any disturbance would likely be similar to that seen during normal near bottom SCUBA dives. During Leg I, up to 22 deployments of the ROV would occur during the expedition, resulting in 172 hours total dive time (~8 hours for each dive).

During these dives, limited sampling operations are planned to collect very selective specimens with the ROV that have the potential to contribute significant scientific discoveries. Biological specimen collections will focus on potential new species or new records for the region, and the dominant morphotype animal (such as a coral or sponge) in a habitat. When possible, only a sub-sample will be taken of biological specimens (e.g., only a piece or branch of corals and sponges will be collected, not the entire organism). Selective rock specimens, that have the potential to contribute significant scientific discoveries, as outlined in the expedition goals, will also be

targeted. These are expected to include rocks from seamounts; manganese-coated rocks; and rock samples in support of the United States Extended Continental Shelf Project. When possible, rock samples will be selected in a way to minimize disturbance to the surrounding environment and to minimize the take of attached organisms.

Mapping Operations on *Okeanos Explorer*

The acquisition of high-resolution seafloor mapping data is an essential precursor to making significant biological, geological, archaeological and oceanographic discoveries. The *Okeanos Explorer* cruises will collect seafloor mapping data to supplement previous work. These maps form the basis for selecting ROV dive targets. ROV cruises would take the next major step in baseline habitat characterization by using the ROV system to visually investigate unknown and little known deep water habitats within the CNMI and MTMNM identified as priority scientists and managers. CTD casts may be conducted to collect additional information about the physical and chemical properties of the water column, including at sites of interest identified from mapping and ROV investigation.

As is standard procedure on exploration cruises with this vessel, the ship will conduct sonar mapping operation during non-ROV operations throughout the cruise. Acoustic instruments that will be operational during the project are a 30 kHz multibeam echosounder (Kongsberge EM302), Kongsberg EK60 singlebeam echosounders (18, 38, 70, 120, 200 and 333 kHz), Teledyne Acoustic Doppler Current Profilers (38 and 300 kHz), and a 3.5 kHz sub-bottom profiler (Knudsen Chirp 3260). Additionally, expendable bathythermographs (XBTs) and the ship's UnderwayCTD (UCTD) will be deployed at regular intervals in association with multibeam data collection. All of these systems are routinely used by this exploration vessel and have provided invaluable scientific data for marine researchers and manager, including numerous National Marine Sanctuaries, the Bureau of Ocean Energy Management and the U.S. Geological Survey.

As is standard procedure on exploration cruises with this vessel, the ship will conduct sonar mapping operations at during non-ROV operations throughout the cruise. Acoustic instruments that will be operational during the project are a 30 kHz multibeam echosounder (Kongsberg EM 302), Kongsberg EK60 singlebeam echosounders (18, 38, 70, 120, 200, and 333 kHz), Teledyne Acoustic Doppler Current Profilers (38 and 300 kHz), and a 3.5 kHz sub-bottom profiler (Knudsen Chirp 3260). Additionally, expendable bathythermographs (XBTs) and the ship's UCTD will be deployed at regular intervals in association with multibeam data collection. All of these systems are routinely used by this exploration vessel and have provided invaluable scientific data for marine researchers and managers, including numerous National Marine Sanctuaries, the Bureau of Ocean Energy Management and the U.S. Geological Survey.

Bridge Officers and Watch Standers will be on watch during all hours and will to look for marine mammals and other observable species potentially sensitive to the sound of the sonars. If cetaceans are sighted, knowledgeable personnel would follow established best management practices to minimize disturbance. If a cetacean is observed, the Mapping Watch Lead and Expedition Coordinator are notified, and if appropriate, the ship will slow down or stop until the animal has departed the area. If cetacean species are present within 400 m of the ship, the vessel will stop until the animals depart the area. When marine mammals are able to be identified by Bridge Officers or Watch Standers, these observations are noted in the NOAA fleet marine mammal observation log as part of standard practice.

Multibeam Sonar
Multibeam sonar data will produce high-resolution bathymetry and acoustic backscatter maps. These maps will provide critical baseline information to scientists and resource managers interested in identifying and expanding our understanding of the important biological habitats and ecological connections in the Monuments, and the geology of the NWHI. Additionally, the data collected will help scientists better understand the size and character of seafloor habitats in the area, allowing for improved targeting of future exploration and research, including the selection of sites for further investigation with a ROV.

Sound velocity -Underway CTD or XBT:
Accurate measurements of sound speed as a function of depth down to approximately 700 meters are needed every 3-6 hours during multibeam sonar mapping operations. These sound speed measurements are essential for ray-tracing calculations used by the EM302 multibeam sonar system in order to collect accurate bathymetry and backscatter data. To obtain these essential data, the *Okeanos Explorer* can either use an XBT or the new underway CTD (UCTD) equipped with a sound velocity probe. The *Okeanos Explorer* plans to use the UCTD during the 2016-17 field seasons as much as possible as rather than conducting XBTs, since UCTD does not leave anything in the ocean after gathering the measurements.

The UnderwayCTD (UCTD)
The UCTD manufactured by Teledyne Ocean science is a piece of equipment used to gather conductivity/temperature/depth (CTD) measurements or sound velocity measurements while the ship is moving. This instrument is mounted on the stern railing and has a re-usable probe that is dropped through the water column then retrieved by rewinding the line onto a motorized spool. The unit would not touch the seafloor. The unit can be equipped with a CTD probe or a sound velocity probe. When equipped with the sound velocity probe, the UCTD can obtain water column profiles down to over 700 meters while the ship is moving at 8 knots, *Okeanos Explorer*'s standard survey speed, so the UCTD can sample the water column while continuously mapping.

Expendable bathythermographs (XBT)
XBTs are deployed to obtain sound velocity profiles. The profiles are required to calibrate the multi-beam system and ensure accurate bathymetric mapping. During the EX-16-05 Leg I ROV cruise, mapping operations would be conducted mainly at night in transit to the next dive location. XBTs will likely be deployed once every 4-6 hours to ensure accurate bathymetric data collection (resulting in a maximum of 2-3 total XBT deployments in a 24-hour period). It is anticipated that UCTD casts will be the preferred and more commonly used method to obtain sound velocity profile data, however XBTs will likely be used when time to obtain the cast data is very limited (e.g. weather windows, vessel traffic, or ship-time constraints) or there is a mechanical or data quality problem with the UCTD. The very fine wire connecting the XBT probe to the ship is extremely easy to break by hand once the probe reaches maximum depth. The minimal tensile strength of the wire should represent a minimal entanglement risk for marine animals. The expended materials are unlikely to result either in any significant environmental impacts to the sea floor or in a significant degradation of marine water quality. Over a period of years, these materials would degrade, corrode, and become incorporated into the sediments.

Single Beam and Split Beam Sonars

Kongsberg EK60 sonars are specifically designed to provide *calibrated* quantitative acoustic data useful for interpreting marine life in the water column of the ocean. Additionally, they are now also used to generate gaseous seep flux rates and their contribution to ocean and atmospheric chemistry. In many cases the ability to observe and measure the acoustic backscatter response of different types of marine life (fish, squid, plankton, etc.) is dependent upon the frequency of the sonar. Therefore, the more frequencies that are used for these acoustic surveys, the more complete the picture that can be gained about the marine environment. OER has received specific feedback from marine scientists in the Pacific region that our EK60 data would be much more useful when collected using multiple frequencies than at just the 18 kHz frequency. Given these benefits, OER intends to gather EK60 data at multiple frequencies as much as possible.

Acoustic Doppler Current Profilers (ADCPs)

Ship-mounted ADCPs have been used on oceanographic research vessels for over 25 years, and are useful for characterizing current speeds and direction at various depths in the ocean. ADCP measurements are therefore critically useful in characterizing the physical oceanography of an area, identifying small to mesoscale ocean current features, and even contributing to our understanding of the climatology of a region with repeated measurements over time. In addition to these scientific benefits, the *Okeanos Explorer* is interested in using the new ADCPs to assess currents near ROV dive locations to inform dive planning and ensure safe ROV deployment and recovery operations. Given these benefits, OER would like to use the new ADCPs within the CNMI and MTMNM as a useful data stream contributing to characterizing the area, providing new information on ocean currents to scientists and managers, and helping to plan effective and safe ROV exploration dives.

Sub Bottom Profiler

The primary purpose of this Knudsen Chirp 3260 (3.5 kHz) sonar is to provide echogram images of surficial geological sediment layers underneath the seafloor to a maximum depth of about 80 meters below the seafloor. The Sub Bottom Profiler is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the multibeam sonar. The data generated by this sonar is fundamental in helping geologists interpret the shallow geology of the seafloor. Collecting this data in the Leg II operating area will provide greatly improved insights into the geology of the region, and supplement existing magnetometer and gravity measurements obtained by other vessels.

CTD Rosette Operations

The CTD rosette instrument is used to obtain conductivity, temperature, depth and other oceanographic data (dissolved oxygen, light scattering, oxygen reduction potential). The system would be lowered to a maximum depth of 6800 m by an embedded scientific winch and wire while the vessel would be stopped and hold station using dynamic positioning. The average time to conduct a CTD casts varies from one to several hours depending on water depth (the CTD is lowered through the water column at 60m/min). CTD casts would be conducted at selected sites including locations where ROV dives are conducted to allow for an improved understanding of the environmental conditions by measuring the physical or chemical properties of the water

column overlying or hosting a particular habitat. The CTD would not touch the seafloor and would have limited time and presence in the marine environment.

Permits

OER has completed an informal consultation with NOAA's National Marine Fisheries Service (NMFS) under section 7 of the Endangered Species Act of 1973 that addresses the potential impacts of project activities to ESA-listed species and critical habitat for all operations to be conducted as part of the 2016-2017 CAPSTONE expeditions. A Letter of Concurrence was received from NMFS on February 7, 2016, concurring with OER's determination that CAPSTONE Expedition activities are not likely to adversely affect ESA-listed marine species, and would have insignificant effects on designated or proposed critical habitat.

Effects of the Project

As expected for ocean research with limited duration or presence in the marine environment, this project will not have the potential for significant impacts. Knowledgeable experts who are aware of the sensitivities of the marine environment will conduct the at-sea portions of this project. The potential gains or beneficial effects of the project seem to outweigh any potential adverse effects. This expedition will provide baseline characterization of poorly understood deep water habitats, including within marine protected areas, contained within the U.S. Exclusive Economic Zone (EEZ). This work will provide essential information for further research, exploration, and conservation of marine habitats within the CNMI and MTMNM.

As defined in Sections 5.05 and 6.03.c.3 (a) of NAO 216-6, this is a research project of limited size or magnitude and will not result in individually or cumulatively significant impacts on the quality of the human environment. Specifically, this research cruise would have only short-term effects with the principle goals of natural resource inventories and environmental monitoring over a wide geographic area. Furthermore, this action would not be subject to any of the exceptions for categorical exclusion provided at NAO 216-6 section 5.05c. As such, this project is categorically excluded from the need to prepare a NEPA environmental assessment.

Appendix D: ESA Section 7 Initiation Letter, Biological Evaluation and Letter of Concurrence

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Pacific Islands Regional Office
1845 Wasp Blvd., Bldg 176
Honolulu, Hawaii 96818
(808) 725-5000 • Fax: (808) 725-5215

Mr. John McDonough
Deputy Director
NOAA Office of Ocean Exploration and Research

Dear Mr. McDonough:

This letter responds to your January 14, 2016 Request for Consultation by the Office of Exploration and Research (OER) regarding efforts aboard the NOAA vessel *Okeanos Explorer* with the proposed action consisting of activities to explore and improve understanding of the distribution and diversity of deep water habitats in the Pacific, and in particular in the Marine National Monuments. You have requested our concurrence under Section 7 of the Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. §1531 et seq.), with your determination that the proposed action may affect but is not likely to adversely affect green, hawksbill, leatherback, olive ridley, and north Pacific loggerhead sea turtles; Main Hawaiian Islands false killer whale distinct population segment, humpback whales, blue whales, fin whales, sei whales, sperm whales, north Pacific right whales, the Indo-West Pacific and Central Pacific distinct population segment of the scalloped hammerhead shark, Hawaiian monk seals; and the coral species *Acropora globiceps,* A. *jacquelineae, A. retusa, A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata.*

Proposed Action/Action Area: The proposed activity is more fully described in your request for consultation and the associated biological evaluation (CAPSTONE 2016). The proposed action (Okeanos Explorer cruises) includes the use of various ship and submersible-deployed electronic systems to collect data on the distribution and diversity of deep water habitats in the Marine National Monuments. The activity would occur during two years with up to 20 research cruises scheduled between February 2016 and December 2017. The expedition teams (26 crew and up to 20 rotating scientists and/or technicians on each cruise leg) would be authorized to conduct mapping and Remotely Operated Vehicle (ROV) surveys using the Okeanos Explorer's multibeam, split beam, subbottom profiler and acoustic Doppler current profiler (ADCP) sonar systems, utilizing the ship's conductivity-temperature-depth (CTD) sampling rosette for various water measurements and deploying an ROV. No activities are scheduled to occur on land.

The suite of sonars aboard the vessel includes a Kongsberg EM302 30 kHz multibeam system, which collect bathymetry and backscatter data; several Simrad EK 60 split-beam sonars that

range from 18 to 333 kHz which are designed to gather measurements of biological and gaseous targets in the water column; and a Knudsen 3.5 kHz chirp sub-bottom profiler. The 300 kHz and 38 kHz ADCPs provide information about current velocity and direction at various depths. Sonar mapping activities will be conducted throughout the proposed action area and during transits to and from sites where operations will be conducted in an effort to fill in gaps in data knowledge and to build on data already collected. The maps generated from these activities will improve understanding of the geology and important biological habitats in the project area.

Conductivity, temperature and depth data will be collected by both an Underway CTD and a CTD rosette instrument. The CTD rosette, which is deployed while the ship is stopped and holding dynamic position, is lowered by a winch and wire to a maximum depth of 6800 m to collect water samples through 24 2.5 L niskin bottles. The CTD rosette will be deployed at select sites where ROV operations are conducted to allow for an improved understanding of the environmental conditions at that particular site. The deployment and retrieval of the CTD rosette takes up to several hours (depending on depth), while the Underway CTD can be deployed while the ship is moving, saving hours of time and fuel. The instrument is mounted on the stern railing and outfitted with a re-useable probe that is deployed and retrieved through the use of motorized spool. The Underway CTD will be used to collect water column profiles to a maximum depth of 700 m.

ROV operations will be designed to provide interdisciplinary site characterization at priority targets in and around monuments, sanctuaries and protected areas, through visual observation of priority targets while acquiring environmental data with onboard sensors. Sampling will be focused on corals and sponges, but will target specimens believed to be new species or new records for an area. No ESA-listed corals would be sampled. As many as 200 deployments of the ROV may occur during the 2016 – 17 field season resulting in 1600 hours of total dive time. The dives will better enable scientists and managers to understand the diversity and distribution of deep water habitats.

The action area covered by the accompanying biological evaluation encompasses the marine environments of Papahānaumokuākea Marine National Monument (PMNM); Oahu and the big island of Hawai'i; the area south and west of Molokai, Lana'i, and Kaho'olawe, the Geologists Seamounts located about 100 nm south of Honolulu; the Musicians Seamounts located about 150 nm NNE of Nihoa Island; all of the Pacific Remote Island Areas composing the Pacific Remote Islands Marine National Monument (PRIMNM); the Commonwealth of the Northern Marianas Islands (CNMI) and the Marianas Trench Marine National Monument (MTMNM); the vicinity of American Samoa and the National Marine Sanctuary of American Samoa (NMSAS); the Rose Atoll Marine National Monument (RAMNM); and the vessel transit areas between Honolulu, Hawai'i, Guam, Saipan, Kwajalein, Pago Pago where ESA-listed marine species or their habitats may be impacted by the proposed activities.

Species That May Be Affected: OER determined that the proposed action may affect but is not likely to adversely affect green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), North Pacific distinct population segment of loggerhead sea turtles (*Caretta caretta*),

olive ridley sea turtles (*Lepidochelys olivacea*), leatherback sea turtles (*Dermochelys coriacea*), Main Hawaiian Islands false killer whale distinct population segment (*Pseudorca crassidens*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), fin whales (*Balaenoptera physalus*), blue whales (*Balaenoptera musculus*), sei whales (*Balaenoptera borealis*), north pacific right whales (*Eubalaena japonica)*, the Indo-West Pacific and Central Pacific distinct population segments of the scalloped hammerhead shark (*Sphryna lewini*), Hawaiian monk seals (*Neomonachus schauinslandi*), Hawaiian monk seal critical habitat and the coral species *Acropora globiceps, A. jacquelineae, A. retusa, A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata.* Detailed information about the biology, habitat, and conservation status of sea turtles can be found in their recovery plans and other sources at http://www.nmfs.noaa.gov/pr/species/turtles/. The same can be found for Hawaiian monk seals and cetaceans at http://www.nmfs.noaa.gov/pr/species/mammals/; and more information on listed corals can be found at http://www.fpir.noaa.gov/PRD/prd_coral.html.

Critical Habitat: The proposed action would take place within designated monk seal critical habitat. Critical habitat was designated under the ESA for the Hawaiian monk seal on April 30, 1986 and revised on May 26, 1988 (53 FR 18988) and again on August 21, 2015 (80 FR 50926). Designated critical habitat includes all beach areas, lagoon waters, and ocean waters out to a depth of 200 m around Kure Atoll; Midway Islands (except Sand Island), Pearl and Hermes Reef, Lisianski Island, Laysan Island, Gardner Pinnacles, French Frigate Shoals, Necker Island, Maro Reef, and Nihoa Island, and includes the seafloor and all subsurface waters and habitat within 10 meters of the seafloor. Around the Main Hawaiian Islands, critical habitat extends in designated areas from the beach out to the 200 meter depth contour, and includes the seafloor and subsurface waters within 10 meters of the seafloor.

Analysis of Effects: In order to determine that a proposed action is not likely to adversely affect listed species, NMFS must find that the effects of the proposed action are expected to be insignificant, discountable, or beneficial as defined in the joint USFWS-NMFS Endangered Species Consultation Handbook: (1) insignificant effects relate to the size of the impact and should never reach the scale where take occurs; (2) discountable effects are those that are extremely unlikely to occur; and (3) beneficial effects are positive effects without any adverse effects (USFWS & NMFS 1998). This standard, as well as consideration of the probable duration, frequency, and severity of potential interactions, was applied during the analysis of effects of the proposed action on ESA-listed marine species, as is described in detail in the OER consultation request. The OER determined that the risk of collisions with vessels and the risk of entanglement would be discountable; and that the risk from exposure to elevated noise level, disturbance from human activity, as well as exposure to wastes and discharges would result in insignificant effects on ESA-listed sea turtles, marine mammals, sharks and corals; and that the potential effects of the proposed action to designated or proposed critical habitat would also be insignificant.

Considering the information and assessments presented in the OER consultation request, and in the best scientific information available about the biology and expected behaviors of the ESA-listed marine species considered in this consultation; NMFS agrees that: 1) the list of ESA-listed species and critical habitats potentially exposed to the effects of the action is correct, 2) the suite

of identified stressors is comprehensive, and 3) the assessment of exposure risk and significance of exposure to those stressors is accurate. Therefore, NMFS agrees that:

- the risk of collisions with vessels for marine mammals, turtles, sharks and the listed coral species in the action area is discountable;
- the risk of entanglement with marine mammals, sea turtles and sharks is discountable; and,
- ESA-listed species in the action area are unlikely to respond to anticipated elevated noise levels, disturbance from human activity, and exposure to wastes and discharges. Further, if any response were to occur, it would be temporary in nature and never reach the scale where it would affect the individual's health, and as such, have insignificant effects.

Conclusion: NMFS concurs with your determination that conducting the proposed Okeanos Explorer cruises are not likely to adversely affect ESA-listed marine species. This concludes your consultation responsibilities under the ESA for species under NMFS's jurisdiction. However, this consultation focused solely on compliance with the ESA. Additional compliance review that may be required of NMFS for this action (such as assessing impacts on Essential Fish Habitat) would be completed by NMFS Habitat Conservation Division in separate communication, if applicable.

ESA Consultation must be reinitiated if: 1) a take occurs; 2) new information reveals effects of the action that may affect listed species or designated critical habitat in a manner or to an extent not previously considered; 3) the identified action is subsequently modified in a manner causing effects to listed species or designated critical habitat not previously considered; or 4) a new species is listed or critical habitat designated that may be affected by the identified action.

If you have further questions please contact Richard Hall on my staff at (808) 725-5018. Thank you for working with NMFS to protect our nation's living marine resources.

Sincerely,

Michael D. Tosatto
Regional Administrator

cc: Justin Rivera, Papahanaumokuakea Marine National Monument
Aaron Nadig, ESA Section 7 Program, USFWS, Honolulu

NMFS File No.: PIR-2016-9774
PIRO Reference No.: I-PI-16-1347-AG

Literature Cited

Campaign to Address Pacific Monument Sciecne, Technology and ocean Needs (CAPSTONE) 2016. Request for Informal Consultation. Letter from John McDonough to Ann Garrett dated January 14, 2016 and attachments.

U.S. Fish and Wildlife Service and National Marine Fisheries Service. 1998. Endangered Species Consultation Handbook. Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act.
http://www.nmfs.noaa.gov/pr/pdfs/laws/esa_section7_handbook.pdf

January 14, 2016

Ann Garrett
Assistant Regional Administrator
Protected Resources Division
NMFS Pacific Islands Regional Office
1845 Wasp Blvd., Building 176
Honolulu, HI 96818

Re: Request to Initiate Consultation under Section 7 of the Endangered Species Act for the Campaign to Address Pacific Monument Science, Technology and Ocean Needs (CAPSTONE Project)

Dear Ms. Garrett:

Operating under a partnership with NOAA's Office of Ocean Exploration and Research and the Office of Marine and Aviation Operations, the *Okeanos Explorer* team is preparing to continue the CAPSTONE campaign into the Central and Western Pacific during the 2016 and 2017 field seasons. The action area for the 2016 – 2017 season will include the marine environments in and around: the Papahānaumokuākea Marine National Monument (PMNM); Oahu and the big island of Hawai'i; the area south and west of Molokai, Lana'i, and Kaho'olawe, the Geologists Seamounts located about 100 nm south of Honolulu; the Musicians Seamounts located about 150 nm NNE of Nihoa Island; all of the Pacific Remote Island Areas composing the Pacific Remote Islands Marine National Monument (PRIMNM); the Commonwealth of the Northern Marianas Islands (CNMI) and the Marianas Trench Marine National Monument (MTMNM); the vicinity of American Samoa and the National Marine Sanctuary of American Samoa (NMSAS); the Rose Atoll Marine National Monument (RAMNM); and the vessel transit areas between Honolulu, Hawai'i, Guam, Saipan, Kwajalein, Pago Pago.

The activity would occur during two years and could include up to twenty different research cruises aboard the NOAA Ship *Okeanos Explorer* scheduled between February 2016 and December 2017. All cruises will focus on collecting critical baseline information in monuments and sanctuaries to meet NOAA science and management needs. The overarching goal of the project is to extend and improve the understanding of the distribution and diversity of deep-water habitats within the marine protected areas in the Pacific. Data and information from the cruises will build on previous work where appropriate, and provide a foundation of publicly-accessible baseline information to improve management and spur further exploration and research. Like previous expeditions in the Gulf of Mexico, western Atlantic, Indonesia, and Hawaii, NOAA

will work with the scientific community and public to characterize unknown and poorly-known areas through telepresence-based exploration. Operations will use the ship's deep water mapping systems, NOAA's 6000m remotely operated vehicles (ROV), CTD rosette, and a high-bandwidth satellite connection for real-time ship to shore communications. These expeditions will help establish a baseline of information in the region to catalyze further exploration, research and management activities.

We propose to conduct activities to explore and improve understanding of the distribution and diversity of deep water habitats. No activities would occur on land. The expedition teams (26 crew and up to 20 rotating scientists/technicians on each cruise leg) would be authorized to conduct mapping and ROV surveys using the *Okeanos Explorer's* multibeam, split beam, subbottom profiler and acoustic Doppler current profiler (ADCP) sonar systems, utilizing the ship's conductivity-temperature-depth (CTD) sampling rosette for various water measurements and deploying an ROV.

Enclosed is a Biological Evaluation (BE) to initiate consultation under Section 7(a)(2) of the Endangered Species Act (ESA). As described in the BE, we have determined that the proposed 2016 CAPSTONE cruises may affect, but are not likely to adversely affect, the following ESA-listed marine species: green sea turtles (*Chelonia mydas*), hawksbill sea turtles (*Eretmochelys imbricata*), North Pacific distinct population segment of loggerhead sea turtles (*Caretta caretta*), olive ridley sea turtles (*Lepidochelys olivacea*), leatherback sea turtles (*Dermochelys coriacea*), Main Hawaiian Islands false killer whale distinct population segment (*Pseudorca crassidens*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), fin whales (*Balaenoptera physalus*), blue whales (*Balaenoptera musculus*), sei whales (*Balaenoptera borealis*), north pacific right whales (*Eubalaena japonica)*, the Indo-West Pacific and Central Pacific distinct population segments of the scalloped hammerhead shark (*Sphryna lewini*), Hawaiian monk seals (*Neomonachus schauinslandi*), Hawaiian monk seal critical habitat; and the coral species *Acropora globiceps, A. jacquelineae, A. retusa, A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata.*

We request your concurrence with our 'not likely to adversely affect' determination for the species listed above and for Hawaiian monk seal critical habitat.

Please contact Kelley Elliott (**Kelley.Elliott@noaa.gov**, 301-734-1024) with questions regarding this consultation request.

Respectfully,

Jay Barth

For John McDaugh

Biological Evaluation
Campaign to Address Pacific Monument Science, Technology and Ocean Needs
(CAPSTONE Project)

Background

NOAA Ship *Okeanos Explorer*, "America's Ship for Exploration", is the nation's first and only federal vessel with a mandate to systematically explore our mostly unknown ocean for the purpose of discovery and the advancement of knowledge. Operating under a partnership with NOAA's Office of Ocean Exploration and Research and the Office of Marine and Aviation Operations, the CAPSTONE project is a major multi-year foundational science effort focused on deepwater areas of U.S. marine protected areas (MPAs) in the central and western Pacific. The overarching goal of the CAPSTONE project is to extend and improve the understanding of the distribution and diversity of deepwater habitats within the MPAs, and collect data and information to support priority monument and sanctuary science and management needs. The effort will also provide critical information relevant to emerging regional issues like deep-sea mining and the potential U.S. Extended Continental Shelf. Data and information from the cruises will provide a foundation of publicly-accessible baseline information to improve management and spur further exploration and research. Like previous expeditions in the Gulf of Mexico, western Atlantic, and Indonesia, NOAA will work with the scientific community and public to characterize unknown and poorly-known areas through telepresence-based exploration. Operations will use the ship's deep water mapping systems, NOAA's 6000m remotely operated vehicles (ROV), underway CTD, CTD rosette, and a high-bandwidth satellite connection for real-time ship to shore communications. These expeditions will help establish a baseline of information in the region to catalyze further exploration, research and management activities.

Action Area

The action area covered by this biological evaluation encompasses the marine environments in and around: the Papahānaumokuākea Marine National Monument (PMNM); Oahu and the big island of Hawai'i; the area south and west of Molokai, Lana'i, and Kaho'olawe, the Geologists Seamounts located about 100 nm south of Honolulu; the Musicians Seamounts located about 150 nm NNE of Nihoa Island; all of the Pacific Remote Island Areas composing the Pacific Remote Islands Marine National Monument (PRIMNM); the Commonwealth of the Northern Marianas Islands (CNMI) and the Marianas Trench Marine National Monument (MTMNM); the vicinity of American Samoa and the National Marine Sanctuary of American Samoa (NMSAS); the Rose Atoll Marine National Monument (RAMNM); and the vessel transit areas between Honolulu,

Hawai‘i, Guam, Saipan, Kwajalein, Pago Pago and these locations where ESA-listed marine species or their habitats may be impacted by an applicant’s activities.

All mapping and ROV operations are expected to be in waters at depths of 250m and greater (one exception is noted in Appendix A, figure 2), including within the boundaries of PMNM, PRIMNM, MTMNM, NMSAS, RAMNM, and the U.S. EEZ. Transit mapping operations are planned between all areas mentioned, including the high seas.

Proposed Action

The applicant proposes to conduct activities to explore and improve understanding of the distribution and diversity of deep water habitats. The activity would occur during two years and could include up to twenty different research cruises aboard the NOAA Ship *Okeanos Explorer* scheduled between February 2016 – December 2017. No activities would occur on land. The expedition teams (26 crew and up to 20 rotating scientists/technicians on each cruise leg) would be authorized to conduct mapping and ROV surveys using the *Okeanos Explorer’s* multibeam, split beam, subbottom profiler and acoustic Doppler current profiler (ADCP) sonar systems, utilizing the ship's conductivity-temperature-depth (CTD) sampling rosette for various water measurements and deploying an ROV.

The overarching goal of the project is to extend and improve the understanding of the distribution and diversity of deepwater habitats within Monuments and protected areas. Data and information from the cruises will build on previous work where appropriate, and provide a foundation of baseline data to improve management and spur further exploration and research. NOAA priorities for the work include a combination of science, education, outreach, and open data objectives that will support management decisions at multiple levels. The effort also serves as an opportunity to highlight the uniqueness and importance of these national symbols of ocean conservation.

The acquisition of high-resolution seafloor mapping data is an essential precursor to making significant biological, geological, archaeological and oceanographic discoveries. The *Okeanos Explorer* cruises will collect seafloor mapping data, supplementing previous work where possible. These maps form the basis for selecting ROV dive targets. ROV cruises would take the next major step in baseline habitat characterization by using the ROV system to visually investigate unknown and little known deep water habitats within and around monument waters identified as priority by scientists and managers. CTD casts may be conducted two ways: 1) with the underway CTD to gather conductivity/temperature/depth measurements or sound velocity

measurements to calibrate sonar data, and 2) using a CTD rosette to collect additional information about the physical and chemical properties of the water column, including at sites of interest identified from mapping and ROV investigation.

The information and data generated by this project will directly contribute to a better understanding of the deep water habitats, ecosystems and geologic history of the Hawaiian Islands, the PRIMNM, the CNMI and MTMNM, the RAMNM, the vicinity of American Samoa and NMSAS, the Geologists Seamounts, and the Musicians seamounts by providing basic information about the rich and unique biological resources and habitats of these regions. It is this understanding that provides continuous support for the monuments and their protection of these resources. The collective understanding established from these expeditions will increase understanding of deep-sea biogeographic patterns across the Central and Western Pacific.

MAPPING

NOAA Ship *Okeanos Explorer* has a suite of scientific sonars, each with a unique exploration application. All of these systems are routinely used by the ocean science community and have provided invaluable scientific data for oceanographers, marine researchers and managers, including numerous National Marine Sanctuaries, the Bureau of Ocean Energy Management and the U.S. Geological Survey. Each sonar's acoustic signal is designed to be narrowly focused to provide precise information about a specific, narrowly defined area of the seafloor or water column beneath the ship. The sonars include a Kongsberg EM302 30 kHz multibeam system; 18 kHz, 38 kHz, 70 kHz, 120 kHz, 200 kHz, and 333 kHz Simrad EK60split-beam fisheries sonars (the 333 kHz will likely not be operational since we don’t currently have the hardware general purpose transceiver to run it, but is included just in case); a Knudsen 3.5 kHz chirp sub-bottom profiler sonar; and 300 kHz and 38 kHz Teledyne Acoustic Doppler Current Profilers (ADCPs). The multibeam maps broad swaths for seafloor bathymetry/backscatter and water column feature detection (e.g. gaseous seeps), the split-beam sonars gather calibrated target strength measurements of biologic and gaseous targets in the water column, the sub-bottom profiler provides data useful for interpreting sub-seafloor geology, and the ADCPs provide information about current velocity and direction at various depths through a water column profile. All of these sonars may not be able to be run concurrently with the multibeam due to inter-sonar acoustic interference – particularly the 38 kHz EK60 which is close to the 30 kHz central operating frequency of the multibeam. To address potential interference these new sonars may be synced to ping at different times than the multibeam, or may be run by themselves without the multibeam pinging.

Mapping activities would occur continuously throughout the day and night except when the ROV is deployed. If cetacean species are present within 400 m of the ship, the vessel would stop until the animals depart the area but the mapping sonars would continue transmitting to avoid startle responses. Standard practice during all *Okeanos Explorer* cruises and operations include Officers or Watch Standers on the Bridge around-the-clock, monitoring the surrounding ocean for the presence of other ships, unanticipated hazards, and marine animals – especially cetaceans. If a cetacean is observed, the Mapping Watch Stander or Science Lead is notified and if appropriate the team then proceeds with protocols to continue monitoring the animal or shut down mapping or other ship operations until the animal has departed the area for an appropriate period of time. Whenever possible, marine mammals are identified by Bridge Officers or Watch Standers, and these observations are noted in the NOAA fleet marine mammal observation log as part of standard practice. During the 2016-2017 field seasons, these procedures will include monitoring for the presence of sea turtles and, when appropriate, taking protection measures.

Multibeam:

Multibeam sonar mapping will be conducted with a Kongsberg EM 302 (30 kHz) sonar in areas within and in the vicinity of the PMNM, the PRIMNM, the CNMI and MTMNM, the RAMNM, the vicinity of American Samoa and NMSAS, offshore of Hawai'i, Oahu and the Geologists Seamounts, and the Musicians Seamounts where gaps are present in the existing coverage, or the existing data is poor quality. Multibeam mapping will also take place during the transits to and from sites where other operations will be conducted, and are planned to continue to build upon previous mapping surveys as much as feasible. Multibeam sonar data will produce high-resolution bathymetry and acoustic backscatter maps. These maps will provide critical baseline information to scientists and resource managers interested in identifying and expanding our understanding of the geology and important biological habitats and ecological connections in the monuments and sanctuaries. Additionally, the data collected will help scientists better understand the size and character of seafloor habitats in the area, allowing for improved targeting of future exploration and research, including the selection of sites for further investigation with a ROV.

UnderwayCTD:

Accurate measurements of sound speed as a function of depth down to approximately 700 meters are needed every 3-6 hours during multibeam sonar mapping operations. These sound speed measurements are essential for ray-tracing calculations used by the EM302 multibeam sonar system in order to collect accurate bathymetry and backscatter data. To obtain these essential data, the *Okeanos Explorer* can

either use an XBT or the new underway CTD (UCTD) equipped with a sound velocity probe. The *Okeanos Explorer* proposes to use the UCTD during the 2016-17 field seasons as much as possible as rather than conducting XBTs, since UCTD does not leave anything in the ocean after gathering the measurements.

The UCTD (http://www.oceanscience.com/Products/UnderwayCTD/Underway-CTD.aspx) manufactured by Teledyne Ocean science is a piece of equipment used to gather conductivity/temperature/depth (CTD) measurements or sound velocity measurements while the ship is moving. A brochure from the manufacturer with pictures and specifications is included as appendix B. This instrument is mounted on the stern railing and has a re-usable probe that is dropped through the water column then retrieved by rewinding the line onto a motorized spool. The unit would not touch the seafloor. The unit can be equipped with a CTD probe or a sound velocity probe. When equipped with the sound velocity probe, the UCTD can obtain water column profiles down to over 700 meters while the ship is moving at 8 knots. 8 knots is the ship's normal ocean mapping survey speed, so the UCTD can sample the water column while continuously mapping. The ship currently obtains sound velocity profiles using expendable probes (XBTs). XBTs are expensive consumable supplies and leave behind plastic and copper waste in the ocean due to the one-time use of each probe. OER has installed the UCTD in order to minimize the use of XBTs while still gathering essential sound velocity profile data needed every 3-6 hours while mapping in order to accurately collect high quality multibeam sonar data.

Expendable Bathythermographs (XBT):

XBTs are deployed to obtain sound velocity profiles. The profiles are required to calibrate the multi-beam system and ensure accurate bathymetric mapping. The XBT type is the Deep Blue probe produced by Lockheed Martin Sippican. A single Deep Blue XBT is 8.5 in. length x 2 in. width and weighs 2.53 lbs. It consists of a plastic spool, hair thin copper wire (< 1mm width), zinc weight, thermistor (comprised of two short wires (< 8.5 in. length)) and is contained in a clear plastic housing. The Deep Blue XBT contains no chemical solutions. During *Okeanos*24-hour mapping cruises, XBTs or UCTD casts will likely need to be completed once every 4-6 hours to ensure accurate bathymetric data collection (resulting in a maximum of 4-6 total XBT deployments in a 24-hour period). During *Okeanos* cruises that conduct daytime ROV dives and evening/nighttime mapping operations, XBTs will likely be deployed once every 4-6 hours to ensure accurate bathymetric data collection (resulting in a maximum of 2-3 total XBT deployments in a 24-hour period). It is anticipated that UCTD casts will be the preferred and more commonly used method to obtain sound velocity profile data, however XBTs will likely be used when time to obtain the cast data is very limited (e.g. weather windows, vessel traffic, or ship-time constraints) or there is a mechanical or data quality problem with the UCTD.

The very fine wire connecting the XBT probe to the ship is extremely easy to break by hand. The minimal tensile strength of the wire should represent a minimal entanglement risk for species of concern. The potential for XBT deployments to impact ESA-listed species was the topic of an informal consultation request from the PMNM to NMFS during PMNM permit review for the *Falkor* expeditions. The determination was that the *Falkor's* use of XBTs may affect, but is not likely to adversely affect, Hawaiian monk seals, green sea turtles, hawksbill sea turtles, leatherback sea turtles, olive ridley sea turtles, North Pacific loggerhead sea turtles, MHI Insular false killer whales, humpback whales, sperm whales, fin whales, blue whales, sei whales, and North Pacific right whales. We expect the same determination would be made with respect to the deployment of XBTs by the Okeanos Explorer.

Single Beam and Split Beam Sonars:
Kongsberg EK60 sonars are specifically designed to provide *calibrated* quantitative acoustic data useful for interpreting marine life in the water column of the ocean. Additionally, they are now also used to generate gaseous seep flux rates and their contribution to ocean and atmospheric chemistry. In many cases the ability to observe and measure the acoustic backscatter response of different types of marine life (fish, squid, plankton, etc.) is dependent upon the frequency of the sonar. Therefore, the more frequencies that are used for these acoustic surveys, the more complete the picture that can be gained about the marine environment. Recent research results demonstrate that the simultaneous use of multiple echo sounder transducer frequencies is useful for improving estimates of fish stocks, aiding in the discrimination of biological scattering layers or different species (Stanton *et al*., 2012), and mapping the location, density, and relative size of fish aggregations relative to benthic habitat features (Costa *et al*., 2014). OER has received specific feedback from marine scientists in the Pacific region that our EK60 data would be much more useful when collected using multiple frequencies than at just the 18 kHz frequency. Given these benefits, OER intends to gather EK60 data at multiple frequencies as much as possible. The NOAA vessel *Oscar Elton Sette* has 38 kHz, 70 kHz, 120 kHz, and 200 kHz EK60 sonars onboard that are commonly used during scientific expeditions within PMNM. Additional information about EK60 sonars can be found here: http://www.simrad.com/www/01/nokbg0240.nsf/AllWeb/A25148D8E9F00D0DC12570DE0050A7CB?OpenDocument

The new additional EK60 sonars are all higher frequency than the existing 18 kHz EK60 unit, and thus all have considerably shorter ranges due to the more rapid attenuation of higher-

frequency sounds in the ocean. Since the source levels sounders are less than the existing echo sounders, they should not be expected to pose any additional risk to ESA-listed species.

Sub-bottom Profiler:
The primary purpose of the Knudsen Chirp 3260 (3.5 kHz) sonar is to provide echogram images of surficial geological sediment layers underneath the seafloor to a maximum depth of about 80 meters below the seafloor. The subbottom profiler is normally operated to provide information about the sedimentary features and the bottom topography that is simultaneously being mapped by the multibeam sonar. The data generated by this sonar is fundamental in helping geologists interpret the shallow geology of the seafloor. Collecting this data within the project areas will provide greatly improved insights into the geology of the region, and supplement existing magnetometer and gravity measurements obtained by other vessels.

Acoustic Doppler Current Profilers (ADCPs)
Ship-mounted ADCPs have been used on oceanographic research vessels for over 25 years, and are useful for characterizing current speeds and direction at various depths in the ocean. ADCP measurements are therefore critically useful in characterizing the physical oceanography of an area, identifying small to mesoscale ocean current features, and even contributing to our understanding of the climatology of a region with repeated measurements over time (Firing and Hummon, 2010). In addition to these scientific benefits, the *Okeanos Explorer* is interested in using the new ADCPs to assess currents near ROV dive locations to inform dive planning and ensure safe ROV deployment and recovery operations. Given these benefits, OER would like to use two newly installed ADCPs as a useful data stream contributing to characterizing marine protected areas, providing new information on ocean currents to scientists and managers, and helping to plan effective and safe ROV exploration dives.

Hull-mounted ADCP transducers project four beams into the water column to record backscatter from the water column and compare the Doppler shift between the 4 beams to generate profiles of water velocity. The *Okeanos Explorer* will be equipped with two new ADCPs: a Teledyne RDI Workhorse Mariner (300 kHz) and an Ocean Surveyor (38 kHz). Technical specifications and descriptions of these instruments are provided in appendix C produced by the manufacturer. ADCPs are Doppler sonar systems, which transmit acoustic signals and listen to the echoes of those signals returned from materials floating with the currents throughout the water column. By processing this information, ADCPs provide information about current velocity and direction at various depths through a water column profile. Like other sonars, the depth range of ADCPs is directly related to the frequency of the system – the lower the frequency the greater the range capability of the sonar. However, lower frequencies provide less vertical

resolution than higher frequencies. The 300 kHz ADCP has a typical range of approximately 110 meters and a maximum range of 165 meters, while the 38 kHz system has a range between 900-1000 meters depending on operating mode and oceanographic conditions. These same two ADCP systems are also installed and utilized on the R/V *Kilo Moana* operated by the University of Hawaii Marine Center.

The 300 kHz ADCP is unlikely to interfere with other sonars on *Okeanos Explorer* since its frequency is much higher than the ship's multibeam, sub-bottom profiler, and EK60 sonars. If testing in early 2016 confirms this to be the case, it will probably be run nearly continuously while the ship is underway in order to gather data on currents that can be utilized by oceanographers to refine climatology and ocean current models.

There is a very high likelihood that the 38 kHz ADCP could interfere with the ship's multibeam and/or new 38 kHz EK60 sonar. If interference occurs, it may be possible to correct the problem by syncing the pings in such a way so as to minimize data degradation. If syncing efforts do not minimize interference, the multibeam sonar data will be given higher priority and the 38 kHz ADCP may only be run sporadically in key areas of interest around distinct features (e.g. seamounts, canyon headwalls) or just prior to deployment of the ship's ROVs. Since these issues will need to be figured out in early 2016, we cannot provide further details on how/when we might turn on this sonar. For evaluation purposes it is therefore reasonable to be conservative and assume that it is possible the *Okeanos Explorer* may wish to run the 38 kHz ADCP at all times while conducting its science missions.

The two new ADCPs are designed to gather data out to a maximum depth of 165 m (300 kHz) and 1000 m (38 kHz), so the associated sound source levels will be much less than the ship's existing permitted deep water (8000m and greater) echo sounders (EM320 multibeam, EK60 18 kHz, and Knudsen sub-bottom profiler). The new ADCP sonars are all higher frequency than the existing *Okeanos* sonars, and thus all have considerably shorter ranges due to the more rapid attenuation of higher-frequency sounds in the ocean. Since the source levels and range are less than the existing echo sounders, they should not be expected to pose any additional risk to ESA-listed species.

ROV OPERATIONS:

The purpose of conducting ROV operations is to conduct interdisciplinary site characterization at priority targets in and around monuments, sanctuaries and protected areas. Interdisciplinary site characterization would be achieved by visually surveying priority targets while simultaneously acquiring environmental data with in situ sensors mounted on the ROVs (CTD and DO). ROV targets include seamounts, ridges, drowned reef terraces, guyots (i.e., flat topped tablemounts), submarine canyons, hydrothermal vent sites, mud volcanoes, submerged cultural heritage sites,

and other types of topography where deep water coral and sponge communities are likely to occur. The combined dives will enable scientists and managers to have a better understanding of the diversity and distribution of deep water habitats in the monuments, and should contribute to enhanced protection of these resources. The ROVs 6000m depth capability puts areas of the monuments within reach that have never been seen before.

The *Okeanos Explorer* is equipped with OER's dedicated, fully integrated, two-body ROV system. The first body of the system is the ROV Deep Discoverer (D2), a 10.4ft long x 6.4ft wide x 8.5ft high vehicle weighing approximately 9150 lbs (in air), and capable of diving to 6000 meters. D2's primary data set is high definition video collected by two HD cameras. In addition to the HD video cameras, D2 carries a CTD with dissolved oxygen sensors. The second body of the system is the camera platform Seirios, an 11.5ft long x 3.67ft wide x 4.05ft high vehicle that weighs 2925 lbs and provides additional lighting and an "aerial" view of D2 while she investigates the seafloor. Like D2, Seirios carries two HD cameras, a Sea Bird 9/11+ CTD with DO2 sensors. During operation, the two vehicles are connected to each other by a "soft" electro-optical tether 30 meters in length. Seirios is also attached to the ship by an 8,200-meter armored fiber-optic cable that provides power and telemetry to the vehicles. ROV operations are conducted primarily during daylight hours while the vessel would be stopped and holding station using dynamic positioning.

ROV operations will typically take place within several meters of the seafloor, and are conducted in a way to minimize seafloor disturbances. On occasion, the ROV is set down on the seafloor in order to acquire very close imagery of habitats or features of interest. Common procedure includes visually scanning the seafloor to ensure the area the ROV is set on does not include corals or other animals, however some animals may reside beneath the sediment or may be too small to see. The ROV also has a temperature probe that may be shallowly inserted into the seafloor sediment to measure the depth or temperature of features of interest. Finally, though we try to prevent any unnecessary seafloor disturbance, it is likely that at some point the ROV will inadvertently touch some benthic fauna (e.g., sea whip) or that water moving through the ROV thrusters will stir up small amounts of seafloor sediment. Any disturbance would likely be similar to that seen during normal near bottom SCUBA dives.

As many as 200 deployments of the ROV may occur during the 2016-17 CAPSTONE project, resulting in 1600 hours total dive time (~8 hours for each dive). Currently 4 deployments of the ROV are planned offshore of Oahu or Hawai'i, 20 in PMNM, 19 at the Musicians seamounts, 69 in and around the PRIMNM (15 at Johnston, 18 at Wake, 12 at Jarvis, and 18 at Howland Baker

and the Phoenix Islands), 46 in and around the CNMI and MTMNM, and 10 in the Vicinity of American Samoa (including NMSAS and RAMNM).

ROV Sampling:
Sampling operations will be conducted during ROV cruises to collect very selective specimen collections with the ROV that have the potential to contribute significant scientific discoveries. Biological specimen collections will focus on, but are not limited to, corals and sponges (and their incidentally collected commensals). Only biological specimens suspected of being new species or new records for the area will be targeted. When possible, only a subsample will be taken of biological specimens (e.g., only a piece or branch of corals and sponges will be collected, not the entire organism). Selective rock specimens that have the potential to contribute significant scientific discoveries as outlined in the expedition goals will also be targeted. These are expected to include rocks from seamounts and manganese-coated rocks. When possible, rock samples will be selected in a way to minimize the amount of attached organisms.

Ultra Short Base Line Acoustic Navigation (USBL):
The Tracklink TL10000MA system is used to track and record the position of the ROVs during the course of a dive. It functions by the transmission of an acoustic pulse from the surface ship, which travels through the water column and triggers a responding acoustic pulse from the ROV. The measurement of the travel time and direction of arrival of the responding acoustic pulse from the ROV enables calculation of the position of the submerged ROV with respect to the surface ship. Integration of this relative position information with the surface ship position as determined by GPS allows the calculation of the position of the ROV on the seafloor. In this way, observations made by the ROV can be geo-referenced to standard latitude, longitude and depth coordinates. The USBL is used during ROV operations, which are conducted daily and primarily during daylight hours while the ship holds station using dynamic positioning. Although such frequencies are within the hearing range of marine mammals, the USBL navigation system is commonly used by researchers and has no known adverse impact on marine life.

The Tracklink operates at frequencies from 7.5 kHz to 12.5 kHz. Acoustic emissions by the USBL system occur at the surface from the hull of the ship, and at both of the ROVs as they travel through the water column and at the seafloor. The repetition rate of emissions is typically no faster than once every 2 seconds, increasing by 1.33 seconds for every 1000 meters of depth of the ROVs. The character of these emissions is detailed below:

Surface transceiver, *Okeanos Explorer*:
Tracklink model TL10000MA
Frequency of operation: 7.5 kHz - 12.5 kHz Spread Spectrum
Beam width: 120º directed at nadir
Peak electrical power: 100 W
Peak acoustic power: 187db relative to 1 micro Pascal at 1 meter.

ROV transponder, Seirios:
Tracklink model TL10010C
Frequency of operation: 7.5 kHz - 12.5 kHz Spread Spectrum
Beam width: 210º directed at zenith
Peak electrical power: 200 W
Peak acoustic power: 190db relative to 1 micro Pascal at 1 meter.

ROV transponder, Deep Discoverer:
Tracklink model TL10015C
Frequency of operation: 7.5 kHz - 12.5 kHz Spread Spectrum
Beam width: 30º directed at zenith
Peak electrical power: 500 W
Peak acoustic power: 200db relative to 1 micro Pascal at 1 meter.

CTD OPERATIONS:

NOAA Ship *Okeanos Explorer* is outfitted with both an underway CTD (addressed in the Mapping section) and a CTD rosette instrument. The CTD rosette instrument is used to obtain conductivity, temperature, depth and other oceanographic data (dissolved oxygen, light scattering, and oxygen reduction potential). The instrument is attached to an open cylindrical steel frame approximately 1.15 m in diameter and 1.4 m high with a 24-position rosette carousel containing 24 2.5 L niskin bottles for collecting water samples. The system would be lowered to a maximum depth of 6800 m by an embedded scientific winch and wire while the vessel would be stopped and hold station using dynamic positioning. The average time to conduct a CTD casts varies from one to several hours depending on water depth (the CTD is lowered through the water column at 60m/min). CTD casts would be conducted at selected sites including locations where ROV dives are conducted to allow for an improved understanding of the environmental conditions by measuring the physical or chemical properties of the water column overlying or hosting a particular habitat. The CTD would not touch the seafloor.

Analysis of Effects

Our analysis considers potential impacts or stressors to identified marine resources within the PMNM; the marine environment around Oahu, the big island of Hawai'i, and the area south and west of Molokai, Lana'i, and Kaho'olawe; the Geologists and Musicians Seamounts; all of the Pacific Remote Island Areas composing the PRIMNM; the CNMI and the MTMNM; the vicinity of American Samoa and the NMSAS; the RAMNM; and the vessel transit areas between Honolulu, Hawai'i, Guam, Saipan, Kwajalein and Pago Pago on green sea turtles (*Cheloniamydas*), hawksbill sea turtles (*Eretmochelysimbricata*), North Pacific distinct population segment of loggerhead sea turtles (*Carettacaretta*), olive ridley sea turtles (*Lepidochelysolivacea*), leatherback sea turtles (*Dermochelyscoriacea*), Main Hawaiian Islands false killer whale distinct population segment (*Pseudorcacrassidens*), humpback whales (*Megapteranovaeangliae*), sperm whales (*Physetermacrocephalus*), fin whales (*Balaenopteraphysalus*), blue whales (*Balaenopteramusculus*), sei whales (*Balaenoptera borealis*), North Pacific right whales (*Eubalaena japonica),* the Indo-West Pacific distinct population segments of the scalloped hammerhead shark (*Sphrynalewini*), Hawaiian monk seals (*Neomonachusschauinslandi*), Hawaiian monk seal critical habitat; and the coral species *Acropora globiceps, A. jacquelineae, A. retusa, A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata*. We believe that the most likely potential impacts or stressors are:

1. Exposure to elevated noise levels;
2. Temporary disturbance from human activity;
3. Entanglement;
4. Collisions with vessels; and
5. Exposure to waste and discharge.

1. Exposure to elevated noise levels

As described earlier, the proposed action would include the operation of NOAA *Ship Okeanos Explorer's* mapping sonar systems, as well as the underwater positioning systems associated with the ROVs Deep Discoverer and Seirios.

The effects on marine life from exposure to high intensity noise vary with the frequency, intensity, and duration of the sound source, and the physiology and hearing characteristics of the exposed animal. Exposure to very high levels of sound can cause soft tissue injuries that could directly result in fatality. Exposure to lower levels at frequencies within the animal's range of hearing may cause injury in the form of permanent hearing damage, also referred to as permanent threshold shift (PTS). Exposure to even lower levels may cause behavioral effects

that include temporary threshold shifts (TTS), temporarily masked communications and/or acoustic environmental cues, alteration of ongoing behaviors, and areal avoidance.
Okeanos Explorer sonars will be turned on for the entirety of each cruise and will only be turned off during ROV dives or CTD rosette casts. We will minimize turning the system on and off as a precautionary measure to avoid possible startling of animals. When the sonars are powered down for ROV and CTD operations, the flexible "soft start" mode will be used to restart the multibeam first. The soft start mode is a delay function, starting the sonar transmissions at a low output level and then gradually increasing to the level required for optimal bathymetry data collection. The soft start modes can either be set at -10 or -20 decibels with a 0 to 15 minute ramp up time to the desired power. We can select -10 dB, -20 dB or maximum transmit power. Maximum transmit power is recommended by Kongsberg for maximizing the mapping swath coverage. In the deepest operating mode the EM302 is 243 dB re 1 microPa. When operating in shallow modes the decibels are 238 dB re 1 microPa. Because the EK60, SBP, and ADCP sonars are of lower intensity than the multibeam, and are run simultaneously with the multibeam, these protective measures will help avoid inadvertent exposure of marine mammals, sea turtles, and hammerhead sharks to all three sonars. If the multibeam sonar is not being used, but other sonar systems are being turned on, they will be started in lower power settings and will gradually (over a 15 minute time period) be adjusted to higher power settings as appropriate for the water depths. This approach essentially mimics the approach of the "soft-start" mode of the multibeam.

We therefore do not believe the *Okeanos Explorer* mapping activities will have any significant adverse effects on ESA-listed species in the monuments, sanctuaries and the waters around the American Samoa and the Main Hawaiian Islands. Similar opinions regarding the safety of multibeam mapping activities have been expressed by the NMFS Southwest Fisheries Science Center in their draft programmatic environmental assessment. Even so and in order to mitigate impacts to marine mammals, observers on the *Okeanos Explorer's* bridge will carefully monitor for the presence of marine protected species, and permitted personnel would follow established best management practices to minimize disturbance. If cetaceans are present within 400 meters of the ship, the vessel would stop until the animals depart the area. We will try to minimize turning sonar systems on and off to reduce the possibility of startle responses by marine mammals that could be in the vicinity of the ship, particularly at night. Leaving them on also provides marine mammals advanced warning that the ship is in the vicinity, further reducing the possibility of a collision. When the systems have been shut down for any reason, such as during an ROV dive or CTD cast, the multibeam soft start mode – a delay function, starting sonar transmissions at a low output level and gradually increasing - would be used to minimize any

impact on cetaceans. Only after the multibeam has been brought from soft start to full power would the SBP sonar then be turned back on.

NMFS Shift Thresholds

The current NMFS-defined threshold for the onset of PTS in cetaceans from exposure to in-water sounds is ≥ 180 dB re 1 µPa. The same threshold for pinnipeds is ≥ 190 dB re 1 µPa. Exposure to impulsive in-water sounds at ≥ 160 dB re 1 µPa is the threshold for the onset of TTS and behavioral disturbance for all marine mammals, whereas the same threshold for exposure to non-impulsive sound (continuous noise) is ≥ 120 dB re 1 µPa. Because the sonar systems to be used in this action are considered impulsive sources, the 160 dB re 1 µPa threshold for the onset of TTS and behavioral disturbance would apply, and significant exposure above that level at a frequency within the animal's hearing range would be considered an adverse impact.

Acoustic Modeling

Accurately predicting the 160 dB re 1 µPa isopleth from any sound source is difficult, but particularly so for multibeam sonar. Using the simplest example, that of an unfocused, omni-directional single point source in unbounded homogenous water, sound will disperse from the source in a spherical pattern. In this example, the equation $RL = SL – (20\text{Log}R + \alpha R)$ estimates spherical spreading loss where RL = received level; SL = source level; R = range in meters, and α is the absorption coefficient in water at 1 m as a function of frequency (Lurton & DeRuiter 2011). In addition to source level and frequency, the distance for which different decibel levels are experienced away from the source is also dependent on a number of other factors that include density, salinity, and the amount of suspended solids in the water. Detailed information on these naturally occurring factors in the marine environment is rarely available and consequently they are generally not considered in the equations.

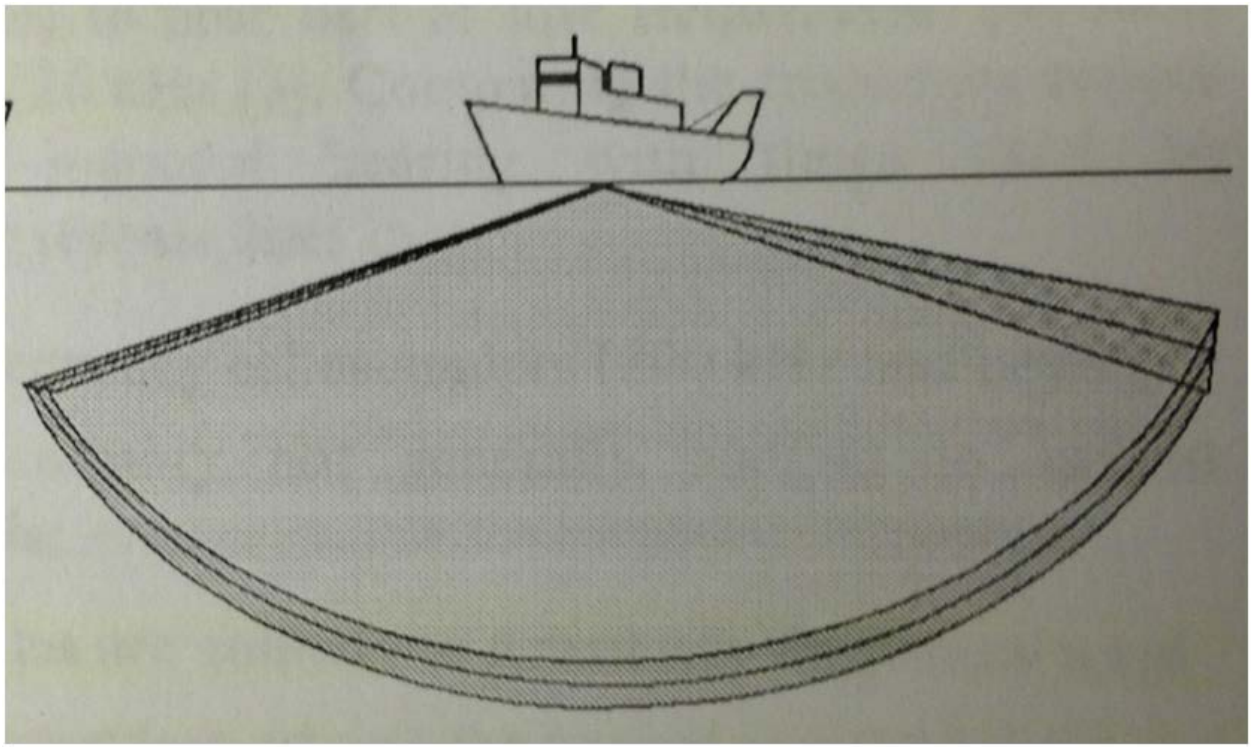
Assuming for the moment that the EM 302 system is a simple omni-directional point source, then the 180 dB and 160 dB re 1 microPa isopleths would fall at approximately 1,000 m and 2,800 m, respectively, based on a α value of 6 dB/km (@30 kHz) as computed from representative CTD casts of local oceanographic conditions in the vicinity of the monuments.

Acoustic Modeling - Generic Multibeam

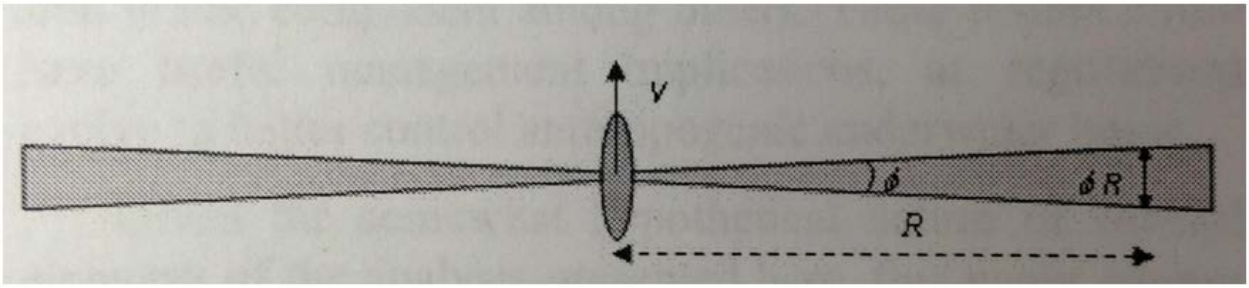
However, multibeam systems are not simple omni-directional point sources but rather are focused sonar arrays that use "selective angular directivity" and furthermore transmit "very short pulses at limited ping rates" (Lurton &DeRuiter 2011). These two characteristics of this type of sonar decrease the potential sound exposure level as well as decrease the probability of the

animals being subjected to TTS threshold intensity levels. Figure 1 provides diagrams excerpted from Lurton &DeRuiter (2011) showing the generalized ensonification volume of a generic multibeam sonar system from both horizontal (Fig 1a) and overhead (Fig. 1b) perspectives. Fig 1b also provides the variables used to estimate the exposure time of a stationary animal as the ship passes on its survey track. The exposure time can be estimated by ØR/V where Ø is the longitudinal transmitting lobe aperture in radians, R is the range from the source to the animal, and V is the speed of the ship.

The aperture of the EM 302 on the Okeanos is 0.5° but since it would operate in dual swath mode in shallower water it will be conservatively treated as 1° (same as the Falkor), yielding a Ø value of 0.02 radians. The ship will be mapping at 8 knots (4.116 m/s). At 200m distance, the exposure times for a stationary animal caught in the ensonification plane of the EM 302 are therefore calculated to be 1 second. This exposure time increases linearly with R so that at 1000 m distance, the exposure time increases to 5 seconds.



1a)



1b)

Figure 1: Diagrams showing a typical multibeam ensonification volume from a) the horizontal and b) the overhead prospective (From Lurton &DeRuiter 2011).

Acoustic Modeling - Okeanos Explorer EM 302 Multibeam

Dr. Xavier Lurton (IFREMER) has recently created a simplified model of the specific behavior of the *Okeanos Explorer's* EM302 system in terms of direct radiated level inside the water. Model output graphics showing radiated sound transmission patterns in the horizontal and vertical planes of the water column are provided in Appendix D(Case Study: Okeanos Explorer - EM 302 - Hawaii). This analysis represents our best estimates of radiated sound levels given the current configuration of the sonar. The assumptions behind the model are:

1) The Deep Mode of the EM302 was used (i.e., longest pulse length and highest power -- or worst case scenario).
2) The model uses the current best understanding of the directivity pattern of the sonar that includes both the individual transducer directivity and the transmit sector beam forming.
3) The model does not include any masking effects by the hull or gondola. The draft of the transducer "gondola" on the Okeanos Explorer is 5.65 m below the water line. This configuration causes a baffle effect from the gondola structure and the hull above, and further reduces the likelihood of direct ensonification of an animal on or near the surface, especially a short distance away from the ship.
4) A value of 6 dB/km @ 30 kHz was used as a first-order approximation of the absorption coefficient representative of oceanographic conditions in the vicinity of PMNM, the PRIMNM, the Main Hawaiian Islands and the Geologists Seamounts.

Figure 1c (below) shows horizontal plane (top-down) views of sound pressure levels at three different receiving depths within the water column directly below the transducer: 10m, 50m, and 200m. These figures demonstrate the remarkably narrow zone of ensonification in the along-

track direction. Note the difference in the 160 dB/µPa isopleth in the beam plane and elsewhere around the ship. For all but this plane, the isopleth occurs at 400 m or less from the ship. For animals directly within the beam plane, sound pressure levels drop below 160 dB/µPa within 1500 m of the ship near the surface, and within 1800 m at a depth of 200 m. Submerged animals more than 400 m from the ship that are caught in the ensonification volume as the ship passes will be only briefly subjected to the elevated sound levels occurring inside the transmitter beam pattern. Furthermore, the narrow fan-shaped beam patterns of the Okeanos Explorer system provide ample possibilities for the animals to quickly escape the sound. The only possible scenario for more extended exposure would be if the animal were to suddenly start moving in the exact direction and speed as the ship while within the narrow ensonification beam, which is unlikely. This very selective spatial pattern of the sound radiation makes this configuration very different from seismic airgun sources (omnidirectional) or military mid-frequency active sonars that are often directed horizontally through the water column.

Figure 1d (below) shows the across track radiation pattern for the full water column below the EM302 transducer, with a close up of the near surface region. The 160 and 180 dB/µPa isopleths are plotted to show ranges from the sonar relevant to potential PTS and TTS impacts on cetaceans.

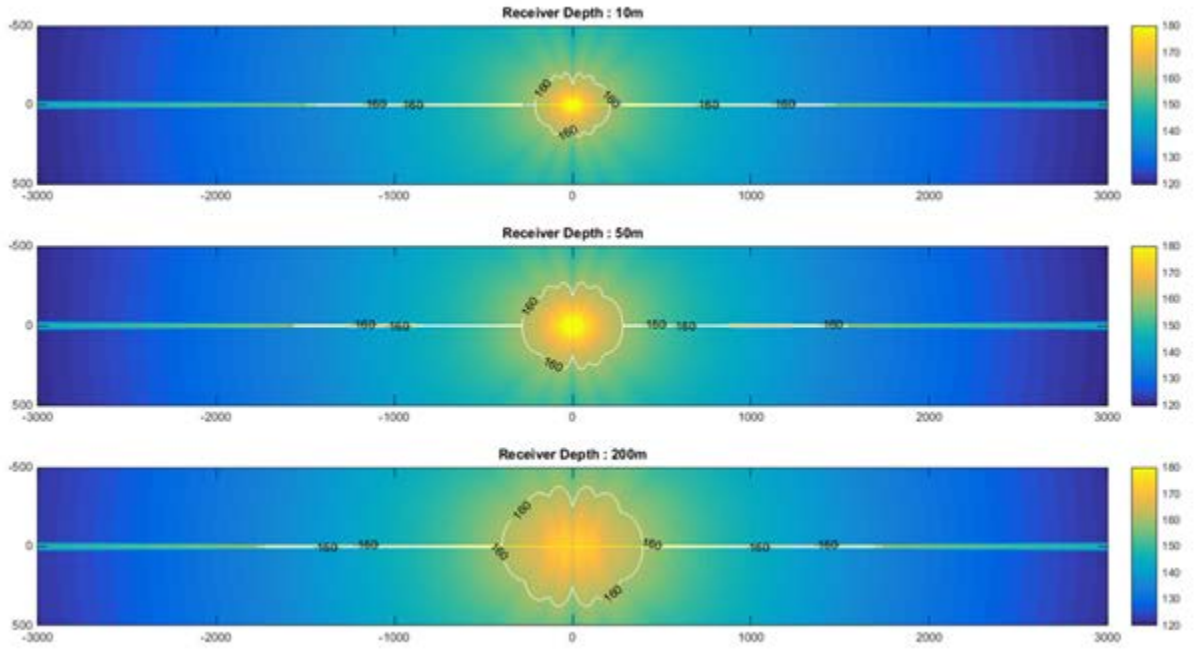


Fig. 1c: Top down view image of the EM302 radiated beam pattern at several depths (10m, 50m and 200m created by Dr. Xavier Lurton (IFREMER). The ship track is straight up, the Y axis is distance in meters while the X axis in distance in meters. The color scale is signal strength in decibels (dB).

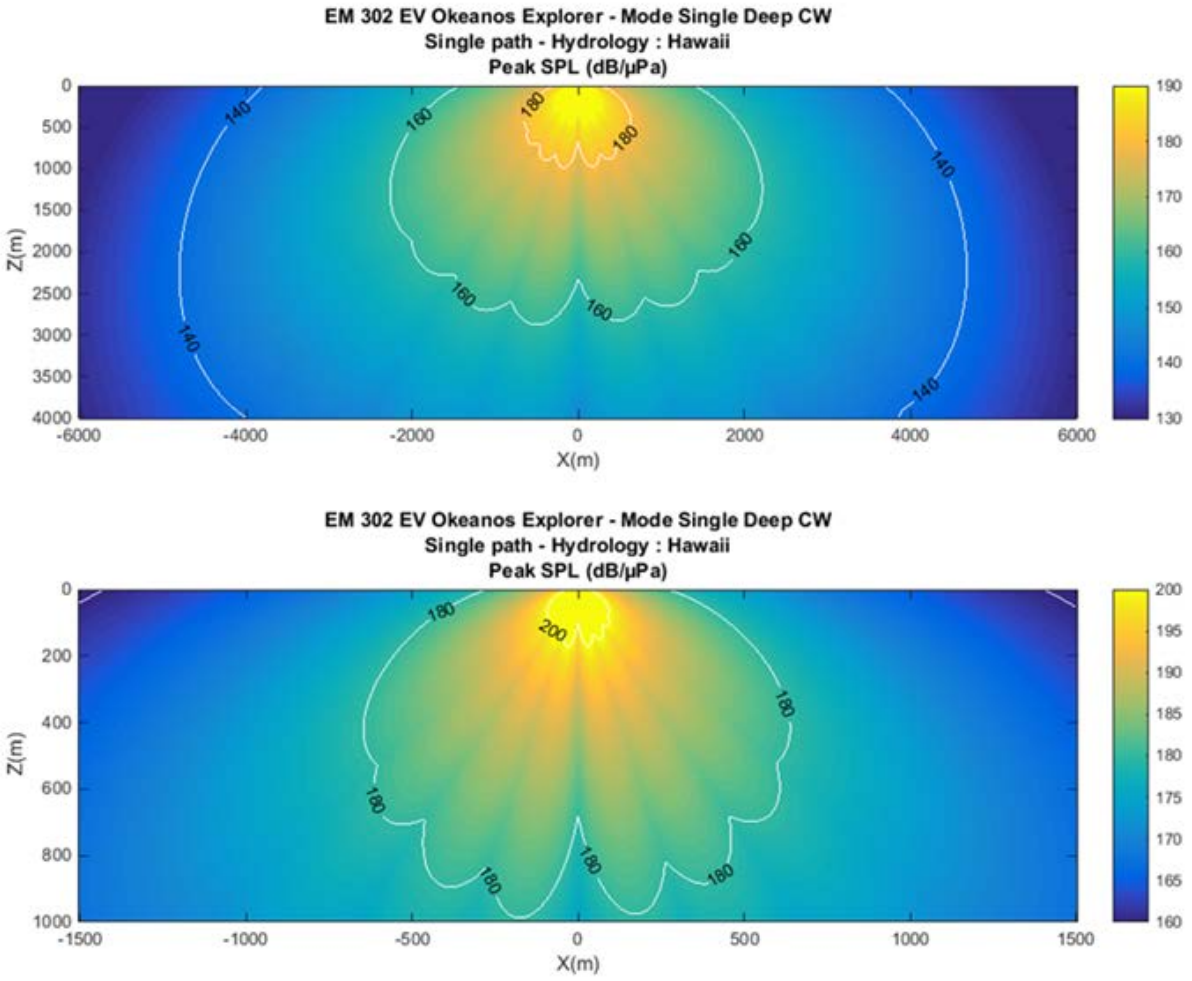


Fig. 1d: Model created by Xavier Lurton (IFREMER) of the EM302 radiated transmission patterns with the 140, 160 and 180 dB/µPa isopleths plotted for the full water column (top) and of the near surface region (bottom) of a single ping, looking forward through the water column in the along track direction. The y axis is depth below sea surface in meters, and the x axis is distance in meters. The color scale is signal strength in decibels (dB).

Additional Considerations Specific to EM 302 Multibeam

Transmit pulse forms and rates are two other differences that distinguish multibeam sonar from other types of sonar and acoustic sources and further reduce their potential threat to ESA-listed species. Sound is not transmitted continuously from these systems but rather in extremely short pulses (i.e., pings). Ping durations obtained from the EM302 manual (page 36) are very brief -- 0.7 to 5.0 milliseconds. The ping rate or in other words, how frequently pings are emitted, is depth dependent and is provided for different depths in tables 2 and 3 of the manual and show that at a depth of 400 m, the ping rate is 30 pings/min, decreasing to 3.6/min at 4000 m. Another way of putting it is that when the ship is mapping in 400 m of water, any submerged animal within the ensonification volume will be subjected to only a 0.7 millisecond ping every 2 seconds. When the ship is mapping in 4,000 m of water, a submerged animal could potentially experience a 5-40 millisecond ping every 17 seconds. The fore-aft width of the ensonification volume at 200 m distance from the ship is approximately 4 meters. Based on a mapping speed of 8 knots and using this width as an example, this distance will be traversed by the ship in 1 second. Therefore, a submerged stationary animal 200m from the ship while it is surveying depths of 400 m should be subjected to at most a single ping of 0.7 milliseconds of duration. If the encounter occurs where the water depth is 4,000 m, the chances are low that it will even be subjected to a single ping.

Another consideration is the hearing range of the various species covered under the ESA. As mentioned earlier, the EM 302 system operates at 30 kHz. Figure 1e provides a general diagram of the hearing ranges of the various groups of marine mammals that was originally presented as Fig 4.2-3 of the Southwest Fisheries Science Center's Draft Programmatic Environmental Assessment released in April, 2013. The frequency range of the EM 302 system was superimposed on the bars. The first observation from this figure is that the system is not expected to produce sound audible to the low frequency cetacean group (baleen whales or Mysticetes) whose hearing range is believed to be below 30 kHz.

The second observation is that the system is also transmitting at the upper portion of the pinniped hearing range. Together, these observations suggest that toothed whales are likely to be the ESA group potentially most affected by the mapping activities. Within the project area, the sperm whale and the false killer whale are the only species of toothed whales that are ESA listed. Observers will therefore pay particular attention to spotting and avoiding these two species.

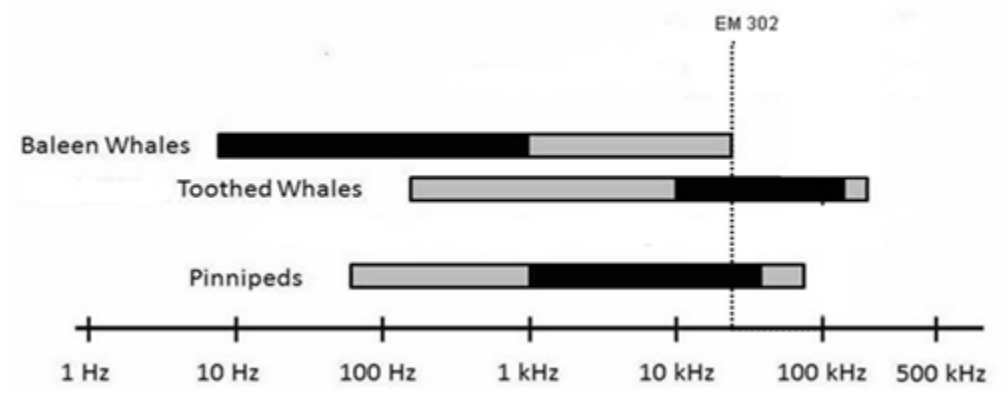


Fig. 1e: Hearing ranges of ESA-listed marine mammals groups in Hawaiian waters. Black bars show the most sensitive portion of these ranges. This figure was modified from Figure 4.2-3 of NOAA's Southwest Fishery Science Center draft Programmatic EA (see text for more details).

On December 23, 2013, NOAA released for public comment it's new "Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals: Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts". The second revision of the document, dated July 23, 2015, is available at http://www.nmfs.noaa.gov/pr/acoustics/draft%20acoustic%20guidance%20July%202015.pdf (last accessed 1/13/16). The document is in review and should be finalized in early 2016. Included are updated acoustic threshold levels for the onset of both PTS and TTS that "will replace those currently in use by NOAA." The updates include PTS and TTS levels for both impulsive and non-impulsive sound sources for 5 marine mammal functional hearing groups that include low, mid, and high-frequency cetaceans, phociid pinnipeds, and otariid pinnipeds. In addition, the updates include the addition of a second new metric for assessing acoustic activities: PTS and TTS cumulative sound exposure level (SELcum) thresholds. These thresholds are calculated with and without marine mammal auditory weighting functions. Since SELcum is not as yet being used for ESA recommendations, we only examined what the new sound intensity thresholds will be, now calculated as dB peak values instead of dB rms values. Tables 6a and 7 in that guidance document provide these threshold values. TTS peak decibel levels range from 195 dB re 1 microPa for high frequency cetaceans, 224 dB re 1 microPa for low frequency cetaceans, and 229 dB re 1 microPa for both families of pinnipeds. While dBpeak (maximum value) is calculated differently than dBrms, the rule of thumb is that the latter are generally 3 dB less than the former (Tom Weber, personal communication and see Fig 1f below). These new TTS thresholds are based on the most current science available and suggest that the

Okeanos Explorer multibeam system will not exceed these levels for any of the functional groups if they are further than 100 m from the ship at the surface and 300 m from the ship if diving directly below the transducer.

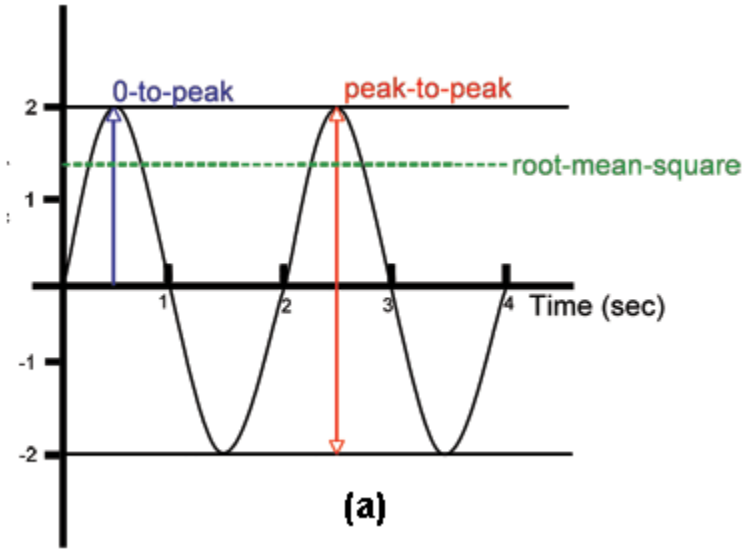


Fig. 1f: Relationship between RMS and Peak dB measurements (from http://www.http://acousticslab.org).

Acoustic Doppler Current Profilers (ADCPs)

Hull-mounted ADCP transducers project four beams into the water column to record backscatter from the water column and compare the Doppler shift between the 4 beams to generate profiles of water velocity. ADCPs are Doppler sonar systems, which transmit acoustic signals and listen to the echoes of those signals returned from materials floating with the currents throughout the water column. Like other sonars, the depth range of ADCPs is directly related to the frequency of the system – the lower the frequency the greater the range capability of the sonar. However, lower frequencies provide less vertical resolution than higher frequencies. The *Okeanos Explorer* is outfitted with two new ADCPs – one high frequency (Teledyne RDI Workhorse Mariner 300 kHz) system, and one lower frequency system (Teledyne RDI Ocean Surveyor 38 kHz). The 300 kHz ADCP has a typical range of approximately 110 meters and a maximum range of 165 meters, while the 38 kHz system has a range between 900-1000 meters depending on operating mode and oceanographic conditions. These same two ADCP systems are also installed and utilized on the R/V *Kilo Moana* operated by the University of Hawaii Marine Center.

The two new ADCPs are designed to gather data out to a maximum depth of 165 m (300 kHz) and 1000 m (38 kHz), so the associated sound source levels will be much less than the ship's existing permitted deep water (8000m and greater) echo sounders (EM320 multibeam, EK60 18 kHz, and Knudsen sub-bottom profiler). The new ADCP sonars are all higher frequency than the existing *Okeanos* sonars, and thus all have considerably shorter ranges due to the more rapid attenuation of higher-frequency sounds in the ocean.

Both ADCP instruments on the *Okeanos Explorer* are manufactured by Teledyne RD Instruments. Teledyne has provided OER with a proprietary technical memorandum dated April 28, 2015 that provides sound pressure levels associated with their ADCP instruments. The following relevant information has been quoted from this memo:

38 kHz ADCP:
"The acoustic pressure along each beam is estimated at 227 dB re micro-Pascal @ 1 meter, at a center frequency of 38.4kHz with a +/-3dB bandwidth of 37.2-39.6kHz, with a typical pulse duration of 37.0milliseconds, and a typical pulse repetition rate of 3.0 seconds. The acoustic pressure along each beam is estimated at 180.0dB re micro-Pascal @ 182 meters. The acoustic pressure 20 degrees off of the main lobe of each beam is estimated at 180.0dB re micro-Pascal @ 22 meters."

300 kHz ADCP:
"The acoustic pressure along each beam is estimated at 215 dB re micro-Pascal @ 1 meter, at a center frequency of 307.2kHz with a +/-3dB bandwidth of 268.8-345.6kHz, with a typical pulse duration of 5.7milliseconds, and a typical pulse repetition rate of 0.75 seconds. The acoustic pressure along each beam is estimated at 180.0dB re micro-Pascal @ 40 meters. The acoustic pressure 20 degrees off of the main lobe of each beam is estimated at 180.0dB re micro-Pascal @1.8 meters."

To put these values in perspective, the EM302 multibeam system has a source level of 243 dB re 1µPa, and the 180 dB/µPa isopleth is located at a range of approximately 1000 meters away from directly below the transducer array. This means the sound pressure from the 38 kHz ADCP is 180 dB/µPa at only 182 meters, compared to 1000 meters for the multibeam. The acoustic beams from the ADCPs are also very focused, with sound energy levels that decrease rapidly away from the main lobe of the transducer. Given the more limited ranges, narrow beams, and sound pressure values reported for the ADCPs, they are expected to have minimal impacts on species of concern. Teledyne states that it has never received a report any marine mammals being affected by its ADCPs.

Background Information: NSF 2011 Programmatic EIS

The National Science Foundation's 2011 document "Programmatic Environmental Impact Statement/Overseas Environmental Impact Statement for Marine Seismic Research Funded by the National Science Foundation or Conducted by the U.S. Geological Survey" provides a detailed analysis of potential impacts of seismic, multibeam, and sub-bottom sonars on sea turtles and marine mammals and provides useful information. The document evaluates deep water multibeam systems ranging from 12-95 kHz. The EM302 operates at 30 kHz so falls within the frequency, source levels, pulse lengths and beam widths evaluated by this report. The SBP on the *Okeanos* is of the same type evaluated in the report. With respect to multibeam echosounders (MBES) and sub-bottom profilers (SBP), the following direct excerpts are conclusions of this document regarding the potential impact on sea turtles, mysticetes, odontocetes, and pinnepeds:

Sea Turtles

"Operation of the MBES, SBP, or pingers is not expected to affect sea turtles, because the associated frequency ranges are above the known hearing range of sea turtles. The SBP operates at 3.5 kHz with a maximum source output of 222 dB re 1 µPa-m. Thus, the frequency range of the SBP is outside the known detection range of sea turtles based on available data. As a result, sea turtles are not expected to be capable of hearing the higher frequency sounds produced by SBPs. Furthermore, the intermittent and narrow downward-directed nature of the MBES and SBP as emitted from the transiting seismic vessel would result in no more than one or two brief ping exposures."

Mysticetes

"During the proposed marine seismic surveys, the pings from the MBES, SBP, and pingers would be very short (<1-64 ms) (Table 2-5).

Table 2-5. Acoustic Parameters of MBESs, SBPs, ADCPs, Pingers, and Acoustic Releases Used by NSF-Funded or USGS Research Vessels Conducting Marine Seismic Research.

Acoustic Source		***Frequency (kHz)***	***Source Level (dB re 1 µPa-m)***	***Pulse Length (ms)***	***Beam Width****	
					Fore-aft	***Athwart.***
MBES	Seabeam 2000	12	234	7-20		
	Seabeam 2100/12	12	237	<1 – 12	2^o x 2^o	
	Kongsberg EM122	12	242	2-15	1^o x 2^o	150^o
	Simrad EM 120/122	12	242	2, 5,15	1^ox1^o, 1^ox2^o	150^o
	Simrad EM 300	30	237 (1^o), 231 (2^o)	0.7, 2,15	1^ox1^o, 1^ox2^o	
	Simrad EM 1002	95	225 (3^o)	0.2, 0.7, 2	2^o x 2^o	
	Krupp-AtkasHydroSweep DS	15.5	237		2.3^o	

SBPs	3.5	222	64	27 ^{o}	
ADCPs	38-1,200	224		30 ^{o}	
Pingers	55-110	183			
Pingers	12	192	0.5, 2, 10		
Acoustic Releases	9-15	187	8		

Notes: *The beams of all acoustic sources would be directed downward from the research vessel. Athwart = athwartship. *Sources:* USCG 2001; L-DEO and NSF 2003e; SIO and NSF 2003; University of Washington 2003; SIO and NSF 2004; SIO 2005a, b; UAF and NSF 2005; University of Hawaii 2005; WHOI.

Thus, a given mammal would not receive many of the downward-directed MBES or SBP pings as the vessel passes by. In the case of the MBESs that operate at 30 kHz or higher, their operating frequencies are too high to have any effects on mysticete behavior. Source levels of the SBPs, another type of echosounder, are lower (maximum source level 222 dB re 1 microPa [rms]) than those of the MBES discussed above (Table 2-5). Thus, there is even less likelihood of TTS occurring through exposure to SBP sounds, even in an animal that is briefly near the source. The SBP is usually operated simultaneously with other higher-power acoustic sources. Many marine mammals, particularly mysticetes, move away in response to the approaching higher-power sources or the vessel itself before the mammals are close enough for there to be any possibility of effects from the SBP's less-intense sounds. The possibility of PTS through exposure to MBES or SBP sounds is considered negligible and PTS is not expected to occur. Burkhardt et al. (2008) concluded that immediate direct injury was possible only if a cetacean dived under the vessel into the immediate vicinity of the transducer. Furthermore, PTS (or any injury or pathological effect) has never been demonstrated for any marine mammal exposed to echosounders such as the proposed MBESs and SBPs."

Odontocetes

"In summary, sounds from all the MBESs would be readily audible to most and possibly all odontocetes when animals are within the narrow angular extent of the intermittent sound beam. As with baleen whales, odontocete communications will not be masked appreciably by MBES, SBP, or pinger signals given their low duty cycles, the brief period (i.e., seconds) when an individual mammal would potentially be within the downward-directed MBES or SBP beam from a transiting vessel, and the relatively low source level of a pinger. Operation of MBESs, SBPs, and pingers is not likely to impact odontocetes. The project MBESs, SBPs, and pingers are not expected to induce TTS. The possibility of PTS through exposure to MBES or SBP sounds is considered negligible."

Pinnipeds

"The SBPs associated with the proposed marine seismic activities operate in the MF range of approximately 3.5 kHz with a maximum source output of 222 dB re 1 μPa-m (rms). The frequency range of the SBPs is within the frequency band audible to pinnipeds. Masking effects due to MBES, SBP, or pinger signals are expected to be minimal or non-existent. Thus, brief exposure of pinnipeds to small numbers of signals from the MBES or SBP would not result in a —take by harassment as defined by NMFS and the ESA. The project MBESs, SBPs, and pingers are not expected to induce TTS. Although the MBESs, SBPs, and pingers can presumably be heard by pinnipeds, their operation is not likely to affect pinnipeds. The intermittent and narrow downward-directed nature of the MBESs and SPBs would result in no more than one or two brief ping exposures of any individual pinniped given the movement and speed of the vessel and animal; such brief exposure to this sound is not expected to cause injury or PTS based on results of limited studies of some pinniped species."

As described above, no marine mammals or turtles would be exposed to sound intensity at or above the levels required for the onset of TTS or PTS, but those species exposed may experience behavioral responses as the result of exposure to the project's sonar noise. Based on the best information available, including the motility of free-ranging marine mammals and turtles in the water column, the propensity for these species (especially marine mammals) to avoid obtrusive sounds, and the proposed mitigation measures, mild alert and startle responses, avoidance of the survey vessel are the most probable responses to exposure. No measurable impacts are expected to occur on the ability of marine mammals and turtles exposed to forage, shelter, navigate, reproduce, and avoid predators and other threats such as vessels. Therefore, the expected behavioral responses expected to result from exposure to the project's sonar noise would have insignificant effects on ESA-listed marine mammals or turtles that may be in the area.

Acoustic Information Related to Elasmobranchs

A sound source produces both pressure waves and actual motion of the medium particles. In fish, particle motion is detected using the inner ear, while pressure signals are initially detected by the gas-filled swim bladder or other bubble of air in the body. These air filled spaces vibrate and serve as a medium to "reradiate" (or resend) the signal to the inner ear as a near field particle motion (Popper, 2008) in those species where a connection exists between the swim bladder and the inner ear.

While the air bladder in fish may play a role in sound detection, its primary purpose is for buoyancy. Elasmobranchs (sharks and rays) on the other hand do not have air bladders. Instead elasmobranchs have developed overly large livers which provide buoyancy. Because of this lack of an air bladder

elasmobranchs are unable to detect pressure waves, instead sharks detect the kinetic stimulus rather than the acoustic pressure wave. Unlike acoustic pressure, the kinetic stimulus is inherently directional, but its magnitude rapidly decreases as it propagates outward from the sound source in the near field (Corwin, 1981).

Although research has shown that the upper range of behavioral sensitivity to this kinetic stimulus is 600 to 800 Hz in both scalloped hammerheads, *Sphrynalewini* (Olla, 1962), and the lemon shark, *Negaprionbrevirostris* (Nelson, 1967); sharks are more low frequency sensitive, with the most effective spectral range occurring from 40 Hz to 300 Hz (Myrberg, 1978). Above these frequencies both the behavioral sensitivity and the sensitivity of the ear fall off rapidly (Corwin, 1981).

As previously described, the NOAA Ship *Okeanos Explorer's* scientific sonars operate at 30 kHz (the multibeam system), 18, 38, 70, 120, 200, and 333kHz (split-beam fisheries sonars), 3.5 kHz (the chirp sub-bottom profiler sonar), and 38 kHz and 300 kHz (ADCPs).All of these frequency ranges are well above the hearing sensitivity ranges for elasmobranchs based on the research that has been done to date.

Based on the best available scientific information which indicates that the multibeam, split-beam and chirp sub-bottom profiler operate and frequencies above the hearing ability for all elasmobranchs (including scalloped hammerheads), and the propensity for the species to avoid human activities; no measurable impacts are expected to occur on the ability of the species to forage, navigate, reproduce, and avoid predators and other threats such as vessels. Therefore, the expected behavioral responses expected to result from exposure to the project's sonar noise would have insignificant effects on the ESA-listed Indo-Pacific distinct population segment of the scalloped hammerhead shark.

2. Temporary disturbance from human activity

Nearly all the activities associated with ROV dives and vessel operations in the PMNM; the marine environment around Oahu and the big island of Hawai'i; the Geologists and Musicians Seamounts; all of the Pacific Remote Island Areas composing the PRIMNM; the CNMI and the MTMNM; the vicinity of American Samoa and the NMSAS; the RAMNM; and the vessel transit areas between Honolulu, Hawai'i, Guam, Saipan, Kwajalein and Pago Pago involve work in the marine environment where ESA-listed species are known to occur. Marine species may experience a startle reaction and resulting stress should they encounter human activities in the water. The reaction could range from one extreme where an animal calmly approaches and

investigates the person or gear, to a panicked response in which the animal flees, which could result in injury or reduce vitality.

The following guidelines for in-water work in the presence of marine protected species and other marine wildlife have been provided by NOAA's National Marine Fisheries Service and Office of National Marine Sanctuaries:

1) A distance of at least 100 yards from humpback whales will be maintained and at least 50 yards from other marine mammals and sea turtles (e.g., dolphins, turtles and Hawaiian monk seals).
   a) All in-water work shall be postponed when these ESA-listed marine species are within these distances of the proposed work, and shall only begin after the animals have voluntarily departed the area.
   b) If ESA-listed marine species other than humpback whales are noticed within 50 yards after work has already begun, that work may continue only if, in the best judgment of the chief scientist, that there is no way for the activity to adversely affect the animal(s). No work shall occur unless at least 100 yards from humpback whales;
2) No attempt will be made to touch, ride, feed, or otherwise interact with any marine protected species:

Sea turtles, marine mammals and sharks usually avoid human activity. The most likely effect on this interaction will be a moderate to high energy avoidance behavior resulting in the animal temporarily leaving the immediate area unharmed. Considering this avoidance behavior, in combination with the nature of the activities, and implementation of the above mentioned guidelines, we have determined that disturbances related to vessel operations and ROV dives will be infrequent, would be temporary in nature and never reach the scale where it would affect the individual's health, and thus are expected to result in insignificant effects on ESA-listed marine species discussed in this biological evaluation.

3. Entanglement

The planned cruise would include the deployment of a CTD or UCTD, which would be deployed over the side of the vessel with a cable; and a ROV, which would be tethered to the vessel; creating the potential for entanglement of the marine species considered in this consultation should any of those animals encounter the cable or tether. However, in addition to compliance with the guidelines listed above, which would require maintaining watch for and avoiding protected marine species, we propose to postpone deployment of these devices when sea turtles, marine mammals or scalloped hammerhead sharks are within 50 yards of the vessel, and all

individuals participating in the activity would closely monitor the instrument cables at all times while they are deployed. Based on the expected compliance with the required protective measures, and the expectation that protected marine species would be widely scattered throughout the proposed areas of operation, we consider it extremely unlikely that any of those animals would come into contact with any of the cables, and have determined that the risk of entanglement would be discountable.

4. Collisions with vessels

Sea turtles and marine mammals must surface to breathe, and they are known to rest or bask at the surface. Therefore, when at or near the surface, these animals are at risk of being struck by the vessel or its propellers during small boat operations and vessel transits to and from the monuments. Potential injuries and their severity will depend on the speed of the vessel, the part of the vessel that strikes the animal, and the body part impacted. Injuries may include bruising, broken bones or carapaces, and lacerations that can often result in death.

Existing information about sea turtle sensory biology suggests that sea turtles rely more heavily on visual cues, rather than auditory, to initiate threat avoidance. Research also suggests that sea turtles cannot be expected to consistently notice and avoid vessels that are traveling faster than 2 knots (kts) (Hazel et al., 2007). Vanderlaan and Taggart (2007) report that the severity of injury to large whales is directly related to vessel speed. They found that the probability of lethal injury increased from 21%, for vessels traveling at 8.6 kts, to over 79% for vessels moving at 15 kts or more. Additionally, since collisions with whales have been reported for both slow and fast moving craft, it appears that, in at least some situations, whales may either be unaware of a vessel's presence or unable to resolve the vessel's proximity and/or vector of approach based on available acoustic cues. Consequently, vessel operators must be responsible to actively watch for and avoid sea turtles and marine mammals, and to adjust their speed based on expected animal density and on lighting and turbidity conditions to allow adequate reaction time to avoid marine animals.

The following guidelines for vessel operation in the presence of marine protected species and other marine wildlife have been provided by NOAA's National Marine Fisheries Service and Office of National Marine Sanctuaries:

1) A distance of at least 100 yards from humpback whales will be maintained and at least 50 yards from other marine mammals and sea turtles (e.g., dolphins, turtles and Hawaiian monk seals).
2) Vessel speed will be reduced to 10 knots or less when operated in the vicinity of marine mammals or sea turtles; Operators shall be particularly vigilant to watch for turtles at or near the surface in areas of known or suspected turtle activity, and if practicable, reduce vessel speed to 5 knots or less.
3) Marine mammals and sea turtles shall not be encircled or trapped between boats or shore;
4) If approached by a marine mammal or turtle while on a boat, the vessel's engine shall be placed in neutral and the animal allowed to pass. If approaching a marine protected species, vessel movement should be from the rear of the animal.
5) No attempt to pursue marine mammals or sea turtles shall be made;
6) A vessel shall be operated in a predictable manner in the presence of marine wildlife, and when leaving an area where marine life is observed, will be slowly maneuvered; and
7) No attempt to herd, chase, or separate groups of marine mammals or females from their young shall be made.
8) All vessels operating in areas where ESA-listed species are present will continue to follow MARPOL discharge protocols, but will postpone any authorized discharge if any protected species are within 100 yards of the vessel.

The scalloped hammerhead shark is a circum-global species that lives in coastal warm temperate and tropical seas. It occurs over continental and insular shelves, as well as adjacent deep waters, but is seldom found in waters cooler than 22° C (Compagno 1984, Schulze-Haugen and Kohler2003). It ranges from the intertidal and surface to depths of up to 450-512 m (Sanches 1991, Klimley 1993), with occasional dives to even deeper waters (Jorgensen et al. 2009). Tagging studies indicate that the species rarely makes long-distance oceanic migrations, but instead disperses along continuous coastlines, continental margins, and submarine features, such as seamounts (Miller et al., 2013).

Although the species is present in much of the Pacific, ranging from Japan and China to New Caledonia in the west, to the Gulf of California to Ecuador in the east; the species range in the central Pacific Ocean is primarily comprised of the Hawaiian Archipelago, which includes the main islands and the Northwestern Hawaiian Islands (Miller et al, 2013). Johnston Atoll is also included in this range due to its proximity to the Hawaiian Archipelago (Miller et al., 2013). Individuals of the species may be found alone, in pairs, or in schools. Adult aggregations may be found offshore over seamounts and near islands, but are most common near the Galapagos, Malpelo, Cocos and Revillagigedo Islands, and within the Gulf of California (Compagno 1984, CITES 2010, Hearn et al. 2010, Bessudo et al. 2011).

Based on the low number of trips, expected adherence to established guidelines, the expectation that protected marine species would be widely scattered throughout the proposed areas of operation, and the limited populations of the protected species in these areas; we have determined that the risk of a vessel collision with a protected marine species would be discountable.

5. Vessel waste and discharge

While operating within the PMNM, all vessels are required to comply with the following regulations (71 FR 51134, 50 CFR Part 404) with regards to permitted types of discharge:

- Discharging or depositing any material or other matter into the Special Preservation Areas (SPAs) or the Midway Atoll Special Management Area (MASMA) except vessel engine cooling water, weather deck runoff, and vessel engine exhaust;
- Discharging or depositing any material or other matter into the Monument, or discharging or depositing any material or other matter outside the Monument that subsequently enters the Monument and injures any resources of the Monument, except fish part used in and during authorized fishing operations, or discharges incidental to vessel use such as deck wash, approved marine sanitation device effluent, cooling water, or engine exhaust.

While an accidental release of waste or discharge may occur which might put protected species at risk to exposure, based on the low number of vessels that operate within the waters of the monuments, expected adherence to above mentioned discharge regulations during all project operations, the expectation that protected marine species are widely scattered throughout the project area and the limited populations of ESA-listed species in these areas, we have determined that the risk of protected species being exposed to vessel waste and discharge would be insignificant.

6. *Determination for ESA-Listed Corals*

The action area for the 2016 – 2017 field season of the *Okeanos Explorer* has an operational minimum depth for both mapping and ROV operations of 250 m, with the majority of the activity occurring in waters greater than 500 m. The only times the vessel will be in water shallower than those depths is entering and leaving port. The planned ports of call for the upcoming field season will include Honolulu, Guam, Saipan, Kwajalein, and Pago Pago.

The expanded operation area for the 2016 -2017 field season of the *Okeanos Explorer* includes the distribution ranges of seven species of corals that were listed under the ESA in September of 2014, the species are: *Acropora globiceps, A. jacquelineae, A. retusa, A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata*.

Most species of corals are found in relatively shallow water where light intensity is strong enough for the symbiotic algae, which provide much of the nutrients that corals survive on, are able to effectively use the light. The distribution and habitat for each of these seven listed species found in the operational area is below:

Acropora globiceps - Reported within federal waters in the Pacific Remote Islands Marine National Monument (Palmyra and Kingman), National Park of American Samoa, Ofu Island unit, and the Rose Atoll Marine National Monument. Habitat has been reported as located in intertidal, upper reef slopes and reef flats in water depths ranging from 0 to 8 m.

A. jacquelineae - Species has not been recorded in federally protected waters, but unconfirmed reports have indicated the species may occur in American Samoa. Habitat has reported as located on subtidal walls, ledges on walls, and shallow reef slopes protected from wave action in depths ranging from 10 to 35 m.

A. retusa - Reported within federal waters in the Pacific Remote Islands Marine National Monument (Johnston, Howland and Kingman), National Park of American Samoa, Ofu Island unit, and the Rose Atoll Marine National Monument. Habitat has been reported as located on upper reef slopes and tidal pools in depths ranging from 1 to 5 m.

A. speciosa - Reported within federal waters in the Pacific Remote Islands Marine National Monument (Kingman Atoll). Habitat has been reported as located in protected environments with clear water and steep slopes or deep, shaded waters in depths ranging from 12 to 40 m. Unconfirmed reports by Bare et al (2010) indicates the species presence in mesophotic assemblages in American Samoa.

Euphyllia paradivisa - The species has not been recorded in federally protected waters, but unconfirmed reports have indicated the species may occur in American Samoa. Habitat has been reported as located on shallow or mid-slope reef environments protected from wave action in depths ranging from 5 to 20 m.

Isopora crateriformis - Reported within federally protected waters in the National Park of American Samoa, Tutuila and Ofu Islands units, and Fagetele Bay National Marine Sanctuary, Tutuila. Habitat has

reported as located in shallow, high-wave energy environments in waters depths ranging from low tide to at least 12 m. Unconfirmed reports by Bare et. al. (2010) indicates the species presence in mesophotic assemblages in American Samoa.

Seriatopora aculeata - The species has not been recorded from federally protected waters. Habitat has been reported as located in shallow reef environments in water depths ranging from 3 to 40 m.

There is potential for some listed corals to be found either adjacent to or within the harbors where the *Okeanos Explorer* will be making port of calls during the 2016 – 2017 field season. Based on the strict adherence to Boating Guidelines in place by NMFS and ONMS, the excellent safety record of NOAA vessels around the world, the strict adherence to the MARPOL protocols, and the low densities and widely scattered nature of the listed corals in the operational area, we have determined the risk to listed corals from a collisions with vessels, from temporary disturbance of human activity and the impact from waste and discharge would be discountable.

Based on the known distribution limits and the preferred habitat types in comparison to the proposed minimum operational limit for the *Okeanos Explorer*, we have concluded that listed corals will not be found in the operation area for the 2016 – 2017 field season, and are not at risk from day-to-day operation of the vessel and are not at risk from the exposure to elevated noise levels or from entanglement.

7. Effects to designated & proposed Hawaiian monk seal critical habitat

Critical habitat for the Hawaiian monk seal was designated under the ESA (53 FR 18990) on April 30, 1986 and revised on May 26, 1988 (53 FR 18988). In the PMNM, critical habitat for monk seals includes all beach areas, lagoon waters, and ocean waters out to a depth of 20 fathoms around Kure Atoll, Midway Islands (except Sand Island), Pearl and Hermes Reef, Lisianski Island, Laysan Island, Maro Reef, Gardner Pinnacles, French Frigate Shoals, Necker Island, and Nihoa Island. On June 2, 2011, NMFS proposed revising critical habitat for monk seals (76 FR 32026) by extending the current designation out to the 500 meter depth contour and including Sand Island at Midway Island. Using the best available scientific information, the proposed revision to critical habitat identifies six essential features for the conservation of monk seals that may require special management consideration or protection:

1. Areas With Characteristics Preferred by Monk Seals for Pupping and Nursing;

2. Shallow, Sheltered Aquatic Areas Adjacent to Coastal Locations Preferred by Monk Seals for Pupping and Nursing;
3. Marine Areas From 0 – 500 m in Depth Preferred by Juvenile and Adult Monk Seals for Foraging;
4. Area With Low Levels of Anthropogenic Disturbance;
5. Marine Area With Adequate Prey Quantity and Quality; and
6. Significant Areas Used by Monk Seals for Hauling Out, Resting, or Molting.

The proposed actions include activities that would occur within three essential features (numbers 3, 4 and 5 above) of existing and proposed critical habitat, but the level of human activity that may occur annually in these areas is minimal and any disturbances caused by human presence would be temporary. Also, all permitted personnel are required to adhere to established Monument BMPs that mirror the NOAA guidelines previously described that effectively prevents or minimizes interactions with monk seals and with critical habitat essential features. There is no Hawaiian monk seal critical habitat designated for the PRIMNM, MTMNM, RAMNM, the CNMI, American Samoa or the NMSAS.

Based on adherence to proposed guidelines, no known record of previous impacts to monk seal critical habitat, and the temporary introduction of human presence to conduct activities that would have minimal impact to the environment, we expect the likelihood of destruction or adverse modification to the current Hawaiian monk seal critical habitat and those habitats that are proposed to be insignificant

Effects Determination

We have evaluated the effects of the proposed actions on the following ESA-listed marine species: green sea turtle, hawksbill sea turtles, leatherback sea turtles, North Pacific loggerhead sea turtle distinct population segment (DPS), olive ridley sea turtles, Main Hawaiian Islands false killer whale DPS, blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, sperm whales, the Indo-West Pacific distinct population segments of the scalloped hammerhead shark, Hawaiian monk seals; and the coral species A*cropora globiceps, A. jacquelineae, A. retusa, , A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata*. Based on our analysis of the potential effects of the proposed action on ESA-listed marine species presented above the proposed action would have insignificant effects on the ESA-listed species under consideration, or the likelihood of exposure would be discountable. Therefore, we have determined that the proposed activities are not likely to

adversely affect those species. We have also determined that the proposed activities would have insignificant effects on the essential features of designated and proposed critical habitat for Hawaiian monk seals, and therefore is not likely to adversely affect critical habitat. Therefore, we request informal consultation per Section 7(a)(2) of the ESA, and your concurrence with our determination that the proposed action may affect, but is not likely to adversely affect, green sea turtles, hawksbill sea turtles, leatherback sea turtles, North Pacific loggerhead sea turtle DPS, olive ridley sea turtles, Main Hawaiian Islands false killer whale DPS, blue whales, fin whales, humpback whales, North Pacific right whales, sei whales, sperm whales, the Indo-West Pacific distinct population segments of the scalloped hammerhead shark, Hawaiian monk seals or existing or proposed Hawaiian monk seal critical habitat; and the coral species A*cropora globiceps, A. jacquelineae, A. retusa, , A. speciosa, Euphyllia paradivisa, Isopora crateriformis,* and *Seriatopora aculeata*.

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Appendix A. CAPSTONE Overview and Fiscal Year 2016 Cruise Operating Area Maps

Okeanos Explorer

Campaign to Address the Pacific monument Science, Technology, and Ocean NEeds (CAPSTONE)

Daniel Wagner, a scientist with the Papahānaumokuākea Marine National Monument, gingerly removes a deep coral from the collection basket on the *Deep Discoverer* remotely operated vehicle. *Image courtesy of Art Howard/NOAA Office of Ocean Exploration and Research, 2015 Hohonu Moana.* Download larger version (768 kb).

In July 2015, a team of NOAA and partners initiated the '**C**ampaign to **A**ddress **P**acific monument **S**cience, **T**echnology, and **O**cean **NE**eds (CAPSTONE)'. CAPSTONE is a major multi-year foundational science effort focused on deepwater areas of U.S. marine protected areas in the central and western Pacific. The investment provides timely, actionable information to support decision making based on reliable and authoritative science. It also serves as an opportunity for the nation to highlight the uniqueness and importance of these national symbols of ocean conservation.

As with all *Okeanos Explorer* expeditions, telepresence technology will allow anyone to follow CAPSTONE expeditions online in real time. All data collections are freely accessible from NOAA within 60 days of collection.

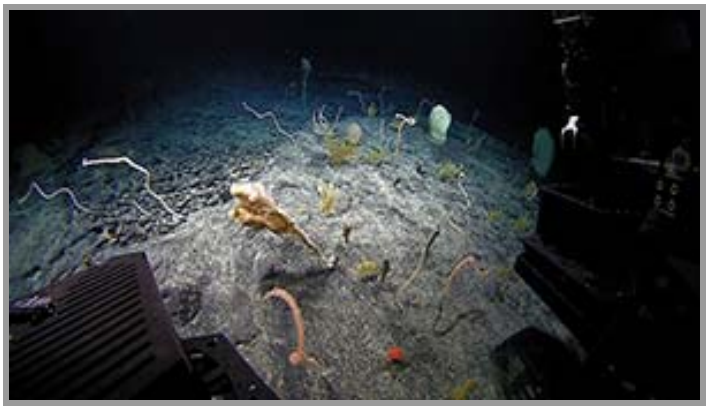
Why Pacific Marine Protected Areas?

The central and western Pacific marine national monuments and national marine sanctuaries encompass over 742,000 square miles of emergent land, coral reef, ocean, and maritime heritage resources. They contain some of the last relatively pristine marine ecosystems on the planet and harbor numerous protected species, as well as undiscovered shipwrecks and cultural landscapes sacred to the indigenous peoples of the Pacific.

Their designation is unprecedented in terms of geographic scope, ecological value, and national symbolism for ocean conservation. However, their remoteness creates substantial challenges. Most deep-water areas remain poorly known and are of high interest to federal and state agencies with research and management responsibilities.

CAPSTONE Goals

The Campaign will provide a foundation of publicly accessible baseline data and information from U.S. marine protected areas in the central and western Pacific. The effort will also provide critical information relevant to emerging regional issues like deep-sea mining and the potential U.S. Extended Continental Shelf.



View from *Deep Discoverer* of a deep coral and sponge community along the Northampton Seamount Ridge, seen during the 2015 expedition. *Click image for credit and larger view.*

Science themes include:

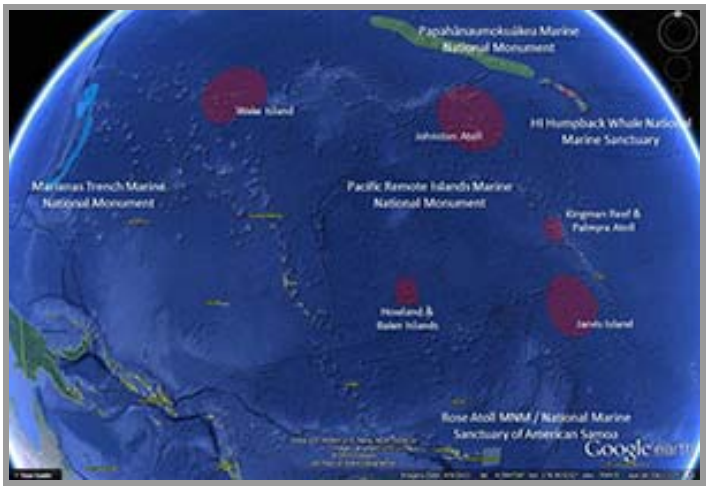
- Acquire data to support priority monument and sanctuary science and management needs;
- Identify and map vulnerable marine habitats – particularly high-density deep-sea coral and sponge communities;
- Characterize seamounts in and around the Prime Crust Zone (PCZ). The PCZ is the area of the Pacific with the highest concentration of commercially valuable deep-sea minerals;
- Investigate the geologic history of Pacific seamounts, including potential relevance to plate tectonics and subduction zone biology and geology; and
- Increase understanding of deep-sea biogeographic patterns across the Central and Western Pacific.

Okeanos Explorer Anticipated Areas of Operations

- **July - September 2015**: The Hohonu Moana: Exploring the Deep Waters off Hawai'i expedition includes four separate cruise legs. Field work is focused along

the Hawaiian Archipelago - including the Papahānaumokuākea Marine National Monument (PMNM) – and the Johnston Atoll region of the Pacific Remote Islands Marine National Monument (PRIMNM).

- **February – September 2016**: Campaign field activities will focus primarily in the western Pacific. We anticipate significant effort in and around the Marianas Trench Marine National Monument, the Wake Island portion of PRIMNM, and additional work in PMNM.
- **October 2016 – September 2017**: Field activities will shift back to the central Pacific and likely include areas extending from the vicinity of the Hawaiian Archipelago south to the equator. Priority areas include Kingman Reef and Palmyra Atoll, Jarvis Island, Howland and Baker Islands, and the Johnston Atoll portions of PRIMNM; the National Marine Sanctuary of American Samoa; and Rose Atoll Marine National Monument. Additional work in the Phoenix Islands Protected Area (PIPA) and Musicians Seamounts is also under consideration.



Google Earth image of the U.S. marine national monuments and national marine sanctuaries in the central and western Pacific. These are the primary geographic areas of CAPSTONE operations between 2015 and 2017. *Click image for larger view.*

**All 2016 and 2017 plans are dependent upon Fiscal Year 2016 and 2017 budget appropriations.*

For More Information

For more information about 2016 and 2017 CAPSTONE plans or to discuss potential regional partnerships please contact Chris Kelley at ckelley@hawaii.edu and Jeremy Potter at jeremy.potter@noaa.gov.

For details on how to get involved with *Okeanos Explorer* activities, please visit this page.

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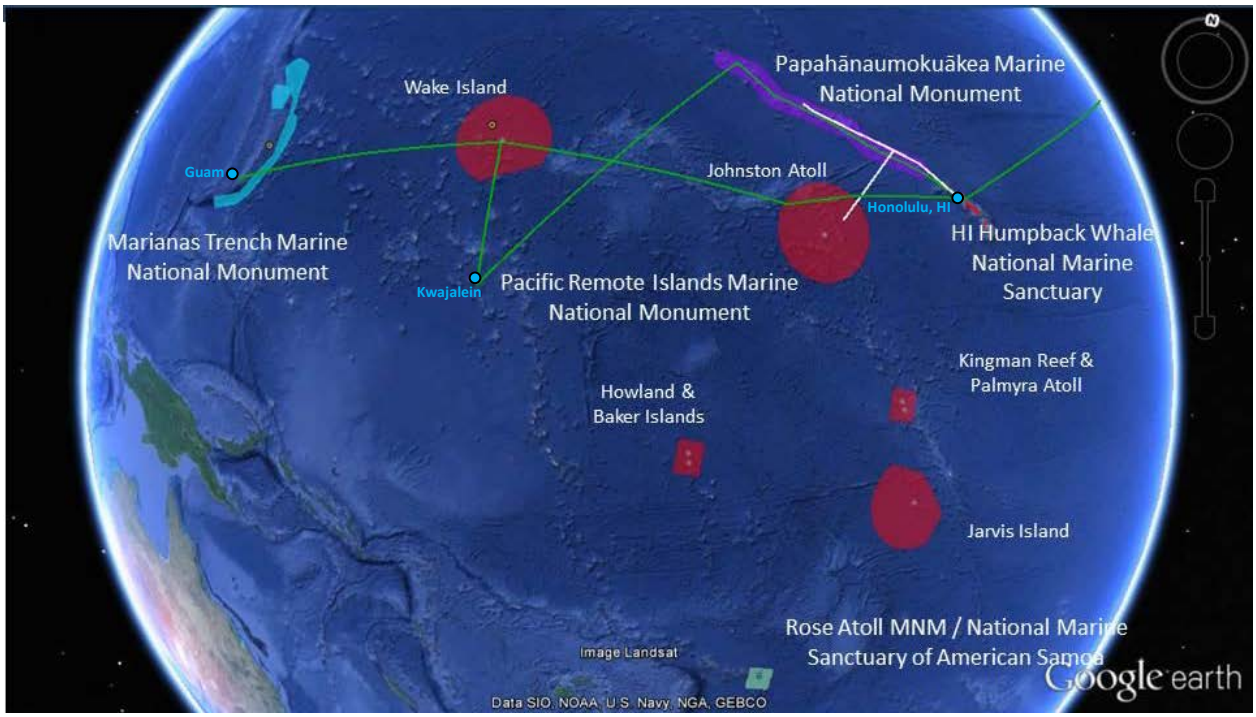
Sign up for the Ocean Explorer E-mail Update List.

NOAA Office of Ocean Exploration and Research
2016 *Okeanos Explorer* Field Season Overview

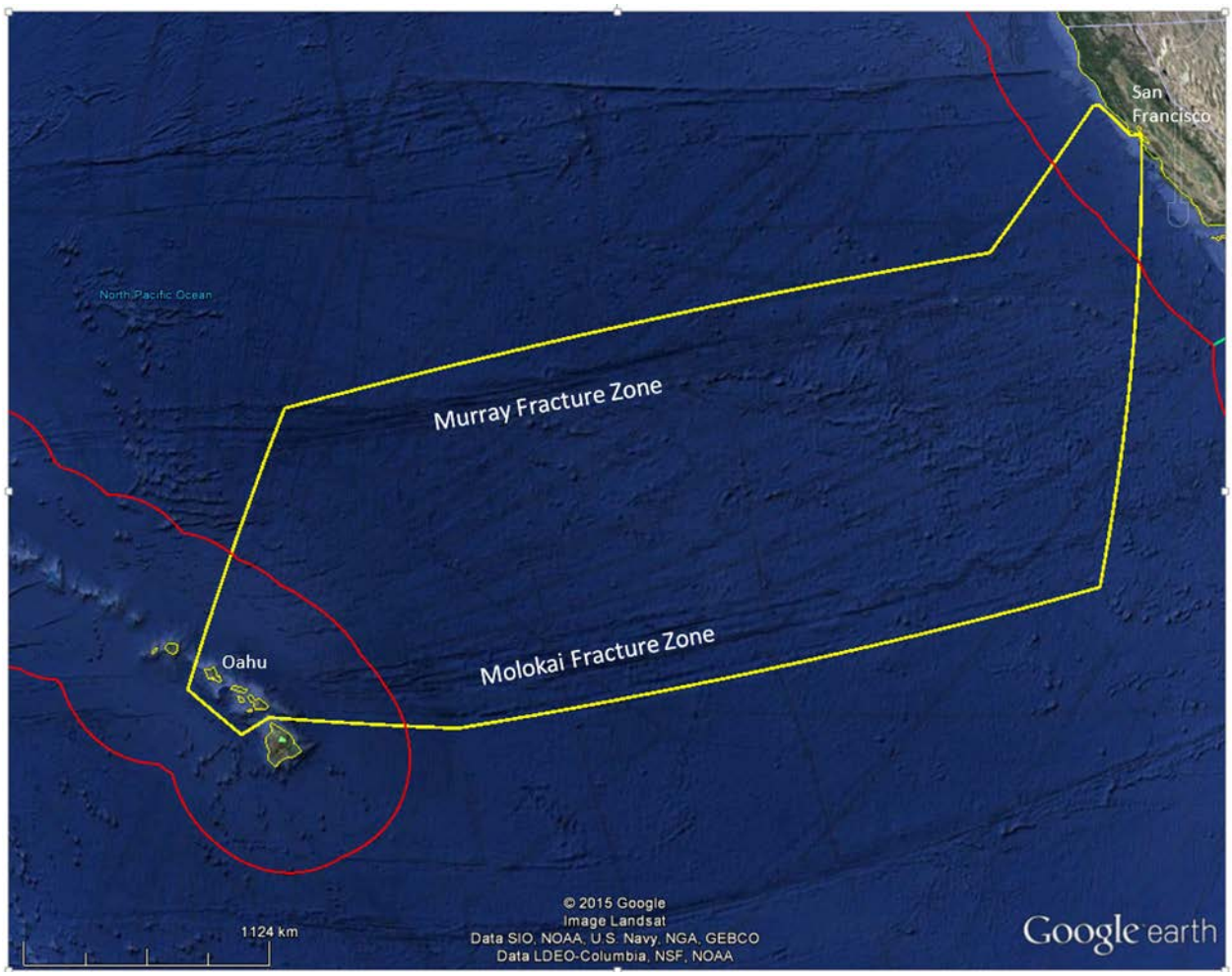
Campaign to Address Pacific monument Science, Technology and Ocean NEeds (CAPSTONE)



Map showing the completed 2015 operating areas, and planned operating areas for the 2016 Campaign to Address Pacific monument Science, Technology and Ocean NEeds (CAPSTONE). The Campaign will focus on systematically collecting baseline information to support science and management needs within and around the Monuments and other protected places in the Pacific from 2015-17. The white lines show the 2015 CAPSTONE areas of operation. The green lines show the planned approach to 2016 operations. Fiscal Year 2016 operations are planned to start with a transit from San Francisco, CA to Honolulu, HI, and include work in the marine environments in and around: the Papahānaumokuākea Marine National Monument (PMNM); Oahu and the big island of Hawai'i; the area south and west of Molokai, Lana'i, and Kaho'olawe; the Wake Atoll portion of the Pacific Remote Islands Marine National Monument (PRIMNM); the Commonwealth of the Northern Marianas Islands (CNMI) and the Marianas Trench Marine National Monument (MTMNM); and the vessel transit areas between Honolulu, Hawai'i, Guam, Saipan, and Kwajalein.

EX-16-01 Transit and Mission Patch Test

Expedition Coordinators: Meme Lobecker & Derek Sowers
Ports: San Francisco, CA to Honolulu, HI
Dates: January 20 – February 7, 2016



EX-16-01 operating area. The yellow box indicates the operating area for the project. The red lines show the approximate location of the US EEZ boundaries. Map made with Google Earth Pro.

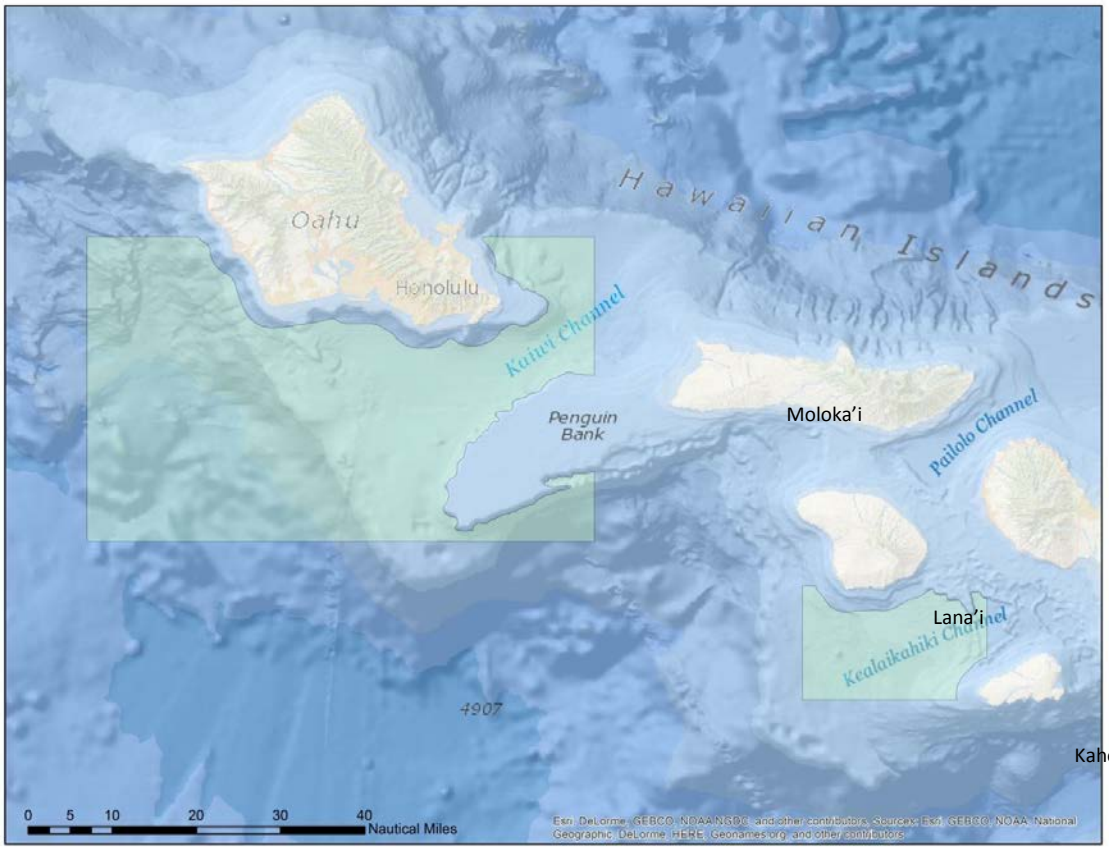
EX-16-01 is an exploration mapping transit cruise from San Francisco, CA to Honolulu, HI. The primary goals of the cruise include: exploratory ocean mapping, shakedown, testing, and calibration of existing and newly-installed equipment, and positioning the ship for the 2016 exploration missions in the central and western Pacific Ocean. New equipment in need of shakedown testing includes a new Very Small Aperture Terminal (VSAT) antenna, a new Keyboard-Video-Monitor (KVM) system, new Doppler speed log, a new POS-MV system, four

new EK 60 single beam sonars, two new ADCPs, new digital file storage systems, and a newly installed UnderwayCTD.

Multibeam, singlebeam and sub-bottom profiler (at the discretion of the CO) mapping operations will be conducted 24 hours a day throughout the cruise. XBT and/or UnderwayCTD sound velocity casts in support of multibeam sonar mapping operations will be conducted at an interval defined by prevailing oceanographic conditions, but not to exceed 6 hours. Initial ADCP testing will be conducted in San Francisco Bay, and a multibeam sonar patch test is planned in Bodega Canyon within the Cordell Banks National Marine Sanctuary. Bathymetric mapping of the Molokai Fracture Zone during the transit to Hawaii is planned, as allowed by equipment shakedown priorities and prevailing sea conditions. Mapping of the Murray Fracture Zone is a contingency option if weather conditions prohibit surveying along the Molokai Fracture Zone. Following completion of the transit to Oahu, EK60 and ADCP calibration and acceptance tests will be the focus of operations in the vicinity of the main Hawaiian Islands for five to seven days utilizing the expertise of visiting scientists and engineers.

EX-16-02 Mission Systems Shakedown/Main Hawaiian Islands Mapping

Expedition Coordinators: Lindsay McKenna & Kasey Cantwell
Ports: Honolulu, HI to Honolulu, HI
Dates: February 12 – 17, 2016



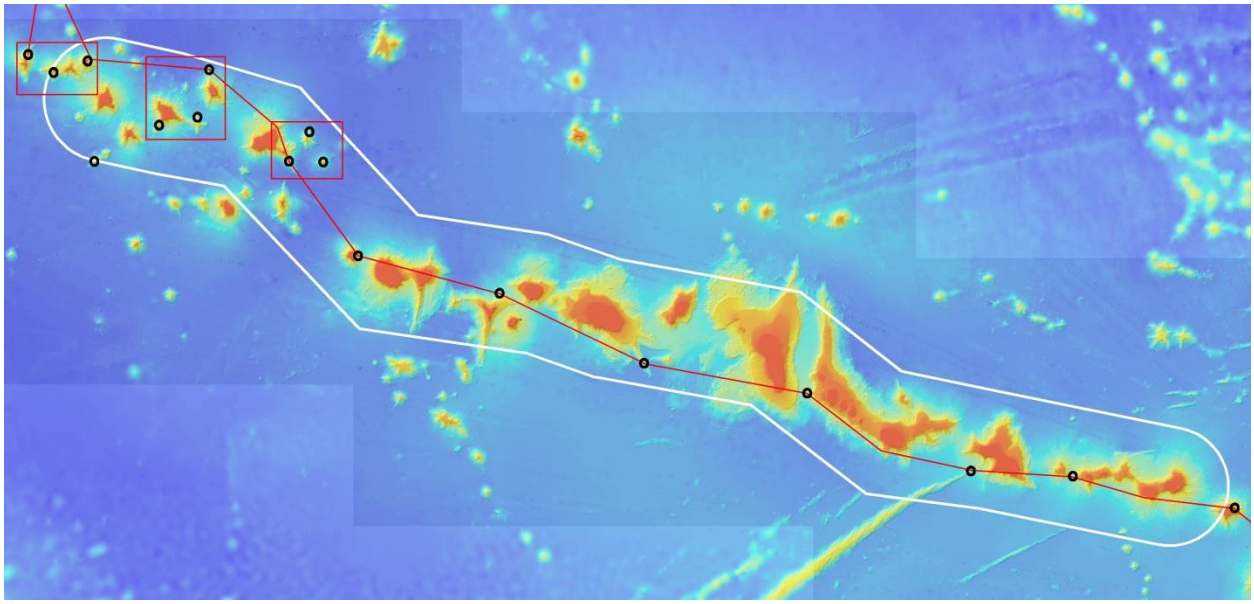
*Map showing the approximate operating area of Okeanos Explorer for EX-16-02. Operations will be conducted in 250m of water and deeper, and will **NOT** be conducted inside state waters or the Hawaiian Islands Humpback Whale National Marine Sanctuary. The green boxes show the planned operating area, but may change underway as engineering and shakedown needs evolve.*

EX-16-02 is a mission system shakedown cruise that will consist of daily ROV dives, mapping, and significant training and testing of new systems, with a primary focus on completing engineering priorities and testing new systems. Operations will be based in the Main Hawaiian Islands and will use the ship's deep water mapping systems (Kongsberg EM302 multibeam sonar, EK60 split-beam fisheries sonars, Knudsen 3260 chirp sub-bottom profiler sonar, Teledyne RDI Workhorse Mariner and Ocean Surveyor ADCPs), NOAA's two-body 6,000 m remotely operated vehicle (ROVs Deep Discoverer and Seirios) system, CTD rosette, and the ship's high-bandwidth satellite connection for real-time ship to shore communications. The ship will conduct 24-hour operations, likely consisting of daytime ROV dives and overnight and transit mapping operations. Exact locations of discrete ROV dives and mapping operations will be determined during the cruise as results of engineering and shakedown tests are evaluated and once weather and operational constraints are factored in. Opportunistic CTD rosette operations are not planned but may be conducted upon request. Mapping operations will be conducted in waters 250 m and deeper. ROV operations will focus in depths between 400 and 4,000 meters and will include high-resolution visual surveys and limited

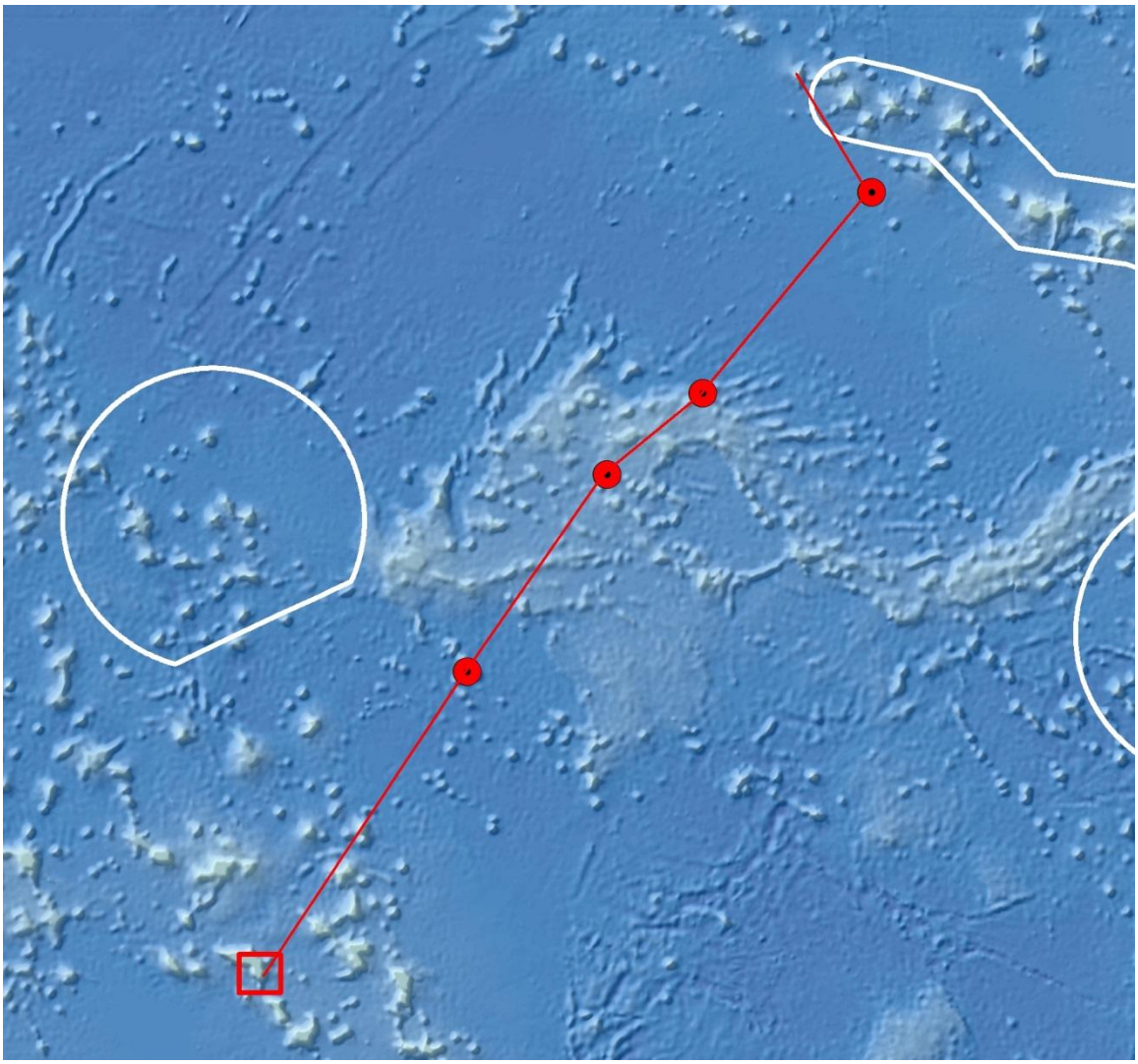
sample collection. Operations will NOT be conducted within State waters or within the boundaries of HIHWNMS.

EX-16-03: Papahānaumokuākea Marine National Monument ROV & Mapping

Expedition Coordinator: Brian Kennedy
Ports: Honolulu, HI to Kwajalein Atoll
Dates: February 23 – March 18, 2016



Map showing the draft cruise track (red lines) and possible ROV dive sites (black dots) during the first part of the cruise. The red boxes are the priority areas for ROV dives and additional mapping work. The white line is the boundary of PMNM.



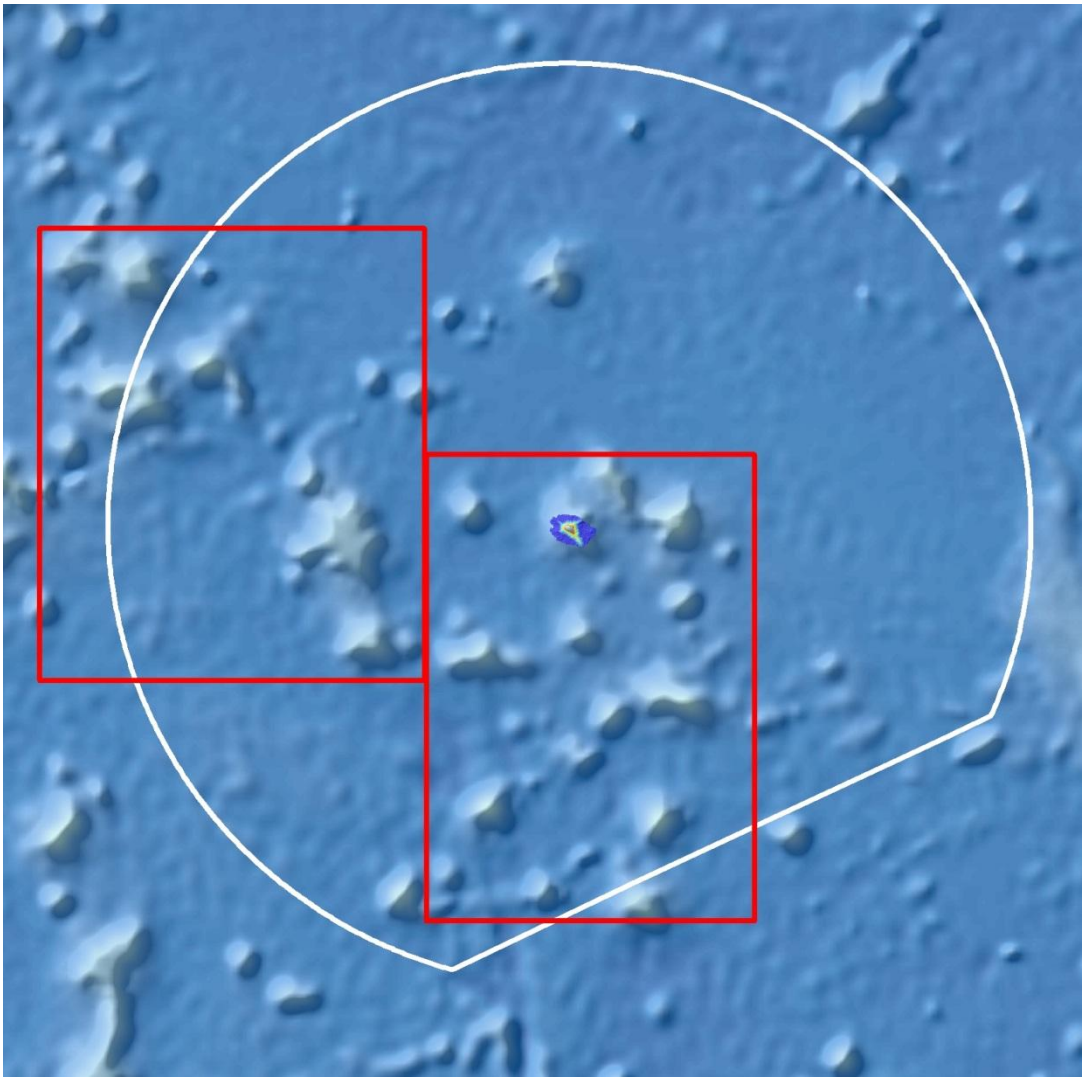
Map showing the draft cruise track (red lines) and possible ROV dive sites (red dots) during the latter part of the cruise. The red box encompasses Kwajalein Atoll, where the ship will pull into port to complete the cruise. The white lines are the boundaries of PMNM, Wake Atoll and the Johnston Atoll Units of the PRIMNM.

Leg 2 is a telepresence-enabled ROV cruise with full shore-based science participation focused on priority ROV dive targets for PMNM. The ship will conduct 24 hour operations consisting of daytime ROV dives and overnight mapping operations including during transit. Opportunistic CTD rosette operations may also be conducted. The ship will depart Pearl Harbor, Oahu and head to Middle Bank on the southern border of PMNM to conduct an ROV dive, and then enter PMNM and conduct daily ROV dives and overnight transit mapping up to the northern section of the Monument. The majority of ROV dives and additional focused mapping will be focused on the northwestern section of the Monument (see red boxes in Figure 3). Afterwards, the ship will depart PMNM and conduct a dive on a potential underwater cultural heritage site, at Helseley Seamount, and perhaps another nearby seamount before commencing

the transit to Kwajalein Atoll. En route to Kwajalein, four dives are planned at Castellano seamount and other seamounts that are part of the Mid-Pacific Mountains. Rift zone ridges and other types of abrupt topography will be targeted due to their likelihood of hosting extensive communities of deepwater corals and sponges, as well as likely manganese crust habitats from 1,000-2,500m.

EX-16-04: Wake Island PRIMNM Preliminary Mapping

Expedition Coordinator: Derek Sowers
Ports: Kwajalein to Guam
Dates: March 23 – April 13, 2016

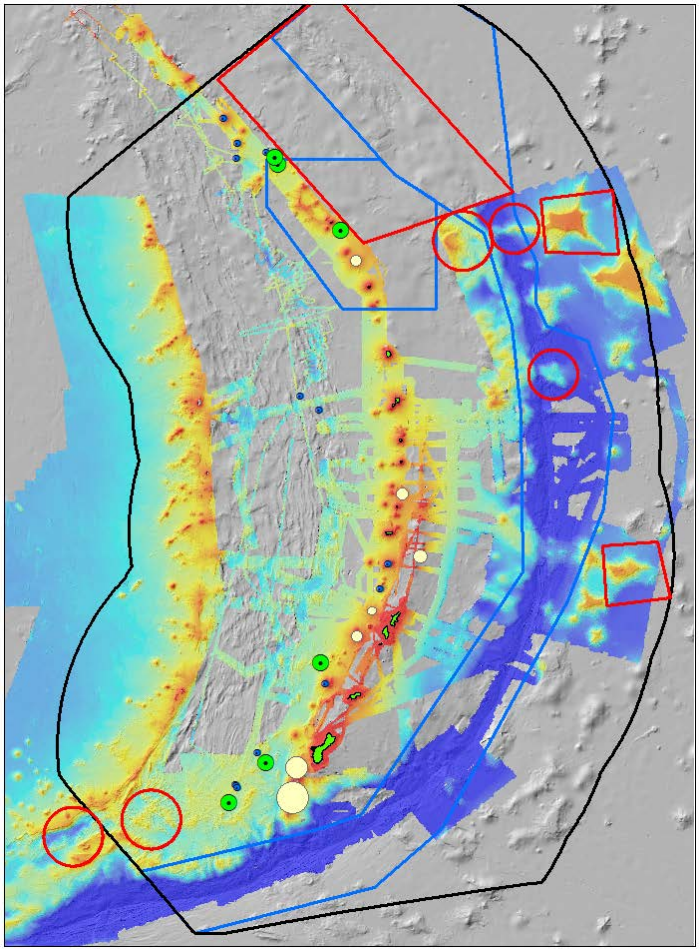


Map showing the likely priority mapping areas for the EX-16-04 mapping cruise to the Wake Island unit of the PRIMNM. The red boxes are priority mapping areas and the white lines are the boundaries of the Wake Island unit of PRIMNM and the U.S. EEZ. All operations will be conducted in 250m or deeper.

EX-16-04 is the first of three cruises focused on deep-water exploration of the Wake Island Unit of the Pacific Remote Islands Marine National Monument. This is a mapping exploration cruise that will conduct 24 hour mapping operations, including during transit, to address unmapped areas surrounding Wake Island. The ship will transit from Kwajalein Atoll to the Wake Island part of PRIMNM. Mapping operations will focus on seamounts, and searching for potential underwater cultural heritage sites on the south side of the island associated with the WWII Battle of Wake Island (see red boxes in figure 6) before transiting to Guam. Opportunistic CTD rosette operations may also be conducted.

EX-16-05 CAPSTONE CNMI & Marianas Trench Expedition

EX-16-05 is a three cruise Expedition focused on deep-water exploration of Commonwealth of the Northern Marianas Islands (CNMI) and the Marianas Trench Marine National Monument (MTMNM).



Map showing the operating area for EX-16-05 Legs 1-3. The black boundary is the U.S. EEZ and the blue lines show the boundaries of the Trench Unit and Islands Unit of the Marianas Trench Marine National Monument. The blue dots (some are covered by other features) are the Active hydrothermal submarine volcanoes composing the Vents Unit of the MTMNM. Existing bathymetric coverage is overlain on the grey satellite bathymetry. The encircled red areas, green and white dots are priority areas for mapping and ROV exploration identified by the science and management community.

Leg 1: CNMI & Marianas Trench ROV & Mapping

Expedition Coordinator: Kelley Elliott
Ports: Guam to Guam/Saipan
Dates: April 20 – May 11, 2016

Leg 1 is a telepresence-enabled ROV cruise with full shore-based science participation that will focus on priority ROV dive sites and mapping areas in the southern half of the CNMI/MTMNM. The ship will conduct 24-hour operations during consisting of daytime ROV dives and overnight mapping operations including during transit. ROV dive sites are expected to include hydrothermal vent sites and sites of interest to Fisheries including deep-sea coral and bottomfish habitats.

Leg 2: CNMI & Marianas Trench Mapping

Expedition Coordinator: Meme Lobecker
Ports: Guam/Saipan to Guam/Saipan
Dates: May 20 – June 11, 2016

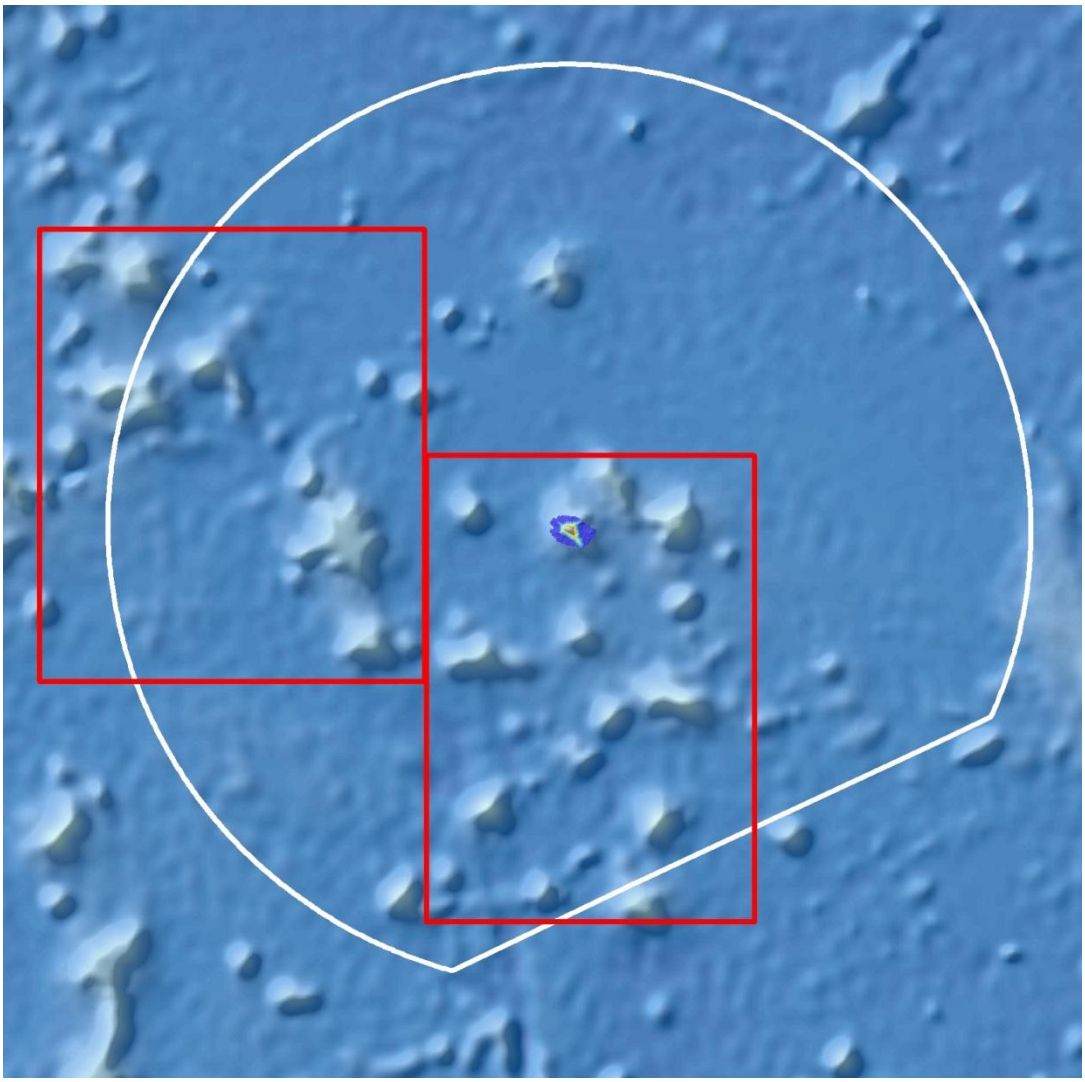
Leg 2 is a 24-hour mapping cruise that will focus on mapping deep-water priorities in the northern half of the CNMI/MTMNM. Mapping priorities includes mud volcanoes and trench/subduction zone areas. CTD rosette operations may also be conducted.

Leg 3: CNMI & Marianas Trench ROV & Mapping

Expedition Coordinator: Kelley Elliott
Ports: Guam/Saipan to Guam/Saipan
Dates: June 17 – July 10, 2016

Leg 3 is another telepresence-enabled ROV cruise with full shore-based science participation that will focus operations on priority ROV dive sites in the northern half of the CNMI and MTMNM, including areas that are mapped during Leg 2. Therefore actual ROV dive locations will be further refined after mapping data is acquired during Leg 2. The ship will conduct 24-hour operations consisting of daytime ROV dives and overnight mapping operations including during transit. ROV dive sites are expected to include mud volcanoes, trench/subduction zone areas and seamounts. CTD rosette operations may also be conducted.

Wake Island Expedition



Map showing the likely priority areas for the EX-16-06 and EX-16-07 cruises focused on the Wake Island unit of the PRIMNM. The red boxes are priority operating areas and the white lines are the boundaries of the Wake Island unit of PRIMNM and the U.S. EEZ. All operations will be conducted in 250m or deeper.

EX-16-06 Wake Island PRIMNM ROV & Mapping
Expedition Coordinator: Brian Kennedy
Ports: Guam to Kwajalein
Dates: July 27 – August 19, 2016

EX-16-06 is the second of three cruises focused on deep-water exploration of the Wake Island Unit of the Pacific Remote Islands Marine National Monument. This is a telepresence-enabled ROV cruise with full shore-based science participation focused on priority ROV dive targets for PRIMNM. ROV dives are expected to focus on seamounts and potential underwater cultural heritage sites. Actual ROV dive locations will be further refined after mapping data is acquired during the EX-16-04 Wake Island preliminary mapping cruise. The ship will conduct 24 hour operations consisting of daytime ROV dives and overnight mapping operations including during transit. Opportunistic CTD rosette operations may also be conducted.

EX-16-07 Wake Island PRIMNM Mapping
Expedition Coordinator: Meme Lobecker
Ports: Kwajalein to Honolulu
Dates: August 25 – September 11, 2016

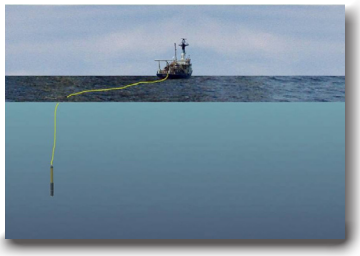
EX-16-07 is the third of three cruises focused on deep-water exploration of the Wake Island Unit of the Pacific Remote Islands Marine National Monument. This is a mapping exploration cruise that will conduct 24 hour mapping operations, including during transit, to address unmapped areas and build on previous mapping coverage surrounding Wake Island. The ship will transit from Kwajalein Atoll to the Wake Island part of PRIMNM where focused mapping operations will occur, followed by transit to Honolulu, HI. Mapping operations will focus on seamounts and potential underwater cultural heritage areas. Opportunistic CTD rosette operations may also be conducted.

Appendix B. Underway CTD Specifications Brochure

OCEANSCIENCE

UnderwayCTD

CTD Profiling From A Moving Vessel



Online Viewers Click For Video

CTD Profiling From A Moving Vessel

The Oceanscience UnderwayCTD provides research-quality CTD profiles while underway at up to 20kts. The unique freefall CTD probe, manufactured by Sea-Bird Electronics affords vertical profiles to a maximum depth of 1250m while underway, with stationary casts possible down to 1500m. The probe is tethered to the ship by up to 2km of high strength line, with a unique deployment winch and re-spooling mechanism that allows the probe to be recovered and relaunched time after time without ever needing to stop or slow down. At a constant 10kts, CTD profiles down to 600m are possible. Bluetooth communications make data handling easy, and provide a fast turnaround between casts.

Maximize Productivity

Save hours of valuable ship time by reducing the necessity to stop the ship for a conventional CTD station, or avoid the use of labor intensive or depth-limited towed CTD profilers. Benefit from greatly improved data quality compared to expendable probes.

Versatile And Simple To Use

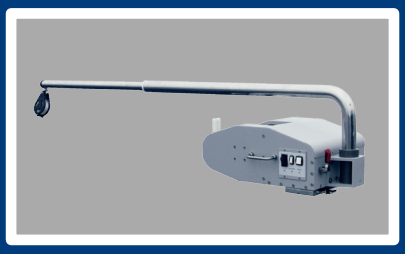
The UnderwayCTD can be installed on practically any vessel. The small footprint winch can be mounted on a post or rail, and can be set up and operated by one person. The UnderwayCTD components can be transported from ship to ship with ease, making the system ideal for gathering high quality data from vessels of opportunity.

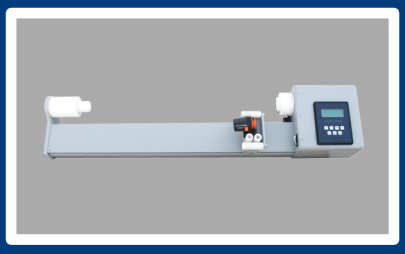
Open Ocean or Shallow Water Options

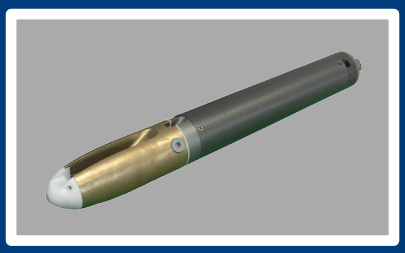
The UnderwayCTD is available in deep water “free cast” or shallow “tow-yo” configurations. Shallow water “tow-yo” operation offers CTD profiles to 200m every 10 mins at 6kts.

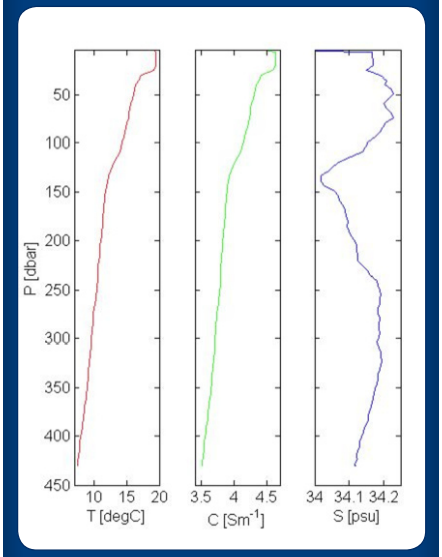
No Expendable Components

UnderwayCTD users leave no sea floor waste behind them, and benefit from temperature and salinity data quality impossible to achieve with single-use profilers.









UnderwayCTD Components

Main Winch

The UnderwayCTD winch features a large capacity reel with a high-torque DC drive unit and motorized levelwind, for fast and safe probe deployment and retrieval. The reel holds up to 2000m of high strength line for maximum profiling flexibility. The main winch not only pays out line during deployment as the probe drops through the water column, but is rotated to provide line for re-spooling onto the probe tail using the rewinder. A compact 1500 W power supply (110/220 VAC, 50/60 Hz input) supplies power to all system components.

Rewinder

The microprocessor controlled UnderwayCTD tail spool rewinder precisely loads the CTD probe tail spool with high strength line, typically 300m to 700m of line is added from the main winch, usually equivalent to the desired cast depth. The unit may be programmed for different profile depths and is automated for quick turnaround.

Probe System

The UnderwayCTD probe consists of a ruggedized and streamlined Sea-Bird CTD with Bluetooth wireless communication. The probe and its attached tail spool loaded with high-strength line is simply dropped from the vessel, reaching its target depth rapidly at a 4m/s drop speed. Profiles are stored on the probe and periodically downloaded as desired during operation. A “gravity pumped” conductivity cell and extremely accurate pressure and temperature sensors offer research quality data during freefall, sampled at 16Hz.

Configuration Options

Select up to 2km of high strength line for maximum depth operation (A), or use thicker line for maximum probe retrievability at higher vessel speeds (B). Use the basic “tow-yo” system for shallow water profiling with target depths of 50m to 300m (C).

	Vessel Speed					
	0kts	2kts	4kts	6kts	8kts	10kts
A. Maximum Depth	1300m	1000m	800m	700m	700m	600m
B. Multi Purpose	1000m	800m	650m	600m	550m	500m
C. Shallow “Tow-yo” (Max)	1000m	700m	550m	450m	400m	350m

Order Codes

UC-WIN - Main Winch
UC-REW - Rewinder
UC-PS - Power Supply
UC-DV - Universal Davit
LINE - Spare line

Contact Information

The Oceanscience Group
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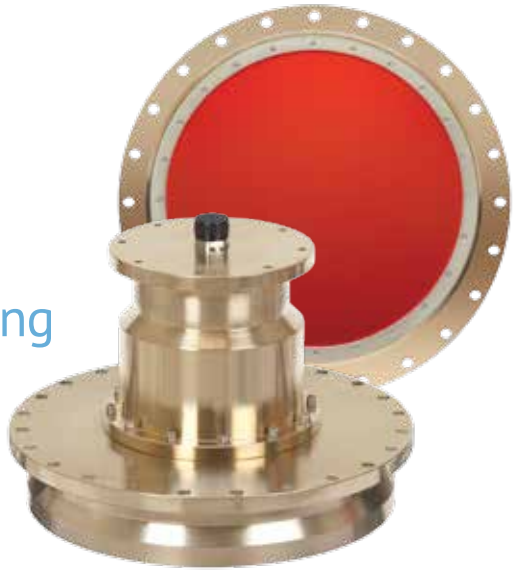
info@oceanscience.com

Appendix C. Technical Specifications of ADCPs

Teledyne RD Instruments

Ocean Surveyor

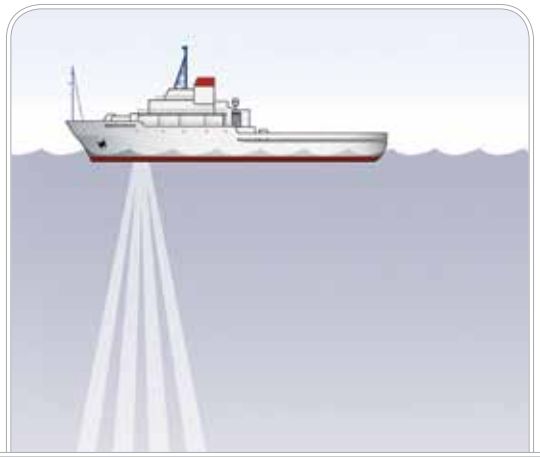
Vessel-Mount Long Range 3-D Current Profiling

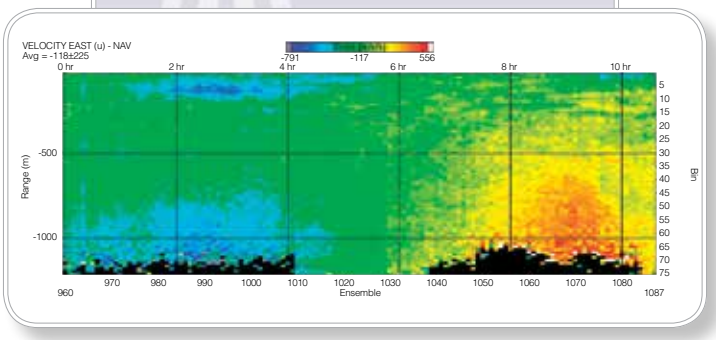


Explore New Depths with Proven ADCP Technology

For over thirty years, Teledyne RD Instruments has been the preeminent supplier of Acoustic Doppler Current Profiling (ADCP) instrumentation for open ocean applications. Teledyne RDI's vessel-mounted OCEAN SURVEYOR family of ADCPs are the only instruments capable of collecting detailed maps of the distribution of water currents and suspended materials through the water column and along the ship's path—at depths and resolutions previously considered unattainable. In real time, the ADCP is also used to aid in situ decision-making, to adapt field operations, and to understand current regime characteristics.

Frequency	Range (m)	Cell Size (m)
38kHz	>1000	24
75kHz	>700	16
150kHz	>400	8





PRODUCT FEATURES

- **Versatile:** Broadband signal processing combines with Narrowband processing to provide the ultimate in data versatility.
- **Compact:** Patented phased array transducers significantly reduce the transducer size and weight for ease of installation.
- **Comprehensive:** The Ocean Surveyor combines current profiling, backscatter profiling, and Doppler Velocity Log capability all within a single instrument.
- **Four-beam solution:** Patented phased array 4-beam design provides increased data reliability and quality assurance.

Applications:

- Climate studies
- Mid-ocean frontal mapping
- Fisheries research
- Deep-water cable-laying projects

Ocean Surveyor

Vessel-Mount Long Range 3-D Current Profiling

TECHNICAL SPECIFICATIONS

Water Profiling	**Long Range Mode**	**38kHz**		**75kHz**		**150kHz**	
	Vertical resolution cell size[1]	Max Range[2]	Precision[3]	Max Range[2]	Precision[3]	Max Range[2]	Precision[3]
	4					>350m	30cm/s
	8			>650m	30cm/s	>400m	16cm/s
	16	>1000m	30cm/s	>700m	16cm/s		
	24	>1000m	20cm/s				
	High Precision Mode	**38kHz**		**75kHz**		**150kHz**	
	Vertical resolution cell size[1]	Max Range[2]	Precision[3]	Max Range[2]	Precision[3]	Max Range[2]	Precision[3]
	4					>225m	15cm/s
	8			<425m	15cm/s	>250m	8cm/s
	16	>900m	15cm/s	>450m	7cm/s		
	24	>950m	10cm/s				
Profile Parameters	Velocity accuracy (typical)	±1.0% ± 0.5cm/s		±1.0% ± 0.5cm/s		±1.0% ± 0.5cm/s	
	Velocity range	-5 to 9m/s		-5 to 9m/s		-5 to 9m/s	
	Number of depth cells	1–128		1–128		1–128	
	Maximum ping rate	0.4Hz		0.7Hz		1.5Hz	
Bottom Track	Max altitude (precision <2cm/s)	1700m		950m		540m	
	Range Accuracy = <±2% actual range[4]						
Echo Intensity Profile	Vertical resolution	Depth cell size, user configurable					
	Dynamic range	80dB					
	Precision	±1.5dB					
Transducer and Hardware	Beam angle	30°					
	Configuration	4-beam, phased array					
	Communications	RS-232 or RS-422 hex-ASCII or binary output at 1200–115,200 baud					
System Power	AC input	90–250VAC, 47–63Hz					
	Power	1400W					
Software	Use TRDI's Windows™-based software for best results: **VMDAS**– Vessel-Mount Data Acquisition System; **WinADCP**–Data Display and Export						
Options	**Velocity** for advanced post processing						
Environmental	Operating temperature	-5° to 45°C					
	Storage temperature	-30° to 60°C					
Standard Sensors	Temperature (mounted on transducer)	Range -5° to 45°C, Precision ±0.1°C, Resolution 0.03°					
System Components	• 38, 75, or 150kHz transducer • 19" rack-mount electronic chassis • All-purpose deck box • Gyrocompass interface board • LCD gyro offset control display User to supply compass input or GPS navigation data and NMEA tilt information						
Dimensions	38kHz: 914.4mm dia.; 75kHz: 480mm dia.; 150kHz: 305mm dia. *(line drawings available upon request)*						

1 Ranges at 1 to 5 knots ship speed are typical and vary with situation.
2 Single-ping standard deviation.
3 User's choice of depth cell size is not limited to the typical values specified.
4 Excludes errors introduced by changes in speed of sound profile, by tilting of transducer, and by slope of bottom.
5 Up to ±20° tilt.

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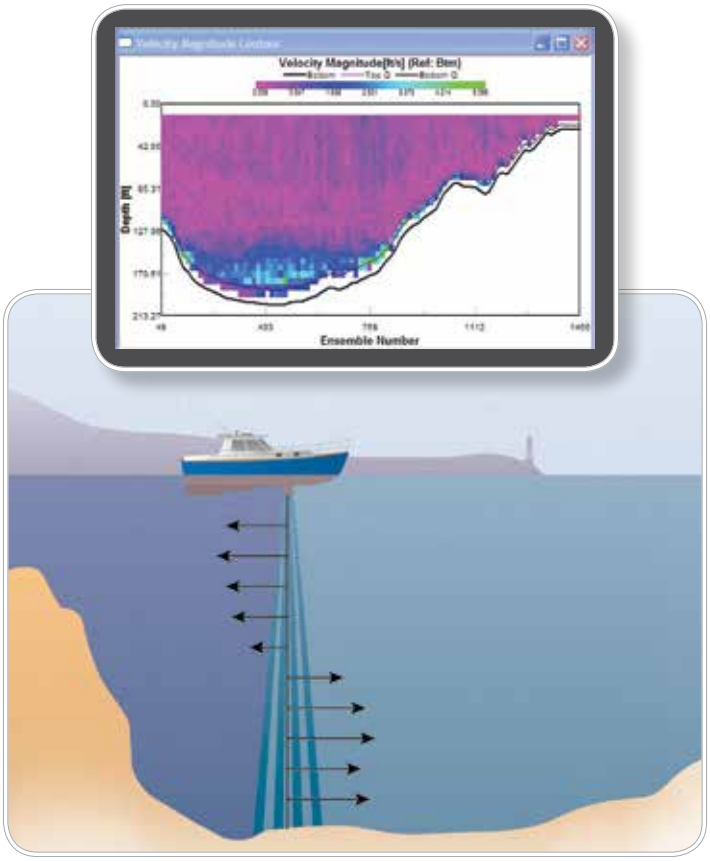
Teledyne RD Instruments

Workhorse Mariner

1200, 600, 300 kHz ADCP

Convenient Hull-Mounted ADCP for Coastal Vessel Applications

Teledyne RD Instruments' WORKHORSE MARINER Acoustic Doppler Current Profiler (ADCP) has become the instrument of choice for researchers and commercial surveyors working in coastal waters. The Mariner is an accurate, rapid sampling current profiling system designed to operate from a moving boat. The Mariner offers all of the benefits of RDI's traditional Workhorse ADCP products in a compact package designed specifically for coastal hull-mount applications. The unit is easily integrated into the vessel's DGPS input to provide integrated ADCP readings with precise position information.



PRODUCT FEATURES

- **Convenience:** By installing the Mariner directly in the vessel's hull, the ADCP is always ready to operate—no need for cumbersome mounting tools and hardware, and the unit is safely protected from external elements.
- **Precision data:** Teledyne RDI's BroadBand signal processing delivers very low-noise data, resulting in unparalleled fine track resolution.
- **A four-beam solution:** Teledyne RDI's 4-beam design improves data reliability by providing a redundant data source in the case of a blocked or damaged beam; improves data quality by delivering an independent measure known as error velocity; and improves data accuracy by reducing variance in your data.

Workhorse Mariner

1200, 600, 300 kHz ADCP

TECHNICAL SPECIFICATIONS

Water Profiling	Depth Cell Size[1]	Typical Range[2] 12m **1200kHz**		Typical Range[2] 50m **600kHz**		Typical Range[2] 110m **300kHz**	
	Vertical Resolution	Range[3]	Std. Dev.[4]	Range[3]	Std. Dev.[4]	Range[3]	Std. Dev.[4]
	0.25m	11m	14.0cm/s				
	0.5m	12m	7.0cm/s	38m	14.0cm/s	see note [1]	
	1m	13m	3.6cm/s	42m	7.0cm/s	83m	14.0cm/s
	2m	15m[2]	1.8cm/s	46m	3.6cm/s	93m	7.0cm/s
	4m	see note [1]		51m[2]	1.8cm/s	103m	3.6cm/s
	8m					116m[2]	1.8cm/s
Long Range Mode	2m	19m	3.4m/s				
	4m			66m	3.6cm/s		
	8m					154m	3.7cm/s
Profile Parameters	Velocity Accuracy	0.3% of water velocity relative to ADCP ±0.3cm/s		0.3% of water velocity relative to ADCP ±0.3cm/s		0.5% of water velocity relative to ADCP ±0.5cm/s	
	Velocity resolution	0.1cm/s		0.1cm/s		0.1cm/s	
	Velocity range	±5m/s default, ±20m/s max		±5m/s default, ±20m/s max		±5m/s default, ±20m/s max	
	Number of depth cells	1–128		1–128		1–128	
	Ping rate	2Hz (typical)		2Hz (typical)		2Hz (typical)	
Bottom Track Parameters	Max. Altitude (m)	27		99		253	
	Min. Altitude (m)	0.8		1.4		2.0	
	Range Accuracy = ±2% actual range[5]						
Echo Intensity Profile	Vertical resolution	Depth cell size, user configurable					
	Dynamic range	80dB					
	Precision	±1.5dB					
Transducer and Hardware	Beam angle	20°					
	Configuration	4-beam, convex					
	Tilt sensor range	15°					
	Transducer face material	Polyurethane					
	Depth rating	200m standard					
	Internal memory	Card not included					
	Communications	Output format is RS-232, ASCII or binary output at 1200–115,200 baud					
Environmental	Operating temperature	-5° to 45°C					
	Storage temperature (without batteries)	-30° to 60°C					
	Weight in air	10.7kg					
	Weight in water	8.1kg					
Software	TRDI's Windows™-based software included: **VMDAS**—Vessel Mount Data Acquisition System; **WinADCP**—Data Display and Export						
Power	External DC input	20–50VDC					
	Teledyne RDI Deck Box input	90–250VAC or 12–50VDC					
	Teledyne RDI Deck Box output	48VDC					
Standard Sensors	Temperature (mounted on transducer)	Range -5° to 45°C, Precision ±0.4°C, Resolution 0.01°					
	Tilt	Range ±15°, Accuracy ±0.5°, Precision ±0.5°, Resolution 0.01°					
	Compass (fluxgate type, includes built-in field calibration feature)	Accuracy ±2°[6], Precision ±0.5°[6], Resolution 0.01°, Maximum tilt ±15°					
Available Options	• Gyro Interface • Pressure Sensor • High-Resolution Water Profiling Modes • **Velocity** for advanced post processing						
Dimensions	311.1mm wide x 217.4mm long *(line drawings available upon request)*						

1 User's choice of depth cell size is not limited to the typical values specified. 2 Longer ranges available. 3 Profiling range based on temperature values at 5°C and 20°C, salinity = 35ppt.
4 BroadBand mode single-ping standard deviation (Std. Dev.). 5 Excludes errors introduced by changes in speed of sound profile, by tilting of transducer, and by slope of bottom.
6 <±1.0° is commonly achieved after calibration.

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Appendix D. Case Study: Okeanos Explorer - EM 302 - Hawaii

Case study: Okeanos Explorer – EM 302 – Hawaii

The field is plotted as the peak sound pressure level (SPL). In the horizontal plane (Figure A), the depth is 10; 50; 200 m. The field is plotted on an area 1000x6000 m. In the vertical plane (Figure B), it is computed down to 4000 m (6000 m on each side) then zoomed to 1000-m depth (1500 m on each side). 140, 160, and 180 dB isopleths shown.

Figure A: Horizontal plane views of sound pressure levels at three different receive depths within the water column directly below transducer: 10m, 50m, and 200m.

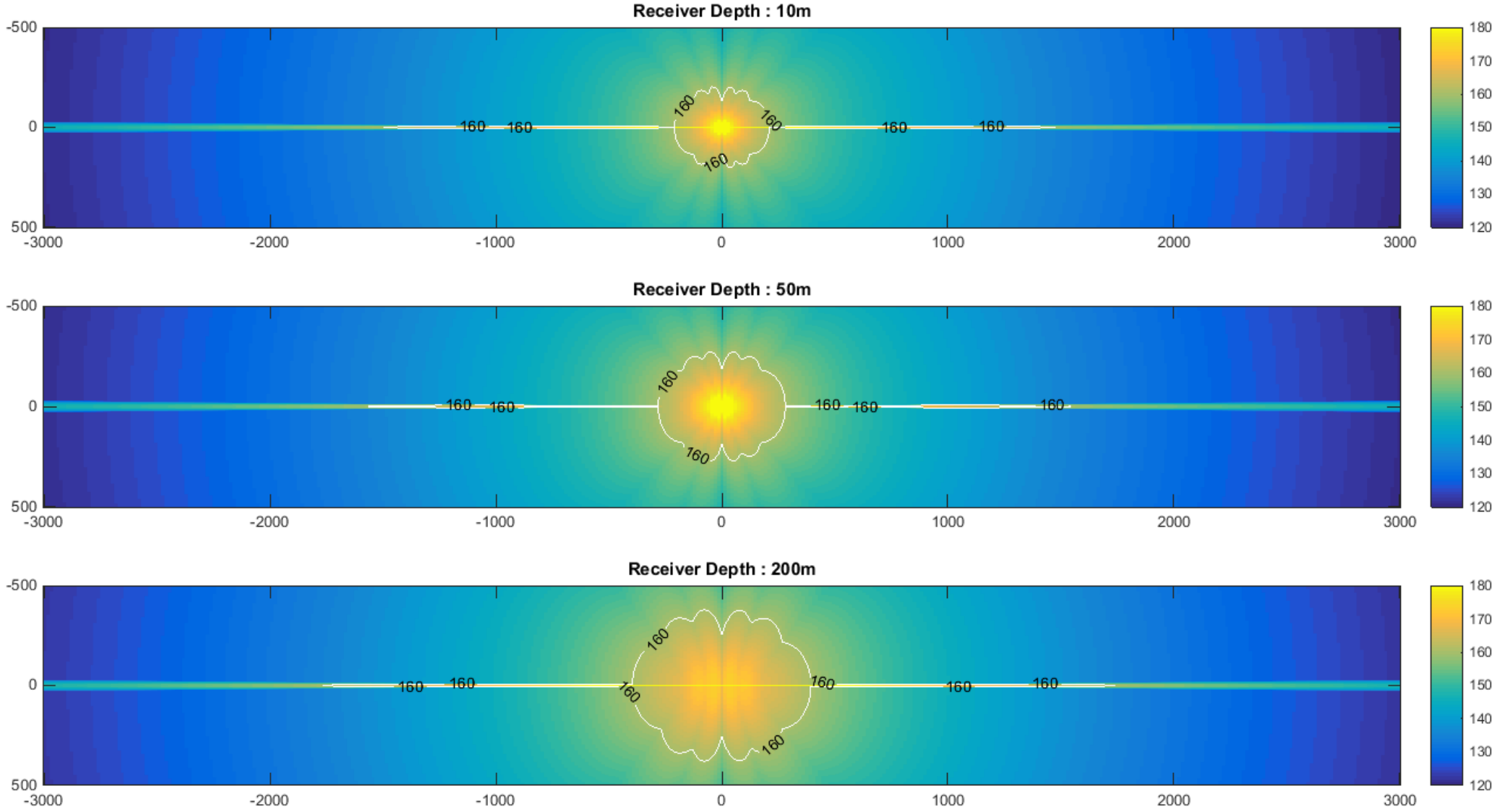
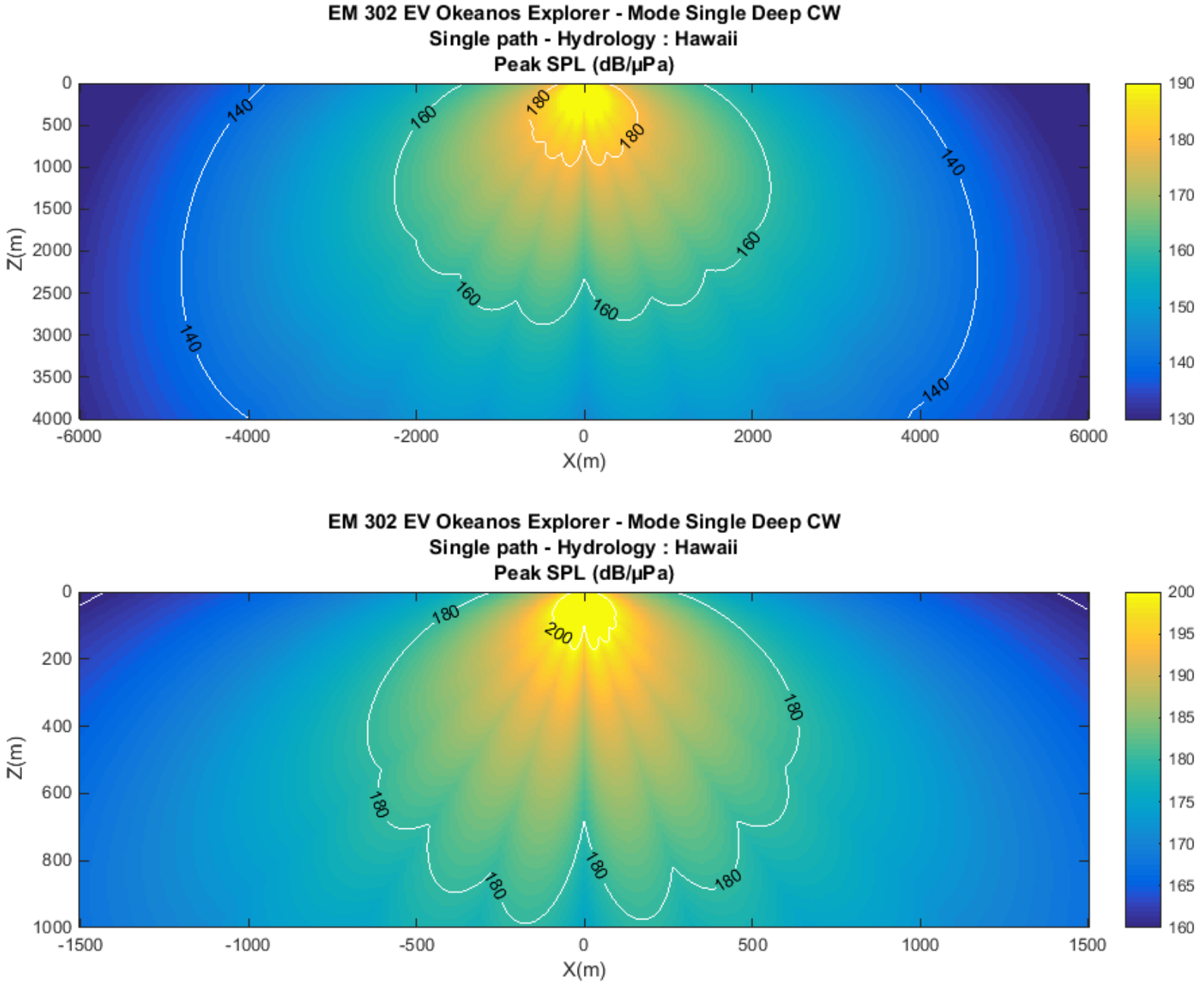


Figure B: Vertical plane view of sound pressure levels in the water column directly below the EM302 sonar transducer.



Model and Figures Provided by Dr. Xavier Lurton

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Appendix E: NASA Maritime Aerosols Network Survey of Opportunity

Survey or Project Name

Maritime Aerosol Network

Points of Contact (POC)

Lead POC or Principle Investigator (PI & Affiliation) **POC: Dr. Alexander Smirnov**	*Supporting Team Members ashore* *Supporting Team Members aboard (if required)*

Activities Description(s)*(Include goals, objectives and tasks)*

The Maritime Aerosol Network (MAN) component of AERONET provides ship-borne aerosol optical depth measurements from the Microtops II sun photometers. These data provide an alternative to observations from islands as well as establish validation points for satellite and aerosol transport models. Since 2004, these instruments have been deployed periodically on ships of opportunity and research vessels to monitor aerosol properties over the World Oceans.

Appendix F: Permits to conduct operations in CNMI managed waters (pending)