

OCEAN EXPLORATION TRUST

Workshop on Telepresence-Enabled Exploration of the Eastern Pacific Ocean

Workshop Report
11-13 December 2014
The Exploratorium, San Francisco, CA

We would like to thank our Sponsors and Major Partners, The Lounsbery Foundation, NOAA Office of Ocean Exploration & Research, The Exploratorium, MIT Media Lab.

More information on the Workshop on Telepresence-enabled Exploration of the Eastern Pacific Ocean can be found at <http://www.oceanexplorationtrust.org/#!2014pacificworkshop/cr81>

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Overview

In December 2014, the Ocean Exploration Trust, in partnership with the NOAA Office of Ocean Exploration and Research (OER), hosted a workshop at the Exploratorium in San Francisco, California, with members of the scientific community to identify and discuss potential targets for telepresence-enabled exploration in the Eastern Pacific Ocean. This document summarizes the background, workshop objectives, key discussions, recommended targets, and other important topics identified by the participants.

Background

On June 12, 2000, President Clinton announced the commencement of a new era of ocean exploration. In an Executive Directive to the Secretary of Commerce, the President announced steps to develop a long-term strategy for such exploration. This action led to the creation of the Ocean Exploration Panel, which consisted of America's leading experts in ocean exploration. Their final report, entitled "Discovering Earth's Final Frontier: A U.S. Strategy for Ocean Exploration", recommended that any new ocean exploration program have a dedicated ship of exploration mounting "Voyages of Discovery", with signature missions forming the centerpiece for such a program.

Following this report, NOAA formed the Office of Ocean Exploration. On September 12, 2000, the House passed HR 2090, the Exploration of the Seas Act sponsored by Representative Jim Greenwood (R-PA) that directed the Secretary of Commerce to contract the National Academy of Sciences to establish a Coordinated Oceanography Program Advisory Panel to report to Congress on an international oceans exploration strategy. In 2003, the "Exploration of the Seas: Voyage into the Unknown" report was issued by this Panel, that also recommended that the ocean exploration program have as its centerpiece a dedicated flagship.

As a result of the Oceans Act of 2000, President Bush created the U.S. Commission on Ocean Policy. That Commission, among other issues, reviewed America's ongoing program in ocean exploration, as well as the findings on the President's Panel on Ocean Exploration and the National Academy of Sciences report. Based upon its three years of deliberations, which involved hundreds of expert witnesses, on July 22, 2004, the Commission issued its final report "An Ocean Blueprint for the 21st Century," included in which was the following recommendation:

The National Oceanic and Atmospheric Administration and the National Science Foundation should lead an expanded national ocean exploration program with additional involvement from the U.S. Geological Survey and the U.S. Navy's Office of Naval Research. Public outreach and education should be integral components of the program.

In June 2009, President Obama established the Interagency Ocean Policy Task Force, composed of 24 senior-level officials from executive departments, agencies, and offices across the Federal government and led by the Chair of the Council on Environmental Quality. The President charged

the Task Force with developing recommendations to enhance the nation's ability to maintain healthy, resilient, and sustainable ocean, coasts, and Great Lakes resources for the benefit of present and future generations. "The Final Recommendations Of The Interagency Ocean Policy Task Force" was issued in July 2010, and among other recommendations adopted the policy to "Increase scientific understanding of ocean, coastal, and Great Lakes ecosystems as part of the global interconnected systems of air, land, ice, and water, including their relationships to humans and their activities." In addition, in its implementation strategy the Task Force stated as a national priority interest "...ocean, coastal, and Great lakes observations, mapping, and infrastructure: Strengthen and integrate Federal and non-Federal ocean observing systems, sensors, data collection platforms, data management, and mapping capabilities into a national system and integrate that system into international observation efforts."

In 2008, Okeanos Explorer became the first NOAA Ship dedicated to ocean exploration. The privately owned and operated Exploration Vessel (E/V) Nautilus became the second national platform dedicated to ocean exploration. In 2007, with funding from the Richard Lounsbery Foundation and with guidance of the Ocean Exploration Advisory Working Group, two workshops were held, one at the Monterey Bay Aquarium and Research Institute focusing on the technological requirements for ocean exploration on the Okeanos Explorer, and the other at the National Geographic Society Headquarters in Washington, D.C. that invited the ocean science research community to help determine the priority areas for exploration in the Pacific Ocean. The results of these workshops defined instrumentation and methodologies that began to be implemented during Okeanos Explorer's initial season of deployment in 2010, as well as during the Nautilus 2009 and 2010 field programs. Both ships have suites of deep submergence vehicles and shipboard sonars to collect data for mapping, sampling, and imaging the oceans. Both ships also employ the latest in advanced telecommunications technology to access experts within the ocean community the moment they are needed, whenever a discovery is made.

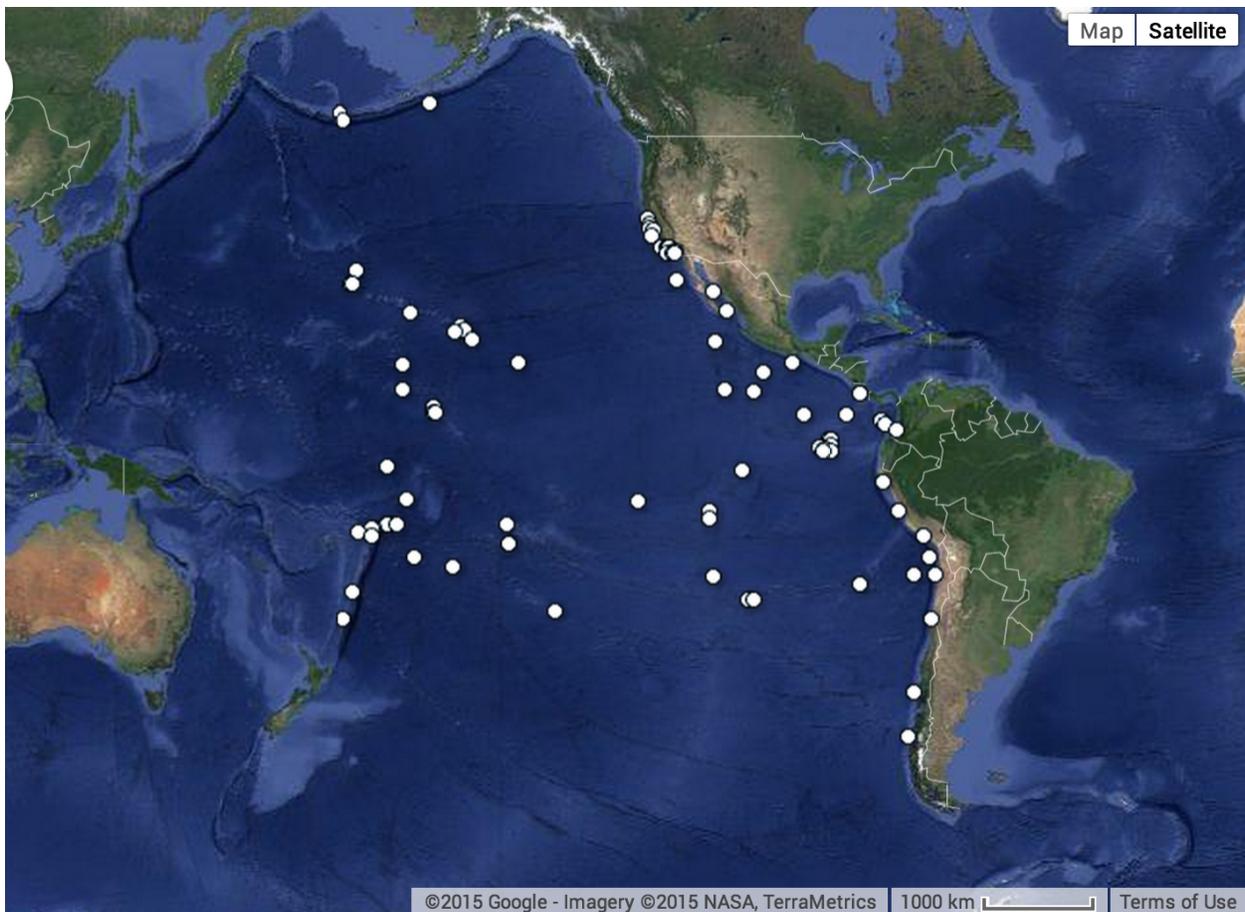
On May 9-10, 2011, NOAA OER held a workshop at the University of Rhode Island's Graduate School of Oceanography. This workshop focused on the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico. Over fifty scientists, archaeologists, and agency representatives reviewed a series of white papers that had been solicited to define the biggest priorities for exploration in those regions, with 26 papers submitted for work in the Atlantic, 12 in the Gulf of Mexico and 11 in the Caribbean Sea. Some of the papers extended or built upon existing primarily biological research, and some of the papers laid out a more general program to survey unexplored terrain.

To follow up on OER's Atlantic Workshop, OET held a follow-up workshop funded by the Lounsbery Foundation to continue a deeper conversation about the Caribbean region in November 2012. Sixty five white papers were submitted, and based on a number of factors, including quality, feasibility, relevance, multidisciplinary nature, and educational potential, thirty seven scientists were invited to participate in this workshop, the Workshop on Telepresence-Enabled Exploration of the Caribbean Region. Including OET and NOAA/OER staff, a total of fifty people participated in the workshop, which was the fourth in this series to identify unknown and underexplored regions of the world's ocean that merit exploration. The results of

the 2012 workshop can be downloaded here:

<http://www.oceanexplorationtrust.org/#!2012-caribbean-workshop/cg3o>

The results of the 2012 Caribbean Workshop were used by OET to plan the *Nautilus* schedules for the 2013 and 2014 field seasons, and many of the scientists that participated in the workshop also participated in the 2013 and 2014 expeditions, either at sea or as Scientists Ashore. Based on the success of this model, the Lounsbury Foundation funded OET to hold a fifth Workshop on Telepresence-enabled Exploration of the Eastern Pacific Ocean. This workshop saw expanded interest, with the submission of 77 white papers, and the participation of 67 scientists, which is nearly double the number of participants at the Caribbean Workshop. OET also held a follow-up webinar to discuss the results of the workshop with both participants, and those that were not able to participate in the workshop in person. This report documents the results of both events.



Locations of white papers submitted for the Eastern Pacific Workshop

Purpose

This workshop and resulting report will support the continuing mandate to strengthen the nation's understanding of the Eastern Pacific Ocean through the use of mapping and exploratory technologies. This workshop report will also provide valuable input to NOAA OER as it prepares for field programs on the *Okeanos Explorer*. In 2015, *Nautilus* will be transiting through the Panama Canal and will conduct 2-3 years of field expeditions in the eastern Pacific before continuing on to explore the western Pacific Ocean. This workshop report will be used by the *Nautilus* team to develop field programs during the period that the ship is operating in the eastern Pacific. We expect that this report will provide valuable input to the national ocean exploration effort, and that this effort will take many years to implement.

In addition to identifying key priority areas for exploration, OET and OER are further developing the Scientist Ashore model of engaging a broad range of scientific expertise through live satellite-based interaction with the ships of exploration. Working with partners identified during the workshop, we also plan to include education and outreach programs in the evolving plan for this region. Telepresence capability will enable us to work with partner countries to foster real-time interaction by their research communities and stakeholders, and open opportunities for engaging the next generation of regional scientists. Because of the possibility for live access to field programs, we expect that participating regional scientific communities will generate broader public support for and interest in exploration of the Eastern Pacific Ocean and ocean exploration in general.

Summary of Plenary Sessions

On the first day, the morning session was dedicated to presenting the concept and operating principles of telepresence-enabled exploration to workshop participants. Katy Croff Bell, OET Executive Vice President, introduced the workshop, and Catalina Martinez, NOAA/OER Rhode Island Regional Program Manager, presented an overview of the history of the development of systematic and telepresence-enabled exploration.

Kelley Elliott, NOAA/OER Field Operations Lead, detailed the technical capabilities of NOAA Ship *Okeanos Explorer*. Nicole Raineault, Director of Science Operations for OET, presented those of E/V *Nautilus*, followed by examples of exploration conducted based on the results of the 2012 Caribbean Workshop.

Examples of telepresence-enabled expeditions, and a perspective on conducting science in this way aboard both *Okeanos Explorer* and *Nautilus*, were presented by Chris German, a member of both the NOAA Ocean Exploration Advisory Board and the *Nautilus* Advisory Board.

The overall purpose of this initial set of presentations was to ensure that all participants were informed of the missions and capabilities of the *Nautilus* and *Okeanos* exploration programs, so

that discussions over the following two days could focus on how best to implement the paradigm and utilize the vessels to the maximum advantage for all participants.

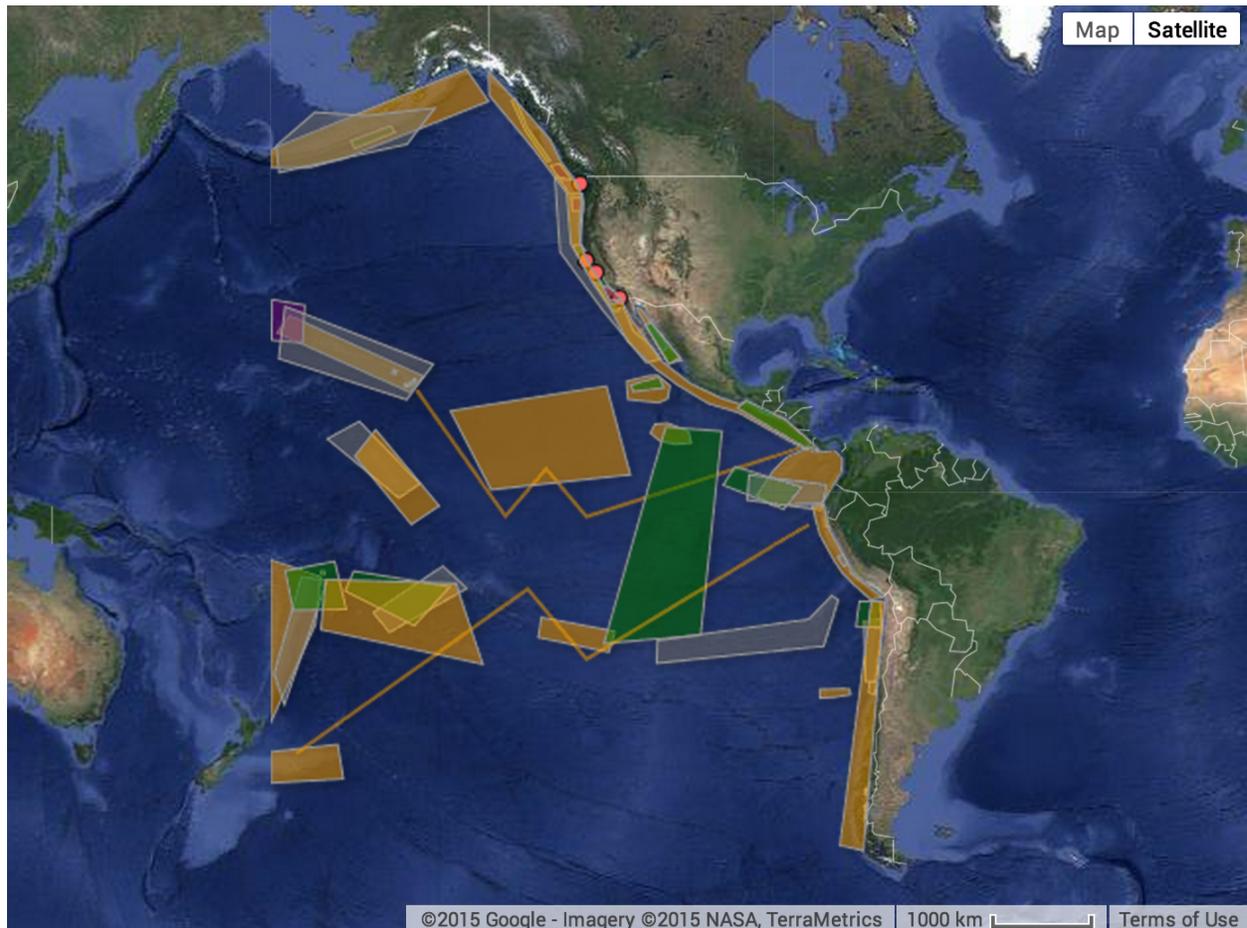
Summary of Breakout Sessions

There were two rounds of breakout discussions. The first consisted of four breakout groups divided by discipline - biology, geology, archaeology, and physical oceanography/chemistry. The major goal of the discipline-based breakout discussions was to identify major Eastern Pacific-wide questions that span multiple regions, for example biogeography of deep reefs, regional tectonics, maritime traffic, etc., which can be answered through telepresence-enabled exploration. A secondary goal was to identify areas/transects that can be conducted to address the key questions. The groups identified a number of key questions within the realms of biological, geological, physical/chemical, and archaeological oceanography that span this Pacific region, as well as 50 areas/transects that can be explored to address those key questions. These areas/transects were overlain on a map of the Eastern Pacific, and seven overlapping Priority Areas were identified, three in the Northern Pacific, two in the South/Central Pacific, and two in the Eastern Pacific.

On the second day, participants were broken up according to geography - Northern Pacific, South/Central Pacific, and Eastern Pacific - to further narrow down exploration target areas in each of the seven Priority Areas. The groups were asked to identify up to 6-10 high priority target areas in each of their regions that would address multiple key questions identified in the first breakout sessions, have high potential for discovery, apply available technologies appropriately, be multidisciplinary in nature, have high potential for education and outreach activities, and be politically feasible (with respect to permitting).

The final result is a list of 33 High Priority Target Areas that will be considered when identifying areas of exploration in the Eastern Pacific region.

Summary of Discipline-based Breakout Discussions



Locations of areas identified during discipline-based breakout sessions that would address key questions for each discipline: Archaeology (purple), Biology (orange), Geology (green), Physics/Chemistry (grey)

Archaeological Oceanography

The Archaeology group for the 2012 Caribbean workshop identified areas and targets for exploration based on both trade routes and historic ports. With a much larger area to consider for the Eastern Pacific, the approach this time was based more on hubs of historic maritime activity, known naval battle sites, and known or suspected deep water wreck sites. Due to the expanse of the Pacific Ocean, trade routes were not considered, rather ocean winds and currents were determined to be more informative to where shipping traffic operates. On a larger scale, we considered the development of Pacific maritime economies, intercultural exchange, and the movement of people within a marine landscape. The results are five key questions that could be investigated by telepresence-enabled exploration, and key areas or sites to target (see map).

Key Questions

AQ-01: What does the patterning of wrecks around key ports tell us about the development of Pacific economies and intercultural exchange?

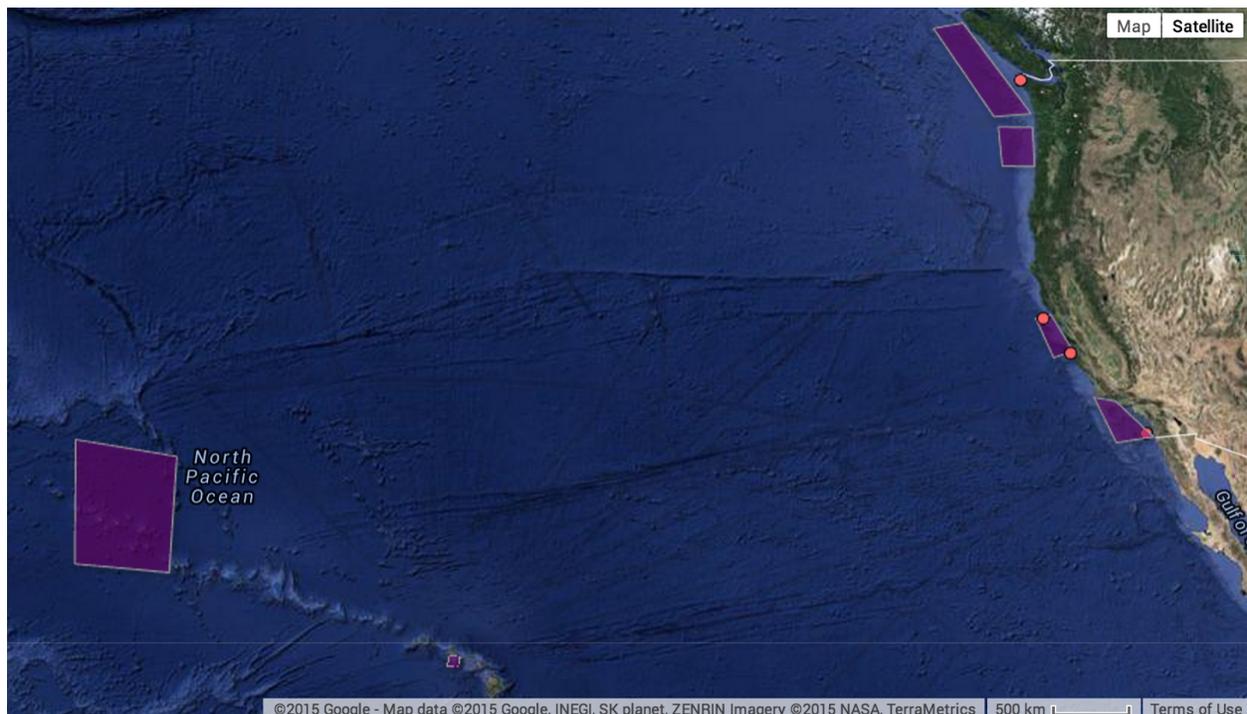
AQ-02: Can potential submerged prehistoric settlement sites be discerned in the post-glacial maximum coastline?

AQ-03: How can we apply a detailed landscape view to an underwater battlefield and deep water archaeological site to reinterpret historical events using forensic evidence?

AQ-04: Can we identify key sites in the Pacific that speak to the archaeology of discard, and what are the environmental impacts of these sites?

AQ-05: Can we find archaeological evidence of pre-European Asian contact at eastern Pacific sites?

Areas of Interest





Locations of areas of interest in the northern (above) and southern (below) hemispheres identified by the Archaeology Breakout Group that would address Key Questions

AA-01: American Samoa

Key Questions Addressed	AQ-01: What is the patterning of wrecks around key ports? AQ-04: What are the impacts of the archaeology of discard?
Specific Targets	Samoan Clipper aircraft; Approaches to Pago Pago
Related White Papers	Samoan Clipper (NC16734) (R. Matthews)
Interested Parties	Russ Matthews, Jim Delgado
Other Information	

AA-02: Battle of Midway, HI

Key Questions Addressed	AQ-03: How can we interpret battles using forensic evidence? AQ-04: What are the impacts of the archaeology of discard?
Specific Targets	WWII Carriers
Related White Papers	Sunken Battlefield of Midway (Catsambis) Battle of Midway & Characterization of USS <i>Yorktown</i> (Delgado) Battle of Midway Sunken Aircraft Survey (Gleason)
Interested Parties	Alexis Catsambis, Jim Delgado, Kelly Gleason

Other Information	
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AA-03: Pearl Harbor, HI

Key Questions Addressed	AQ-01: What is the patterning of wrecks around key ports? AQ-03: How can we interpret battles using forensic evidence? AQ-04: What are the impacts of the archaeology of discard?
Specific Targets	I-400; Midget subs; Scuttled ships after WWII; Ordnance dump; Stickleback sub
Related White Papers	USS Stickleback (SS-415) (A. Catsambis) Exploration of Approaches to Pearl Harbor (J. Delgado)
Interested Parties	Alexis Catsambis, Jim Delgado
Other Information	

AA-04: Olympic Peninsula, WA

Key Questions Addressed	AQ-01: What is the patterning of wrecks around key ports? AQ-02: Can submerged prehistoric settlement sites be found? AQ-04: What are the impacts of the archaeology of discard? AQ-05: Can we find pre-European Asian contact in the Americas?
Specific Targets	SS Pacific, steamer in 1875; Seattle/Vancouver ports; Asian drift wrecks
Related White Papers	None
Interested Parties	
Other Information	

AA-05: Central Oregon Coast, OR

Key Questions Addressed	AQ-02: Can submerged prehistoric settlement sites be found? AQ-04: What are the impacts of the archaeology of discard? AQ-05: Can we find pre-European Asian contact in the Americas?
Specific Targets	Prehistoric sites
Related White Papers	None
Interested Parties	
Other Information	

AA-06: Central California Coast, CA

Key Questions Addressed	AQ-01: What is the patterning of wrecks around key ports? AQ-02: Can submerged prehistoric settlement sites be found? AQ-04: What are the impacts of the archaeology of discard? AQ-05: Can we find pre-European Asian contact in the Americas?
Specific Targets	Mystery tug; Carrier USS Independence; Nuclear waste field; City of Rio; USS Macon; USS Stewart; Lost shipping containers
Related White Papers	Lost Shipping Containers in the Deep (A. DeVogelaere) USS Independence (J. Delgado) Gulf of the Farallones Shipwrecks and Landscape (J. Delgado)
Interested Parties	Andrew DeVogelaere, Jim Delgado
Other Information	

AA-07: Southern California Coast, CA

Key Questions Addressed	AQ-01: What is the patterning of wrecks around key ports? AQ-02: Can submerged prehistoric settlement sites be found? AQ-04: What are the impacts of the archaeology of discard? AQ-05: Can we find pre-European Asian contact in the Americas?
Specific Targets	Islands as paleoshoreline; Shipwrecks
Related White Papers	Channel Islands Early Sites and Unmapped Wrecks (L. Dodd) Northern Channel Islands Shelf Region (C. Nicholson)
Interested Parties	
Other Information	

AA-08: Lima, Peru

Key Questions Addressed	AQ-01: What is the patterning of wrecks around key ports? AQ-04: What are the impacts of the archaeology of discard?
Specific Targets	Approaches to historic port
Related White Papers	
Interested Parties	
Other Information	

AA-09: Valparaiso, Chile

Key Questions Addressed	AQ-01: What is the patterning of wrecks around key ports? AQ-04: What are the impacts of the archaeology of discard?
Specific Targets	Approaches to historic port
Related White Papers	
Interested Parties	
Other Information	

Biological Oceanography

With such a large area to consider, the biology group crafted broad questions in such a way as to cover a diversity of habitat types. They made sure to include protected and non-protected areas, pristine sites and those under anthropogenic stress, and also suggested transects through unexplored regions with varied bathymetry. Key discussions focused on connectivity, adaptive capacity, and management challenges associated with potential impacts of our changing global climate. The results are six key questions that can be applied in virtually any location to gain a better understanding of the eastern Pacific Ocean biologically, and to help inform the management community in the region.

Key Questions

BQ-01: What is the distribution of biodiversity in the water column and on the seafloor?

BQ-02: What biological baseline information is required to facilitate effective environmental management?

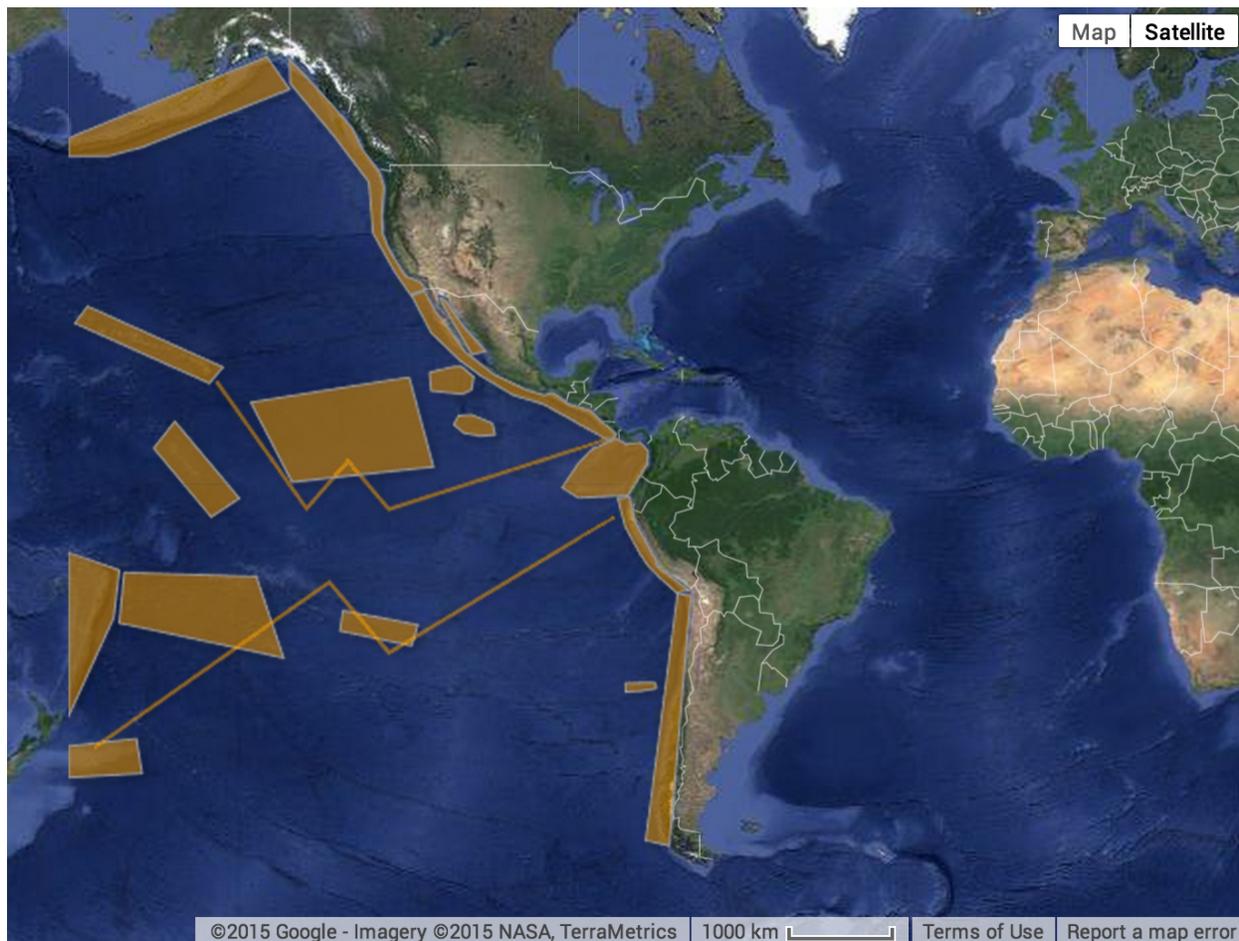
BQ-03: What are the large-scale biogeographic boundaries of the deep Pacific?

BQ-04: What are the successional patterns of deep sea communities following perturbation?

BQ-05: How are biological systems interconnected in the Eastern Pacific?

BQ-06: How can natural environmental gradients in the East Pacific help inform organism and ecosystem adaptations to global change?

Areas of Interest



Locations of areas of interest identified by the Biology Breakout Group that would address Key Questions

BA-01: Chatham Bank

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-03: What are the large-scale biogeographic boundaries? BQ-04: What are the successional patterns of deep communities? BQ-05: How are biological systems interconnected?
Related White Papers	
Interested Parties	Rachel Boschen, Malcolm Clark, Ashley Rowden, Santiago Herrera
Other Information	High biodiversity across an oceanographic front, subject to deep-sea fishing and prospecting for deep-sea minerals

BA-02: Tonga/Fiji/Kermadec

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-03: What are the large-scale biogeographic boundaries? BQ-04: What are the successional patterns of deep communities? BQ-05: How are biological systems interconnected?
Related White Papers	Kermadecs (R. Boschen) Active Volcanic Calderas of the Northern Lau Basin (J. Lupton) Active submarine volcanoes of the Central Pacific (K. Rubin) Forearc to Arc Transition in the N Tonga Trench (K. Kelley) NE Lau Basin - Northern Tonga Subduction Zone (R. Embley)
Interested Parties	Rachel Boschen, Malcolm Clark, Ashley Rowden, Santiago Herrera
Other Information	Interest in mineral deposits; diverse array of benthic habitats; possible latitudinal gradient in biodiversity

BA-03: Cook Islands to French Polynesia

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-04: What are the successional patterns of deep communities? BQ-05: How are biological systems interconnected?
Related White Papers	Deep Sea Minerals (A. Swadling) Rarotonga hotspot (M. Jackson) Active submarine volcanoes of the Central Pacific (K. Rubin) Society Island Hotspot (C. German)
Interested Parties	Alison Swadling, Chris German, Diva Amon, Rachel Boschen, Malcolm Clark, Michael Parke, David Gruber
Other Information	Of particular interest: Niue, Teahitia Seamount, Ahurei

BA-04: Pitcairn Islands

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-05: How are biological systems interconnected?
Related White Papers	Active submarine volcanoes of the Central Pacific (K. Rubin)
Interested Parties	
Other Information	Navy mapping targets (Red Dots) exist between French Polynesia (Area BA-03) & McDonald Seamount (this area)

BA-05: Line Islands

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-03: What are the large-scale biogeographic boundaries? BQ-05: How are biological systems interconnected?
Related White Papers	Line Islands (L. Watling) Exploration and mapping of 3 Pacific locations (J. Caselle) Palmyra Atoll and Kingman Reef (E. Petrucio) Phoenix Islands (E. Cordes)
Interested Parties	Erik Cordes, Christina Kellogg, Alison Swaddling, Michael Parke, David Gruber
Other Information	Phoenix Islands Protected Area (PIPA)

BA-06: Central North Pacific

Key Questions Addressed	BQ-01: What is the distribution of biodiversity?
Related White Papers	
Interested Parties	
Other Information	Great White Shark Cafe

BA-07: Hawaii

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-04: What are the successional patterns of deep communities? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	Deep Hawaiian Slopes (A. Baco-Taylor) Coral Reef Ecosystems of the Au'au Channel (J. Martinez) Loihi Seamount (B. Glazer)
Interested Parties	Michael Parke, Diva Amon, David Gruber
Other Information	Of particular interest: <ul style="list-style-type: none"> ● NW Hawaiian Islands ● Loihi ● Big Island of HI where there are known lava flow age gradients and deep sea corals (BQ-04)

BA-08: Aleutian Arc

Key Questions Addressed	BQ-01: What is the distribution of biodiversity?
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	BQ-03: What are the large-scale biogeographic boundaries? BQ-04: What are the successional patterns of deep communities? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	Western Aleutians at the Amchitka Pass (K. Kelley) Amatignak Spur and Canyon, Aleutian Ridge Islands (D. Scholl) Alaska-Aleutian transition zone (U. ten Brink)
Interested Parties	Santiago Herrera
Other Information	Fathometer Reef

BA-09: North America Margin

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-03: What are the large-scale biogeographic boundaries? BQ-04: What are the successional patterns of deep communities? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	Deep habitat in Bodega Canyon and Continental Slope (D. Lipski) Lost Shipping Containers in the Deep (A. DeVogelaere) Deep Oases: Seamounts and Food-Falls (A. DeVogelaere) Rodriguez and Adjacent Seamounts (C. Mobley) Northern Channel Islands Shelf Region (C. Nicholson) Santa Cruz Escarpment (C. Mobley) Footprint and Piggybank Reef (C. Mobley) Trask Knoll and Santa Cruz Canyon (J. Lunden) Southern California Borderland (M. Cormier) Mapping of the California Continental Borderland (J. Chaytor)
Interested Parties	Peter Etnoyer, Christina Kellogg, Santiago Herrera
Other Information	Areas of interest: Cordell Bank; approaches to San Francisco; Davidson Seamount; Channel Islands; Southern California Bight; California Current LME

BA-10: Gulf of California

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-06: What are adaptations to global change?
Related White Papers	Deep Bioluminescence and Biofluorescence (D. Gruber) Southern Gulf of California (B. Dreyer)
Interested Parties	D. Gruber, Peter Etnoyer

Other Information	
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BA-11: Mexico & Central America Margin

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-03: What are the large-scale biogeographic boundaries? BQ-04: What are the successional patterns of deep communities? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	Isle Guadalupe, Mexico (A. Simms) Mesoamerican Trench (E. Escobar) Costa Rica Margin (E. Cordes)
Interested Parties	Elva Escobar, Erik Cordes, Lisa Levin, Santiago Herrera, David Gruber
Other Information	

BA-12: Revillagigedo Islands

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-05: How are biological systems interconnected?
Related White Papers	Revillagigedo Archipelago and Mathematician Ridge (S. Carey)
Interested Parties	Peter Etnoyer
Other Information	

BA-13: Clipperton Island

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-05: How are biological systems interconnected?
Related White Papers	Pristine Seas expedition to Clipperton (E. Sala) Deep Bioluminescence and Biofluorescence (D. Gruber)
Interested Parties	Jenn Caselle, David Gruber
Other Information	

BA-14: Eastern Tropical Pacific

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-03: What are the large-scale biogeographic boundaries?
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	BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	Isla de Coco and Seamounts (P. Auster) Malpelo Ridge, Colombia (S. Herrera) Colombian Pacific (A. Gracia) Gorgona National Natural Park (E. Londono-Cruz) Deep Macrobenthos of the Galapagos and Rapa Nui (R. Dunbar) Large Deep-Water Lava Flows in the W. Galápagos (D. Fornari) Galapagos Rift (T. Shank) Galapagos Deep Pelagic Biodiversity (M. Vecchione) Galapagos Platform (D. Wanless) Magma Supply on the Galapagos Spreading Center (S. White) Galápagos Transform Fault (E. Mittelstaedt)
Interested Parties	Pete Auster, Jorge Cortes, Santiago Herrera, Adriana Gracia, Edgardo Londono-Cruz, Rob Dunbar, Tim Shank, Mike Vecchione
Other Information	Galapagos of particular interest

BA-15: Peru Margin

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-03: What are the large-scale biogeographic boundaries? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	Peru Margin Habitat Heterogeneity (L. Levin)
Interested Parties	Lisa Levin, Santiago Herrera, Diva Amon
Other Information	Peruvian Canyons for fishing pressure

BA-16: Chile Margin

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-02: What biological information is required for management? BQ-03: What are the large-scale biogeographic boundaries? BQ-04: What are the successional patterns of deep communities? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	Petit spot volcanism off the coast of Chile (F. Davis) Pacific Trenches (T. Shank) Biodiversity Hotspot on the Chilean Margin (L. Levin) Deep-sea fauna inhabiting Chilean canyons (D. Amon) Chile Rise (B. Dreyer)

Interested Parties	Tim Shank, Lisa Levin, Diva Amon, Santiago Herrera
Other Information	Off Concepcion, Chile (last big earthquake, BQ-04); N Chilean coast mine dumping site; What are the local-scale anthropogenic impacts to deep-sea Chilean biological communities?

BA-17: Juan Fernandez Islands

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-03: What are the large-scale biogeographic boundaries? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	
Interested Parties	
Other Information	

BT-01: Equator Transit

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	
Interested Parties	
Other Information	Water column transect

BT-02: South Pacific Transit

Key Questions Addressed	BQ-01: What is the distribution of biodiversity? BQ-05: How are biological systems interconnected? BQ-06: What are adaptations to global change?
Related White Papers	
Interested Parties	
Other Information	

Geological Oceanography

The geology group focused their discussion on key questions in marine geology that could be addressed in the Eastern Pacific. Some of the questions had fairly strict geographic requirements, lending themselves to small boxes. Other questions lent themselves to broader geographical areas of interest, even encompassing the entire basin. There was vibrant discussion surrounding volcanic processes and coastal/shelf hazards. The group recognized the opportunities for interdisciplinary science within the Eastern Pacific and discussed interrelationships between magmatism, tectonism, crustal fluid flow, biology, and climate. The list of questions reflects an effort to generalize many of the specific topics discussed.

Key Questions

GQ-01: What are the tectonic/volcanic/sedimentary controls on submarine groundwater flow and discharge?

GQ-02: What are the characteristics of submarine geohazards in the Eastern Pacific and how do they relate to the tectonic setting?

GQ-03: What factors control the origin, distribution, evolution and eruptive behavior of submarine volcanoes?

GQ-04: What are the patterns of marine mineral resources of the Eastern Pacific and how do they relate to tectonic and oceanographic processes?

GQ-05: What are the magmatic, tectonic, and morphological characteristics of plate boundary intersections?

GQ-06: What are the possible climate impacts of submarine geological processes?

GQ-07: What are the geomorphic provinces of the Pacific basin and how would they be defined and characterized?

GQ-08: How would you create a geological map of the entire eastern Pacific at a scale similar to the DNAG North America map (1:5,000,000)?

GQ-09: Are there large undiscovered cosmic impact structures in the Eastern Pacific Ocean?

GQ-10: What are the relationships between ecosystems and geological processes in the Eastern Pacific?

Areas of Interest



Locations of areas of interest identified by the Geology Breakout Group that would address Key Questions

GA-01: Samoa, Niue, & Tonga Trench

<p>Key Questions Addressed</p>	<p>GQ-01: What are the controls on fluid flow? GQ-03: What factors control submarine volcanism? GQ-04: What are the patterns of marine mineral resources? GQ-05: What are the characteristics of plate boundaries? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?</p>
<p>Related White Papers</p>	<p>Active Volcanic Calderas of the Northern Lau Basin (J. Lupton) NE Lau Basin - Northern Tonga Subduction Zone (R. Embley) Active submarine volcanoes of the Central Pacific (K. Rubin) Forearc to Arc Transition in the N Tonga Trench (K. Kelley) Vailulu'u volcano and Muliava sanctuary (W. Cover) Vailulu'u Seamount, Samoan Volcanic Chain (J. Konter)</p>

	Deep Sea Minerals (A. Swaddling)
Interested Parties	Katie Kelley, John Lupton, Bob Embley, Wendy Cover, Jasper Konter, Alison Swaddling, Santiago Herrera, Rachel Boschen, Ashley Rowden, Richard Wysoczanski, Cornel de Ronde
Other Information	

GA-02: Cook Islands & French Polynesia

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-03: What factors control submarine volcanism? GQ-05: What are the characteristics of plate boundaries? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	Rarotonga hotspot (M. Jackson) Society Island Hotspot (C. German) Active submarine volcanoes of the Central Pacific (K. Rubin)
Interested Parties	Matt Jackson, Chris German, Ken Rubin, Alison Swaddling, Rachel Boschen, Malcolm Clark, Santiago Herrera
Other Information	

GA-03: Hawaii

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-02: What are the characteristics of submarine geohazards? GQ-03: What factors control submarine volcanism? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	Loihi Seamount (B. Glazer)
Interested Parties	Brian Glazer
Other Information	Area of interest: Loihi Seamount

GA-04: Aleutian Arc

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-02: What are the characteristics of submarine geohazards? GQ-05: What are the characteristics of plate boundaries?
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	GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	Alaska-Aleutian transition zone (U. ten Brink) Amatignak Spur and Canyon, Aleutian Ridge Islands (D. Scholl) Western Aleutians at the Amchitka Pass (K. Kelley)
Interested Parties	Uri ten Brink, Katie Kelley, Dave Scholl, Chris German, Santiago Herrera
Other Information	

GA-05: Cascadia Margin

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-02: What are the characteristics of submarine geohazards? GQ-05: What are the characteristics of plate boundaries? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	
Interested Parties	Chris German, Santiago Herrera, Carlos A. Vargas
Other Information	

GA-06: California Margin

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-02: What are the characteristics of submarine geohazards? GQ-05: What are the characteristics of plate boundaries? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	Rodriguez and Adjacent Seamounts (C. Mobley) Northern Channel Islands Shelf Region (C. Nicholson) Santa Cruz Escarpment (C. Mobley) Footprint and Piggybank Reef (C. Mobley) Trask Knoll and Santa Cruz Canyon (J. Lunden) Southern California Borderland (M. Cormier) Mapping of the California Continental Borderland (J. Chaytor)
Interested Parties	
Other Information	

GA-07: Gulf of California

Key Questions Addressed	GQ-03: What factors control submarine volcanism? GQ-05: What are the characteristics of plate boundaries? GQ-06: How do submarine geological processes impact climate? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	Deep Bioluminescence and Biofluorescence (D. Gruber) Southern Gulf of California (B. Dreyer)
Interested Parties	Adam Soule, Brian Dreyer, Scott White, Steve Carey
Other Information	

GA-08: Revillagigedo Islands

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-02: What are the characteristics of submarine geohazards? GQ-03: What factors control submarine volcanism? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	Revillagigedo Archipelago and Mathematician Ridge (S. Carey)
Interested Parties	Chris German, Brian Dreyer
Other Information	

GA-09: Central American Margin

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-02: What are the characteristics of submarine geohazards? GQ-05: What are the characteristics of plate boundaries? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	Mesoamerican Trench (E. Escobar) Costa Rica (E. Cordes)
Interested Parties	Elva Escobar, Erik Cordes, Adam Soule, Carlos A. Vargas
Other Information	

GA-10: East Pacific Rise

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-03: What factors control submarine volcanism? GQ-05: What are the characteristics of plate boundaries? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	East Pacific Rise, Off-Axis (A. Soule) Gofar Transform Fault (J. McGuire) East Pacific Rise off-axis eruptions (S. White) Hydrothermal circulation on Garrett transform fault (J. Warren) Pito Deep, EPR (M. Cheadle)
Interested Parties	Adam Soule, Jeff McGuire, Scott White, Jessica Warren, Mike Cheadle, Chris German, Brian Dreyer, Carlos A. Vargas
Other Information	

GA-11: Galapagos

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-03: What factors control submarine volcanism? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
Related White Papers	Large Deep-Water Lava Flows in the W. Galápagos (D. Fornari) Galapagos Rift (T. Shank) Galapagos Platform (D. Wanless) Magma Supply on the Galapagos Spreading Center (S. White) Galápagos Transform Fault (E. Mittelstaedt)
Interested Parties	Dan Fornari, Tim Shank, Dorsey Wanless, Scott White, Eric Mittelstaedt, Carlos A. Vargas
Other Information	

GA-12: Chile Margin

Key Questions Addressed	GQ-01: What are the controls on fluid flow? GQ-03: What factors control submarine volcanism? GQ-05: What are the characteristics of plate boundaries? GQ-07: What are the geomorphic provinces of the Pacific basin? GQ-08: How to create a geological map of the eastern Pacific? GQ-10: How are ecosystems and geological processes related?
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Related White Papers	Petit spot volcanism off the coast of Chile (F. Davis) Pacific Trenches (T. Shank) Chile Rise (B. Dreyer)
Interested Parties	Katie Kelley, Chris German, Brian Dreyer, Fred Davis, Carlos A. Vargas
Other Information	Known fluid flow targets from NOAA-OER 2010, 2012 work aboard RV <i>Melville</i> at Chile Triple Junction

Physical & Chemical Oceanography

The Physical and Chemical Oceanography Breakout Group focused on seawater chemistry, marine pollution, and the physical forcing that interacts with seafloor topography and affects water mass characteristics and the distribution of nutrients, minerals, and dissolved oxygen. The group considered basin-scale and mesoscale circulation, abyssal flows, waves and tides, the variability of pH and alkalinity, the oxygen minimum zone, and plumes from cold seeps and hydrothermal vents. These discussions were summarized with 14 questions that could be addressed through deep ocean exploration. The group then identified geographic areas that would be representative of the phenomena and conditions featured in these questions, and suitable for mapping and exploration.

Key Questions

PCQ-01: How do large scale currents in the upper ocean (equatorial currents, eastern boundary currents, and associated undercurrents) interact with islands and seamounts, and how do they affect marine archeology, nutrient and mineral distribution, and O₂ variability?

PCQ-02: How do mesoscale features such as eddies and upwelling jets interact with seamounts, islands, and the abyss, and what is their impact on O₂ and nutrient distribution?

PCQ-03: How do tides, wind-driven waves, and internal waves interact with islands, seamounts, and the continental shelf, and how do they contribute to ocean mixing?

PCQ-04: What is the direction and magnitude of abyssal flow, and is it impacted by mesoscale eddies and/or internal waves?

PCQ-05: What are the sources, fluxes, and sinks of nutrients required for primary production? Are they retained along the coast, or are there significant losses due to mixing and exchanges offshore? What are the causes and extent of ocean desertification?

PCQ-06: What is the depth of the O₂ minimum zone, and how does that depth vary in the vicinity of the continental shelf break, islands, and seamounts? What is the impact of the O₂ minimum zone on biology and geology?

PCQ-07: How do pH and alkalinity vary spatially and temporally, and what is the impact on carbonate saturation levels? Where is the transition to unsaturated water, and how unsaturated is the water below the transition zone?

PCQ-08: Why are vertical-walled coral atolls present in the Pacific? What is the impact of pH and O₂ levels on their existence?

PCQ-09: How are cold seeps distributed in a given region, and how far can they be detected in the water column? How far are the chemicals from these seeps transported by currents?

PCQ-10: How does ocean chemistry vary in the vicinity of hydrothermal vents? How far do mineral and nutrient-rich plumes extend from their source, and what is their fate?

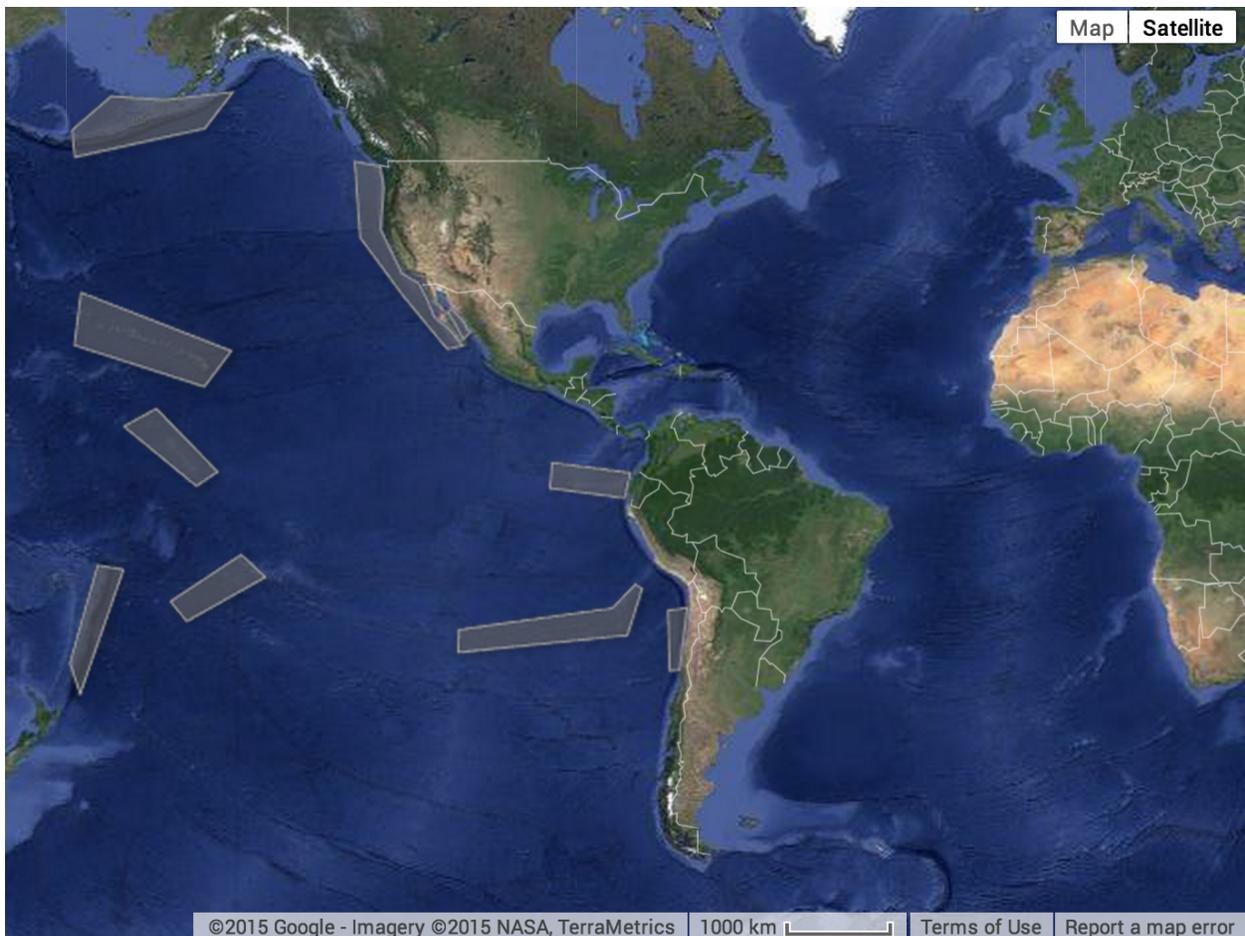
PCQ-11: How does ambient noise in the oceans vary spatially and temporally?

PCQ-12: What is the lateral and vertical extent of plastics in the water column? Is ingestion of plastics concentrating toxins in the food chain?

PCQ-13: How are sediments transported in submarine canyons?

PCQ-14: What is the fate of Fukushima radionuclides, and can they be used to trace abyssal circulation?

Areas of Interest



Locations of areas of interest identified by the Physics/Chemistry Breakout Group that would address Key Questions

PCA-01: Kermadecs

Key Questions Addressed	PCQ-01: How do large scale currents interact with topography? PCQ-02: How do mesoscale features interact with topography? PCQ-03: How do waves and tides interact with topography? PCQ-04: What is the nature of abyssal circulation? PCQ-07: What is the variability and impact of pH and alkalinity? PCQ-10: How do hydrothermal vents affect ocean chemistry? PCQ-11: How does ambient noise vary spatially and temporally?
Related White Papers	Kermadecs (R. Boschen)
Interested Parties	Craig Stevens, Hannah Prior, Leigh Marsh, Ashley Rowden, Richard Wysoczanski, Cornel de Ronde, Craig Stevens
Other Information	Ridges, trenches, seamounts, hydrothermal vents, East Australia Current, South Equatorial Current, Antarctic Bottom Water

PCA-02: Cook Islands to French Polynesia

Key Questions Addressed	PCQ-01: How do large scale currents interact with topography? PCQ-03: How do waves and tides interact with topography? PCQ-04: What is the nature of abyssal circulation? PCQ-05: What are the sources, fluxes, and sinks of nutrients? PCQ-06: What is the depth and impact of O ₂ minimum zones? PCQ-07: What is the variability and impact of pH and alkalinity? PCQ-08: Why are vertical-walled atolls present in the Pacific? PCQ-10: How do hydrothermal vents affect ocean chemistry? PCQ-11: How does ambient noise vary spatially and temporally?
Related White Papers	Active Submarine Volcanoes of the Central Pacific (K. Rubin) Rarotonga Hotspot (M. Jackson)
Interested Parties	Philip Sutton, David Valentine, Katherine Kelley
Other Information	Active volcanoes; Circulation questions; French nuclear tests on coral atolls

PCA-03: Line Islands

Key Questions Addressed	PCQ-01: How do large scale currents interact with topography? PCQ-03: How do waves and tides interact with topography? PCQ-05: What are the sources, fluxes, and sinks of nutrients? PCQ-06: What is the depth and impact of O ₂ minimum zones? PCQ-07: What is the variability and impact of pH and alkalinity?
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	<p>PCQ-08: Why are vertical-walled atolls present in the Pacific?</p> <p>PCQ-09: How are cold seeps distributed in a given region?</p> <p>PCQ-11: How does ambient noise vary spatially and temporally?</p> <p>PCQ-12: What is the extent of plastics in the water column?</p> <p>PCQ-13: What is the fate of sediments in submarine canyons?</p>
Related White Papers	<p>PRINM & Seamounts with Mining Potential (A. Baco-Taylor)</p> <p>Palmyra Atoll and Kingman Reef (E. Petruncio)</p> <p>Pacific Remote Islands Marine National Monument (B. Roarke)</p> <p>Active Submarine Volcanoes of the Central Pacific (K. Rubin)</p> <p>Line Islands Area (L. Watling)</p>
Interested Parties	Michael Parke, Palmyra Atoll Research Consortium
Other Information	Are the islands of the central pacific dissolving? vertical walls - some are undercut; South Equatorial Current, North Equatorial Counter Current

PCA-04: Hawaii

Key Questions Addressed	<p>PCQ-01: How do large scale currents interact with topography?</p> <p>PCQ-02: How do mesoscale features interact with topography?</p> <p>PCQ-03: How do waves and tides interact with topography?</p> <p>PCQ-05: What are the sources, fluxes, and sinks of nutrients?</p> <p>PCQ-06: What is the depth and impact of O2 minimum zones?</p> <p>PCQ-07: What is the variability and impact of pH and alkalinity?</p> <p>PCQ-09: How are cold seeps distributed in a given region?</p> <p>PCQ-10: How do hydrothermal vents affect ocean chemistry?</p> <p>PCQ-11: How does ambient noise vary spatially and temporally?</p> <p>PCQ-12: What is the extent of plastics in the water column?</p> <p>PCQ-13: What is the fate of sediments in submarine canyons?</p>
Related White Papers	<p>Deep Hawaiian Slopes (A. Baco-Taylor)</p> <p>Approaches to Pearl Harbor and Oahu, Hawaii (J. Delgado)</p> <p>Loihi Seamount (B. Glazer)</p> <p>Coral Reef Ecosystems of the Au' Au Channel (J. Martinez)</p>
Interested Parties	Michael Parke
Other Information	Volcanoes, hydrothermal vents, North Equatorial Current, Hawaiian Lee (Subtropical) Counter Current, plastic debris

PCA-05: Aleutian Arc

Key Questions Addressed	<p>PCQ-01: How do large scale currents interact with topography?</p> <p>PCQ-02: How do mesoscale features interact with topography?</p>
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	<p>PCQ-03: How do waves and tides interact with topography?</p> <p>PCQ-04: What is the nature of abyssal circulation?</p> <p>PCQ-05: What are the sources, fluxes, and sinks of nutrients?</p> <p>PCQ-06: What is the depth and impact of O₂ minimum zones?</p> <p>PCQ-07: What is the variability and impact of pH and alkalinity?</p> <p>PCQ-09: How are cold seeps distributed in a given region?</p> <p>PCQ-10: How do hydrothermal vents affect ocean chemistry?</p> <p>PCQ-11: How does ambient noise vary spatially and temporally?</p> <p>PCQ-13: What is the fate of sediments in submarine canyons?</p> <p>PCQ-14: What is the fate of Fukushima radionuclides?</p>
Related White Papers	<p>Western Aleutians at the Amchitka Pass (K. Kelley)</p> <p>Amatignak Spur and Canyon, Aleutian (Ridge) Islands (D. Scholl)</p> <p>Alaska-Aleutian Transition Zone (U. ten Brink)</p>
Interested Parties	
Other Information	<p>Volcanism, active venting, Alaskan Current, strong internal tides and ocean mixing</p>

PCA-06: US & Mexico Margin

Key Questions Addressed	<p>PCQ-01: How do large scale currents interact with topography?</p> <p>PCQ-02: How do mesoscale features interact with topography?</p> <p>PCQ-03: How do waves and tides interact with topography?</p> <p>PCQ-05: What are the sources, fluxes, and sinks of nutrients?</p> <p>PCQ-06: What is the depth and impact of O₂ minimum zones?</p> <p>PCQ-07: What is the variability and impact of pH and alkalinity?</p> <p>PCQ-09: How are cold seeps distributed in a given region?</p> <p>PCQ-10: How do hydrothermal vents affect ocean chemistry?</p> <p>PCQ-11: How does ambient noise vary spatially and temporally?</p> <p>PCQ-12: What is the extent of plastics in the water column?</p>
Related White Papers	<p>California Continental Borderland (J. Chaytor)</p> <p>Southern California Borderland (M. Cormier)</p> <p>Gulf of the Farallones Shipwrecks & Landscape (J. Delgado)</p> <p>Deep Oases: Seamounts and Food-Falls (A. DeVogelaere)</p> <p>Lost Shipping Containers in the Deep (A. DeVogelaere)</p> <p>Channel Islands Early Sites and Unmapped Wrecks (L. Dodd)</p> <p>Surveys of Deep Habitat in Cordell Bank (D. Lipski)</p> <p>Trash Knoll and Santa Cruz Canyon (G. Hoffman)</p> <p>Rodriguez and Adjacent Seamounts (C. Mobley)</p> <p>Santa Cruz Escarpment (C. Mobley)</p> <p>Footprint and Piggybank Reef (C. Mobley)</p> <p>Northern Channel Islands Shelf Region (C. Nicholson)</p> <p>Revillagigedo Archipelago and Mathematician Ridge (S. Carey)</p> <p>Isle Guadalupe, Mexico (A. Sims)</p>

Interested Parties	Peter Etnoyer, Santiago Herrera
Other Information	California Current System, Upwelling, internal tides With regard to Deep Sea Corals and Sponge Ecosystems & ocean acidification, consider both current adaptation to acidification and as potential paleo record of ocean acidification

PCA-07: Gulf of California

Key Questions Addressed	PCQ-03: How do waves and tides interact with topography? PCQ-05: What are the sources, fluxes, and sinks of nutrients? PCQ-06: What is the depth and impact of O ₂ minimum zones? PCQ-07: What is the variability and impact of pH and alkalinity? PCQ-09: How are cold seeps distributed in a given region? PCQ-10: How do hydrothermal vents affect ocean chemistry? PCQ-11: How does ambient noise vary spatially and temporally? PCQ-13: What is the fate of sediments in submarine canyons?
Related White Papers	The Southern Gulf of California (B. Dreyer)
Interested Parties	Ryan Porter, James Head, Jay Dickson, Nathan Daczko, Danielle Sumy, Brandi Reese
Other Information	Seismically active, hydrothermal vents, islands and seamounts, numerous submarine canyons, monsoonal wind forcing

PCA-08: Galapagos

Key Questions Addressed	PCQ-01: How do large scale currents interact with topography? PCQ-02: How do mesoscale features interact with topography? PCQ-03: How do waves and tides interact with topography? PCQ-05: What are the sources, fluxes, and sinks of nutrients? PCQ-06: What is the depth and impact of O ₂ minimum zones? PCQ-07: What is the variability and impact of pH and alkalinity? PCQ-09: How are cold seeps distributed in a given region? PCQ-10: How do hydrothermal vents affect ocean chemistry? PCQ-11: How does ambient noise vary spatially and temporally? PCQ-13: What is the fate of sediments in submarine canyons?
Related White Papers	Deep Sea Macrobenthos of the Galapagos & Rapa Nui (R. Dunbar) Large Lava Flows in the Western Galápagos (D. Fornari) Formation of an Intra-Transform Spreading Center in the Galapagos Transform Fault (E. Mittelstaedt) Eastern Pacific Seamount Moats (R. Pockalny) Galapagos Rift (T. Shank) Galapagos Deep Pelagic Biodiversity (M. Vecchione)

	Galapagos Platform (D. Wanless) Magma Supply Gradients at Galapagos & Seamounts (S. White)
Interested Parties	
Other Information	Interaction of Eastern Boundary Currents and Equatorial Currents, Tropical Instability Waves, upwelling, volcanism, hydrothermal vents, seamounts

PCA-09: Salas y Gomez

Key Questions Addressed	PCQ-01: How do large scale currents interact with topography? PCQ-02: How do mesoscale features interact with topography? PCQ-03: How do waves and tides interact with topography? PCQ-05: What are the sources, fluxes, and sinks of nutrients? PCQ-06: What is the depth and impact of O ₂ minimum zones? PCQ-07: What is the variability and impact of pH and alkalinity? PCQ-09: How are cold seeps distributed in a given region? PCQ-10: How do hydrothermal vents affect ocean chemistry? PCQ-11: How does ambient noise vary spatially and temporally? PCQ-13: What is the fate of sediments in submarine canyons?
Related White Papers	Easter Island and Sala y Gomez Island (D. Amon) Sala y Gomez Seamount Chain in the SE Pacific (J. Blanco)
Interested Parties	
Other Information	Seamount chemistry; Numerous unmapped seamounts; Coastal upwelling; Easter Island

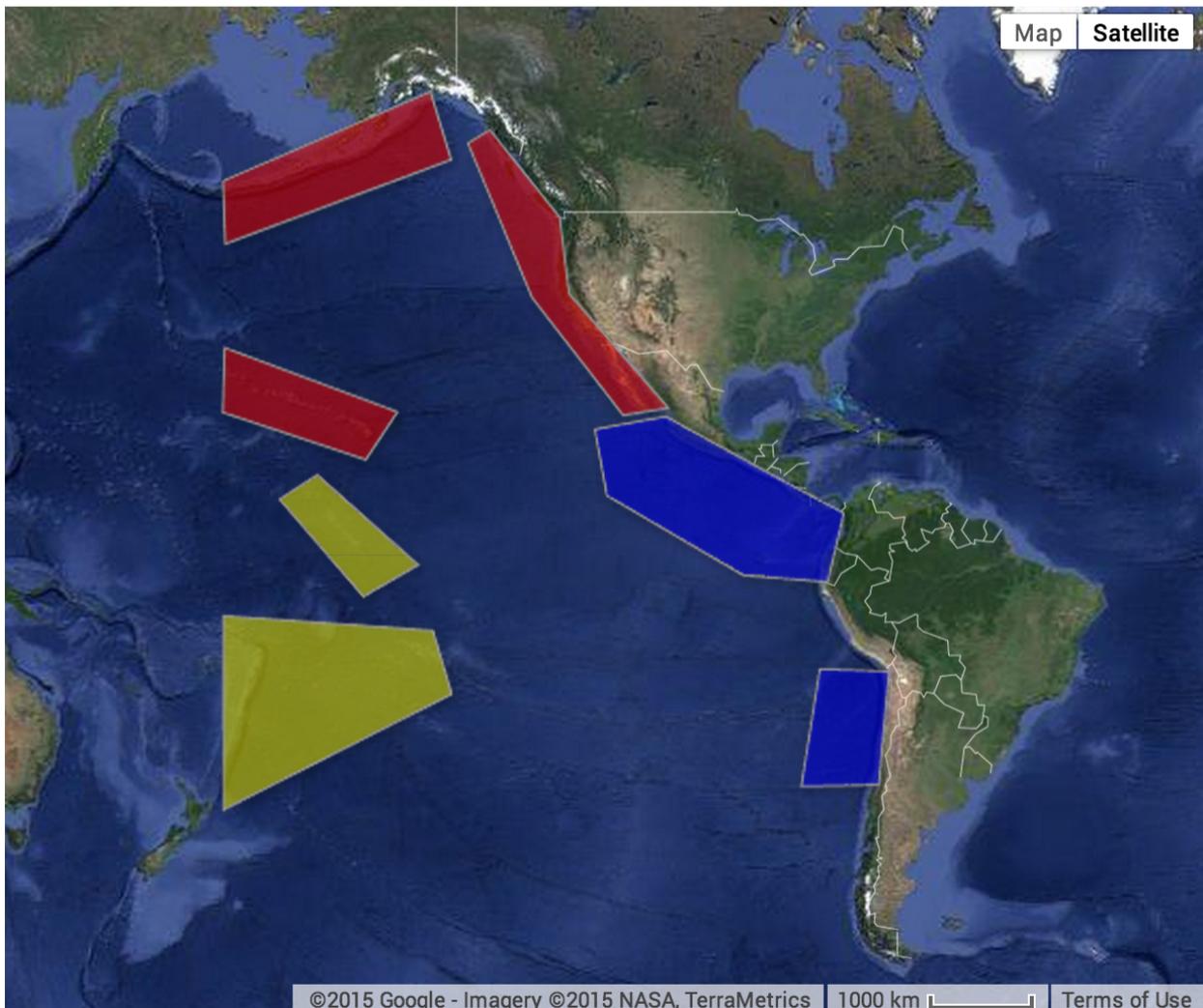
PCA-10: Central Chile Margin

Key Questions Addressed	PCQ-01: How do large scale currents interact with topography? PCQ-02: How do mesoscale features interact with topography? PCQ-03: How do waves and tides interact with topography? PCQ-05: What are the sources, fluxes, and sinks of nutrients? PCQ-06: What is the depth and impact of O ₂ minimum zones? PCQ-07: What is the variability and impact of pH and alkalinity? PCQ-09: How are cold seeps distributed in a given region? PCQ-11: How does ambient noise vary spatially and temporally? PCQ-13: What is the fate of sediments in submarine canyons?
Related White Papers	Deep Sea Fauna Inhabiting Chilean Canyons (D. Amon) Chile Rise (B. Dreyer) The Chemosynthetic Ecosystem off Peru and Chile (V. Gallardo) Biodiversity Hotspot on the Chilean Margin (L. Levin)
Interested Parties	

Other Information	Copper mining tailings are discharged into offshore canyons - how are these sediments transported? Humboldt/Peru/Chile Current, upwelling; Microbial mats on shelf under the O2 minimum zone
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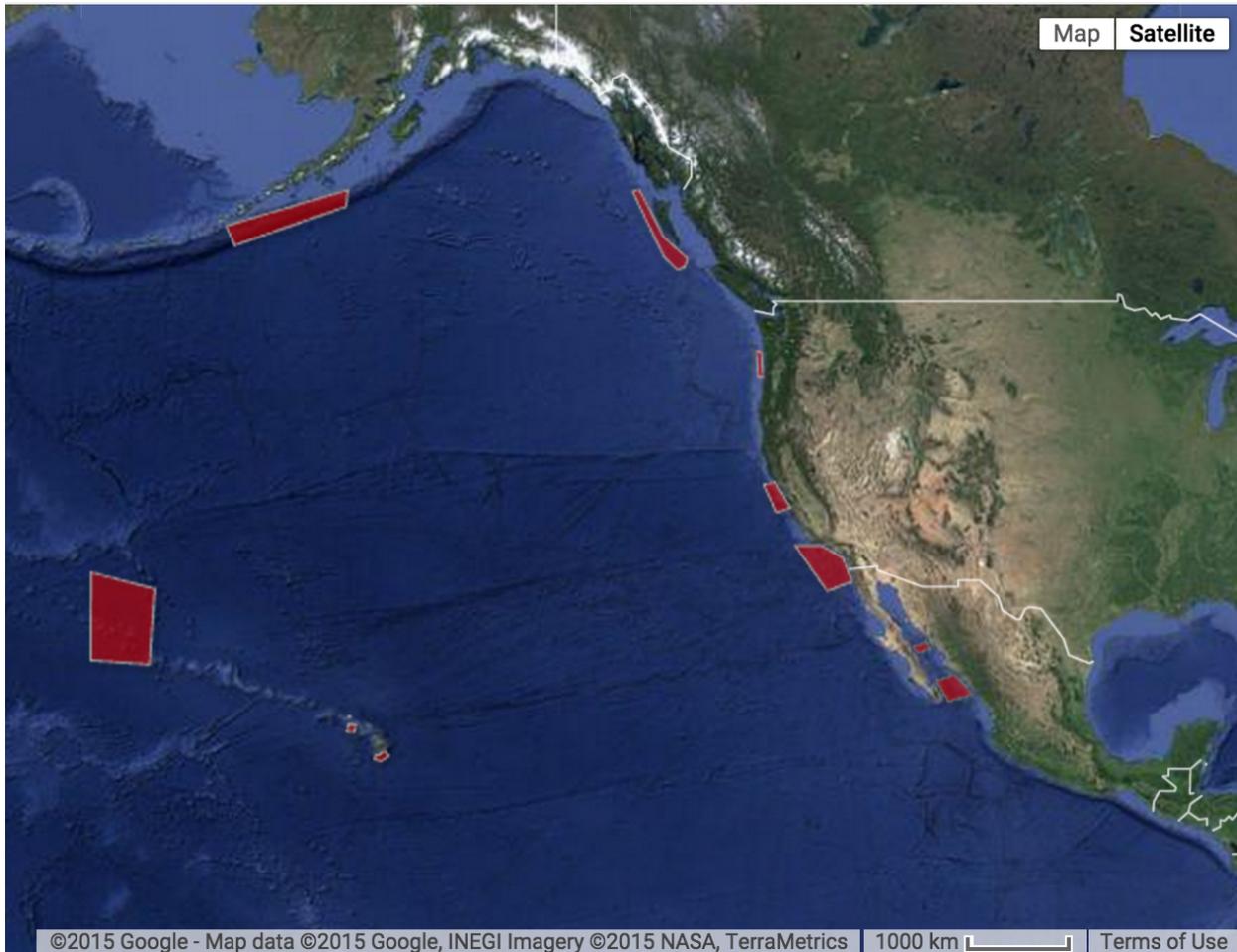
Summary of Regional Breakout Discussions

Based on the results of the discipline-based breakout discussions, seven areas were identified in which geological, biological, archaeological, and physical exploratory interests overlapped. These areas were divided between three groups for regional breakout discussions: Northern Pacific, South/Central Pacific, and Eastern Pacific. Regional breakout groups were charged with identifying high-priority target areas within the priority areas that merit exploration on the basis of geological, biological, and archaeological priorities, as well as educational interest, technical feasibility, and likelihood of permitting.



Locations of Priority Areas that were the basis of discussion for the Regional Breakout Groups: Northern Pacific (red), South/Central Pacific (yellow), and Eastern Pacific (blue)

Northern Pacific



Locations of High Priority Target Areas identified by the Northern Pacific Breakout Group

NPA-01: Loihi Seamounts

Overview	
Depth Range	2,000-5,000 m
Archaeology	Opportunistic
Biology	Lava flow age gradient for communities
Geology	Seamounts and hot spot volcanism, landslide hazard
Physics/Chemistry	
Education & Outreach	
Existing Data	Well mapped, shovel ready for ROV

Technical Feasibility	ROV Dives
Permitting Details	USA
Related White Papers	Loihi Seamount (B. Glazer)
Interested Parties	
Additional Information	

NPA-02: Pearl Harbor & S-28

Overview	Some shovel-ready archaeological targets known
Depth Range	100-4,000 m
Archaeology	Approaches to Pearl Harbor, aircraft, historic shipwrecks; already known 20-30 targets, including submarine S-28
Biology	Oahu-Maui channel, coral habitat, biological colonization/succession on wrecks of known dates
Geology	Volcanic flows, landslides
Physics/Chemistry	
Education & Outreach	
Existing Data	Mapping of some areas complete, but many gaps
Technical Feasibility	~10 days, ROV dives
Permitting Details	USA
Related White Papers	USS Stickleback (SS-415) (A. Catsambis) Exploration of Approaches to Pearl Harbor (J. Delgado)
Interested Parties	Alexis Catsambis, Jim Delgado
Additional Information	

NPA-03: Midway

Overview	
Depth Range	4,000-6,000 m
Archaeology	Sunken aircraft and Japanese aircraft carriers
Biology	Deep sea biodiversity and corals

Geology	National monument, mapping
Physics/Chemistry	
Education & Outreach	
Existing Data	<i>Falkor</i> has done some mapping, more to be done
Technical Feasibility	Too deep for <i>Hercules</i> , long descent time for D2
Permitting Details	USA
Related White Papers	Sunken Battlefield of Midway (Catsambis) Battle of Midway & Characterization of USS Yorktown (Delgado) Battle of Midway Sunken Aircraft Survey (Gleason)
Interested Parties	Alexis Catsambis, Jim Delgado, Kelly Gleason, Michael Parke
Additional Information	

NPA-04: Aleutian Arc

Overview	An area of a volcanic island chain selected for geohazard and tsunami potential and active vents and seeps, and deep water habitat characterization, especially as an area in need of mapping.
Depth Range	500-6,000 m
Archaeology	Dutch Harbor wrecks; Pribilof Canyon; opportunistic
Biology	Habitat characterization; 6-foot sponges with crabs; deep seeps; deep diving mammals
Geology	Tsunami hazards; seafloor fluid flow
Physics/Chemistry	Possible seeps
Education & Outreach	No good recent data
Existing Data	
Technical Feasibility	Seafloor mapping ROV AUV for detailed mapping / location of fluid flow sites? Possible <i>Sikuliaq</i> work?
Permitting Details	USA
Related White Papers	Western Aleutians at the Amchitka Pass (K. Kelley)

	Amatignak Spur and Canyon, Aleutian Ridge Islands (D. Scholl) Alaska-Aleutian transition zone (U. ten Brink)
Interested Parties	Chris German, Christina Kellogg, Santiago Herrera
Additional Information	

NPA-05: Queen Charlotte Fault

Overview	This is part of a dynamic triple junction off Canada's west coast that has not been well-studied. This area was selected for mapping and geohazard assessments, upwelling and seep biology, and potential paleoshorelines for glacial and habitation evaluation.
Depth Range	300-2,500 m
Archaeology	Palaeoshorelines; opportunistic along migration route
Biology	Habitat characterization
Geology	Earthquakes and active fault, possible seeps, narrow swath for mapping; glacial history
Physics/Chemistry	Water column mapping for seeps; upwelling
Education & Outreach	
Existing Data	Very little done here previously
Technical Feasibility	Seafloor mapping, water column survey
Permitting Details	Canada
Related White Papers	
Interested Parties	
Additional Information	

NPA-06: Coastal Oregon

Overview	The effects of the Kuroshio current and Alaska current present an opportunity to locate evidence of prehistoric migration, and the coastline offers an opportunity for mapping and geohazard assessment.
Depth Range	100-500 m

Archaeology	Prehistoric sites; coastal migration
Biology	
Geology	Geohazards
Physics/Chemistry	
Education & Outreach	
Existing Data	Ocean Networks Canada and PMEL/UW are communicating/collaborating on projects in this area
Technical Feasibility	Mapping; ROV dives; Very shallow, may not be cost effective for mapping; could be a transit
Permitting Details	USA
Related White Papers	
Interested Parties	
Additional Information	

NPA-07: Central California

Overview	
Depth Range	100-3,000 m
Archaeology	USS <i>Stewart</i> ; nuclear and ordnance dumping; many others
Biology	Gulf of the Farallones & Monterey Bay National Marine Sanctuaries; seeps; trawling effects, rockfishes, deep-sea corals and sponges
Geology	Geohazards; mapping; seamounts (including Davidson); canyons; San Andreas Fault
Physics/Chemistry	California Current
Education & Outreach	Deep reef ecology, sustainable fishing
Existing Data	Check with Sanctuaries and MBARI. Multibeam and habitat classification maps available from USGS for Rittenburg Bank and Farallon Escarpment.
Technical Feasibility	2-4 weeks mapping & ROV
Permitting Details	USA

Related White Papers	Lost Shipping Containers in the Deep (A. DeVogelaere) USS Independence (J. Delgado) Gulf of the Farallones Shipwrecks and Landscape (J. Delgado) Surveys of deep habitat in Bodega Canyon (D. Lipski) Deep Oases: Seamounts and Food-Falls (A. DeVogelaere)
Interested Parties	Peter Etnoyer, Guy Cochrane, Santiago Herrera
Additional Information	Opportunity to assist Sanctuary expansion planning by exploring new habitat

NPA-08: Southern California Margin

Overview	Highly complex seafloor topography and a dynamic upwelling environment in direct proximity to the largest cities on the US West Coast. Abundant deep-sea corals and sponges in some areas. Impending threats from ocean acidification, warming, land based pollution, and bottom fishing but a fairly well-established MPA network is present and increasingly effective.
Depth Range	100-2,000 m
Archaeology	Submerged prehistoric landscape, oldest human habitation, 13,000 years; potential for ship and aircraft wrecks; ordnance dumps
Biology	Channel Islands National Marine Sanctuary; exploration of seamounts; deep sea corals, sponges and fishes; ocean acidification; hydrothermal venting; whale falls
Geology	Tectonics at plate boundary, seabed morphology, geohazards; faulting and landslides, tsunami potential, subsidence processes. Mapping important
Physics/Chemistry	Water chemistry; pH; aragonite saturation; paleo-climate
Education & Outreach	Paleo-shorelines; ocean acidification; seamounts; deep-sea corals, sponges, and fishes
Existing Data	Large gaps in multibeam coverage, but MBES coverage does exist. Depths between 50-300 m are relatively well studied but very little information exists for deeper benthic communities.
Technical Feasibility	<ul style="list-style-type: none"> ● 3-4 weeks mapping ● Additional time for ROV dives ● Possible seasonal constraints; note there are Naval training exercises in some areas

Permitting Details	USA; possible extension south into Mexican waters
Related White Papers	Rodriguez and Adjacent Seamounts (C. Mobley) Northern Channel Islands Shelf Region (C. Nicholson) Santa Cruz Escarpment (C. Mobley) Footprint and Piggybank Reef (C. Mobley) Trask Knoll and Santa Cruz Canyon (J. Lunden) Southern California Borderland (M. Cormier) Mapping of the California Continental Borderland (J. Chaytor)
Interested Parties	Peter Etnoyer, Branwen Williams, Christina Kellogg, Jenn Caselle
Additional Information	Hancock and Seamount 109 mapped by EX but unexplored

NPA-09: Gulf of California

Overview	Geologically young active rifting and spreading in a biologically diverse ecosystem. Gulf of California is the geological transition between classic seafloor spreading (East Pacific Rise) and transform faulting (San Andreas Fault Zone). High sedimentation rates in the Gulf between continental and Baja Mexico provides a rare opportunity to study multiple aspects of a “sedimented ridge,” e.g., implications for carbon budgets from depth, seafloor habitability zones and limits, and unusual seafloor morphology during magmatic emplacement and/or eruption. Active hydrothermal venting and vent communities offer fantastic outreach in multiple languages.
Depth Range	400-2,500 m
Archaeology	Opportunistic
Biology	Guaymas Basin communities, tube worms in sedimented area, overlap between seep and vent biology; bioluminescence; Alarcon Rise hosts active hydrothermal vent communities discovered in 2012 (MBARI).
Geology	Heavy sedimentation with ridge (Guaymas), magmatic intrusion into sediment; plate boundary. The geologically young Alarcon Rise (northmost segment of the EPR, south of Guaymas) hosts a volcanic edifice of rhyolite, a lava type virtually unknown at mid-ocean ridge spreading centers. Active hydrothermal venting. Near-ridge seamounts, many with summit caldera.
Physics/Chemistry	Vents
Education & Outreach	Potential for live streaming in Spanish

Existing Data	Decent multibeam coverage, but old data; 1m bathymetry (MBARI) on the Alarcon Rise axis and part of one seamount.
Technical Feasibility	2-4 weeks mapping & ROV
Permitting Details	Mexico; Mexican permits may be challenging
Related White Papers	Deep Bioluminescence and Biofluorescence (D. Gruber) Southern Gulf of California (B. Dreyer)
Interested Parties	Brian Dreyer, Steve Carey, Scott White, Adam Soule, Stephanie Bush, Santiago Herrera, David Gruber
Additional Information	Navy red dots

NPT-01: Hawaii Transit

Overview	
Depth Range	1,000 m
Archaeology	
Biology	
Geology	
Physics/Chemistry	
Education & Outreach	
Existing Data	
Technical Feasibility	1 day dive on S-28
Permitting Details	USA
Related White Papers	
Interested Parties	
Additional Information	

NPT-02: North Pacific Transit

Overview	See southern Orange Transect path on Biology map (page 14). The purpose is to take advantage of any anticipated transits between the N. American margin study areas and the SW Pacific, so that the ship does not just dead-head from one
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	port to another but uses a leg of shiptime to conduct first-order characterization of what lives in the Pacific Ocean (including at the seafloor) at a series of stations across the Pacific. In the S Pacific, between the high biodiversity Peru Margin and the equally high biodiversity Indonesian margin there must be more than a million square kilometers where there have been insufficient studies EVER to assign a biodiversity/species richness value to what lives in the world's largest ocean basin.
Depth Range	0-6,000 m
Estimated Operations	1-day vertical ROV dives, spaced out at ANY interval that allow this work to fit within ship's at-sea endurance will make a huge contribution. In an absence of ANY prior data, every dive will represent a significant contribution.
Archaeology	
Biology	Oh yes.
Geology	
Physics/Chemistry	
Education & Outreach	High likelihood of new species
Existing Data	
Technical Feasibility	Easy - just stop once in a while, as ship heads across the Pacific, dive the ROV to the seafloor and back, recover and move on
Permitting Details	Might need to thread route between many island nation EEZs to stay in international waters and make permitting easier.
Related White Papers	
Interested Parties	
Additional Information	

NPT-03: Gulf of Alaska Transit

Overview	
Depth Range	
Archaeology	
Biology	

Geology	Seafloor mapping
Physics/Chemistry	
Education & Outreach	
Existing Data	
Technical Feasibility	
Permitting Details	Canada, USA
Related White Papers	
Interested Parties	
Additional Information	

NPT-04: Olympic Peninsula Transit

Overview	
Depth Range	300-500 m
Archaeology	SS Pacific; Asian drift wrecks; Chinese junks
Biology	
Geology	
Physics/Chemistry	Big Eddy
Education & Outreach	
Existing Data	
Technical Feasibility	
Permitting Details	USA
Related White Papers	
Interested Parties	
Additional Information	

NPT-05: Central California Transit

Overview	
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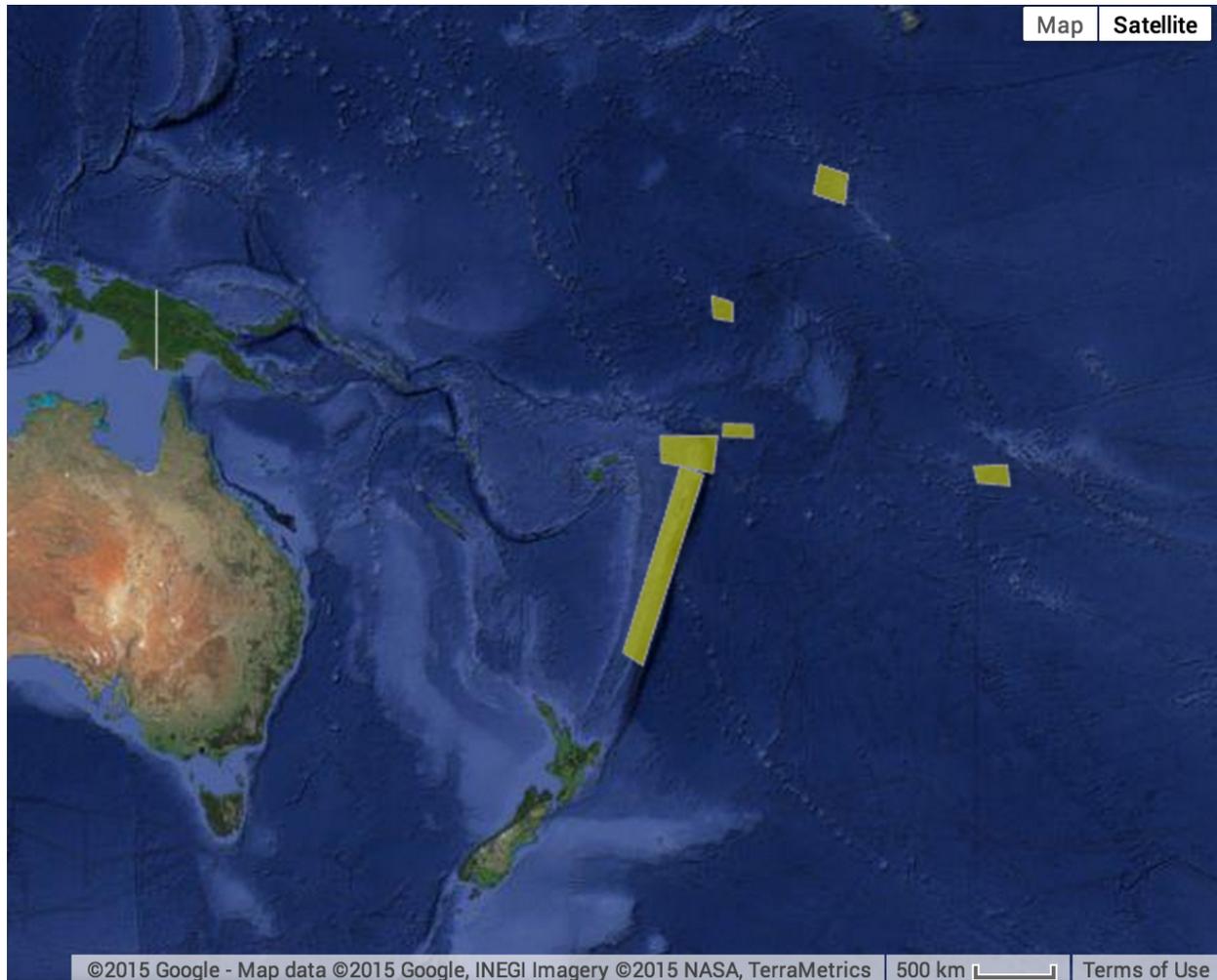
Depth Range	
Archaeology	
Biology	Possible seeps
Geology	Davidson Seamount; Diablo Canyon power station
Physics/Chemistry	
Education & Outreach	
Existing Data	
Technical Feasibility	
Permitting Details	USA; some National Marine Sanctuaries
Related White Papers	
Interested Parties	
Additional Information	

NPT-06: Baja California Transit

Overview	
Depth Range	
Archaeology	Trade/shipping route
Biology	
Geology	Seafloor mapping
Physics/Chemistry	
Education & Outreach	
Existing Data	
Technical Feasibility	
Permitting Details	Mexico, USA
Related White Papers	Isle Guadalupe, Mexico (A. Simms)
Interested Parties	

Additional Information	
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South/Central Pacific



Locations of High Priority Target Areas identified by the South/Central Pacific Breakout Group

SCPA-01: Kingman Reef & Palmyra Atoll

Overview	<ul style="list-style-type: none">● Building on data collected by HURL. Some multibeam around Palmyra that shows steep vertical walls that are undercut with caverns. These are potential slope failures and tsunamigenic. Need to document deep water corals.● Enric Sala has been here - shark-dominated ecosystems, stunning. Imagery would be excellent for outreach.● A lot to be documented in terms of the distribution of species from deep to shallow.● Existing consortium of researchers (Palmyra atoll research consortium-PARC) and facility
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Depth Range	100-600 m
Archaeology	Oral history of WWII aircraft that took off and crashed within visual range - perhaps too deep to find. Potential to find - not specific locations to find.
Biology	An interesting biogeographic area; nearshore areas are protected from fishing, part of the Pacific Remote Islands Marine National Monument
Geology	<ul style="list-style-type: none"> ● What is the origin of these island? No known hydrothermal activity or data to suggest it. ● Seamount formation, evolution, hotspot processes? ● Mineral exploration. Mining countries have same interest in these features as they do elsewhere (Manganese). ● Potential for slope failures and tsunamigenesis.
Physics/Chemistry	O2 minimum zone seems to come into play with these vertical walls.
Education & Outreach	Request Internship opportunities to be prioritized for locals to have the opportunity.
Existing Data	<ul style="list-style-type: none"> ● Multibeam collected here shows some really interesting bumps (cluster of mounds) south of Palmyra. HURL collected. ● Recently acquired ECS data? ● Pisces dives here - URL video archive. ● Imagery from drop cams. Jen Caselle, UCSB, national geographic - surveyed fishes at depths of 150-500 m.
Technical Feasibility	<ul style="list-style-type: none"> ● ROV, pH, Multibeam, Bioluminescence ● The surface currents are significant. You might have an issue using an ROV here. Would definitely want a 2-body system. ● Possible mapping on vertical wall faces ● Refueling would likely need a barge.
Permitting Details	<ul style="list-style-type: none"> ● USA ● USFWS refuge, permitting goes through USFWS ● Facility managed by The Nature Conservancy ● Research organized by Palmyra Atoll Research Consortium ● Research facility that could support 25-30 researchers at Palmyra. An airstrip from Hawaii. ● Didn't get boundaries expanded, due to opposition from tuna fisheries?

Related White Papers	Palmyra Atoll and Kingman Reef (E. Petruncio) Exploration and mapping of three Pacific locations (J.Caselle) Line Islands (L. Watling)
Interested Parties	Emil Petruncio, Jenn Caselle, Les Watling, Scott France, Palmyra Atoll Research Consortium, Christina Kellogg, Michael Parke, David Gruber
Additional Information	

SCPA-02: Phoenix Islands & Line Islands

Overview	<ul style="list-style-type: none"> ● The worlds largest world heritage site. Howland and baker in here - part of the PRIMNM. We don't know what we're protecting here. There have been extremely limited deep water data - don't know the corals, biogeographic provinces, etc. Have no idea. ● Need baseline data for sampling. ● A seamount chain and cluster of seamounts for testing some connectivity questions.
Depth Range	0-6,000 m
Archaeology	<ul style="list-style-type: none"> ● Amelia Earhart's plane, the search for which is ongoing ● Liscomb Bay, Escort Carrier was lost along the way in a famous battle.
Biology	Interesting biogeographic area. As of Jan 1 - a no take division.
Geology	<ul style="list-style-type: none"> ● What is the origin of these island? No known hydrothermal activity or data to suggest it. ● Seamount formation, evolution, hotspot processes? ● Mineral exploration. Mining companies have same interest in these features as they do elsewhere (Manganese nodules).
Physics/Chemistry	Same processes that affect seamounts, North equatorial current, upwelling. A lot going on here.
Education & Outreach	Kiribati - the king is very interested. Schools and the public. Most of the population lives on Tarawa. University of South Pacific, Kiribati campus.
Existing Data	Very little multibeam.
Technical Feasibility	No port facilities. Sampling the crust itself might be difficult, but study the biological communities.

Permitting Details	<ul style="list-style-type: none"> ● USA ● WHOI and New England Aquarium have permits to do shallow water work. ● Lots of interest for mining countries - Kiribati is wanting to set up their legal framework. Expect mining exploration licenses to be issued.
Related White Papers	Phoenix Islands (E. Cordes), Deep Sea Minerals (A. Swaddling)
Interested Parties	Randi Rotjan, Tim Shank, Brendan Roark, Amy Baco-Taylor, Erik Cordes, Alison swaddling, Santiago Herrera, Michael Parke
Additional Information	

SCPA-03: American Samoa

Overview	<ul style="list-style-type: none"> ● Interest in characterization of American Samoa National Marine Sanctuary ● Location and survey of Samoan Clipper, Pan American airliner that was lost in 1938 ● Exploration of Vailulu'u hot spot, an active submarine volcano in the last decade
Depth Range	
Archaeology	<p>Samoan Clipper: A Pan America airliner - the iconic company in the pioneering days of air power. In the process of opening an airway to Auckland. Lost Jan 11, 1938. (Russ Matthews)</p> <p>Within a few hours a fuel slick and debris was spotted on the surface in 1938. Debris of aircraft was specifically picked up, including an officer's jacket with the Pan American Airways logo. Clear they were on the spot within hours.</p> <p>Sikorsky S-42, Plane went down fairly intact Biggest sonar target the wing, 118 ft long, 13 feet wide Position: Down to DMS Depth: 1800 m</p>
Biology	<ul style="list-style-type: none"> ● Vailulu'u is a great biological stepping stone. Other hot spots to the east. Samoan hot spot is one of those stepping stones. ● Advise collection of seafloor samples from western Samoa for baseline characterizations (Alison Swaddling) ● Center of shallow water biodiversity for the region, presumption is it is also the center of deepwater biodiversity. Almost no deepwater data.

Geology	<ul style="list-style-type: none"> ● American Samoa NM & Vailulu'u tectonically unknown ● Several hydrothermal systems in crater of Vailulu'u, which has been volcanically active in past decade ● 300m cone grew between successive US ship/Pisces visits in 1999 and 2005; U-series suggests it erupted in November of 2004 ● Teleseismic recordings and local earthquake activity suggest the volcano has been actively deforming since the mid 1990s
Physics/Chemistry	
Education & Outreach	New education center in region
Existing Data	<ul style="list-style-type: none"> ● American Samoa NMS - need seafloor mapping ● Vailulu'u mapped with seabeam in 2004-2005 ● Seismicity stretches to the rift areas ● Talk to Craig Young, Hubert Staudigel for data at Vailulu'u (also Staudigel et al., 2006 PNAS paper) ● J. Konter has the before and after dome growth bathymetry grids and access to the original multibeam
Technical Feasibility	<ul style="list-style-type: none"> ● Multibeam, ROV, sidescan sonar, magnetometer ● Not sure depth range aside from Samoan Clipper
Permitting Details	USA, with additional NMS permits
Related White Papers	<p>Samoan Clipper (NC16734) (R. Matthews) Exploration of Bottomfish Habitat (W. Cover) Vailulu'u volcano and Muliava sanctuary (W. Cover) Vailulu'u Seamount, Samoan Volcanic Chain (J. Konter) Active submarine volcanoes of the Central Pacific (K. Rubin)</p>
Interested Parties	Ken Rubin, Russ Matthews, Wendy Cover, Jasper Konter, Chris German, Santiago Herrera, Michael Parke
Additional Information	

SCPA-04: Northeast Lau Basin

Overview	<p>Main theme: More active Arc and backarc volcanoes and backarc spreading centers (there are several) - there's a high density of activity, it's the fastest subduction zone in the world. Lots of different processes. One of two erupting volcanoes - lots of recent history about this including lava flows in last decade. Several unexplored volcanoes/calderas, several in NW Lau, including one that is 10-11 km diameter between spreading center and Arc. There's so much going on here that in</p>
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	one week we found two erupting in backarc and West Mata. Any information from multibeam survey in the area will likely find more. A change and evolution region.
Depth Range	700-3,600 m
Archaeology	Opportunistic
Biology	<ul style="list-style-type: none"> ● Low pH environment with mussel beds nearby. Fascinating biology. ● Erupting volcano - 3 species of vent endemic biology. - Came back in 2012 and there were 13 species. Tremendous increase. Shrimp and amphipods ● Natural succession and response to perturbation. Timeline from eruptions to compare. ● Several hydrothermal vent systems with longer-lived communities to the north ● Bioluminescence around vent fluids? ● Interest in bioluminescence data here, teaming up where sampling is already going to occur.
Geology	<ul style="list-style-type: none"> ● Dredges have pulled up Peridotites. Likely blocks of this. Hydrothermal vent systems. ● Multiple recent seafloor eruptions ● Unique modern Boninite province with active sulfide formation ● Large, mostly unexplored, submarine calderas
Physics/Chemistry	<ul style="list-style-type: none"> ● Water column fluids high pH fluids - seeing high pH, basic environments. Great potential not just for volcanic, but also like at Lost City. Haven't found there - hope would be to find one here. ● South equatorial current extending down, would be interesting to see how the plumes are being advected
Education & Outreach	Good potential, University of the South Pacific (Suva, Fiji and Nuku'alofa, Tonga Campuses)
Existing Data	<ul style="list-style-type: none"> ● Compilation funded by NSF (Ken Rubin says) - a lot of expeditions with different data quality provides a baseline. Exists and is freely accessible. ● In the active volcanic portions, would like new data to compare changes ● Multibeam collected by NOAA/NSF since 2008 with backscatter available; older multibeam also ● Floats in the Lau Basin from 2004 (Andreas did a years tracking of currents to get the regional oceanography at

	<p>plume depths, 2000m, may have been profiling floats down to 2000m and back up again)</p> <ul style="list-style-type: none"> ● He data from cruises back to early 2000s (John Lupton) ● CTDs ● Several rock samplings expeditions here, some is more accessible than others ● Imagery and other data collected on NOAA/NSF expeditions (2009-2012) by ROV and towed camera available ● Several mining countries have interests (nautilus, blue water) have freely shared information with researchers (Ken) in the past. Dives have been made and we know where they are and generally what they found (Bob Embley) ● Germans have worked up on the Arc (northern Tonga), not sure how accessible data is ● Japanese in Basin ● Koreans, but concerned with minerals, not sure how accessible data is ● There are dives
<p>Technical Feasibility</p>	<ul style="list-style-type: none"> ● AUV reconnaissance ● Multibeam ● ROV ● Glider ● Chemical Sensors ● Lab has developed a bioluminescent camera that could be added to this (David Gruber) - a CMAS camera that usually goes on a microscope - great for outreach. Just got funding and may be able to make it go deeper (currently to 2000m?) ● Nuku'alofa, Tonga is a decent port
<p>Permitting Details</p>	<ul style="list-style-type: none"> ● Permits: Samoa, Tonga and Fiji - would want Permits from these three. ● Ports: Depending on service, go into Suva Fiji) for the port. Apia, not as many services. ● Politics: Maritime boundary disputes between Tonga and surrounding countries (Fiji, Samoa, A. Samoa, Niue). ● King of Tonga requires copy of all data to be given to him, concerned that data is provided to the mining companies. Might be possible to get data from mining companies first. ● A lot of concern of getting baseline information before mining exploitation ● Question about collection permits? Tim Shank has done a

	<p>lot of biological permits, so has Chuck Fisher and Pete Girguis.</p> <ul style="list-style-type: none"> ● All mining companies do give data to government, biological data should be releasable, geological often with-held ● Alison Swaddling might be able to help, she works with Pacific countries quite closely ● These countries have minimal data on their mineral resources and would be very grateful for data sharing
Related White Papers	<p>Active Volcanic Calderas of the Northern Lau Basin (J. Lupton) Active submarine volcanoes of the Central Pacific (K. Rubin) NE Lau Basin - Northern Tonga Subduction Zone (R. Embley) Forearc to Arc Transition in the N Tonga Trench (K. Kelley) Deep Sea Minerals (A. Swaddling)</p>
Interested Parties	<p>Ken Rubin, Rachel Boschen, Tim Shank, Pete Girgius, Chuck Fisher, John Lupton, Bob Embley, Jessica Warren, Katie Kelley, Alison Swaddling, Santiago Herrera</p>
Additional Information	<ul style="list-style-type: none"> ● Samoa Tsunami - epicenter here ● Local people who would like to be trained on doing science - great for local capacity building ● Interest in establishing marine protected areas

SCPA-05: Tonga-Kermadec Arc

Overview	<p>Deep basins, ridge, active & inactive hydrothermal areas, known mineral deposits. An area with a broad diversity of habitats really interesting from a biological and geological, and interdisciplinary perspective. Also, potential for archaeological sites.</p>
Depth Range	<p>The target area includes abyssal depths that would be potentially inaccessible to <i>EV Nautilus</i>. Survey depths could extend from 100 m to 4,000 m.</p>
Archaeology	<p>Raoul Island (only inhabited) – possibility of some small shipwrecks in the region.</p>
Biology	<ul style="list-style-type: none"> ● Diversity of deep-sea habitats including abyssal plain, ridge, seamount, deep-basin, trench and hydrothermally active environments ● Seamounts in the general region have a high diversity of corals and sponges ● Different vents sites have different dominating organisms ● Potential for latitudinal gradient in diversity within the Kermadec region

	<ul style="list-style-type: none"> ● Some southern sites have been investigated but sites within the northern part of the NZ EEZ are largely unknown.
Geology	Hydrothermal vents; Biggest submarine volcano ever erupted, Harvre Volcano. B. Embley suggest this would be an amazing place to go.
Physics/Chemistry	Strong tide, diurnal tide, so there are probably strong bottom currents and interesting benthic communities within the Kermadec region.
Education & Outreach	<ul style="list-style-type: none"> ● Sir Peter Blake Trust for engagement with young people, local schools, etc. (Hannah Prior) ● Te Papa, the national museum with Auditorium type facilities where broadcasts could be conducted ● Various higher education institutions to be involved with, such as Victoria University of Wellington ● Personal and some public internet connections can be slow in NZ but should be adequate for telepresence. ● Potential to engage neighbouring Pacific Island nations, especially Tonga. ● Will be important to engage local Maori
Existing Data	<ul style="list-style-type: none"> ● Previous sampling efforts (ROV, submersible dives, sleds, trawls) have focused on a handful of southern seamounts, with very little data existing in the northern part of the EEZ. ● Existing data is held by NIWA, GNS and overseas collaborators, including Bob Embley. Multibeam and various GIS layers can be supplied ● High quality broad scale bathymetry is available for the Kermadec area, with high resolution multibeam for many of the seamounts ● Previous work has identified which seamounts along the Kermadec Arc are hydrothermally active ● The ongoing EM300 survey will provide 25m grid multibeam data ● There have been a limited number of ROV/HOV dives within the southern part of the NZ EEZ on a handful of seamounts
Technical Feasibility	<ul style="list-style-type: none"> ● New Zealand has a large port in Auckland available for mobilization and ship repairs if required ● NIWA vessels company could assist with mobilisation in Auckland ● NIWA vessels also has a research ship, R.V. Tangaroa, that

	<p>has conducted numerous scientific voyages in the Kermadec region. The vessel is outfitted with DP and could accommodate ROVs, although NZ does not have any deep-sea submergence vehicles of its own</p> <ul style="list-style-type: none"> ● NIWA hosts the National Invertebrate Collection (NIC), which can assist with the curation of invertebrate samples ● Te Papa houses the national fish collection and could assist with the curation of fish samples ● A ~3 week cruise could allow 2 weeks on station, depending on how far North of Auckland the target area is located ● Exploration in this area would benefit from the use of CTDs and sensors to measure oceanographic parameters, mapping facilities, AUVs to prepare one site overnight whilst diving at another target location, gliders to search for hydrothermal vents ● New Zealand universities and CRI's could contribute additional sensors/equipment if required ● The best sea conditions are generally February to April, however planning should include 20-25% contingency to accommodate for bad weather ● From Auckland, it's several days to a week depending on how far north the target areas are located. There are plenty of sites further south to visit to make it a more interesting transit ● There are numerous overseas collaborators with interest in the region, including scientists from Germany, Japan, France, the UK and USA. Onshore watches could potentially be run around the clock with these different institutions ● There is a remote chance that the NZ Navy may be able to provide assistance for refuelling/resupply whilst on station ● Exploration in the abyssal depths of the Kermadec trench may be possible through collaboration with UK and USA partners that have lander technology
<p>Permitting Details</p>	<ul style="list-style-type: none"> ● Tonga, New Zealand. Permitting within NZ waters can be assisted by NIWA/GNS ● Prospecting permits have been issued for seafloor massive sulfide mining at various of the volcanoes; mining interest exists from Neptune and Nautilus minerals ● The northern part of the NZ EEZ has been proposed as a Pew Global Legacy Area for conservation purposes ● The northern part of the NZ EEZ is also a Benthic

	<ul style="list-style-type: none"> ● Protection Area, closed to bottom trawling
Related White Papers	Active submarine volcanoes of the Central Pacific (K. Rubin) Kermadecs (R. Boschen)
Interested Parties	Rachel Haas, Leigh Marsh, Rachel Boschen, Hannah Prior, Ashley Rowden, Malcolm Clark, Richard Wysoczanski, Cornel de Ronde, Ken Rubin, Santiago Herrera, Pew Global Legacy group
Additional Information	The Kermadec Arc has several 'shovel-ready' sites from previous multibeam trips. Additional multibeam will be required on the Colville ridge and deep basins prior to dives.

SCPA-06: French Polynesia

Overview	Focus on hotspot trace east of Tahiti
Depth Range	1,500-4,000 m
Archaeology	
Biology	<ul style="list-style-type: none"> ● Hydrothermal vent biology and dispersal questions, comparison opportunities ● Stepping stones - would be really interesting to study. ● Traced chemical anomalies from 4,000 km away on SEPR during 2013 GEOTRACES cruise - chemical vent-signals dispersed far, so biology could be dispersed this far too: what species, here, will be similar to south EPR fauna? ● Could do transects on the way in and out. ● Seamounts are at a range of depths <p>McDonald Seamount</p> <ul style="list-style-type: none"> ● Area was known as a fishing ground - a shoal. ● Looking for places that are shallow where they can work their way down a slope to characterize different depths. ● A good place to help fill in lack of knowledge gaps across the Pacific ● Divergence of the equator - could be designed to intersect at McDonald Seamount. ● Abyssal depths more like 6000m
Geology	<ul style="list-style-type: none"> ● Area had series of earthquakes in the 1980's ● Seismically-active (and eruptive?) volcanoes from 1,500 to 4,000 m in a narrowly defined area due East of Tahiti define the active hot-spot trace (cf Loihi, off SE tip of Hawaii's Big Island).

	<ul style="list-style-type: none"> ● Only shimmering water and clear, unfocused diffuse flow observed in immediate follow-up (French) dives in late 1980s but black smokers are present now (Dec 2013) = option to study how a system of known (<25 y) age has developed. ● Identifying which volcanoes are active, and how long have they been active? See the hydrothermal activity - no collection of rocks. Want to understand how different compositions of magma erupt, the mode of eruption. A pure discovery site from the morphological perspective. ● McDonald Seamount: Erupted in 1989. Collected some rocks here, saw pumice on surface.
Physics/Chemistry	<ul style="list-style-type: none"> ● One CTD cast here with unambiguous Black smoker (Joe Resing, Chris German) - this is a shovel ready black smoker that has yet to be dived on. Know the age of the smoker, past images from 25 years ago, could follow-up. ● Then compare and contrast to other equivalent hot spots across the Pacific, like Vailulu'u, that you could compare results to (also relevant to biogeography).
Education & Outreach	
Existing Data	<ul style="list-style-type: none"> ● 25-year old single beam ● Some submersible dives on Teahitia & McDonald Seamount
Technical Feasibility	<ul style="list-style-type: none"> ● Could include the Navy Red Dots and McDonald Seamount and could be a 3 week cruise. Turn it into a ROV cruise, conduct a CTD cast (add MAPRs?), and dive on discovered seamounts. ● Multibeam mapping & CTD/MAPRs to locate vents ● AUV dives to maximize results ● Follow up with ROV dives
Permitting Details	Tahiti (France)
Related White Papers	Active submarine volcanoes of the Central Pacific (K. Rubin) Society Island Hotspot (C. German)
Interested Parties	Ken Rubin, Chris German, Santiago Herrera, Diva Amon, Carlos A. Vargas
Additional Information	

Eastern Pacific



Locations of High Priority Target Areas identified by the Eastern Pacific Breakout Group

EPA-01: Revillagigedo Archipelago

Overview	Volcanically active group of seamounts
Depth Range	250 to several thousand meters
Archaeology	
Biology	Pristine Seas/biological baseline assessment and possible protection
Geology	1993 volcanic activity. Alkaline volcanism - very interesting magma chemistry. Basaltic balloons like eruption one off Sicily. Only 4 known places in the world where this occurs.
Physics/Chemistry	Possible hydrothermal venting
Education & Outreach	Great outreach potential

Existing Data	Multibeam to south, where there was a submarine eruption, but sparse.
Technical Feasibility	
Permitting Details	Mexico; Mexican Navy base on island
Related White Papers	Revillagigedo Archipelago and Mathematician Ridge (Carey)
Interested Parties	Steve Carey, Cl. Siebe, Paul Rose, Enric Sala, Karen Wishner, Samuel Gomez, Brian Dreyer
Additional Information	

EPA-02: Mesoamerican Trench

Overview	
Depth Range	
Archaeology	
Biology	
Geology	Large earthquake zone to map
Physics/Chemistry	
Education & Outreach	
Existing Data	Sparse multibeam
Technical Feasibility	
Permitting Details	Mexico
Interested Parties	S. Gomez, E. Escobar
Additional Information	

EPA-03: Clipperton Island & East Pacific Rise

Overview	
Depth Range	Shallow (SCUBA depth) to 4,000-5,000 m
Archaeology	
Biology	Significant biological interest

Geology	Off axis EPR magma bodies exist here.
Physics/Chemistry	
Education & Outreach	NGS interested in Pristine Seas project at Clipperton
Existing Data	A lot of data on eastern end of box
Technical Feasibility	<ul style="list-style-type: none"> ● SCUBA, mapping, ROV ● Certain areas may be shovel-ready for AUV/ROV work
Permitting Details	France
Related White Papers	2015 Pristine Seas Expedition to Clipperton (E. Sala) East Pacific Rise, Off-Axis (A. Soule)
Interested Parties	Enric Sala, Adam Soule, Paul Rose, Scott White, Dorsey Wanless
Additional Information	

EPA-04: Costa Rica Margin

Overview	Extensive areas of cold seeps
Depth Range	400-2,000 m
Archaeology	
Biology	Vents and seeps together and probably some other subducting areas out there. Interesting biogeography - affinities with GOM, Caribbean. Ecosystems are beautiful.
Geology	Vents and seeps. Serpentinization of upper mantle by fluid flow along bend-related normal faults occurring here. There have been no seafloor observations along these faults, which are predicted to host vent sites. High-value exploration along these faults with potential for lost-city-like sites.
Physics/Chemistry	O ₂ gradients are very interesting here
Education & Outreach	Lots of potential as biology is gorgeous, and interesting geological setting. The presence of serpentinization has relevance to origin of life via pre-biotic chemistry
Existing Data	Alvin dives and German work, so much data here. Multichannel seismic work and collaborations with Costa Rican Gov't agencies - Fornari. Dan Lizarralde at WHOI for seismic contacts in CR. Many areas have been mapped.

Technical Feasibility	<ul style="list-style-type: none"> ● Mapping, ROV ● Suggest adding AUV dives to search for/locate serpentinizing fluid sites ● Water depths OK and close to shore
Permitting Details	Costa Rica; Good contacts for permits
Related White Papers	Costa Rica Margin (E. Cordes)
Interested Parties	Erik Cordes, Lisa Levin, Eric Mittelstaedt, Adam Soule, Diva Amon, Chris German
Additional Information	

EPA-05: Colombia Margin

Overview	<p>Due to its geographic location - not only at the heart of the southern Caribbean, but at the point of formation of the Isthmus of Panama - Colombia is a key piece of the global biogeographic puzzle. Colombia is considered one of the most biodiverse countries in the world, both on land and shallow oceans. However, its importance in terms of its contribution to the biodiversity and resources in the deep sea remains unknown.</p> <p>Part of a full mountain range into Colombia, including shallow and deep seamounts. Malpelo Ridge is deeper and could group them together.</p>
Depth Range	200-4,000 m
Archaeology	
Biology	<p>Geologic events, such as the closure of the Central American Seaway and the establishment of the Isthmus of Panama, are fundamental drivers of biological diversification. The connection created by the Isthmus, between the South American and North American sub-continent, triggered an exchange of species that drastically altered the biological landscapes on both landmasses. In a similar way, the Isthmus isolated the marine ecosystems of the Eastern Pacific from the Atlantic-Caribbean, separating the evolutionary trajectories and ecological dynamics of both ocean systems.</p> <p>What is the degree of connectivity between the deep-sea coral and seep biological communities in the equatorial Eastern Pacific and those found in higher latitudes both north and south?</p>

	<p>Were the communities in the deep-sea Eastern Pacific isolated from the ones in the Caribbean/Atlantic long before the formation of the Isthmus of Panama? Is the equatorial Eastern Pacific a distinct deep-sea biogeographic province?</p> <p>Biological corridor of islands along ridge to include Galapagos. Identification of deep-sea seamount ecosystems, their distribution, habitat composition, and ultimately their role and contribution to the deep sea ecology of the region.</p>
Geology	Deep sea ecosystems and geological process relationships
Physics/Chemistry	
Education & Outreach	Great interest from science museums in the two largest cities in Colombia, Bogotá (Maloka) and Medellín (Parque Explora), to follow the expedition via telepresence. Outreach materials and communications for this expedition bilingual, in English and Spanish, to reach Hispanic audiences in the US as well as throughout Colombia and Latin America.
Existing Data	RDB dove in Panama Basin & some Navy submarine dives in this region in the 1970s. Done trawls and found lots of octocorals. Not mapped, but relatively shallow. 6 short dives performed by the Fundación Malpelo in collaboration with Yagan Production, using the DeepSea ROV deployed by the Under Sea Hunter in 2008, to a maximum depth of 258 meters. Biodiversity Invemar cruises carried out in 2002 and 2012, from 200 to 1,000 m depth.
Technical Feasibility	<p>Shovel-ready; relatively shallow</p> <p>The proposed area could be one the first targets in the Pacific after the Nautilus crosses the Panama Canal. The Fundación Malpelo has been performing extensive shallow-water work (via scuba) in the area since 1999 with the collaboration of the Natural National Parks of Colombia and the Colombian Navy (permit-granting authorities). Consequently, there is significant experience in obtaining permits to perform expeditions in this area.</p>
Permitting Details	<ul style="list-style-type: none"> ● Colombia ● E. Londono-Cruz included contacts from National Parks for permitting in his white paper ● Santiago Herrera and Juan Sanchez have obtained support from Colombia's Presidential Agency of International Cooperation and the Colombian NAVY for permitting.

Related White Papers	Colombian Pacific (A. Gracia) Gorgona National Natural Park (E. Londono-Cruz) Malpelo Ridge (S. Herrera)
Interested Parties	Edgardo Londono-Cruz, Eric Mittelstaedt, Stephanie Bush, Levin Levin, Diva Amon, Adriana Gracia, Santiago Herrera, Tim Shank, J. Sanchez, S. Bessudo
Additional Information	Gorgona National Park part of World Heritage Site designation proposal The Malpelo Ridge is considered a biological hotspot characterized by the large aggregations of pelagic fauna found on the seamounts and the diverse coral communities found a shallow and mesophotic depths. Part of this region is contained in a marine protected area created in 1995 (Malpelo Fauna and Flora Sanctuary) and was declared world heritage in 2006.

EPA-06: Galapagos

Overview	Several overlapping questions about the Galapagos, particularly in biology and geology.
Depth Range	100-3,600 m
Archaeology	n/a
Biology	Surveying to ID corals as a function of depth, O ₂ , pH, samples (Dunbar). Mid-water biology would be great add on for food web studies (Bush). Flows could be hundreds to thousands of years old, of interest for succession of organisms on lava flows (Dunbar).
Geology	Sampling of lavas for understanding submarine volcanism processes (Fornari). Volcanic cones (Wanless; Mittelstaedt).
Physics/Chemistry	Equatorial undercurrent and upwelling very interesting. Western Galapagos waters most productive and could structure benthos. Vertical O ₂ and pH gradients are large.
Education & Outreach	Significant education/outreach potential.
Existing Data	Fornari for available data - Hi Res Multibeam (NGDC and Geomapapp) throughout northern province and around periphery of platform (W/S). Also sidescan. Bathy data is poor for platform area, so potential for significant contribution to map area in Hi Res. EX ROV dives during GALREX. Alvin dives at 86 & 91 (2002, 2005). Also camera tows from 2006 (Scott White).

Technical Feasibility	Technically feasible, except multibeam mapping of shallow spires may be hazardous.
Permitting Details	<ul style="list-style-type: none"> ● Ecuador ● N. Raineault in process of applying for permits, with input from D. Fornari.
Related White Papers	<p>Deep Macrobenthos of the Galapagos and Rapa Nui (R. Dunbar) Large Deep-Water Lava Flows in the W. Galápagos (D. Fornari) Galapagos Rift (T. Shank) Galapagos Deep Pelagic Biodiversity (M. Vecchione) Galapagos Platform (D. Wanless) Magma Supply on the Galapagos Spreading Center (S. White) Galápagos Transform Fault (E. Mittelstaedt)</p>
Interested Parties	Paul Rose, Dan Fornari, Rob Dunbar, Dorsey Wanless, Eric Mittelstaedt, Scott White, Tim Shank, Stephanie Bush
Additional Information	Lost gear (D. Fornari)

EPA-07: East Pacific Rise: Wilkes to Garrett

Overview	
Depth Range	2,000-4,500 m
Archaeology	
Biology	Very high; new venting has been found at Garrett
Geology	New vent sites
Physics/Chemistry	
Education & Outreach	High potential for outreach
Existing Data	<p>Wilkes: Bathy of whole area - Ewing atlas hydrosweep. No sampling. Gravity, magnetics of whole area. Garrett: Bathy exists, but it's old. Would want to remap the some of the area & collect samples here. French data.</p>
Technical Feasibility	
Permitting Details	High Seas
Related White Papers	<p>Hydrothermal Circulation on Garrett Fault, EPR (J. Warren) EPR Off-Axis Eruptions, Lavas and Fluid Flows (S. White)</p>
Interested Parties	Dan Fornari, Scott White, Dorsey Wanless, Eric Mittelstaedt, Lisa

	Levin, Jessica Warren, Chris German
Additional Information	

EPA-08: Pito Deep

Overview	Pito Deep is a deep canyon connecting two limbs of the EPR formed by rotation of the Easter microplate. Pito Seamount is a verified black smoker site (only one previous dive in 1993 & no previous biological/fluid/temperature sampling). Pito Deep provides access to crustal cross section.
Depth Range	Top of Pito Seamount 2,200 m extending to >4,500 m.
Archaeology	None
Biology	<ul style="list-style-type: none"> ● Black smoker site with with a fauna of alvinellid, bythograeid, bythitid fish, alvinocaridid shrimp, but no vestimentiferan tubeworms. How has community evolved since 1993? No previous biological sampling. ● Use the biological samples for genetic studies to compare with species collected elsewhere along the EPR in this region to test for barriers to larval dispersal
Geology	<ul style="list-style-type: none"> ● Pito Seamount: Poorly explored vent site (one previous Nautilite dive). One active black smoker (in 1993); many dead vents, but likely other active vents not found. ● Pito Deep: Unexplored canyons (to east) which provide crustal cross sections. - one of the few sections in Pacific where this occurs. ● Pito Deep largely unexplored for hydrothermal venting (nite time CTD program proposed).
Physics/Chemistry	Fluid flow/venting. No previous fluid sampling or temperature measurements of Black Smoker site. Likely other undiscovered sites.
Education & Outreach	Birch Aquarium, Scripps and Laramie Geological Museum. Student involvement: University of Wyoming, University of Victoria (Canada)..
Existing Data	Multibeam data. Two previous dive programs (one exploratory-Nautilite 1993 and one focused on dike section (Alvin & Jason 2004). Only a single previous dive in the areas suggested for this study.
Technical Feasibility	OK

Permitting Details	High Seas
Related White Papers	Pito Deep, EPR (M. Cheadle)
Interested Parties	Mike Cheadle, Rob Pockalny, Diva Amon, Eric Mittelstaedt, Dorsey Wanless, Chris German, Barbara John, Laurence Coogan, Kathy Gillis (UVic)
Additional Information	Mag 7.1 earthquake to west of proposed site in Fall 2014

EPA-09: Sala y Gomez Ridge to Easter Island

Overview	This is a chain of over 400 seamounts, most of which have never been explored. This chain passes through several different productivity zones, potentially giving way to varying communities on seamounts in each zone. Seamounts are known to host communities which have very high diversity and abundance. Some of these fauna may occur over multiple seamounts providing the opportunity to study connectivity across the chain. These environments and the fauna inhabiting them have never been characterized.
Depth Range	1,000-3,500 m
Archaeology	
Biology	Unique biogeography because it is huge and isolated. Potential for new species and communities across large bathymetric and geographic ranges. Major orange roughy fishery in the past. Now a protected marine area so there is opportunity to maybe observe pristine habitats as well as some impacted by fishing.
Geology	Very high, seamounts. Little bathymetry so much mapping will be needed.
Physics/Chemistry	
Education & Outreach	Unexplored and pristine so a lot of potential here. Should be visually stunning.
Existing Data	Not much. Some trawling has been done. Very little bathy.
Technical Feasibility	Long transit
Permitting Details	Chile & High seas
Related White Papers	Fauna surrounding Easter and Sala y Gomez Islands (D. Amon)
Interested Parties	Diva Amon, Jose Blanco, Rob Dunbar, Eric Mittelstaedt, Stephanie

	Bush, Dorsey Wanless, Santiago Herrera
Additional Information	

EPA-10: Peru Margin

Overview	
Depth Range	600 m (coast), 4,000 m (canyons, 6,000 m (trench)
Archaeology	Archaeological site off Lima, Peru
Biology	Seep areas in canyons, lots of interesting biology seen in Johnson Sea Link video
Geology	Cold seeps
Physics/Chemistry	
Education & Outreach	Very high. Major science oceanographic institute is very engaged
Existing Data	French papers from there, bathy available, JSL there in 1990 (geo), video
Technical Feasibility	OK
Permitting Details	Peru; Peruvian groups excited to partner and work there (Lisa L)
Related White Papers	Peru Margin Habitat Heterogeneity (L. Levin)
Interested Parties	Lisa Levin, Diva Amon, Santiago Herrera
Additional Information	

EPA-11: Chile Margin

Overview	Petit Spots of particular interest
Depth Range	<4,000 m
Archaeology	
Biology	
Geology	Subduction of an active spreading center at the Chile trench. Sediment- hosted spreading ridge. Uncommon tectonic-magmatic arrangement.
Physics/Chemistry	

Education & Outreach	High; Smithsonian interest through K. Kelley
Existing Data	Need to map the trench, but there is some existing bathy
Technical Feasibility	OK
Permitting Details	Chile; J. Blanco agreed to assist with permits
Related White Papers	Petit Spot Volcanism off the Coast of Chile (F. Davis) Chile Rise (B. Dreyer)
Interested Parties	Katie Kelley, Rob Pockalny, Jose Blanco, Tim Shank, Fred Davis, Brian Dreyer, Santiago Herrera
Additional Information	(Sediment-hosted) Vents known at Chile Triple Junction from water column work (Lilley, Lupton) in 2010-12. Strong interest in the unusual chemistry of young Chile Rise basaltic lavas.

EPA-12: Chilean Canyons

Overview	Canyons are known biodiversity hotspots and those of Chile have never been explored biologically nor geologically.
Depth Range	400-2,000 m
Archaeology	
Biology	Known methane seeps off Concepcion (800 m); many of the canyons are potentially full of methane seeps. Canyon habitats are areas of enhanced biodiversity and abundance which also feature distinct faunal assemblages; many harbor huge deep-water coral assemblages. Chilean canyons have never been studied biologically and very few of the seeps have been visited by ROVs. Canyons close proximity to land and rivers also make them particularly vulnerable to anthropogenic impacts e.g. dumping on mine tailings, litter, trawling.
Geology	
Physics/Chemistry	
Education & Outreach	Very high
Existing Data	Bathy exists -Germans. 6 international cruises have gone through there, so a significant amount of data exist. Shovel ready.
Technical Feasibility	OK
Permitting Details	Chile; J. Blanco to assist with permits

Related White Papers	Biodiversity Exploration on the Chilean Margin (L. Levin) Deep-sea fauna inhabiting Chilean canyons (D. Amon)
Interested Parties	Levin Levin, Jose Blanco, Diva Amon, Santiago Herrera
Additional Information	

Next Steps

Feedback & Reports

We seek feedback in the form of comments and other input for discussion from the scientific community on this draft report on the Workshop on Telepresence-enabled Exploration of the Eastern Pacific Ocean.

Please comment directly on this Google Document no later than January 16, 2015:

https://docs.google.com/a/oceanexplorationtrust.org/document/d/1Gh_B8h2fquYsIFqT0p4zSgzAVI9cZWPra1viCif4Xw/edit#

The final report will be available by January 30, 2015 at:

<http://www.oceanexplorationtrust.org/#!2014pacificworkshop/cr81>, and a summary report will be published in the Supplement to Oceanography Magazine in March 2015.

Develop Eastern Pacific Exploration Database

Based on the Eastern Pacific Workshop Report, White Papers, and community feedback, we will develop a database on exploration of the Eastern Pacific region for use by the Nautilus Exploration Program, NOAA Office of Ocean Exploration and Research, and other programs that are interested in using it for reference in planning exploratory missions in the Eastern Pacific.

Develop *Nautilus* Schedule

The Workshop Report will be discussed on March 3, 2015, with the Nautilus Advisory Board, with a view to building a 3-5 year exploration campaign in the Eastern Pacific Ocean.

Develop Engagement Strategy

The schedule approved by the Nautilus Advisory Board will be used to develop an engagement strategy with workshop participants, as well as other members of the scientific community, local Pacific governments, and education and outreach partners, to include as many stakeholders as possible in the planning and execution of the Nautilus Exploration Program in the Eastern Pacific.

Participants

List of Workshop Participants

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(f) - Facilitators (m) - Mappers (r) - Rapporteurs

Breakout Groups by Region

Northern Pac	South/Central Pac	Eastern Pac
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Workshop Agenda

DAY 1: Thursday, 11 December

1800-1900: Welcome reception at Exploratorium Lifelong Learning Lab

Welcome reception with drinks and appetizers at the Exploratorium in Lifelong Learning Lab. Welcome includes introduction to and workshop overview.

1900-2200: Exploratorium After Dark

Participants are welcome to stay at the Exploratorium for their weekly “After Dark” event.

DAY 2: Friday, 12 December

0800-0845: Breakfast in Exploratorium Forum

0845-1145: Plenary Introduction & Discussion

0845-0900	Welcome & Introductions (Ballard & Bell)
0900-0920	History of Telepresence-enabled Exploration (Martinez)
0920-0950	Okeanos Exploration Program (Elliott)
0950-1010	BREAK
1010-1040	Nautilus Exploration Program (Raineault)
1040-1100	A Scientist’s Perspective on Using Telepresence (German)
1100-1130	Discussion
1130-1145	Breakout Group Instructions

1145-1245: Lunch

1245-1630: Discipline-based Breakout Group Discussions

1245-1430	Convene in Breakout Groups by Discipline (Session 1) Archaeology Biology Chemistry/Physics Geology
1430-1500	Break
1500-1630	Reconvene in Breakout Groups by Discipline (Session 2)

1630-1650: Plenary Discussion

1630-1650	Convene in Plenary
1650-1730	Summary of Day 2, Plan for Day 3, Discussion

1730: Adjourn

DAY 3: Saturday, 13 December

0800-0845: Breakfast in Teaching & Research Room

0845-1100: Plenary Breakout Group Summaries & Discussion

- 0845-0900 Welcome and Plan for Day 3
- 0900-0920 Report from Archaeology Breakout Group (Delgado)
- 0920-0940 Report from Biology Breakout Group (German)
- 0940-1000 Report from Chemistry/PO Breakout Group (Petrunco)
- 1000-1020 Report from Geology Breakout Group (Hammond)
- 1020-1040 Instructions for Regional Breakout Groups

1040-1110: Break

1110-1640: Regional Breakout Group Discussions

- 1110-1240 Convene in Breakout Groups by Region (Session 3)
 - Northern Pacific
 - South/Central Pacific
 - Eastern Pacific
- 1240-1340 Lunch
- 1340-1510 Reconvene in Breakout Groups by Region (Session 4)
- 1510-1540 Break
- 1540-1640 Reconvene in Breakout Groups by Region to summarize results (Session 5)

1640-1730: Plenary Discussion

- 1640-1700 Convene in Plenary
- 1700-1730 Workshop conclusions, Questions, & Next Steps

1730: Adjourn