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ONLINE RESOURCES

Livestreaming at : http://bit.ly/SOI-Live

Twitter Hashtag: #soisymposium

Schmidt Ocean Institute invites collaborators, advisers, and thought leaders around the world to beautiful Hawaii. At the Schmidt Ocean Institution 2013 Research Symposium, we will discuss how the latest technological innovations, globally expanding connectivity, and cultural shifts towards transparency and open sharing of research outcomes in ocean sciences can be best leveraged, so that we accelerate our understanding of the oceans and catalyze meaningful change on a global scale. The purpose of this symposium is to examine ocean sciences from the technological, operational, and informational perspectives seeking cross-disciplinary workflow improvement opportunities through innovation in technologically advanced marine operations, engineering, and information sharing.

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Dear Friends and Colleagues,

It is our pleasure to welcome you to the inaugural Schmidt Ocean Institute research symposium.

The last several years have been a remarkable journey for the Institute. With the release of Google Earth and Google Ocean, the acquisition and refit of our research vessel, Falkor, and the first year of our successful scientific operations at sea, we have continued deep conversations about the connection between humanity and the oceans, the diversity of life under the sea, and how this new digital age can help us build the needed capacity to gather and share the raw data and interpreted knowledge about the oceans, our planetary life support system.

We have seen that ocean sciences are conventionally segregated into disciplines, whether physical, chemical, and biological oceanography, marine ecology, geology, or others. Those disciplines have their own distinct objectives, but they also have many commonalities in the structure of their respective workflows.

In each field, the scientific process follows a series of stages, starting with the formulation of a research question, progressing to the design of an experiment to obtain empirical evidence, development of sensors and systems to collect the data or samples, marine operations to deliver the instruments to the sites of interest, post-processing of the data and samples to extract the data, analysis of the data and interpretation, and, ultimately, communication of the resulting knowledge to the broader community.

Notably, there is potential for technological innovations at each of these stages to benefit multiple research fields, and, conversely, the lack of technological sophistication or inability to access available prior data that can create bottlenecks across several disciplines.

To address this challenge, the Schmidt Ocean Institute views ocean sciences from the technological, operational, and informational perspectives. As an oceanographic facility operator, the Institute focuses on workflow improvement across the ocean sciences, seeking to fill the niche of technologically advanced marine operations, engineering, and information sharing.

It is our hope, as a result of this symposium, that we will identify new scientific and technological opportunities for the Schmidt Ocean Institute and help our collaborating researchers and organizations advance their oceanographic pursuits.

We wish you a most engaging, productive, and enlightening meeting.

Eric and Wendy Schmidt

We would like to thank the members of the SOI 2013 Research Symposium Steering Committee, in alphabetical order:

Dr. Dennis Bartels

Dr. Jim Bellingham

Dr. Peter Cornillon

Dr. Jules Jaffe

Mr. David McKinnie

Ms. Mary Miller

Dr. Russ Moll

Dr. Daniel Pauly

Dr. Edith Widder

Accelerating the Pace of Ocean Science through Technological Advancement and Open Sharing of Information

AGENDA

Thursday, October 31, 2013

1:00 pm - 6:00 pm	**Registration Desk in Coconut Grove Lanai** Check-in for the symposium
2:00 pm - 5:30 pm	**Guided tours of R/V Falkor** Vans will be leaving from the porte cochere to transport scheduled tour participants to Aloha Tower
6:00 pm - 10:00 pm	**Pre-conference Welcome Dinner Reception in Coconut Grove** *Rain Location: Monarch Room*

Friday, November 1, 2013

7:00 am – 8:30 am	**Registration Desk open in Coconut Grove Lanai** Late check-ins available outside the Regency Room
7:30 am - 8:30 am	**Breakfast at the Monarch Room**
8:30 am - 8:40 am	**Welcome and Introductory Remarks** Mrs. Wendy Schmidt, Co-Founder of SOI
8:50 am – 8:55 am	**Symposium Overview** Dr. Victor Zykov, Dr. Russ Moll, and Ms. Teling Peterson
9:00 am - 9:35 am	**A Vision for Ocean Research: 150 Years Post HMS Challenger**, Opening key note by Dr. Marcia McNutt, AAAS, followed by a Q&A session *Standards are few and far between. Interoperability is rare across platforms and instrument systems. We must start working as a coherent community rather than as individuals or as institutions.*

9:40 am - 10:40 am **Technology Integration for the Marine Sciences**, a panel discussion moderated by Dr. Daniel Pauly, UBC, followed by a Q&A session

The role of science in addressing today's global challenges depends crucially on our ability to turn the data collected at various scales by various sampling systems into actionable and timely knowledge.

Panel Participants: Dr. Cabell Davis, WHOI; Dr. Paul Falkowski, Rutgers University; Dr. Rainer Froese, GEOMAR; Dr. Tim Shank, WHOI

11:00 am - 12:00 pm **Breakthrough Opportunities in Ocean Science through Revolutionary Instruments**, a panel discussion moderated by Dr. Jules Jaffe, Scripps Institution of Oceanography, followed by a Q&A session

The panel will discuss the steps necessary to design, develop, implement, and carry data from innovation of ocean instruments to the successful description of oceanic processes.

Panel Participants: Dr. Ed DeLong, MIT; Dr. Charles Eriksen, University of Washington; Dr. Deirdre Meldrum, Arizona State University; Dr. Ajit Subramaniam, Gordon and Betty Moore Foundation

12:00 pm - 1:30 pm **Lunch at the Monarch Room**

1:30 pm - 2:30 pm **Robotics and the Ocean Frontier**, a panel discussion moderated by Dr. Jim Bellingham, MBARI, followed by a Q&A session

Robotic systems are not a 'drop in' replacement for existing systems, rather they offer new capabilities and require innovative methods of operations.

Panel Participants: Dr. Michael Klages, University of Gothenburg; Dr. Vincent Rigaud, Ifremer; Dr. Henrik Schmidt, MIT; Ms. Mikell Taylor, Bluefin Robotics

2:30 pm - 3:00 pm **Coffee break**
Refreshments will be provided at the Promenade

3:00 pm - 4:00 pm **Evolving Roles of Research Vessels**, a panel discussion moderated by Mr. David McKinnie, NOAA, followed by a Q&A session

New research vessel designs aim to increase flexibility and adaptability, drive down operating costs, and extend the reach.

Panel Participants: Dr. Bruce Appelgate, Scripps; Mr. Marc Nokin, Ifremer; Dr. Peter Orter, UNOLS; RDML David A. Score, NOAA

5:30 pm - 7:00 pm **Dinner at the Ocean Lawn**
Rain Location: Monarch Room

7:00 pm - 7:35 pm **Up for Grabs: Technology and the Race to Control the Ocean**, a plenary presentation by Dr. Jim Bellingham, MBARI , followed by Q&A session

We are increasingly in a race: can we develop the technology to value and monitor ocean services before the consumption of resources overwhelms all caution?

8:00 pm - 10:00 pm **Traditional Hawaiian Luau Show at the Ocean Lawn**

Saturday, November 2, 2013

7:45 am – 8:45 am **Breakfast at the Monarch Room**

8:50 am – 8:55 am **Chairman's Remarks**
Dr. Eric Schmidt, Co-Founder of SOI

9:00 am - 10:00 am **Oceanographic Research Organization Essentials: Bricks and Mortar or Virtual?** A panel discussion moderated by Dr. Edith Widder, ORCA, followed by a Q&A session

This panel will discuss how oceanographic research organizations may best structure themselves to minimize the challenges and maximize benefits as the oceanography undergoes major technological and operational shifts.

Panel Participants: Dr. Susan Avery, WHOI; Dr. David Conover, NSF; Dr. Peter Girguis, Harvard; Mr. Gene Massion, MBARI; Dr. Oscar Schofield, Rutgers

10:00 am - 10:30 am **Coffee break**
Refreshments will be provided at the Promenade

10:30 am - 11:30 am **Ocean Data Sharing and Analytics**, a panel discussion moderated by Dr. Peter Cornillon, URI, followed by a Q&A session

This panel will address issues associated with the stewardship, discovery, access and use of oceanographic data in the future, with particular attention being paid to issues related to the expected rapid growth of in situ *observations.*

Panel Participants: Mr. Matthew Arrott, NSF OOI; Mr. James Gallagher, OPeNDAP; Mr. John Graybeal, Marinexplore; Mr. Brian Sullivan, Google Ocean; Dr. Dawn Wright, ESRI

11:30 am - 1:00 pm **Lunch at the Monarch Room**

1:00 pm - 1:35 pm **Surgical Exploration of the Seafloor Using a Combination of Multibeam, AUV, and ROV Data**, a plenary presentation by Dr. Charlie Paull, MBARI, followed by a Q&A session

Dr. Paull will discuss examples of coordinated use of a suite of diverse ocean research technologies, including multibeam echo sounders, underwater autonomous vehicles, and remotely operated robots, to holistically investigate seafloor across multiple scales, and swiftly transition from broad area surveillance to targeted feature investigation.

1:40 pm - 2:40 pm **From the Oceans to the Public: Streamlining the Path of At-Sea Observations to Meaningful Public Engagement**, a panel discussion moderated by Dr. Dennis Bartels, Exploratorium, followed by a Q&A session

This panel will discuss innovative approaches leveraging the new ocean research platforms to captivate worldwide learners.

Panel Participants: Ms. Jenifer Austin Foulkes, Google Ocean; Ms. Allison Fundis, Ocean Exploration Trust; Dr. Kim Juniper, Univ. of Victoria, ONC; Ms. Lily Simonson, Visual Artist; Mr. Richard Vevers, Catlin Seaview Survey

4:00 pm - 4:15 pm **Coach to Bishop Museum.** Motor coach departs from the porte cochere

5:00 pm - 5:30 pm	**Arrivals at the Bishop Museum** Cocktails and appetizers
5:30 pm - 6:30 pm	**Docent- and self-guided tours of the Bishop Museum**
6:30 pm - 7:30 pm	**Dinner at the Bishop Museum**
7:30 pm - 8:00 pm	**Let There Be Light: Exploring and Mapping the Ocean with Bioluminescence**, a presentation by Dr. Edith Widder, ORCA *A look at the lighter side of ocean exploration and mapping - from ancient Polynesians who used bioluminescence as an aide to navigation, to modern applications of bioluminescence as a tool for mapping pollution - as well as a behind the scenes look at how bioluminescence contributed to capturing the first images of a giant squid, filmed in its natural habitat.*
8:00 pm - 8:15 pm	**Closing Remarks**
8:15 pm – 10:00 pm	**Hawaiian Entertainment at the Bishop Museum**
9:00 - 10:00 pm	**Transfer to the Royal Hawaiian** Motor coaches will be leaving from the museum gates to transport symposium attendees to the Royal Hawaiian

Sunday, 3 November 2013

8:00 am - 11:00 am	**Departure Brunch** at the Monarch Room
9:00 am - 12:00 noon	**Guided tours of R/V Falkor** Vans will be leaving from the porte cochere to transport scheduled tour participants to Aloha Tower

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A Vision for Ocean Research: 150 Years Post HMS Challenger

Opening key note by Dr. Marcia McNutt, AAAS

We are but 9 years away from the sesquicentennial anniversary of the HMS Challenger's grand voyage, an expedition widely regarded as the birth of oceanography. As we near that landmark occasion, has ocean research since marked incremental advances, or a dramatic departure from that 19th century model, better tuned to the urgency of today's need for knowledge and current technological advances? Challenger was a steam-assisted Royal Navy corvette refit for trawling, dredging, water and sediment sampling, and taking depth soundings. She circumnavigated the globe from 1872 to 1876 with a multi-disciplinary team of scientists who documented the chemistry and natural history of the oceans. Their work was published in 50 volumes (available online today!). Today, drifters, gliders, and AUVs routinely gather more data on water physical and chemical properties in a day than the Challenger gathered in its entire expedition. But we must do more, and start working as a coherent community with shared standards, interoperability, planning and priority setting, and modular and interchangeable systems.

Dr. Marcia McNutt is a geophysicist who is the nineteenth editor-in-chief of *Science*. Prior to joining *Science*, she served as the fifteenth director of the US Geological Survey from 2009 to 2013 as one of a group of accomplished scientists who populated top government posts as part of President Obama's "dream team." During her tenure, the USGS responded to a number of major disasters, including earthquakes in Haiti, Chile, and Japan, and the Deepwater Horizon oil spill.

McNutt has also served as president and chief executive officer of the Monterey Bay Aquarium Research Institute (MBARI), in Moss Landing, CA. During her time at MBARI, the institution became a leader in developing biological and chemical sensors for remote ocean deployment, installed the first deep-sea cabled observatory in US waters, and advanced the integration of artificial intelligence into

autonomous underwater vehicles for complex undersea missions. McNutt began her faculty career at MIT where she became the Griswold Professor of Geophysics and served as Director of the Joint Program in Oceanography & Applied Ocean Science & Engineering, offered by MIT and the Woods Hole Oceanographic Institution. Her own research area is the dynamics of the upper mantle and lithosphere on geologic time scales, work that has taken her to distant continents and oceans for field observations. She is a veteran of more than a dozen deep-sea expeditions, more than half of which she has served as chief scientist or co-chief scientist.

McNutt's honors and awards include membership in the National Academy of Sciences, the American Philosophical Society, and the American Academy of Arts and Sciences. She also holds honorary doctoral degrees from Colorado College, University of Minnesota, Monmouth University, and Colorado School of Mines. She was awarded the Macelwane Medal by the American Geophysical Union in 1988 for research accomplishments by a young scientist and the Maurice Ewing Medal in 2007 for her significant contributions to deep-sea exploration. The US Coast Guard awarded her their Meritorious Service Medal, the noncombat equivalent to the Bronze Star, for her work on the Deepwater Horizon oil spill.

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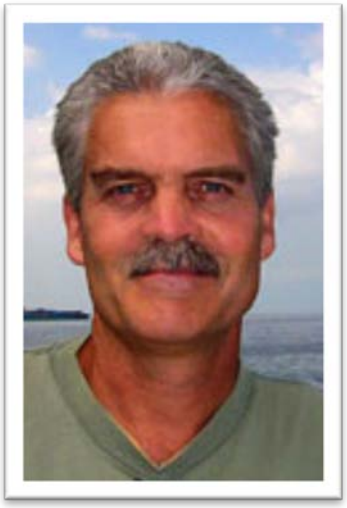
Technology Integration for the Marine Sciences
Panel discussion moderated by Dr. Daniel Pauly, UBC

Panel Participants: Dr. Cabell Davis, WHOI; Dr. Paul Falkowski, Rutgers University; Dr. Rainer Froese, GEOMAR; Dr. Tim Shank, WHOI

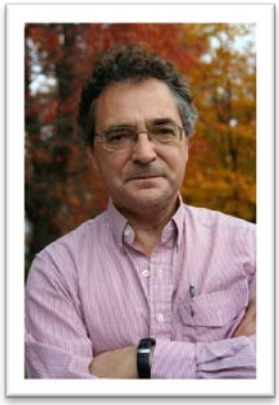
In the next decades, rising populations and incomes will place huge demands on services from marine ecosystems, while their ability to deliver these services (especially seafood and recreation) will be increasingly challenged, notably, by the fisheries themselves and by global warming, and possibly by seafloor mining. The role of science in addressing these challenges depends crucially on our ability to turn the data collected at various scales by various sampling systems into actionable and timely knowledge. While physical oceanography—similar to meteorology—has a long practice of data standardization, sharing and incorporation into global quantitative models, marine biology and fisheries science have not developed systems analogous to the developments in physical oceanography. This panel will discuss (and attempt to answer questions related to) how ocean scientists view the above challenges from their disciplinary perspectives and as part of a response by the ocean science community as a whole.

Dr. Daniel Pauly is a French citizen who completed his high school and university studies in Germany. After many years at the International Center for Living Aquatic Resources Management (ICLARM), in Manila, Philippines, Dr. Daniel Pauly became in 1994 a Professor at the Fisheries Centre of the University of British Columbia (in Vancouver, Canada), of which he was the Director from 2003 to 2003. Since 1999, he is also Principal Investigator of the *Sea Around Us* project, devoted to studying documenting and mitigating the impact of industrial fishing on the world's marine ecosystems.

The concepts, methods and software Daniel Pauly (co-)developed, documented in over 500 heavily-cited publications, are used throughout the world, following multiple courses and workshops given in four languages on all five continents. This applies especially to the ELEFAN software for fish growth analysis, the Ecopath approach for modelling aquatic ecosystems, FishBase, the online encyclopedia of fishes. This work is recognized in various profiles, notably in *Science, Nature* and the *New York Times,* and by numerous awards, notably the *International Cosmos Prize* (Japan, 2005), the *Volvo Environmental Prize*, (Sweden, 2006), the *Ramon Margalef Prize* (Spain, 2008) and the *Nierenberg Prize for Science in the Public Interest* (US, 2012).



Dr. Cabell Davis is a senior scientist in the biology department at the Woods Hole Oceanographic Institution (WHOI) and is director of WHOI's Ocean Life Institute. His general research area is plankton ecology with a focus on zooplankton. He did his PhD research in Woods Hole at the Boston University Marine Program, where he studied the copepods of Georges Bank, a rich fishing ground east of Cape Cod. He has used a combination of biological-physical modeling, field sampling, and laboratory experiments to determine the underlying mechanisms controlling observed distributions of zooplankton species. He co-developed the video plankton recorder, an underwater video microscope with automatic image identification, and has used it to obtain high-resolution data on fragile plankton. He currently is collaborating with MIT engineers in developing a small underwater digital holographic camera for imaging plankton. He is also modeling the impact of climate change on the fisheries ecosystem on Georges Bank as part of the U.S. Northwest Atlantic Global Ocean Ecosystem Dynamics program.



Dr. Paul G. Falkowski is the Bennett L. Smith Professor and director of the Environmental Biophysics and Molecular Ecology Program in the Institute of Marine and Coastal Sciences and Department of Earth and Planetary Science at Rutgers University. His scientific interests include evolution of the Earth systems, paleoecology, photosynthesis, biophysics, biogeochemical cycles, and symbiosis. Falkowski earned his B.S. and M.Sc. degrees from the City College of the City University of New York and his Ph.D. from the University of

British Columbia. After a post-doctoral fellowship at the University of Rhode Island, he joined Brookhaven National Laboratory in 1976 as a scientist in the newly formed Oceanographic Sciences Division. He served as head of the division from 1986 to 1991 and deputy chair in the Department of Applied Science from 1991-1995, responsible for the development and oversight of all environmental science programs. In 1996, he was appointed as the Cecil and Ida Green Distinguished Professor at the University of British Columbia. He moved to Rutgers University in 1998. He received a John Simon Guggenheim Fellowship in 1992; the Huntsman Medal in 1998; the Hutchinson Prize in 2000; the Vernadsky medal from the European Geosciences Union in 2007, the Ecology Institute Prize in 2010 and the Albert 1st Medal in 2011. In 2001, he was elected a Fellow of the American Geophysical Union; in 2002, he was elected to the American Academy of Arts and Sciences; in 2007, he was elected to the United States National Academy of Sciences; and in 2008, he was elected as a Fellow of the American Academy of Microbiology. Falkowski lives in Princeton with his wife, Sari Ruskin.

Dr. Rainer Froese is the project leader and coordinator of FishBase, the largest and most widely used biological information system available on the web. He was one of the architects of FishBase, having been involved since its inception in 1990 at the International Center for Living Aquatic Resources Management (ICLARM) in Manila, Philippines. Previously, he worked on life history strategies of fish larvae and on computer-aided identification systems at IfM. Fish are the largest group of vertebrates, with about 30,000 species, and interact with countless other species. Froese's research focuses on biodiversity and population dynamics of fishes with the goal of conservation and sustainable management in mind. He prefers data-rich approaches that emphasize commonalities rather than differences between species. He claims that the often-heard statement "Nothing is known about fish X" is usually not true because reasonable first estimates with error margins can be made for many life history traits if the maximum length and age at first maturity are known.

Getting the scientific names right is a precondition to any serious work in biodiversity. Froese therefore accepted in 1995 an invitation to join the Species 2000 Project Management Team, an initiative to establish an authoritative checklist of scientific names for all organisms on earth. Froese considers the intelligent merging of available biological and environmental data as one of the main tasks of the new field of biodiversity. In 2001 he accepted an invitation to join an

international committee to establish an Ocean Biogeographic Information System, which is intended to make use of the Internet by combining occurrence and abundance data for marine species with oceanographic data sets.

Dr. Timothy Shank, an Associate Scientist in the Biology Department at the Woods Hole Oceanographic Institution, combines molecular genetic approaches and ecological studies to understand the conditions and adaptations that allow biodiversity to evolve and thrive in deep-sea ecosystems, including chemosynthetic, seamount, and cold-water coral systems. Shank received his undergraduate degree in Biology and German from the University of North Carolina at Chapel Hill and a Ph.D. in Ecology and Evolution from Rutgers University. He has participated in more than 50 scientific expeditions 13 as chief or co-chief scientist) to deep-sea hydrothermal vents, hydrocarbon seeps, continental slopes, canyons, and seamounts in the Arctic Ocean, Eastern Pacific, Northern Atlantic, Sea of Cortez, Northeast Pacific, Galápagos Rift, Southeast Pacific, Central Indian Ocean, and Indonesian Seas, discovering more than 16 new hydrothermal vent fields and seamounts around the world, and was recently a Fellow of the Deep Ocean Exploration Institute. He has participated in more than 50 submersible dives, 100 remotely operated vehicle dives, and 40 autonomous underwater vehicle dives. He has been a principal or co-principal investigator on 30 federal and international research programs, presented more than 40 invited seminars, including testimony to the U.S. Senate and House of Representatives. He currently serves as the Chief Science Advisor and on Advisory Boards for the NOAA Ocean Exploration and Research Program. He has served on the United States Deep Submergence Science Committee (currently ex-officio) as well as on Steering Committees for both the ChEss (Biogeography and Diversity of Chemosynthetic Ecosystems) and CenSeam (the Global Census of Marine Life on Seamounts) for the Census of Marine Life. Shank served on the development team of the hybrid remotely operated vehicle Nereus, and now is the Director of the international Hadal Ecosystems Studies (HADES) Program marking a new era in deep-ocean research trench and abyssal regions. His expertise in faunal evolution and ecology have shaped our views on how deep-sea fauna have radiated and evolved in relation to oceanographic processes and geologic history on mid-ocean ridges, hydrocarbon seeps and seamounts.

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Breakthrough Opportunities in Ocean Science through Revolutionary Instruments Panel discussion moderated by Dr. Jules Jaffe, Scripps Institution of Oceanography

Panel Participants: Dr. Ed DeLong, MIT; Dr. Charles Eriksen, University of Washington; Dr. Deirdre Meldrum, Arizona State University; Dr. Ajit Subramaniam, Gordon and Betty Moore Foundation

Oceanography is a "young science," and the ability to observe oceanographic processes—at all scales—is fundamental to progress. In this session we will spend some time in retrospective examination of past successes in instrument development, consider present opportunities and funding mechanisms, and imagine how a future might foster important breakthroughs—and what those breakthroughs might be.

Dr. Jules Jaffe is a research oceanographer with the Marine Physical Laboratory at Scripps Institution of Oceanography, University of California, San Diego.

His research interests are broadly concerned with the use of new technology for observing oceanic phenomena and the development of inverse techniques for their interpretation. His research has focused primarily on ocean ecology; he has also worked in biomedical applications. In the realm of ocean ecology, several acoustic systems invented by Jaffe resulted in the first ever behavioral observations of zooplankton in situ. In addition, the small-scale distribution of phytoplankton, as mapped via an autonomously deployed imaging fluorometer, provided unprecedented views of oceanic biota. A new generation of miniature, sensor-equipped drifters that can acoustically network is also being considered in order to gain insights into coastal circulation and larval transport. Most recently, Jaffe is developing underwater microscopes for in-situ characterization of micro and macro plankton.

Born in Merrick, New York, Jaffe graduated cum laude from State University of New York, Buffalo, with a bachelor's degree in physics. He attended the Georgia Institute of Technology, where he received a master's degree in biomedical information science, and the University of California, Berkeley, where he received a doctorate in biophysics. Following graduation, Jaffe was a software engineer at Diasonics, Inc., in Milpitas, Calif., and, concurrently, a postdoctoral fellow at the UC Lawrence Berkeley National Laboratory. Subsequently, he was a consultant to KLA Instruments Inc., in Santa Clara, Calif. He joined the science staff at Woods Hole Oceanographic Institution in 1984. While at Woods Hole, he held a research fellowship from the Pew Memorial Foundation. Jaffe joined SIO in 1988 as a research scientist in the Marine Physical Lab. He is a fellow of the Acoustical Society of America and was a Visiting Miller Professor at U. C. Berkeley. He was recently cited for having the "best paper" at the International Ocean Optics Meeting (2012). He lectures widely to public audiences on in-situ methods and also his previous involvement with the finding of the Titanic in 1985. The National Science Foundation, the Office of Naval Research, California Sea Grant, the U.S. Army Breast Cancer Research Program, the Seaver Institute of Los Angeles, and the W. M. F. Keck Fouccation of Los Angeles have supported his research.

Dr. Edward DeLong received his Bachelor of Science degree in Bacteriology at the University of California Davis, and his Ph.D. in Marine Biology at Scripps Institute of Oceanography. He was a Professor in the Department of Ecology, Evolution and Marine Biology at the University of California Santa Barbara for seven years, before joining the Monterey Bay Aquarium Research Institute where he was a Senior Scientist and Chair of the Science Department. He now serves as a Professor at the Massachusetts Institute of Technology in the Departments of Civil and Environmental Engineering and Biological Engineering, where he holds the Morton and Claire Goulder Family Professorship in Environmental Systems. DeLong has served for the past seven years as the co-Director and Research Coordinator for the Center for Microbial Oceanography: Research and Education (C-MORE). DeLong's central efforts have been devoted to the study of microbes and microbial processes in the ocean, combining new techniques in genomics and computational biology with field-based approaches in microbial oceanography. Most recently DeLong has been integrating 'omics and bioinformatic approaches with autonomous, *in situ* sensing and sampling technologies, to map and quantify microbial plankton distribution and dynamics, and assess their impacts on biogeochemical and oceanographic

processes. DeLong is a Fellow in the American Academy of Arts and Sciences, the American Academy of Microbiology, the American Association for the Advancement of Science, and the U. S. National Academy of Sciences.

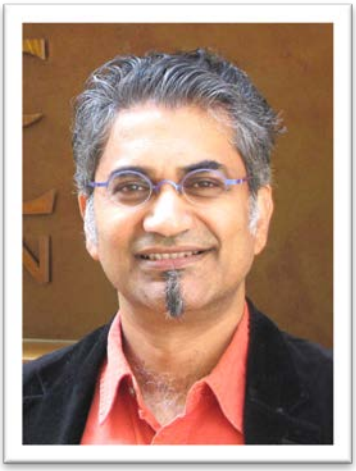
Born at the beginning of the Anthropocene in San Francisco, **Dr. Charlie Eriksen** is an observational physical oceanographer whose work has addressed internal waves, mixing, equatorial dynamics, air-sea interaction, mesoscale and submesoscale eddies, boundary currents, and subarctic circulation. He received his formal education in Cambridge at the academies on the upper then lower Charles. After a post-doc on Cape Cod, he returned to a pair of temporary faculty positions at the downriver institution before taking a sabbatical in La Jolla, followed by a terminal faculty position at the nominally state supported university in Seattle. There he fulfilled the prophesy in his doctoral dissertation that "Eventually he will return to the west coast to live."

A devotee of moored techniques in the first quarter century of his career, he abandoned them nearly two decades ago to focus on developing and using underwater gliders. His Seagliders continuously have held the autonomous underwater vehicle single mission range and endurance records for more than a dozen years. His latest passion is Deepglider, the only underwater glider capable of full ocean depth (6 km) operation. He is convinced that fleets of small affordable platforms are the most promising means of observing the ocean and leading to its greater understanding.

Dr. Deirdre R. Meldrum, is currently the ASU Senior Scientist, Director of the Biosignatures Initiative to transform healthcare, Director of the Center for Biosignatures Discovery Automation (CBDA) in the Biodesign Institute, and tenured full Professor of Electrical Engineering in the Ira A. Fulton Schools of Engineering. She is also Director and Principal Investigator of the National Institutes of Health (NIH) Center of Excellence in Genomic Sciences (CEGS): Microscale Life Sciences Center (MLSC), 2001-present with $36M in support, pioneering live single-cell analysis technologies to

study cellular heterogeneity in cancer and other diseases. She has led research programs totaling nearly $80M over 20 years, spanning the topics of automation for genomics, microscale systems for biological applications, biosignatures, robotics, sensors, Sensorbots for biogeochemical sensing in the oceans, flexible structures, and fuzzy logic control for freeway transportation systems. As part of her ocean exploration research, Dr. Meldrum dove on the Alvin submersible off of the Research Vessel (R/V) Atlantis in the NE Pacific Ocean to 2200 meters below sea level in 2006, to perform Raman spectroscopy and other experiments. She has been engaged in research and education forums with the National Academy of Engineering and the National Institutes of Health. Internationally, she has served on the Swiss NSF panel for the SystemsX Systems Biology Program, met with the NSF of Taiwan regarding collaborations with University of Washington, and met with the leaders of Singapore to forge partnerships with Arizona State University (ASU).

Dr. Meldrum is a member of the American Association for the Advancement of Science (AAAS), the Institute for Electrical and Electronics Engineers (IEEE), the American Chemical Society (ACS), the Association for Women in Science (AWIS), the Human Genome Organization (HUGO), the Society of Women Engineers (SWE), and Sigma Xi. Her honors include an NIH Special Emphasis Research Career Award (SERCA) in 1993, a Presidential Early Career Award for Scientists and Engineers (PECASE) in 1996 “for recognition of innovative research utilizing a broad set of interdisciplinary approaches to advance DNA sequencing technology,” Fellow of the AAAS in 2003, and Fellow of IEEE in 2004, Senior Editor for the IEEE Transactions on Automation Science and Engineering,(T-ASE) 2003-2010, Chair of the IEEE T-ASE Advisory Board 2010-2011, member of the National Advisory Council for Human Genome Research for the U.S. Department of Health and Human Services 2006-2008 and 2011-present, and is a member of the advisory board for Microsoft Research Connections, 2007-present. Deirdre R. Meldrum received the B.S. in civil engineering from the University of Washington, Seattle, WA, in 1983, the M.S. in electrical engineering from Rensselaer Polytechnic Institute, Troy, NY, in 1985, and the Ph.D. in electrical engineering from Stanford University, Stanford, CA, in 1993. She completed the Stanford Executive Program at Stanford University in 2009.



Dr. Ajit Subramaniam is the program director of the Marine Microbiology Initiative (MMI) at the Gordon and Betty Moore Foundation. The goal of the second phase of MMI is to uncover the principles that govern the interactions among microbes - who interacts with whom, how, when, where, and the consequences thereof - and that influence the microbially mediated nutrient flow in the marine environment - who consumes and excretes what, where, how much, when, and the consequences thereof.

Ajit is a biological oceanographer with expertise in biogeochemical cycles, remote sensing, bio-optics, and phytoplankton physiology. He has worked on understanding the processes that can explain why particular species of phytoplankton grow where they do, the factors that cause such blooms, that lead to their demise, and the consequences of these blooms.

Ajit has more than 20 years of research experience and has participated in over 50 research cruises. He came to the Gordon and Betty Moore Foundation from the Lamont Doherty Earth Observatory at Columbia University where he is a Lamont Associate Research Professor. He served as a program manager in the Biological Oceanography Program at the U.S. National Science Foundation in 2008-2009. He has worked for the NOAA Coastal Services Center in Charleston, SC, the University of Maryland in College Park, MD, and the University of Southern California in Los Angeles prior to moving to Lamont Doherty Earth Observatory in 2004. Ajit earned his Ph.D. in Coastal Oceanography and M.S. in Marine Environmental Science from SUNY, Stony Brook.

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Robotics and the Ocean Frontier
Panel discussion moderated by Dr. Jim Bellingham, MBARI

Panel Participants: Dr. Michael Klages, University of Gothenburg; Dr. Vincent Rigaud, Ifremer; Dr. Henrik Schmidt, MIT; Ms. Mikell Taylor, Bluefin Robotics

The ocean remains mostly unobserved, largely because it is a remote and hostile environment and opaque to our natural senses. However, the advent of increasingly capable robotic systems is fundamentally changing our ability to observe and work in the ocean. While these systems are in their infancy, their impact has already been dramatic. However, as with almost every new technology, there are challenges as well. Robotic systems are not a 'drop in' replacement for existing systems, rather they offer new capabilities and require innovative methods of operation. Their performance is limited by factors such as the current state of the art of underwater sensors and autonomous software. In this discussion, panelist will discuss the technological drivers for newer, more capable robots, how they might be used, the transformations they might engender, and the scientific problems they could address.

Dr. James (Jim) Bellingham is Chief Technologist at the Monterey Bay Aquarium Research Institute. Prior to serving as Chief Technologist, Jim was Director of Engineering at MBARI from 1999 to 2006. During his tenure as Director of Engineering, he was responsible for expanding MBARI's engineering focus from ROV design to a broader development of advanced ocean observing systems. Prior to coming to MBARI, Dr. Bellingham ran the Autonomous Underwater Vehicle Laboratory in the MIT Sea Grant Program from 1988 to 2000. In 1997, Dr. Bellingham co-founded Bluefin Robotics Corporation, a leading manufacturer of Autonomous Underwater Vehicles, which was purchased by Battelle Memorial Corporation in 2005.

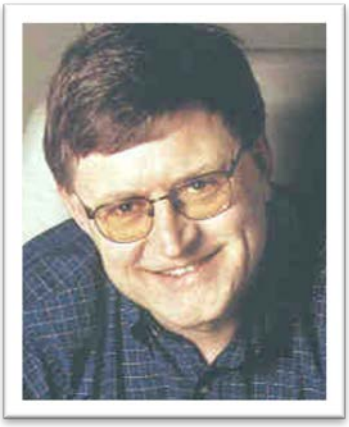
Jim has S.B., S.M and a PhDs in Physics from the Massachusetts Institute of Technology. His is a pioneer in the creation and use of Autonomous Underwater Vehicles (AUVS), which are underwater robots that operate without human supervision. In the process of developing AUVs, Bellingham has spent considerable time at sea, leading over 20 AUV expeditions in many locations around the world, including high latitudes. Jim's has received numerous awards and honors including the Lockheed Martin Award for Ocean Science and Engineering, Antarctic Service Medals, the WHOI Steinbach Visiting Scholar, and the MIT Robert Bruce Wallace Lecture.

Dr. Bellingham is Chair of the Naval Research Advisory Committee. He is a member of the Battelle National Security Global Business Strategic Advisory Group, and Strategic Advisory Boards for Liquid Robotics and PolyPlus Corporations. He was a Director at Hawkes Remotes Incorporated before its recent purchase. He has served on National Academies studies for advanced seafloor observatories, the arctic observing network, and for prioritizing ocean infrastructure, as well as a Naval Studies Board Committee for distributed remote sensing systems. Jim was a member of the Deep Submergence Science Committee for six years. Dr. Bellingham has organized and participated in many community workshops.

Dr. Michael Klages, born 1961 in Germany, graduated in 1988 in biology (diploma). He received his PhD in 1991 from the University of Bremen after defending his thesis on the biology and population dynamics of gammaridean amphipods of the Antarctic Weddell Sea. After a three years period as post-doc at the Alfred Wegener Institute for Polar and Marine Research (AWI) in Bremerhaven he held a position as science officer at the Federal Ministry for Science and Technology in Bonn for 18 months. From 1995 he was senior scientist at AWI and focused on Arctic deep-sea ecology. In 2000 he became head of an interdisciplinary project group with thematic focus on Arctic deep-sea biodiversity and technology development. During this period he was responsible for the operation and payload development of an AUV, and the regular use of work-class ROVs onboard the German research icebreaker "Polarstern". The establishment of a stand-alone deep-sea observatory in 1999 in the Arctic Fram Strait, covering a depth range from 1000 -5500 m, was another achievement during his leadership. Today, this observatory has gathered one of

the largest and most comprehensive data sets of an Arctic deep-sea region. In 2011 he was co-applicant of a conceptual application to the Federal Research Ministry in Germany to connect key stations of the observatory with a power and fiber-optic cable to Svalbard. Since December 2012 he is director of the Sven Lovén Centre for Marine Sciences at the University of Gothenburg in Sweden.

Dr. Vincent Rigaud is director of the Underwater System Unit within Ifremer since 2003 and was formally head of the Robotics, Navigation and Vision R&D Laboratory. The underwater systems department is in charge of research and development on new underwater systems and design, integration and overhauls of operational systems for the Ifremer fleet. The activity covered AUVs (AsterX and IdefX), ROV (Victor6000), Manned submersible (Nautile),Deep tow sonar (SAR, Sysif), Observatories (Antares ,Km3, Deepseanet, Esonet) and related technologies and instrumentations. He is graduated in 1990 as Doctor in Signal Processing and Automation from University of Rennes, and INRIA, France and engineering degree in oceanography from Toulon University. After an experience in the offshore industry, he joined Ifremer in 1990, and since have been involved in several projects within Ifremer, with an activity split between operational engineering and research projects, with a high level of activity at sea mainly as head of technological campaigns. In 2011 he has launch with his team the development of a new innovative hybrid system named HROV to be operational early 2014. In 2012 he has launched the new European Center for Underwater Technologies (CETSM), and has contributed to the setup of a new European Underwater Research Group with Marum and AWI in Germany named Phoenix. He is engaged in numerous European and industrial projects in the field of underwater systems. He has published around 118 papers since 1988, and has supervised 7 PhD students. He is teaching in several engineering schools. He is co-editor of several journals (Journal of Field Robotics, Journal of Marine Technologies). He was auditor of the Fondation Méditerranéenne d'Etude Stratégique and of the Institut de Hautes Etudes pour la Science et la Technologie. He is author or co-author of several active patents Selection of Recent significant publications). He is engaged within several international advisory boards (MARUM, ROBEX)



Dr. Henrik Schmidt is Professor of Mechanical & Ocean Engineering at the Massachusetts Institute of Technology. He received his MS degree from The Technical University of Denmark in 1974, and his PhD. from the same institution in 1978. From 1978 to 1982 he worked as a Research Fellow at Risoe National Laboratory in Denmark. From 1982 to 1987 he worked as Scientist and Senior Scientist at the NATO SACLANT ASW Research Centre in Italy. He has been on the MIT faculty since 1987. He has served as Associate Director of Research at the MIT Sea Grant College Program from 1989-2002, and as Associate Department Head 1994-2002. He served as Acting Department Head of Ocean Engineering from 2002 - 2004. Professor Schmidt's research has focused on underwater acoustic propagation and signal processing, in particular on the interaction of sound in the ocean with seismic waves in the ocean bottom and the Arctic ice cover. His work has been of theoretical, numerical and experimental nature. He has been Principal Investigator in two Arctic ice station experiments, and Chief Scientist for several recent, major experiments in coastal environments. He has developed numerically efficient numerical algorithms for propagation of acoustic and seismic waves in the ocean and solid earth environment, including the SAFARI and OASES codes which are used as a reference propagation models in more than 100 institutions around the world. In recent years Professor Schmidt has been pioneering the development of new underwater acoustic sensing concepts for networks of small Autonomous Underwater Vehicles (AUV) for distributed MCM and ASW. Prof. Schmidt was lead-PI for the multi-institutional PLUSNet team developing a distributed, autonomous acoustic sensing concept, under the ONR Undersea Persistent Surveillance Program. In addition to a long string of papers in the archival literature, Professor Schmidt has co-authored a textbook on computational ocean acoustics. He is a Fellow of the Acoustical Society of America (ASA), and he was the 2005 recipient of the ASA “Pioneer of Underwater Acoustics” medal.

Ms. Mikell Taylor has spent six years designing AUVs with Bluefin Robotics based in Quincy, MA. In addition to subsea vehicles, she has worked on humanoid manufacturing robots, planetary rovers, and various other robotic platforms. She is also a proud volunteer with the FIRST Robotics Competition. Ms. Taylor received a degree in Electrical and Computer Engineering from Olin College of Engineering as a member of their inaugural class, and in 2011 was selected as a Woman to Watch by Mass High Tech.

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Evolving Roles of Research Vessels, Panel discussion moderated by Mr. David McKinnie, NOAA

Panel Participants: Dr. Bruce Appelgate, Scripps; Mr. Marc Nokin, Ifremer; Dr. Peter Orter, UNOLS; RDML David A. Score, NOAA

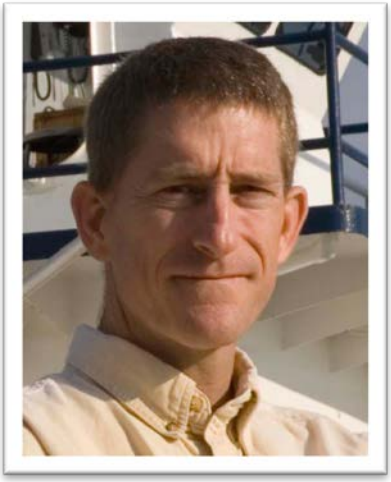
Oceanographic research has typically depended on ocean-going ships. Despite the high value of today's satellite-based measurements, moored systems, drifters and floats, and more recently AUVs and gliders, ships remain critical to advancing our understanding of the ocean today. But ships are expensive to build and operate. The research fleet in the U.S. and other developed nations is dwindling along with budgets for fleet capital investments and operations. If dedicated research vessels remain critical in the future, what kinds of ships will they be? How will they operate? Panelists will discuss designs that will increase flexibility and adaptability, technologies and modes of operation that can extend the reach of these vessels, and ways to network existing and planned opportunities for data collection and research requirements.

Mr. David McKinnie is senior advisor for the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research. His expertise includes development of domestic and international external partnerships, moving concepts to operations, and translating science for decision makers.

He served as NOAA liaison to the U.S. Embassy in Jakarta, where he coordinated the first-ever joint Indonesia-U.S. ocean exploration expedition in 2010. He is the U.S. lead for the Indonesia-U.S. Ocean Exploration Partnership. He was technical manager for the NOAA component of the Indian Ocean Tsunami Warning System. David worked with counterparts in Thailand, Sri Lanka, India, the Maldives, Indonesia, and Australia to design and implement the first phases of the Indian Ocean system and global tsunami warning system framework while serving as U.S. representative to the Intergovernmental Oceanographic Commission on tsunami issues. David has negotiated many

international agreements since 2005 for ocean technology transfer, ocean exploration, and ocean/climate observations partnerships.

David earned a MS in Natural Resources from the University of Michigan and BA in History from Colorado College.



Dr. Bruce Appelgate. As Associate Director of Scripps Institution of Oceanography, Dr. Appelgate directs the Scripps fleet of four research vessels, which conduct oceanographic research worldwide. A research geologist, Appelgate also directs the Scripps Shipboard Technical Support unit, which provides technical expertise on all aspects of scientific instrumentation aboard Scripps' research vessels. Appelgate also oversees the Nimitz Marine Facility in Point Loma, a 6.5 acre facility that serves as home port to the Scripps fleet and its 150 mariners and staff, with an annual budget of $30M. In 2009, Appelgate led a successful Scripps proposal to the Office of Naval Research to operate the newest U.S. research vessel, the R/V *Sally Ride*, which is currently under construction for delivery in 2015.

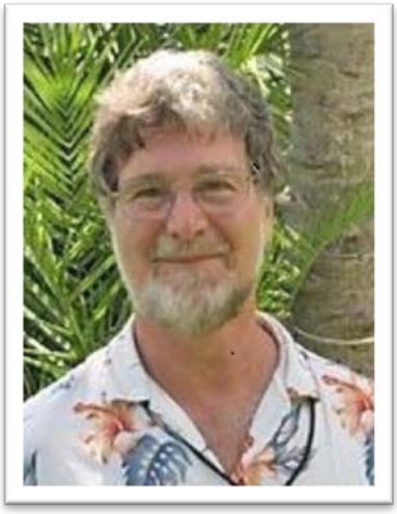
Dr. Appelgate has participated in more than 80 oceanographic research missions as Principal Investigator, Chief Scientist, or Geophysicist, resulting in more than 50 refereed publications and professional presentations that have appeared in *Geology*, the *Journal of Geophysical Research*, *Tectonics*, *Marine Geology*, *Bulletin of Volcanology* and the *Transactions of the American Geophysical Union*. His awards include a National Science Foundation Postdoctoral Fellowship, a National Research Council Resident Research Associateship, the J. Watumull Merit Scholarship, and three Society of Exploration Geophysicists Foundation Scholarships.

Dr. Appelgate earned a Ph.D. in marine geology and geophysics from the University of Hawai`i in 1995, an M.S. degree in oceanography from Oregon State University in 1988, and a bachelor's degree in geology from Humboldt State University in 1985. A native San Diegan, he was raised in the North County community of Rancho Bernardo and graduated from Poway High School in 1981.

Prior to joining Scripps, Dr. Appelgate worked as a research geologist at the University of Hawai`i, where he served as Director of the Ocean Technology Group, Principal Investigator for the Pacific Island Benthic Habitat Mapping Program, and Director of Field Operations for the Hawai`i Mapping Research Group. Dr. Appelgate also served as Director of Technical

Development at Seabed Mapping New Zealand Ltd., where he applied geophysical exploration techniques toward understanding deepwater fisheries in the New Zealand Exclusive Economic Zone. Dr. Appelgate's research interests include seafloor mapping and marine geology and geophysics, especially using bathymetric and imaging sonars to study the structure and tectonics of plate boundaries.

Mr. Marc Nokin graduated as a mechanical engineer from the "Ecole Centrale de Paris". He joined IFREMER in 1985 and started working on underwater systems development. After a year in JAMSTEC in 1990 (Japan), he was committed to the development of the ROV *Victor 6000*. He then moved to Brest (France) in 2000 for the building of RV *Pourquoi pas?* (2000-2006). Since 2007, Marc Nokin is the head of the "Ships and Onboard Equipment" department in Ifremer. This unit is in charge of new constructions, modernizations and up-grading of the institute's research vessels, and mainly of the scientific equipment aspects.



Dr. Peter B. Ortner is the Director of the Cooperative Institute of Marine and Atmospheric Studies at the Rosenstiel School of Marine and Atmospheric Science (http://www.ci-mas.org) located at the University of Miami but incorporating all nine of the major Florida and U.S. Caribbean research universities. Prior to coming to RSMAS he served as the Chief Scientist and Acting Director of NOAA's Atlantic Oceanographic and Meteorological Laboratory co-located in Miami on Virginia Key. He is one of the world's experts in studying the ocean and its living resources through acoustic and optical techniques which have been primarily applied in the context of interdisciplinary oceanographic programs such as BioSYNOP, GLOBEC, SABRE and NECOP. Dr. Ortner has participated in numerous research cruises throughout the world including the Atlantic, Pacific and Indian Oceans, the Arabian and Caribbean Seas, the Gulf of Alaska and the Gulf of Mexico. He has over 100 scientific publications and serves on numerous scientific advisory panels and is presently the Chair of the of the University-National-Laboratory-Systems

(UNOLS) Council that oversees the U.S. academically operated national research vessel fleet. As a Research Professor in the Division of Marine Biology and Fisheries at the Rosenstiel School, Dr. Ortner has mentored numerous graduate students and post-doctoral fellows. He is one of the founding members of SCOR-IAPSO Working Group "OceanScope" whose goal is to instrument the international merchant marine fleet to systematically probe the ocean's interior and co-editor of the Working Group's final report (http://www.scor-int.org/Publications/OceanScope_Final_report.pdf).

Rear Admiral David A. Score is Deputy Director of the NOAA Commissioned Officer Corps and NOAA Office of Marine and Aviation Operations Deputy Director for Operations.
RDML Score served most recently as Director of OMAO's Marine Operations Center, which oversees all NOAA ship fleet operations. He previously served as Commanding Officer of the NOAA Marine Operations Center-Atlantic in Norfolk, Virginia. Before directing NOAA's Atlantic fleet, RDML Score commanded NOAA Ship Gordon Gunter, which conducted key research missions during the BP Deepwater Horizon oil spill response.

Since his commission as a NOAA Corps officer in 1990,RDML Score has served aboard six NOAA vessels, including NOAA ships Miller Freeman, Ferrel and Nancy Foster. These ships conducted operations from the Bering Sea to the Caribbean Sea. He is an accomplished NOAA diver and dive master and has supervised more than 2,000 dives.

RDML Score has also served in a variety of management and operational roles at Channel Islands, Gray's Reef and Florida Keys National Marine Sanctuaries. As the superintendent of Florida Keys National Marine Sanctuary, he oversaw a complex regulatory program and partnerships with three state and six federal agencies. RDML Score has a strong record of achievement. He has received eight NOAA special achievement awards, two Department of Commerce bronze medals, and was the 1999 NOAA National Association of Commissioned Officers Junior Officer of the Year. He holds a bachelor's degree in marine biology and advanced research from the Florida Institute of Technology and studied biology at Georgia Southern University.

RDML Score has a wife and two daughters.

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Up for Grabs: Technology and the Race to Control the Ocean
Plenary presentation by Dr. Jim Bellingham, MBARI

How much is the ocean worth? In an increasingly crowded and affluent world, many measure the value of the ocean by the resources it contains—without accounting for the value of services the ocean provides for our wellbeing. Technology plays a key role, offering both the capability to find and extract ocean resources, as well as the means to understand ocean services and measure their health. But can we develop the technology to value and monitor ocean services better before the consumption of resources overwhelms all caution?

Dr. Bellingham's full bio appears on pages 29-30.

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Oceanographic Research Organization Essentials: Bricks and Mortar or Virtual? Panel discussion moderated by Dr. Edith Widder, ORCA

Panel Participants: Dr. Susan Avery, WHOI; Dr. David Conover, NSF; Dr. Peter Girguis, Harvard; Mr. Gene Massion, MBARI; Dr. Oscar Schofield, Rutgers

The shift in oceanographic research from expedition-based data gathering to internet-connected observatory networks presents benefits and challenges for oceanographic research organizations. Well maintained ocean observatories with appropriate data policies will promote collaboration among investigators spanning the globe, eliminate geographic constraints, and promote innovation. But helping the oceanographic community to embrace an open data environment, maintain strong communication channels among globally distributed research teams, and secure sustained funding to support observing networks and data archives represent significant challenges. Panelists will discuss how oceanographic research organizations can minimize challenges and maximize benefits.

Dr. Edith Widder is a MacArthur Fellow, a deep-sea explorer and conservationist who combines expertise in oceanographic research and technological innovation with a commitment to reversing the worldwide trend of marine ecosystem degradation. She received her undergraduate degree in Biology from Tufts University and her MS in Biochemistry and PhD in Neurobiology from the University of California, Santa Barbara. Two years after completing her Ph.D., Dr. Widder became certified as a Scientific Research Pilot for Atmospheric Diving Systems. She holds certifications that qualify her to dive the deep diving suit *WASP* as well as the single-person untethered submersibles *DEEP ROVER* and *DEEP WORKER* and she has made over 250 dives in the *JOHNSON-SEA-LINK* submersibles.

A specialist in bioluminescence, she has been a leader in helping to design and invent new submersible instrumentation, and equipment to enable unobtrusive deep-sea observations. Her innovations have produced footage of rare sharks, jellyfish, and crustaceans, as well as led

to the discovery of a new species of large squid in 2004 and in 2012 the first recordings of the giant squid, *Architeuthis*, in its natural habitat. In 2005, in order to help protect the ocean she loves, Widder co-founded the Ocean Research & Conservation Association, a not-for-profit dedicated to the study and protection of marine ecosystems and the species they sustain through development of innovative technologies and science-based conservation action.

Dr. Susan K. Avery is the President and Director of the Woods Hole Oceanographic Institution (WHOI) Dr. Avery earned a doctorate in atmopsheric science from the University of Illinois in 1978. Her research interests include studies of atmopsheric circulation and precipitation, climate variability and water resources, and the development of new radar techniques and instruments for remote sensing. She is the author or co-author of more than 80 peer-reviewed articles and has interests in scientific literacy and the role of science in public policy and decision support. Dr. Avery has served on many national and international boards, committees, commissions, and program review committees, and is active in professional societies. She is a fellow of the Institute of Electrical and Electronics Engineers, the American Association for the Advancement of Science, and of the American Meteorological Society, for which she also served as president.

Prior to joining WHOI, Dr. Avery served on the faculty at the University of Colorado, Boulder from 1982-2008. She served as director of the Cooperative Institute for Research in Environmental Sciences where she facilitated new interdisciplinary research efforts spanning the geosciences while bringing them together with social and biological sciences. She also helped establish a successful K-12 outreach program and a Center for Science and Technology Policy Research—efforts to make CIRES research more applicable, understandable, and accessible to the public. From 2004-2007 she served in interim positions as vice chancellor for research and dean of the graduate school, as well as provost and executive vice chancellor for academic affairs at the University of Colorado at Boulder. Dr. Avery helped form an integrated science and assessment program that examines the impacts of climate variability on water in the American West. She also worked with the National Oceanic and Atmospheric Administration and the Climate Change Science Program to help formulate a national strategic science plan for climate research.

Dr. Avery uses her current position at WHOI and her background in atmospheric research to convey the importance of understanding the Earth as a system connected by ocean, atmosphere, terrestrial, and human interactions. Under her leadership, WHOI is diversifying funding and pursuing more interdisciplinary discovery research as well as problem-oriented research and the application of fundamental research to ocean-related crises. The institution is also developing a wide range of platforms and tools for access to the ocean.

Dr. David O. Conover serves as the Director, Division of Ocean Sciences at the National Science Foundation. As Division Director, Dr. Conover manages a budget exceeding $340 million, and oversees two major facility construction projects, the Ocean Observatories Initiative ($400M) and the Arctic research vessel R/V Sikuliaq ($200M).

Dr. Conover retains the position of Professor of Marine Science in the School of Marine and Atmospheric Sciences (SoMAS) at Stony Brook University, Long Island, N.Y. where he served as Dean from 2003-2010. As an expert on the ecology of marine fishes and fisheries science, he has authored over 100 papers including many in leading journals such as *Nature* and *Science*.

Dr. Peter Girguis is a Loeb Professor of Natural Sciences at Harvard University. His research focuses on microbes that flourish in so-called "extreme environments". He is particularly interested in understanding the role they play in mediating global biogeochemical cycles. His research is highly interdisciplinary, and he employs a variety of molecular microbiological and geochemical techniques as appropriate. He also develops novel instruments and samplers –such as underwater isotope analyzers and microbial samplers- to enable the broader community to interrogate these relationships in a manner previously unattainable.

He received his B.Sc. from UCLA, and his Ph.D. from the University of California Santa Barbara, where he worked with Dr. James Childress on the physiological and biochemical adaptation of deep-sea hydrothermal vent tubeworm symbionts.

He did postdoctoral research at the Monterey Bay Aquarium Research Institute with Dr. Ed Delong on the growth and population dynamics of anaerobic methanotrophic microbes.

Mr. Gene Massion currently works at the Monterey Bay Aquarium Research Institute where he has been for the last 18 years. Previously he was with MariPro, a defense contractor in Goleta CA for 12 years. While at Maripro, Gene has worked on a variety of novel systems for Oceanographic research including the Environmental Sample Processer (ESP), the Monterey Accelerated Research System cabled observatory (MARS), several chemical sensors, and a variety of other buoyed, cabled and free floating systems. Gene currently works in the Chemical Sensor Lab at MBARI where he is developing more instrumentation and a free drifting profiling float for coastal oceanographic applications. While at Maripro he worked on a wide variety of ocean going projects including underwater acoustic signal processing systems, several unique surveillance systems and several cabled underwater tracking and communication systems. Gene has been lucky enough to work on all aspects of these systems including concept development, mechanical, electrical, software and system engineering and has spent a lot of time at sea deploying what he's built.

Dr. Oscar Schofield is a Professor of Biological Oceanography at Rutgers University interested in how plankton dynamics structure marine food webs and feedback on the ocean's biogeochemistry. His research focus has combined genetics and biochemistry with the development of new ocean observing technologies (satellites, radars, and autonomous underwater vehicles). He is co-Director and co-Founder of the Coastal Ocean Observation Laboratory (COOL), which has become a technology and research group of 5 faculty and a team of over twenty technicians and students. The COOL group has been awarded and managed over fifty million dollars in competitive awards from NOAA, Office of Naval Research, Department of Homeland Security, NASA and the National

Science Foundation over the last 20 years. Dr. Schofield's research efforts have focused on polar and temperate waters with extensive efforts in the Southern Ocean, with ongoing research along the West Antarctic Peninsula and the Ross and Amundsen Seas. The group has also focused on integrating the research into innovative education and outreach efforts spanning K-12 to undergraduate students and the general public.

Dr. Schofield will serve as the Clo-Lead for Theme 3 in the C-SOBOM project and will also provide glider expertise to the research team.

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Ocean Data Sharing and Analytics, Panel discussion moderated by Dr. Peter Cornillon, URI

Panel Participants: Mr. Matthew Arrott, NSF OOI; Mr. James Gallagher, OPeNDAP; Mr. John Graybeal, Marinexplore; Mr. Brian Sullivan, Google Ocean; Dr. Dawn Wright, ESRI

Satellite-derived observations of the ocean have contributed ever-expanding volumes of observed oceanographic data, providing views of the cloud-free ocean at high spatial and temporal resolution. The difficulty of managing, accessing and using these data also continues to grow, but the associated management problems are relatively tractable—the number of datasets is small and the growth in the volume of data is easily predicted. By contrast, the difficulty in dealing with *in situ* observations is likely to increase much more rapidly, offering a host of new problems and aggravating old ones. The anticipated exponential increase in the availability of, and interest in, access to *in situ* datasets applies to all of the oceanographic sub-disciplines. Panelists will address issues associated with the stewardship, discovery, access and use of oceanographic data in the future, with particular attention being paid to issues related to the expected rapid growth of *in situ* observations.

Dr. Peter Cornillon received his PhD in Experimental High Energy Physics from Cornell University in 1973. He joined the Societal Analysis Department of the General Motors Research Laboratory as a systems analyst in 1972. From 1975-1980 he worked as a research faculty member in Ocean Engineering at the University of Rhode Island (URI) addressing issues related to sediment transport and oil spill modeling. In 1981 he moved to the Graduate School of Oceanography at URI focusing on remote sensing as it applies to the physics of the ocean. In order to address data access issues related to the large volumes of satellite-derived data that he was using, Dr. Cornillon began working on distributed data systems in 1992 with his group eventually developing the OPeNDAP data access protocol designed to facilitate access to oceanographic data on the web. In 2007 he shifted the focus of his research from data systems back to remote sensing and currently has an active program in the analysis of sea surface temperature fronts identified in satellite-derived SST fields of the global ocean.

Dr. Cornillon's 90+ peer-reviewed publications cover a broad range of studies from those based on data derived from satellite-borne infrared, color and microwave (both passive and active) instruments to those related to distributed data systems. Dr. Cornillon has also served on numerous committees and working groups related to data management issues such as: NASA's Global Change Master Directory Advisory Committee, NRC's Committee on Geophysical and Environmental Data, NSF's Ocean Information and Technology Infrastructure Working group, NRC's Committee on Environmental Information for Naval Use, NSF's Advisory Committees to Geosciences and Polar Programs and NOAA's Data Archiving and Access Requirements Working Group.

Mr. Matthew Arrott has over 20 years of experience in program leadership and engineering management for software and network systems. Matthew helped found Currenex (now a subsidiary of State Street) and has held leadership positions in Dreamworks SKG, Autodesk and the National Center for Supercomputing Applications.

His most recent work with the University of California has focused on delivering high value multi-agency cyber infrastructure for the NSF-funded Ocean Observatories Initiative, a global scale instrumentation of the world's oceans for scientific exploration. The diversity of roles that Matthew has held gives him a rare insight into how business problems manifest themselves across industries and the unexpected benefits generated from collaborative initiatives.

Mr. James Gallagher is one of the developers of the DAP protocol (along with Peter Cornillon, Glenn Flierl and George Milkowski) and has been with OPeNDAP since its inception as the DODS project in 1993. OPeNDAP is both the name of a non-profit organization and the commonly-used name of a protocol which the OPeNDAP organization has developed.

The DAP2 protocol provides a discipline-neutral means of

requesting and providing data across the World Wide Web. The goal is to allow end users, whoever they may be, to access immediately whatever data they require in a form they can use, all while using applications they already possess and are familiar with. In the field of oceanography, OPeNDAP has already helped the research community make significant progress towards this end. Ultimately, it is hoped, OPeNDAP will be a fundamental component of systems which provide machine-to-machine interoperability with semantic meaning in a highly distributed environment of heterogeneous datasets. The OPeNDAP organization exists to develop, implement, and promulgate the OPeNDAP protocol. It presents the results of its work freely to the public with the hope that it will be of service in many disciplines and facilitate sharing of and access to their data streams.

Mr. John Graybeal is the Data Manager for Metadata and Semantics at Marinexplore, and Project Lead at Marine Metadata Interoperability project. He has 30 years of experience in software and systems engineering for scientific applications, including contract and project leadership. At Marinexplore John is developing the metadata and semantic strategies for the ocean data management systems. The strategies must satisfy data management and curation requirements for the open and enterprise applications.

As OOI CI Product Manager at UC San Diego/Scripps Institute of Oceanography, John performed strategic analysis and integration of the Cyberinfrastructure product for the National Science Foundation's Ocean Observatories Initiative. He performed various senior project roles during this period, including System Development Manager and Operations Manager.Systems Engineer

At MBARI, John performed software engineering and development for marine systems. He led the team developing the Shore Side Data System (SSDS), and helped create Marine Metadata Interoperability project (http://marinemetadata.org), with over 500 members supporting interoperable marine data management. He continues as MMI's Project Lead, recently coordinating the migration of its semantic repository to the Harte Research Institute.

As a member of Google Oceans, **Mr. Brian Sullivan** works with academic, governmental, commercial, and nonprofit institutions to leverage Google's geospatial platforms to further ocean research, communication, and public engagement. Projects include scaling ingestion, visualization, and analytics of bathymetry, biological, regulatory and other spatial datasets. He loves his current role as he is a sucker for the environment and an avid diver for research and fun. Previously, he managed digital divide programs in West Africa, held various technical positions, and was a strategy consultant in financial services. He holds a Bachelor & Masters in Systems Engineering from the University of Pennsylvania. Various attempts to forage and live off the land (and water) have been met with mixed success, were always rewarding, but often left him a little peckish.

Dr. Dawn Wright is chief scientist of Esri, the world's leading geographic information system (GIS) software, research and development company. As chief scientist, Dr. Wright aids in formulating and advancing the intellectual agenda for the environmental, conservation, climate, and ocean sciences aspect of Esri's work, while also representing Esri to the national/international scientific community. She maintains an affiliated faculty appointment as Professor of Geography and Oceanography in the College of Earth, Ocean, and Atmospheric Sciences at Oregon State University. Dr. Wright's research interests include geographic information science; ocean informatics and cyberinfrastructure; benthic terrain and habitat characterization; and the processing and interpretation of high-resolution bathymetry, video, and underwater photographic images. She has authored or co-authored more than 130 articles and five books on marine geographic information systems, hydrothermal activity and tectonics of mid-ocean ridges, and marine data modeling and cyberinfrastructure. Dr. Wright has participated in over 20 oceanographic research expeditions worldwide, including 10 legs of the Ocean Drilling Program, three dives in the deep submergence vehicle Alvin and twice in the Pisces V. Her fieldwork has taken her to some of the most geologically active regions of the planet, including the East Pacific Rise, the Mid-Atlantic Ridge, the Juan de Fuca Ridge, the Tonga Trench, and volcanoes under the Japan Sea and the Indian Ocean.

Dr. Wright serves on the U.S. National Academy of Sciences Ocean Studies Board, the NOAA Science Advisory Board, the Science Advisory Council of Conservation International, the Blue Ribbon Panel of the Global Partnership for Oceans, and many journal editorial boards. She is a AAAS Fellow, as well as a fellow of Stanford University's Leopold Leadership Program. In 2007, she was named U.S. Professor of the Year for the State of Oregon by the Carnegie Foundation for the Advancement of Teaching and the Council for the Advancement and Support of Education. Dr. Wright holds an Individual Interdisciplinary Ph.D. in Physical Geography and Marine Geology from the University of California, Santa Barbara, an M.S. in Oceanography from Texas A&M, and a B.S. cum laude in Geology from Wheaton College (Illinois).

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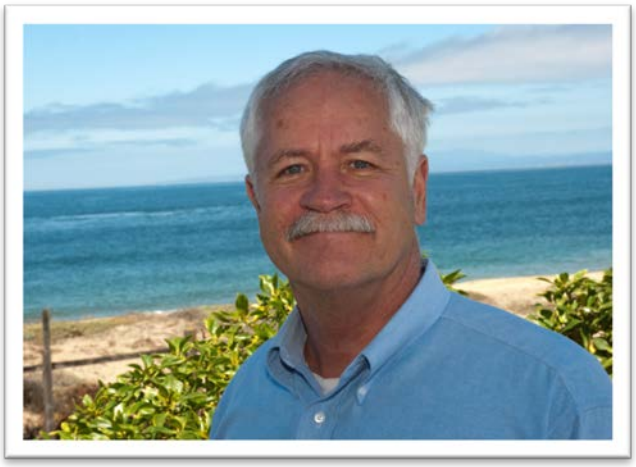
Surgical exploration of the seafloor using a combination of multibeam, AUV, and ROV data, Plenary presentation by Dr. Charlie Paull, MBARI

This plenary will highlight examples of coordinated use of diverse ocean research technologies—including multibeam echo sounders, underwater autonomous vehicles, and remotely operated robots—to investigate the seafloor holistically across multiple scales, and transition swiftly from broad area surveillance to targeted feature investigation.



Dr. Charlie Paull is a marine geologist who holds degrees from Harvard, University of Miami, and Scripps Institution of Oceanography (SIO). Presently, he is a Senior Scientist at the Monterey Bay Aquarium Research Institute (MBARI), having recently stepped down from his service as the Chair of the Research Department. Previously, he held the Amos Hawley Distinguished Professorship at the University of North Carolina at Chapel Hill. He has also worked for the US Geological Survey in Woods Hole, the ETH in Zurich, and as a soft money researcher at SIO, exposing him to institutions with varying goals and organizational models. Over Dr. Paull's career he has also pursued an unusually broad diversity of research topics. These include being the chief proponent and co-chief scientist for an ODP Leg, serving as chief scientist for the MBARI Monterey Ocean Observing System which has developed and installed cable-connected deep-water sea floor infrastructures, and leading various sea floor exploration efforts using ROV's, HOVs, and AUV's in multiple settings within the Atlantic, Pacific and Arctic Oceans. These efforts are documented in over 175 peer-reviewed publications, which vary from curiosity driven basic research to science done to address specific societal needs.

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From the Oceans to the Public: Streamlining the path of at-sea observations to meaningful public engagement
Panel discussion moderated by Dr. Dennis Bartels, Exploratorium

Panel Participants: Ms. Jenifer Austin Foulkes, Google Ocean; Ms. Allison Fundis, Ocean Exploration Trust; Dr. Kim Juniper, Univ. of Victoria, ONC; Ms. Lily Simonson, Visual Artist; Mr. Richard Vevers, Catlin Seaview Survey
[Panel Co-Organizer: Ms. Mary Miller, Exploratorium]

Panelists will explore ways that international audiences can engage more deeply and authentically with the world's oceans through new communication tools, state-of-the-art technologies and open access to scientific data. Offering multiple perspectives about communicating with diverse audiences, in both public settings and through digital platforms, panelists will discuss ways to leverage the unprecedented access and transparency that new ocean research platforms offer to worldwide learners. Panelists will also elucidate different audiences and purposes for outreach, considering whether action is an implied or explicit goal of ocean sciences learning, and examine issues of different learning pedagogies and how they connect (or not) to ocean content and the various technologies and tools now in play. Specific examples of ocean sciences learning models will be introduced to illustrate both the predictable barriers to understanding and the promising possibilities going forward, with particular attention to those that might scale.

Dr. Dennis M. Bartels, an internationally known science education and policy expert, became Executive Director of the Exploratorium in 2006. He holds a PhD in Education Administration and Policy Analysis from Stanford University, and his work has received more than $28 million in grants from the National Science Foundation (NSF) and other sources. He is leading a historic capital project and a $300 million capital campaign to relocate the Exploratorium to Piers 15/17 on San Francisco's famed waterfront.

In 2009, he was appointed to the Education Working Group for the President's Council of Advisors on Science and Technology. In 2010, he

was named to the Ocean Research Advisory Panel (ORAP), which provides independent advice and guidance to the more than 20 federal agencies of the National Oceanographic Partnership Program.

Dr. Bartels has testified before committees of both the United States Senate and House of Representatives and before the full House Science Committee concerning the role of the NSF in K–12 science and math education. He's served on the Advisory Committees of the NSF's Education and Human Resources Directorate and the Environmental Research and Education Directorate. He has also been an invited guest and speaker about science and mathematics education in England, France, the Netherlands, Japan, Malaysia, Brazil, and China. Dr. Bartels was elected an AAAS Fellow for his energetic leadership in systemic science education reform, informal science education, and research and development of innovative mathematics, science, and technology curricula. He is also an elected Fellow of the American Educational Research Association (AERA) and of the International Society for Design and Development in Education (ISDDE).

Ms. Jenifer Austin Foulkes founded and manages Google's Ocean Program which aims to make Google Earth and Google Maps more comprehensive with a multi-resolution ocean map. Learn more at our Ocean Program Youtube playlist and Ocean Education Showcase. She recently partnered with Catlin Seaview Survey to launch Underwater Street View in Google Maps. The Google Ocean Program was awarded the 2012 Wildaid Leadership Award and the 2012 Blue Frontier Peter Benchley Excellence in Exploration award alongside President Tong of Kiribati and US Senator Sheldon Whitehouse. In 2007, she launched the Google Earth Outreach Program which supports nonprofit groups using Google's geotools to change the world. Jenifer went on leave from her PhD program at Stanford University to work for Google's cofounders. Jenifer serves on the Sylvia Earle Alliance Mission Blue foundation, the Blue Ocean Film Festival and the UC Davis Bodega Marine Lab external advisory boards, on the TSCOM subcommittee of the General Bathymetric Chart of the Oceans group and on the Working Group for the World Bank Global Partnership for the Oceans. She recently spoke at Google I/O and the United Nations. Jenifer enjoys photography, diving, and inspiring a love for the sea in her children.

Ms. Allison Fundis is the Director of Education for the Ocean Exploration Trust, where she brings a diverse background of education, science, and sea-going experience to engage students, educators, and the public in ocean exploration and research. After beginning her career as a high school chemistry and biology teacher, she retooled and found her passion for marine geology and sea-going research. She has extensive experience on research expeditions utilizing a variety of technologies and submersibles and is passionate about making authentic research experiences available to the public, educators, and the next generation of scientists and engineers. Before joining the Ocean Exploration Trust in 2013, Allison worked with the Ocean Observatories Initiative at the University of Washington developing educational resources and programs utilizing real-time data and telepresence capabilities from sea.

Allison holds a M.S. degree in Geology from the University of Florida and a B.A. in Human Ecology and Marine Science from the College of the Atlantic. Her geological studies focused on understanding the controls on eruption dynamics in submarine volcanic systems.

Dr. S. Kim Juniper is Science Director for the Ocean Networks Canada undersea cabled observatory. He is also a Professor in the School of Earth and Ocean Sciences and the Department of Biology at the University of Victoria, and holder of the BC Leadership Chair in Ocean Ecosystems and Global Change. The primary focus of his research has been the microbiology and ecology of submarine hydrothermal systems. Juniper co-leads the Biodiversity theme in the Canadian Healthy Oceans Network (CHONe). He has been an advisor to the International Seabed Authority on the biology of hydrothermal vents and current chairs the InterRidge Industry Liaison Committee that is working with the deep-sea mining sector to develop joint guidelines for the environmentally responsible extraction of seafloor massive sulphide ore deposits.

Ms. Lily Simonson's large-scale canvases, which magnify marine invertebrates to human scale, invite viewers to immerse themselves in both the otherworldly and anthropomorphic qualities of deep sea fauna. Simonson collaborates with a range of scientists, including biologists, planetary scientists, and oceanographers, to explore and paint the extreme habitats that host extraordinary species.

Last year, Simonson joined the Scripps Institution of Oceanography's San Diego Coastal Expedition aboard the Research Vessel Melville to observe and paint the deep-sea fauna collected by researchers from the oxygen minimum zone. She also served as an embedded artist on a National Science Foundation expedition to the McMurdo Dry Valleys of Antarctica, and she has delivered lectures and shown her paintings at scientific symposia including the Census of Marine Life Summit at the Royal Society of London, the World Conference on Marine Biodiversity in Aberdeen. Her paintings and drawings have been exhibited across the US and Europe and her art has appeared in a range of media outlets, including the LA Times, LA Weekly, MTV, the Huffington Post, CBS News, and MSNBC. Simonson holds an MFA from UCLA and a BA from UC Berkeley. She has taught painting and drawing at UC Berkeley, the Norton Simon Museum of Art, and CSU Pomona.

Mr. Richard Vevers is the founder of the not-for-profit Underwater Earth, of the Catlin Seaview Survey and inventor of the revolutionary 360-degree Seaview camera. Richard has a background in advertising (working at some of the top London agencies) and a decade of experience as an underwater photographer and science communicator.

It is this experience that has given him a unique approach to ocean exploration and science communication. It is an approach that aims to help major scientific studies achieve their full potential by transforming their global value, reignite corporate support for ocean science, and create a groundswell of public support for ocean science projects

The Catlin Seaview Survey is the first major case study of this approach – a project that has reached billions of people globally and engaged millions though social media. It has brought together the scientific community through powerful collaborations and is transforming the study of coral reefs on a global scale.

The project is engaging the world with ocean science - allowing the 99% of people who have never dived to virtually explore our oceans (through Google Street View) and helping them discover exactly what is going on beneath the waves.

Ms. Mary Miller is responsible for leading multidisciplinary teams in creating innovative and engaging content about current scientific research for the Exploratorium's award-winning website and museum exhibits and programs. She is also a Webcast producer and host, science writer, online media producer, and liaison to the scientific research community on numerous education and outreach partnerships. Mary is the director for a 5-year partnership with the National Oceanic and Atmospheric Administration and facilitates collaborations between the two organizations to host research vessels and scientists at the museum and to develop visualizations, media narratives, and interpretations of ongoing environmental research, including climate change and ocean and atmospheric research. She also leads the Wired Pier project in the museum's Bay Observatory gallery, a glass building at the end of Pier 15 with panoramic views of San Francisco Bay and the city skyline. Wired Pier is a suite of instruments and environmental sensors located on the roof and in the water that measures weather, climate, water quality and bay conditions. Wired Pier data is shared with scientists, students and educators in real time on the Web and through a high-definition video wall and monitors in the Observatory, allowing visitors to check current conditions and track environmental change over time. The high-definition, nine-screen video wall also displays high-resolution data visualizations and streaming video from ships at sea. Mary has a degree in marine science and a master's certificate in science communication from U.C. Santa Cruz. She co-created the digital media track and teaches multimedia science journalism in the UCSC Science Communication Program.

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Let There Be Light: Exploring and Mapping the Ocean with Bioluminescence
Presentation by Dr. Edith Widder, ORCA

A look at the lighter side of ocean exploration and mapping—from ancient Polynesians who used bioluminescence as an aide to navigation, to modern applications of bioluminescence as a tool for mapping pollution—as well as a behind-the-scenes look at how bioluminescence contributed to capturing the first images of a giant squid, filmed in its natural habitat.

Dr. Widder's full bio appears on pages 43-44.

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ABOUT SCHMIDT OCEAN INSTITUTE

Schmidt Ocean Institute was created by Eric and Wendy Schmidt in 2009 to enable research that expands understanding of the world's ocean using advanced technology, intelligent observation, and the open sharing of information.

The organization invites select scientific teams from around the world to conduct collaborative research at no cost aboard its flagship, *Falkor*, launched in 2012. After a year of sea trials, SOI's full operations aboard *Falkor* began in 2013. Work with a wide range of collaborating scientists and institutions has included research on deep coral areas damaged by the Deepwater Horizon spill, and a study of the geology, chemistry, and biology of hydrothermal vents near the Cayman Islands. Projects for 2014 will include mapping the deeper reaches of the new Papahānaumokuākea Marine National Monument in the Northwest Hawaiian Islands, and exploring the Marianas Trench off Guam.

Marine research groups that would like to work aboard *Falkor* submit proposals that go through a rigorous peer review by scientists from relevant fields. From proposals that receive high ranks for scientific value, the institute chooses those projects that best align with its mission and that require work in geographical areas *Falkor* can reach in a given year. SOI's sister organization, the Marine Science and Technology Foundation, also support the development of promising oceanographic technologies that might one day be used aboard *Falkor* or elsewhere.

ABOUT FALKOR

The globally capable 272-foot research vessel *Falkor* is Schmidt Ocean Institute's key operational asset. In 2012, SOI completed a full refitting of *Falkor*, an ice-strengthened former German fisheries vessel. She now has a 13,000-nautical-mile range and a max speed of 20 knots.

One of the ship's key assets is a specialized gondola beneath the hull that isolates an array of sonar senders and receivers from the interference of bubbles washing down the main hull. This allows survey work at 12 knots—the normal cruising speed. *Falkor* is equipped with sonar systems for shallow and deep seafloor mapping, sub-bottom and current profiling, and fisheries studies. An initial test of the seafloor mapping system led to the discovery of the remains of the wreck of the S.S. *Terra Nova*, a polar exploration ship that sank off Greenland in 1943.

In June of 2013, Falkor entered the Pacific for the first time and was based out of Victoria, British Columbia for three months before steaming to Hawaii. Ports of call in 2014 will include Guam and Australia, and we anticipate working in the Western Pacific during 2015. Science is *Falkor*'s compass, so her path beyond that won't be set until the year's collaborative research projects are selected

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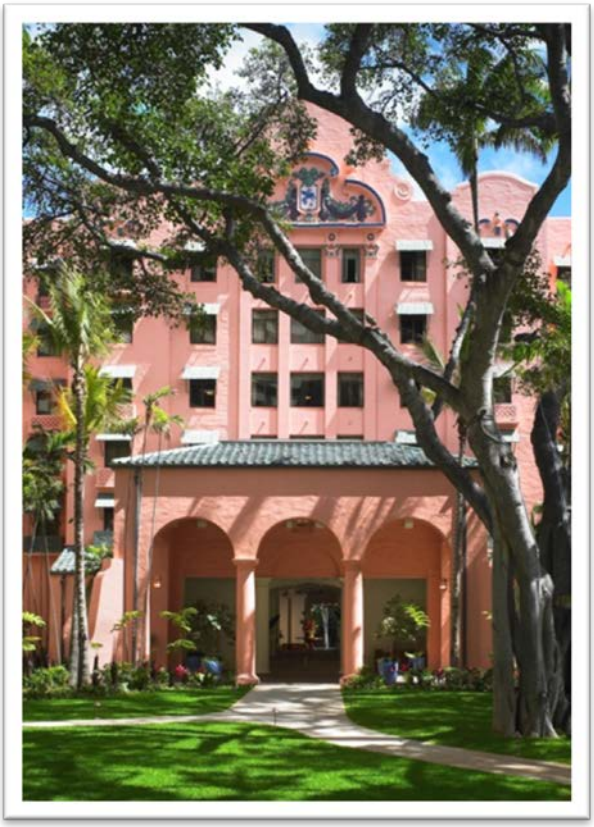
THE ROYAL HAWAIIAN



Welcome to The Royal Hawaiian in beautiful Honolulu. The original resort was built with a price tag of $4 million and was a six-story, 400-room structure, fashioned in a Spanish-Moorish style which was popular during the time period and influenced by screen star Rudolph Valentino. The site of The Royal Hawaiian boasts a majestic lineage. The area was used as a playground for King Kamehameha I after he conquered the island of Oahu. Queen Kaahumanu's Summer Palace was previously located in what is now the resort's Coconut Grove garden. During WWII, The Royal Hawaiian was leased exclusively to the U.S. Navy as a rest and recreation center for the Pacific Fleet. The resort reopened to the public in February 1947.

The inspiring and distinctive character of The Royal Hawaiian is known throughout the world as a destination of unparalleled romance and luxury. The 'Pink Palace of the Pacific' emerged from a complete renovation of the historic building on January 20, 2009 as one of the world's elite collection of resorts for luxury and romance. The distinctive architecture and its rosy hue remain, as do the elegant details that nod to the resort's storied past. Now, however, 21st-century upgrades seamlessly meld with the thoughtfully chosen, classic design elements, creating a decidedly chic atmosphere that is still captivatingly Hawaiian. In late 2010, the Royal Beach Tower underwent a complete upgrade, bringing in state-of-the-art amenities and pristine elegance. The restored resort highlights the indigenous culture and history of the islands in its new guest programs, offering authentic and enriching experiences, refined service and an elevated ambiance of unrivaled facilities and location.

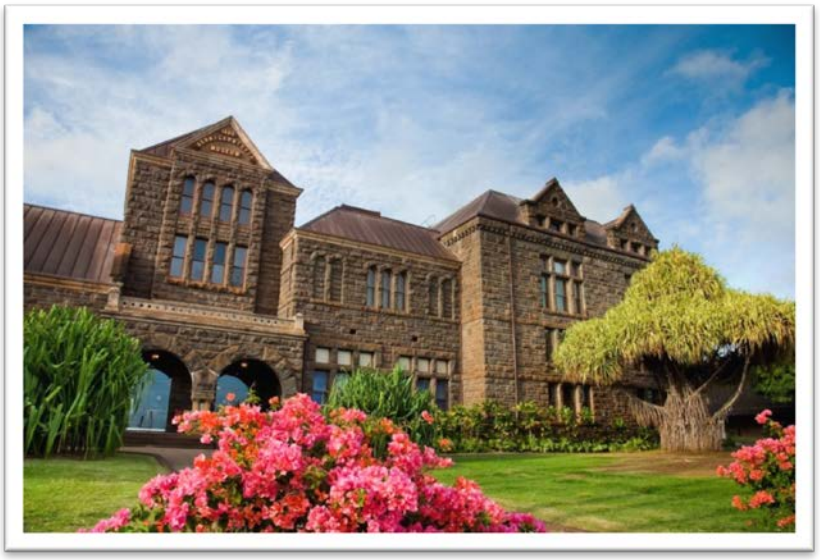
OCEAN SUSTAINABILITY

One of the reasons Schmidt Ocean Institute chose the Royal Hawaiian as the location for the inaugural Research Symposium is the resort's commitment to environmental sustainability, which includes a range of programs under their "Pink is the New Green" initiative. Reducing power use by 30 percent before 2020 is one goal. Attendees might notice ongoing installation of solar panels on the main tower, or room lights that have been replaced with more efficient LED bulbs.

On the ocean sustainability side, the Royal Hawaiian purchases fresh seafood daily from the non-profit Hawaii Seafood Council at Honolulu's Pier 38. The group sells only closely monitored, line-caught products such as opakapaka (pink snapper) that comply with the United Nations Food and Agriculture Organization's Code of Conduct for Responsible Fisheries.

The Royal Hawaiian also incorporates environmental stewardship messages into its recreational programs, among other efforts. The legendary Waikiki Beach Boys, for instance, (whose ranks once included Duke Kahanamoku, a father of modern surfing) show guests how to surf and paddle outrigger canoes, but now they also teach reef protection and other ways to be "Kai Akamai," or ocean smart.

ABOUT BISHOP MUSEUM



The Bishop Museum was founded in 1889 by Charles Reed Bishop in honor of his late wife, Princess Bernice Pauahi Bishop, the last descendant of the royal Kamehameha family. The Museum was established to house the extensive collection of Hawaiian artifacts and royal family heirlooms of the Princess, and has expanded to include millions of artifacts, documents and photographs about Hawai‘i and other Pacific island cultures.

Today, Bishop Museum is the largest museum in the state and the premier natural and cultural history institution in the Pacific, recognized throughout the world for its cultural collections, research projects, consulting services and public educational programs. It also has one of the largest natural history specimen collections in the world. Serving and representing the interests of Native Hawaiians is a primary purpose of the Museum.

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