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EAGER: Developing At-Sea & Telepresence-Led Deep-Submergence Science Leadership

Project PIs/Mentors

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OVERVIEW

A training experience for Early Career Scientists was developed and carried out, with the goal of increasing participants understanding of current Deep Submergence capabilities and readiness to propose and conduct their own research using these assets within a few-year timeframe. Two dozen ECS participated in person and 56 individuals signed up to tune in remotely. New research on methane seeps was carried out with *Alvin, Sentry*, and ship-deployed, standard CTD and hydrographic wire tools on the Mid Atlantic slope south of Woods Hole MA, including geological, chemical, oceanographic, and biologic sampling and characterizations. Telepresence was used for both scientific purposes and outreach between ship and shore, with an aim to assess its effectiveness and explore ECS-driven modes of using it. Outreach was multi-pronged, with a variety of social media avenues, live museum interviews, traditional media spotlights and public web streaming of shipboard video.

INTRODUCTION

In 2011, the University National Oceanographic Laboratory System (UNOLS) introduced Chief Scientist Training Cruises to engage Early Career Scientists (ECS) and new users with leadership responsibilities of multi-disciplinary science at sea (Reimers & Alberts 2012). To date, there have been six at-sea training cruises, including the first training cruise on a global class UNOLS vessel in 2016 (R/V *Thompson*) with 21 ECS participants[2]. The total number of ECS who have joined training cruises at sea now stands at 120 individuals. In support of this engagement with ECS and new users, a roadmap for oceanographic expeditionary planning (DeSilva & Girguis 2014) is available on the UNOLS website. In addition, an on-shore '*Alvin* New Users Workshop' was convened at the Woods Hole Oceanographic Institution (WHOI) in September 2015 (12 participants) and focused on capabilities, sampling, and proposal strategies, with dive simulations for recently graduated PhDs and post-docs, most with limited exposure to deep-submergence field experiments. The UNOLS Office maintains a longitudinal record of UNOLS-supported

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[2] PIs of earlier Chief-Scientist Training Cruises—Claire Reimers, Ken Coale, and Allan Devole—offered insights that helped shape the successful proposal that supported this work.

oceanographic trainees and their subsequent engagement in oceanographic research proposals and expeditions.

The Deep-Submergence Science Committee (DeSSC) initiated an ECS program in 2012, and has convened 4 workshops for ECS/New Users as an extension of its fall meeting. These workshops focused on deep-sea research, grant writing, technology, data management, etc. As a result of this and other DeSSC efforts, including the recent DESCEND 2 workshop [1] that solicited participation by ECS, there exists a cohort of ECS and new users well aware of deep-submergence assets and capabilities and who are informed about priorities for research in the deep sea. Until this project, there had been no at-sea leadership development opportunities for ECS using National Deep Submergence Facility (NDSF) assets.

Separately, NSF has supported exploration of new approaches to telepresence-enabled oceanographic research, and the deep-submergence science community has been a major player in this effort, including the TREET program (Transforming Remotely-Conducted Research through Ethnography, Education, & Rapidly Evolving Technologies) led by C German (WHOI). ECS have yet to be engaged as leaders in telepresence research programs.

In this EAGER program, we conducted a research and training cruise for 24 Early Career Scientists. Novel to this program were the use of the NDSF assets *Alvin* and *Sentry* at sea, research telepresence[2] between the Inner Space Center (ISC) University of Rhode Island and R/V *Atlantis*, and the explicit inclusion of a science communication component.

PROGRAM OBJECTIVES

Key objectives included providing ECS with experience in:

i. planning and executing collaborative, interdisciplinary research
ii. leadership in cruise and dive/mission planning and execution
iii. integration of instrumentation with *Alvin/Sentry/*other deep-submergence assets
iv. telepresence-enabled data acquisition and seafloor-to-ship-to-shore communications
v. data management, sharing, reporting
vi. science communication and outreach to broader audience(s)

[1] "Developing Submergence SCiencE for the Next Decade". This workshop focused on defining critical research themes and identifying how both existing and new deep-submergence technologies can be better deployed to help address these research needs.

[2] Telepresence Level 3 (UNOLS Telepresence Guidance Document) was provided through HiSeasNet (6x3 Mhz). Includes high-definition (HD) video [including a mobile telepresence unit (MTU) on *Atlantis*], two way audio, and data transfers; network speeds of about 6 Mbps ship-to-shore, and 3 Mbps shore-to-ship (see subcontract, supplementary docs). We are grateful Dwight Coleman and his team (Inner Space Center, URI), Kevin Walsh (HiSeasNet, Scripps Institution of Oceanography), Ken Feldman (U Washington), and Julian Dale (Duke University) for their technical support of the telepresence effort.

PROGRAM TIMELINE

As planning for the program evolved, high-level constraints emerged, including use of Woods Hole as the start and end port, a maximum of 8 days on station, plus a personnel exchange mid-way through the cruise. The Project evolved according to the timeline in Table 1.

RESEARCH POTENTIAL

Deep-submergence science opportunities for *Alvin* dives and *Sentry* missions included numerous shallow (~500 m) and deep (~1500 m) seep sites (Skarke et al. 2014) and canyon environments (Quattrini et al. 2016) at the shelf-break off Woods Hole. These and other sites in the area provided opportunities for biological, chemical, geological, and physical oceanographers. Final study site selection is illustrated in Figure 1.

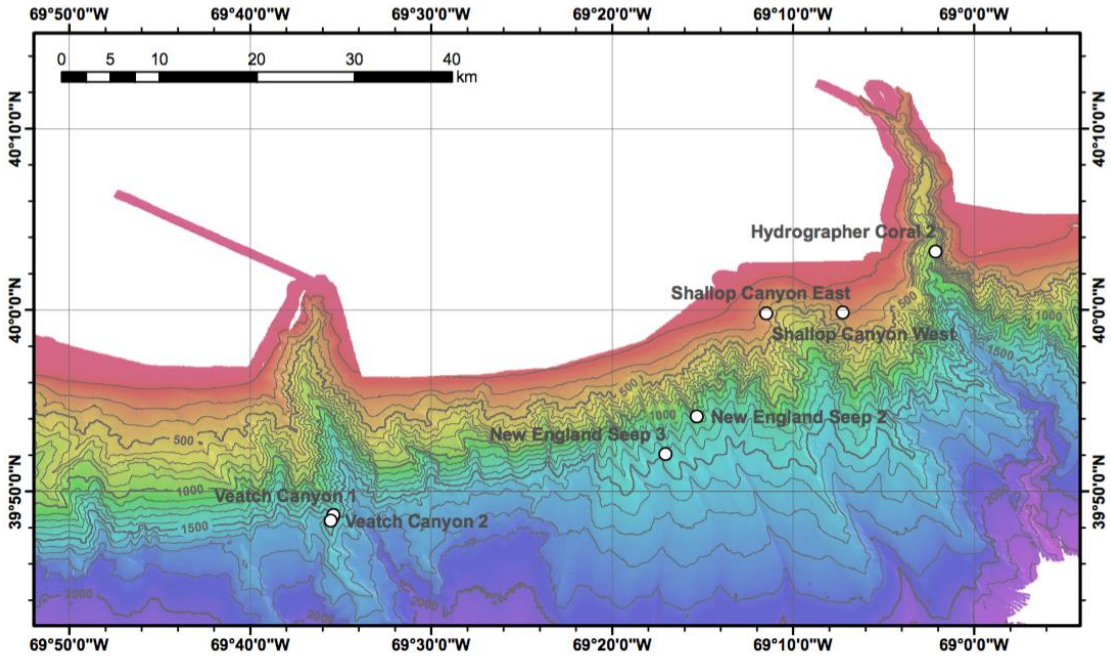


Figure 1. AT36 study site locations. Courtesy A Skarke.

RECRUITMENT OF EARLY CAREER SCIENTISTS

An Announcement of Opportunity (Appendix 1) for the Leadership Training Cruise was distributed to the UNOLS listserv, including the UNOLS early-career scientist listserv. Individuals were required to complete an application that collected demographic information as well as statements of research and training goals, plans for use of NDSF assets over the next five years, referees, etc.

Thirty-one applications were received, from which 24 finalists (Table 1) and 4 alternates were selected after review and discussion of application materials by the PIs. The 24 finalists (Figure

2, Appendix 2) were of high caliber, diverse, representing different ranks, disciplines, geographic regions, and institutions (Table 2). There were twice as many women as men.

Figure 2. The EAGER AT36 Team.

CO-CHIEF SCIENTIST SELECTION AND DISTRIBUTED LEADERSHIP

Mentors nominated potential Co-Chief Scientists and then ranked nominees from among the well-qualified individuals after review and discussion of applications, experience, and demonstrated leadership. Letters of reference were sought for the top candidates, and a unanimous vote selected Drs. Anne Dekas and Adam Skarke to be Co-Chiefs from a slate of strong candidates. The science party organized itself into sampling teams under the guidance of the Co-Chiefs; leadership responsibilities were distributed through these teams and through assignment to other tasks, including sample logging, sample basket preparation, etc.

Table 1. Scientific Party[1]

Team A (ISC Leg 1)	**Team B (*Atlantis* Leg 1)**
PARTICIPANTS	**PARTICIPANTS**
Dekas A, Co-Chief Sci	Skarke A, Co-Chief Sci
Bagge L	Borelli C
Barco R	Boulahanis B
Djurhuus A	Bowman C
Fernandez J	Bush S
Fulweiler R	Brugler M
Kinsey J	Hoffman C
Kocot K	Jungbluth S
Navarro M	Marlow J
Pasulka A[2]	McVeigh D
Wagner, A	Netburn A
Zambon J	Twing K
MENTORS	**MENTORS**
Van Dover C	Blackman D
Bates K	Fornari D
Soule A	

Table 2. Participant demographics

RANK		**DISCIPLINES**	
Assistant/Associate Professors	6	Biological Oceanography	11
Post-Doctoral Scholars	13	Biogeochemistry/Microbiology	4
PhD Students	5	Chemical Oceanography	3
		Marine Geology/Geochemistry	2
GENDER		Physical Oceanography	1
Female	16	Paleoceanography	2
Male	8	Marine Biology	1
GEOGRAPHIC DISTRIBUTION		**Number of Institutions**	21[3]
East Coast	10		
West Coast	8		
Gulf Coast	3		
Central	3		

[1] J Dale (Marine Engineer), A Williams (Videographer), K Feldman (Res Tech) and N St Fleur (NY Times, leg 2 only) were also aboard *Atlantis.*

[2] Participated remotely on Leg 2.

[3] Boston University, California Institute of Technology, California State University Monterey, California State University Sacramento, Columbia University (LDEO), Duke University, Harvard University, Monterey Bay Aquarium Research Institute, Mississippi State University, North Carolina State University, NY City College of Technology, Stanford University, University of Alabama, University of California Santa Cruz, University of Cincinnati, University of Maryland Eastern Shore, University of Minnesota, University of Rochester, University of South Florida, University of Southern California, University of Utah

CRUISE PREPARATION

Cruise preparation took place through a series of hundreds of e-mail conversations and videoconferences[1] from April through July 2016 (Table 3).

Table 3. Cruise Preparation Timeline

05 April	Evaluation of applicants	Mentors
26 April	Participants confirmed, biosketches circulated	Co-chiefs
6 May	Initial pre-cruise planning call	WHOI, Mentors, Co-Chiefs
13 May	Full pre-cruise planning call	WHOI, All* (participants listen in)
19, 23 May	All-hands meetings[2]	All
31 May	Detailed cruise planning & team assignments	Co-Chiefs and mentors
by 3 June	Individual team meetings (calls)	Participants
6 June	Assessment survey planning call	Mentors, Harvard colleagues
16 June	Dive planning, sample logs, outreach	Mentors, Co-Chiefs, WHOI Media
24 June	WHOI Training agenda review	Mentors
20 July	Alvin dive briefing[3]	Alvin Pilot, Participants, Mentors

** All=Mentors, Co-chiefs, Participants*

PRE-CRUISE TRAINING PROGRAM 26-27 JULY 2016

Participants arrived in Woods Hole on 25 July in time to attend an evening reception/dinner/icebreaker at Fenno House. WHOI leaders, scientists, and NDSF operations personnel joined the social event.

On 26-27 July, invited speakers engaged with participants on key training topics, with emphasis on introductions to UNOLS, DeSSC, and the National Deep-Submergence Facility. The full agenda may be found in 2. Each presentation was recorded. The on-line video archive listing may be found in Appendix 3.

SUPPORTING TEAMS

Sentry Operations Team, led by Carl Kaiser
Alvin Operations Team, led by Bob Waters
R/V *Atlantis* Captain Al Lunt, Officers, and Crew
WHOI SSSG Techs: Dave Sims, Allison Heater
Data Tech: Ken Feldman (U Washington)
Inner Space Center, U Rhode Island, led by Dwight Coleman
UNOLS: Annette de Silva
WHOI Graphics: Tim Silva

[1] We used ZOOM and BlueJeans as our videoconferencing platforms.
[2] A recording of the 23 May meeting may be found here: https://bluejeans.com/s/9IS4/
[3] Recording of this session may be found at: https://bluejeans.com/s/a0Ry/

Remote Early Career Scientists

As the program developed, we undertook to engage additional, 'Remote ECS' through telepresence. We had 56 respondents (Appendix 4) from 24 US institutions[1], one federal agency (US Fish & Wildlife Service), and 7 countries[2] to our Announcement of Opportunity that was distributed to the UNOLS listservs and that found its way to an international list serv. Remote ECS had access to live video feeds during the on-shore (pre-cruise) training sessions (Appendix 2), all live science feeds from *Atlantis* and the Inner Space Center, and to the archived video sessions (Appendix 3).

TRAINING ACTIVITIES

To summarize the large number of training activities undertaken, we have summarized these activities according to asset (*Alvin, Sentry*, Multicorer and MISO camera system, CTD, Gravity Core, XBT) and approach (Telepresence, Science Communication) in Tables 4 through 12 below.

In addition to these activities, the mentors presented a short series of topical talks during the cruise:

Television Interview Training **KARL BATES**
Navigation: What ties it all together **DAN FORNARI**
NSF: Insights from a former Program Manager **DONNA BLACKMAN**
Effective Multidisciplinary Proposal Strategies I **CINDY VAN DOVER**
Elevators and Elephants: Equipment options of NDSF **ADAM SOULE**

[1] American Museum of Natural History, Bigelow Laboratory, Duke University, East Carolina University, Lehigh University, Louisiana State University, NY City College of Technology, University of Oregon, Oregon State University, Rosenstiel School of Marine Science, Rutgers University, Texas A&M University Corpus Christie, Scripps Institution of Oceanography, University of Alaska Fairbanks, University of Florida, University of Hawaii, University of Maryland Eastern Shore, University of Maryland College Park, University of Michigan, University of Puerto Mayaguez, University of Rhode Island, University of South Carolina, University of Washington, Virginia Union University, Woods Hole Oceanographic Institution.
[2] Brazil (2), Canada (4), Chile, England, India, Italy, Nairobi.

Table 4. ALVIN OPERATIONS

TRAINING ACTIVITIES	COMMENTS
9 Dives A4827 Engineering (29 July) A4828 Veatch Canyon (30 July) A4829 Shallop Canyon W (1 Aug) A4830 Shallop Canyon W (1 Aug) A4831 Hydrographer Canyon (3 Aug) A4832 Shallop Canyon E (4 Aug) A4833 New England Seep 2 (5 Aug) A4834 New England Seep 2 (5 Aug) A4835 Veatch Canyon	31 July dive cancelled to allow for Variable Ballast Pump repairs. A4831 included the first-ever (?) new Alvin mid-water dive. 4 August morning dive cancelled due to ground fault in 24V system. Two days with 'bounce' dives (1 and 5 Aug) helped increase the number of participants able to experience *Alvin*. Participants consulted with *Alvin* engineers to design a new tool for recovering crab specimens.
Divers 14 participants dived in Alvin	Bagge, Barco, Borelli, Bowman, Bush, Dekas, Djuurhuus, Fernandez, Fulweiller, Hoffman, Kinsey, Kocot, Twing, Wagner (plus Dufour, NSF Program Manager)
Dive Planning Site selection Divers Dive plans Waypoints Sampling priorities	Co-Chief Scientists were responsible for site selection in consultation with mentors to optimize site locations within constraints of the field program. Co-Chiefs also developed a transparent set of guidelines for selection of individuals who would dive in Alvin based on seniority, the likelihood of submitting a proposal for NDSF work in the near future, scientific requirement to dive (e.g., to test an instrument) and whether or not a participant had previously dived in *Alvin*. Dive plans were prepared by the Co-Chief Scientist aboard *Atlantis* in consultation with the participants at ISC and on the ship and oversight from the mentors and *Alvin* team. Waypoints and sampling priorities were developed by consensus through discussions among participants and discussion with Alvin Ops leaders. Some participants had the opportunity to review past Alvin dive logs and PI reports to select dive waypoints.
Navigation Underlays Track plots	Co-Chief Scientists and participants accessed gridded data from NGDC and used these to prepare underlays for *Alvin* navigation.

Sampling and Sample Processing Basket layout Water sampling Niskins 3rd-party water sampler Push cores Biology samples Rock samples Slurp samples Including mid-water work Sample logs Dive summaries	Co-Chief Scientists provided oversight for basket layout and sampling priorities in consultation with the Alvin Ops team. Sampling priorities were drafted by water, sediment, and benthic teams prior to the start of the cruise and refined daily as appropriate. Responsibilities for basket management, sample logs, etc., were distributed among participants.
Video In-hull systems Post-dive editing	Divers were exposed to video options in the sub and all shipboard participants had access to video files on each leg. Best practices in in-hull video work were not covered due to lack of time to focus on this. Other shipboard activities prevented most individuals from undertaking post-dive video reviewing and editing.
Text Messaging	Sub-Ship text messaging was available to the science team. It was used both to resolve questions and to update the ship and shore participants with activities. The mid-water texting on A4831 is one example, where the success of the effort was conveyed while the dive was underway (Figure 3).
Mid-Water Sampling	*Alvin* undertook its first mid-water sampling since the upgrade at the instigation of ECS. Achieving neutral buoyancy to observe and sample at 250 m, 500m, 750 m in 1000 m total water depth was successful. A hyperiid amphipod and its salp house collected on the mid-water dive is shown in Figure 4.

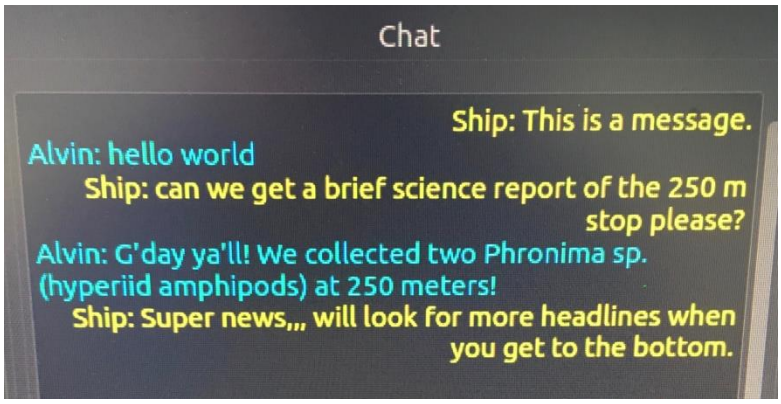


Figure 3. One of the first science chats, *Alvin* to *Atlantis*.

Figure 4. *Phronima* sp. (hyperiid amphipod) and its salp house from mid-water *Alvin* sampling. Photo by ECS Laura Bagge**.**

Table 5. SENTRY OPERATIONS

TRAINING ACTIVITY	COMMENTS
Dives (local time) S386 Veatch Canyon 3 (28/29 July) S387 New England Seep 2 (29/30 July) S388 Veatch 1 (30/31 July) S389 New England Seep 3 (4/5 Aug) S390 Veatch Canyon (5/6 Aug)	*Sentry* gently touched bottom on the first dive, hit bottom hard on the second dive, and became stuck on the bottom on the third dive. Further dives were scrubbed as *Sentry* Team worked to resolve the issue of a ~30-pound weight gain. *Sentry* was deconstructed to inspect for failure. None was found. Redeployed with caution. S389 deployment, multibeam only, with initial protocol designed to test behavior, followed by extensive mapping; detected an ORP anomaly co-located with a carbonate shelf. S390 – first science use of Edgetech 850 sidescan sonar!
Dive Planning Site selection	Co-Chief Scientists developed a site-selection strategy pre-cruise designed to provide sufficient time for data processing to deliver reconnaissance information in advance of *Alvin* dives to the same location. Daily mission planning was led by a participant in the *Sentry* Science Team, in consultation with the Co-Chiefs and *Sentry* Ops leader.

Data Gathering and Analysis Science Instruments Multibeam Water column Bathymetry 850 KHz Sidescan Sonar Camera Sensors Temperature Depth Oxidation-Reduction Potential O_2	*Sentry* Dive Reports generated by the Sentry Team were shared with participants. Reports include sections on vehicle configuration, positions, narrative, issues and proposed solutions, dive stats, sensor information, and plots and images (nav plot, sensor time-series and georeferenced plots).

Table 6. MULTICORE 400 WITH MISO SYSTEMS (IMAGING, DEPTH, ALTITUDE) OPERATIONS

TRAINING ACTIVITY	COMMENTS
Deployments #1 29 Jul (39 46, 69 35) #2 29/30 Jul (39 54, 69 15) #3 31 Jul (39 52, 69 17) #4 03 Aug Shallop Canyon E (failed) #5 04 Aug Shallop Canyon E #6 04 Aug Shallop Canyon E Towing #7 05/06 Aug Veatch C (cam battery failed)	Multicore (Figure 5) training operations were led by mentors D Fornari, A Soule, with participant trainees. 30 Aug: With horizontal and vertical-viewing cameras for water column imaging (Figure 6). 4 Aug: dual multicore deployment – second deployment used in reconnaissance vertical imaging mode to characterize a previously unexplored acoustic plume signal

Figure 5. MISO Multicorer System (*left)*; image of sampling area (4 m altitude; laser dots 10 cm apart)

Figure 6. Multicore mid-water images.

Table 7. CTD 911 OPERATIONS

TRAINING ACTIVITY	COMMENTS
Deployments #1 31 July Veatch Canyon #2 31 July New England Seep 2 #3 03 Aug Hydrographer Canyon #4 04 Aug New England Seep 3	Participants worked with SSSG techs to deploy and recover the CTD rosette and they handled the winch and sampling. Participant Anni Durjhuus gave a CTD training session about using R to plot CTD data to the ISC participants on Leg 1.

Table 8. GRAVITY CORE OPERATIONS

TRAINING ACTIVITY	COMMENTS
Deployments	
#1 30 Jul 39 48.4, 69 35.56	
#2 31 Jul 39 48.35, 69 35.5	

Table 9. XBTs

TRAINING ACTIVITY	COMMENTS
Deployments	
#1 29 Jul 39 50.3, 69 37.2	
#2 29 Jul 39 53.3, 69 17.81	
#3 31 Jul 39 49.48, 69 31.12	
#4 31 Jul 39 51.58, 69 19.28	
#5-8 6 Aug (transit from Veatch to WH)	

Table 10. MULTIBEAM

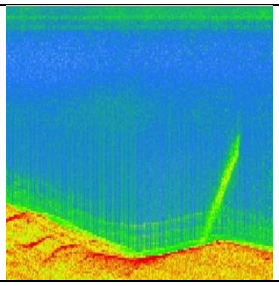
TRAINING ACTIVITY	COMMENTS	
Surveys #1 30 July transit #2 01 Aug #3 5 Aug at ORP anomaly detected by *Sentry*		Seep bubble plume at Veatch Canyon 2 relocated using shipboard multibeam water column data.

Table 11. TELEPRESENCE

TRAINING ACTIVITY	COMMENTS
Training Sessions (1115h)	Bates, Fornari, Van Dover, Blackman, Soule
Science Planning Meetings (1300h)	Daily sessions to discuss *Alvin* and *Sentry* plans and other activities, priorities.
Science Debriefs (1830 h)	Daily sessions to hear *Alvin* diver debriefs, various updates, further planning.
Science discussions (*ad lib*)	Multiple sessions among subgroups, between individuals or members of teams, between co-chiefs, and with co-chiefs and mentors.
Data Transmission	A key part of the telepresence experience was the ability to move large data files from ship to shore during dedicated transmission intervals. This provided ISC participants with datasets (e.g., CTD data, *Sentry* images, *Alvin* navigation files) for plotting and in-depth analysis.
Slack (https://slack.com/)	Slack was used to maintain dialogue during telepresence sessions when the satellite dropped out. Remote participants were also invited to Slack chats. Slack activity also helped build communities among the ship and shore participants.
NOAA Ocean Exploration	NOAA Educator Telepresence Immersion Workshop at ISC. ECS participants shared the experience on 4 Aug with 9 educators (reach of 530 students). See Appendix 5 for agenda.
General Remarks	The many different modes of engagement with telepresence infrastructure are illustrated in Figure 7. There was creative use of telepresence throughout the cruise by ECS. Powerpoint presentations were routine, as was switching computers so that maps, images, dive plans, etc. could be shared. At one point, video of a multibeam image on a cell phone was relayed from ship to shore to illustrate a discussion of a plume detected a few minutes earlier using the shipboard multibeam.

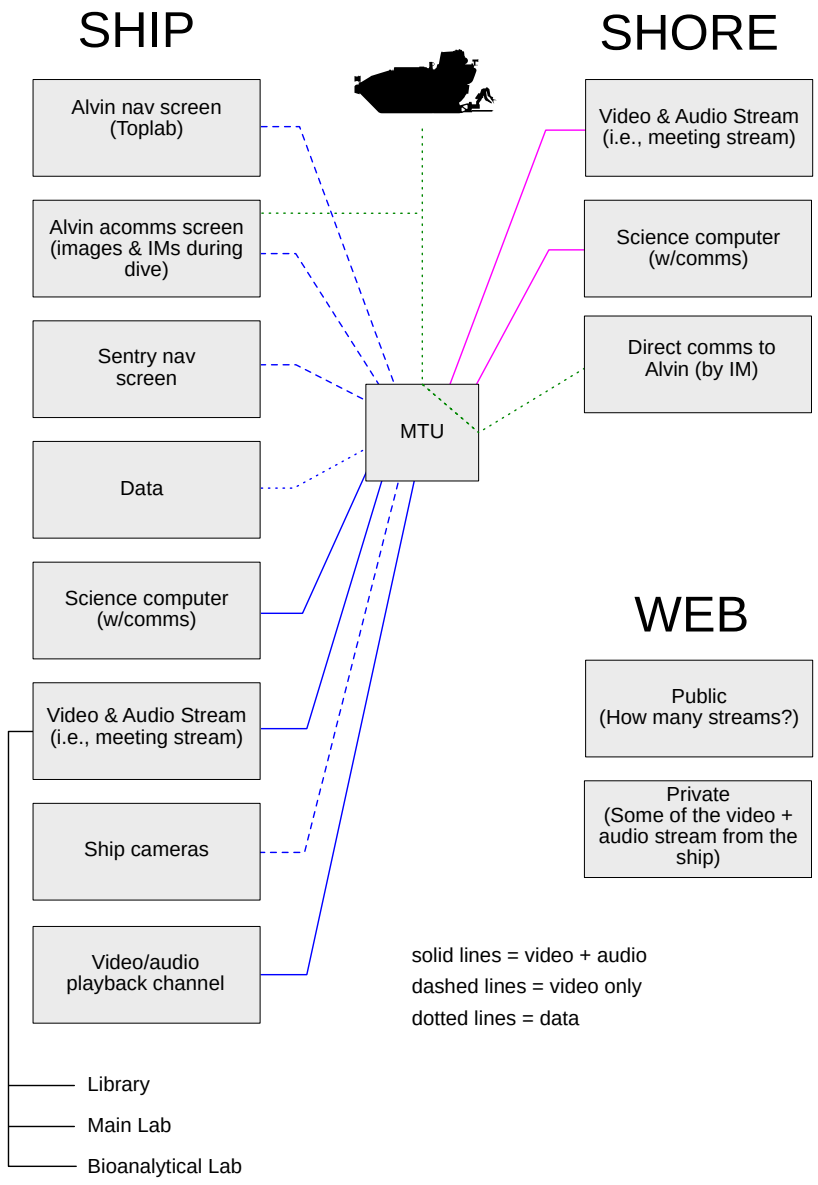


Figure 7. Diagram of the telepresence feeds and hubs on *Atlantis* to the Mobile Telepresence Unit (MTU) to shore. Direct communications from *Alvin* to shore were not accomplished.

Table 12. SCIENCE COMMUNICATION

TRAINING ACTIVITY	COMMENTS
Science communication talks	Mentor KL Bates introduced basic concepts of clear communication and explained how scientific communication generally differs from the way non-scientists prefer to be reached. https://youtu.be/n-gtGIVddRg Bates also discussed social media tools and tactics that the ECS would be encouraged to use during both legs of the training cruise. https://youtu.be/BsunMdmsWmg)
Interview Training through Experiential Learning	Bates and shipboard videographer Anthony Williams of Kansas State University performed brief on-camera interviews with each trainee called *"What do YOU do?"* that are to be provided in unedited form to each participant for potential use at their home institutions, together with 'B roll' video of shipboard activities.
Documentary Film (Underwater Currents)	A documentary film crew hired by WHOI to do a short film about *Alvin* interviewed ECS participants aboard the ship during Leg 1.
NY Times Facebook Live	Leg 2: New York Times reporter Nicholas St. Fleur put several shipboard ECS on camera for live and taped video interviews.
NY Times - Science Times	St Fleur interviewed ECS and cruise participants (operations teams, mentors, ship's crew) for a Science Times article.
Live YouTube Interviews with Divers	Divers were interviewed on camera before and after their dives for telepresence and live-stream to the web.
Outreach to American Museum of Natural History, NC Museum of Natural Science	Several ECS on ship and shore participated in live video links with audiences at these museums (2 times per museum) during Leg 2. ECS M Brugler led the AMNH initiative. AMNH videos: https://drive.google.com/drive/folders/0B50SQT3hr-hUcEk1NjlITEtRaDQ
Outreach to So. California High School	ECS Colleen Hoffman initiated this Facebook Live effort, and improvised with Facebook Messenger for a Q&A session given our poor telepresence link during Leg 1.
AT36 Today	This was meant to be a live daily news update presented by ECS from the ISC during Leg 1, but

	because of challenges with telepresence and scheduling, only one show was produced.
Twitter & Instagram	Bates served as editor-in-chief for #SeafloorSci. Several ECS acted as co-editors and major contributors. Most, if not all, participants fed tweets throughout the program to #SeafloorSci. Content focused on images and text that conveyed the variety of activities undertaken at the ISC and on *Atlantis*. The hashtag serves as a log of these activities, some of the science and technology behind them, and participants' experiences. The social media campaign on Twitter and Instagram was organized around the hashtag #SeaFloorSci, which appeared 598 times on Twitter between July 25 and Aug. 7. Analysis by the site hashtracking.com says the hashtag potentially reached 695,900 unique Twitter users, but the actual number is surely much less than the theoretical maximum expressed in this statistic. There were 162 contributors to the hashtag #SeafloorSci, with fewer than 30 people posting as members of this cruise. This means we were engaging users outside our group. The Twitter account collected 67 followers. The Instagram account created for the cruise, @at36_eager, (https://www.instagram.com/at36_eager/) featured specimens, data visualizations and the faces of participants. It grew similarly, reaching 106 followers with 79 posts by Aug. 7. The most popular post using #SeaFloorSci drew 1,100 likes on Instagram. ECS Robinson "Wally" Fulweiler of Boston University launched a very successful "*Meet the Scientist*" series of mini-profiles on Instagram that featured ECS and mentors.
Institutional Outreach (examples)	Kevin Kocot, University of Alabama: http://wvua23.com/alabama-assistant-professor-may-have-found-new-species/
General Remarks	We elected not to create a new Facebook page for this cruise, because of its short duration and our inability to purchase paid views. Prior experience

	with purpose-built accounts for UNOLS training cruises has shown Facebook to reach only a limited audience, even though the UNOLS content was excellent and Facebook is the most popular social network. Similarly, we didn't put any effort into a cruise blog as has been used before, because of evidence that the time commitment of creating posts was not rewarded by commensurate readership. That said, a couple of ECS who were already blogging on personal accounts continued to do so on the cruise and we shared their posts through the cruise Twitter and Instagram accounts.

Cruise Report, Data Management Planning, and Demobilization

Participants were responsible for generating the final Cruise Report, with guidance from the mentors. A Cruise Report outline was generated on Leg 1, and content for the Cruise Report was gathered and organized during Leg 2. In-port training days at the end of the cruise (7, 8 August) were devoted to completion of the Cruise Report, assessment (see assessment details below), assignment of responsibilities for data management, and demobilization.

ASSESSMENT

I. Team discussion.

Participants and mentors met on shore to discuss the program, including what worked well and suggestions for improvement. Participants will summarize this and other discussions about the program effectiveness in their Cruise Report. The Mentors capture here the several themes that emerged. The ECS summary of this same discussion is in Appendix 7.

Challenges of the Short Duration, Telepresence-Enabled Research Training Cruise: Participants recognized that the short durations of each Leg precluded fully developing the potential of the resources available.

Formal Training: The two-day training session was too compact and passive, and the group training sessions during the cruise were also not as effective as intended.

RECOMMENDATIONS:

- Provide UNOLS Shiptime Request and other training as pre-cruise webinars. The *Alvin* pre-brief offered through a web conference and archived video was a good example of this approach.
- Cover training content through small group interactions with mentors.
- Provide examples of the basic documents used in planning missions (e.g., dive plan, basket plan, sample logs).
- Offer case study and problem-solving exercises (e.g., 'homework' on decisions scenarios, mission planning).

Chief Scientist Leadership: Participants appreciated transparency and inclusion in the decision-making process as real events transpired and wished for more of this.

RECOMMENDATIONS:

- Chief Scientist 'shadowing'. There was agreement that this would be well worth trying.
    - A 'Chief-Scientist-of-the-Day' concept was discussed, but mentors noted that this approach has been tried on other Chief Scientist training cruises and was not successful, especially with regard to working with the ship's crew.

Mentors: Participants enjoyed small-group and one-on-one interactions with mentors, but wished that they had a chance to work with all mentors.

RECOMMENDATION:

- If training takes place with a telepresence component, have participants swap, but keep the mentors in place.

Peer-to-Peer Training: Participants valued small group, peer-to-peer training related to their expertise.

RECOMMENDATION:

- Encourage participants to consider peer-to-peer training and to come prepared to undertake such training, especially where it includes an active, experiential learning. A good example was Anni Djurhuus' CTD analysis training where participants learned to use the CTD package for R to plot data. Other peer-to-peer activities included training in Fledermaus and GeoMap App and video editing.

***Alvin* and *Sentry* Ops:** Participants valued working with the *Alvin* and *Sentry* team leaders, and wanted more engagement.

RECOMMENDATIONS:

- Offer more formal opportunities to engage with *Alvin* and *Sentry* teams to pitch ideas.
- Offer more engagement opportunities with *Alvin, Jason, Sentry* operations about what is available.

Work Flow Demands: Shipboard participants on both legs had long hours of sample processing every day in addition to meetings and deployments. This was recognized to be both a consequence of appropriately ambitious sampling plans for sediment and water using *Alvin* and wire samplers and the unusual circumstance of a training cruise with few people to process any given type of sample.

RECOMMENDATIONS:

- Be aware of over-extending human resources in terms of both science and ship personnel and plan accordingly.
- Ensure meetings have agendas and strive for more efficient exchange of information.

Telepresence: Participants were interested in the potential of telepresence, but because of connectivity issues encountered in Leg 1, they did not have the opportunity to put telepresence to good use in analyzing data for planning missions or writing papers. At least one participant felt that the telepresence experience was a net loss. Participants were not sure of what they were supposed to do at the Inner Space Center.

RECOMMENDATIONS:

- Offer more structured training opportunities at the Inner Space Center.
- Consider the need for more mentoring about making opportunity rather than waiting for opportunity.
- Better define science objectives related to data analysis.

At least one mentor offered the view that had telepresence been working well during leg 1, with good data and communication capabilities, participants would have been encouraged to be more creative in their use of telepresence.

Mapping: Participants wanted more training in mapping; they viewed mapping as fundamental to the responsibilities of the Chief Scientist.

RECOMMENDATIONS:

- Ensure there are mentors with mapping skills involved in the program at both the Inner Space Center and on the ship.
- Ask DeSSC and UNOLS to offer 'Mapping Basics for Chief Scientists' workshops at ECS meetings and through webinars and exercises.

Science Communication: Participants valued this aspect of their training. Those who did not have Karl Bates as an in-person mentor expressed their wish that he could have been in both places at once. Only about half the participants had previously used Social Media; all seemed to embrace the idea and might continue to use Twitter and other social media platforms into the future to tell their science narratives. There was discussion of the value of social media efforts as part of a science portfolio.

RECOMMENDATIONS:

- Encourage peer-to-peer rehearsals of interviews, with feedback.
- In response to a participant query about how to capture social media efforts on a CV, it might be useful to have a discussion about social media and outreach components of a scientist's portfolio at the next DeSSC ECS meeting.

Assessment: There was no mid-cruise or post-cruise assessment of the program with the Captain, SSSG, Alvin and Sentry Leads and the program team.

RECCOMMENDATION:

- Ensure there are mid-point and final all-leader discussions to provide an opportunity for course correction and to exchange lessons learned.

2. ECS On-Line Survey

An on-line survey (Appendix 8) prepared by mentors Blackman and Van Dover and put on-line using Survey Monkey by Caitlin Mandel (UNOLS) was administered on the first afternoon in port after the cruise. https://www.surveymonkey.com/r/DeSSC_ECS_Assessment. Full results may be requested from Cindy Van Dover clv3@duke.edu.

Summary of ECS Survey Results

Pre-training: A majority (75%) of the ECS had prior seagoing experience, having sailed on more than 2 cruises, however 42% had no prior experience with Deep Submergence. Those with prior HOV experience (42%) had all worked with Alvin; only 5 of the 24 had experience with AUV. Most ECS (88%) had some proposal writing experience, but only 13% had submitted a seagoing proposal. Knowledge about UNOLS, NDSF, pre-cruise planning, and aspects of cruise documentation was moderate, with average ECS response (3.0 out of 5 possible) to a series of

15 statements (Question 8, Q-8) indicating that many were not aware of personnel, capabilities, or procedures.

Planning and asset use: The ECS were asked to respond to the same series of 15 statements (Q-23) based on their knowledge as the cruise/telepresence was finishing. Most areas had responses suggesting strong or very strong average understanding (4.3-4.7 out of 5 possible), just the foreign clearance issue showed lower average indication of understanding (3.5). Other areas where 1-3 people noted less than good understanding after the training were: cruise planning, cruise documentation, the different roles of individuals in the ship or technical groups, and NDSF vehicle positioning. Answers to specific questions testing this type of knowledge generally confirmed the ECS claims, with exceptions as follows. A couple people still didnt know when to submit a STR (Q-12), almost half the group lacked clarity on who schedules ship time (Q-16), 30% did not understand that non-NDSF deep submergence costs would have to be supported by the NSF science program. About 20% of the group could not estimate possible *Alvin* coverage during a single dive and about twice as many were not clear on possible *Sentry* multibeam or photo mosaic coverage for a single dive.

Multi-disciplinary project leadership: Almost all participants indicated increased understanding of approaches that can improve multi-disciplinary research cruise outcomes (Q-9), with just a couple people noting little change in their appreciation of transparency in decision making at sea. A few people appeared to still be hesitant about the scope of planning required and how to prioritize/maximize data acquisition. The need to select team membership based on expertise was clearly understood (Q-14). Confidence in leading an oceanographic cruise (Q-43) was expressed by 67% of the ECS, the rest mentioned a variety of reasons for their hesitation. The subgroup all learned useful things but many felt additional experience, perhaps via a more senior colleague, would help them be ready for leading a large, complex study.

Marine Research: Data or samples obtained during the cruise were useful to 90% of the participants for their own research and all but 2 broadened their knowledge of oceanographic methodologies.

Science Communication (Q-11): Almost all participants used social media to share their science during the project, 67% being very active. The live interaction training led 88-95% to indicate that they felt better able to handle live interviews, science cafe or museum presentations in the future. Most (79-91%) felt they better understood how to communicate more clearly and using plain language to public audiences. One person felt this training was the most valuable thing gained during the project.

Telepresence: The ECS obtained familiarity with telepresence and indicated they would likely use it for their research in the next 5 yrs. Only a few indicated they might be unlikely to engage in a future telepresence activity that required them to be onshore (Q-10). All participants pointed to the ability for scientific discourse as an advantage of telepresence and 67% of the group felt that outreach/education opportunities were an advantage. While connectivity problems were mentioned, the disadvantages most often cited were the time required to

communicate (poor sound, need to repeat) and the increase in time needed for decision making with a larger group involved. A few people felt that live telepresence 24 hrs a day was unnecessary and impeded onboard interactions, either by making meetings more formal or restricting informal exchange in the labs.

Plans for proposal submission, future collaboration: All but 2 participants indicate plans to submit a NSF deep submergence proposal in the coming 5 yrs, with 67% likely within 1-2 yrs. Just over half the group also expects to submit a proposal(s) to NOAA in this timeframe. All but 2 indicated that the training increased the likelihood of their requesting ship time in a future proposal. Most participants valued the chance to form new research connections within the ECS group, 88% expect to continue these collaborations.

Overall: All participants recommend that NSF and ONR support more training like this (Q-44). Most (92%) felt the mentors were very helpful, two felt they were moderately helpful. Learning how to plan and conduct a deep submergence cruise was cited most often as the 'most important thing learned', followed by insight on working with NDSF.
Three participants indicated that learning about interdisciplinary collaboration was most important to them.

Responses indicate that many aspects of the training were perceived as effective, with no one thing standing out (Q-29). Less effective aspects (Q-31) included training lectures during the cruise, the very condensed timeframe and the mixture of training and data/sample processing demands, poor connectivity for telepresence during Leg 1 and the associated reduced engagement of the first group at ISC. Several participants left the cruise with uncertainties about *Sentry*, its data, or mapping more generally (Q-28). Questions remained on a variety of topics relating to future proposal efforts- who to contact, how to form a team, would telepresence be necessary, how to frame the proposal, but no one theme dominated responses to this question. The general feedback on the program (Q-45) was uniformly enthusiastic and included suggestions for reformatting so that training lectures could be more effective (as webinars prior to the cruise, for example). One Leg1 ISC participant felt that the telepresence portion of the experience was not very useful.

3. ECS Remote Participants On-Line Survey

We also developed a short survey for our 56 remote participants to discover whether, despite the technological shortcomings, this approach has possibilities. There were 18 respondents as of 14 August 2016. Full results may be requested from Cindy Van Dover clv3@duke.edu.
https://www.surveymonkey.com/r/Remote_DeSSC_ECS_Assessment

Summary of ECS Remote Participants Survey Results

Pre-Cruise Training Program. Only a third of the respondents (6 individuals) watched most of the two-day training program. However, most (16 participants) expect to review the archived sessions. Most or all of the topics covered were considered to be useful to respondents (Figure 8).

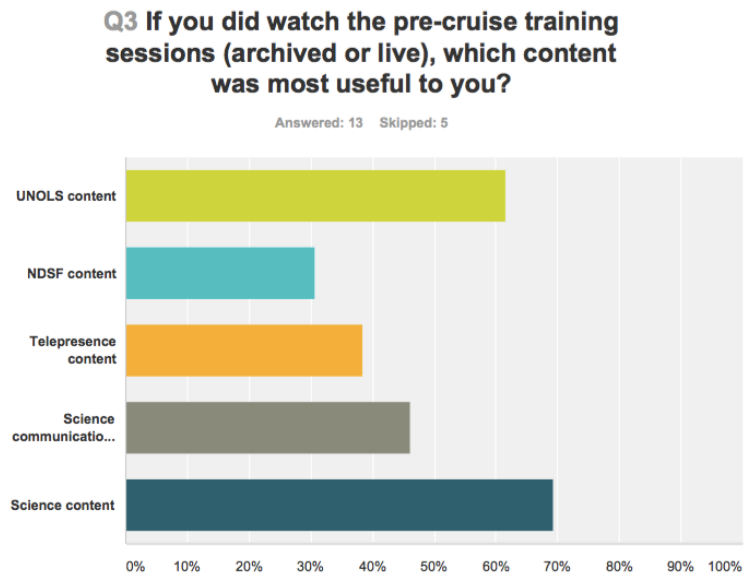


Figure 8. Remote participant responses to key pre-cruise training topics**.**

Only 6 remote participants tuned into live feeds during the cruise > 6 times during the first leg; even fewer 'regularly' tuned into live feeds during the second leg, despite the better connectivity on the second leg. But at least 50% of the respondents did watch at least one live feed.

Science debriefs were the considered to be the most useful feed (Figure 9). Email updates were useful so participants knew when to tune in, but a better, more consistent plan for announcement of the start of an activity should be sought (an app?).

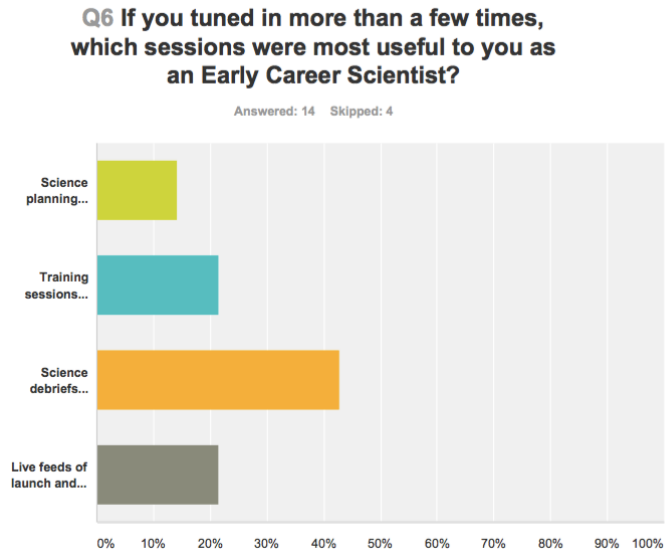


Figure 9. Remote participants considered science debriefs to be the most useful content offered.

Half of the remote participant respondents followed #seafloorsci daily and most (2/3) of respondents found it useful for outreach and science communication.

Perhaps the most valuable part of the survey was the comment section in response to Q10 ("**Please help us understand if a remote training opportunity for Early Career Scientists during a regular research cruise could be useful. What training would you find most valuable? Please focus only on what could not be obtained by some other means. For example, what recommendations do you have for the content, structure, and duration of such training during a cruise?").**

Key observations and recommendations are captured here, in slightly edited form for readability:

- "If telepresence is going to be part of the training, that thorough tests on the audio and video links should be done beforehand, and there should be an easier way to let the speakers know that the feeds were malfunctioning."

- "I think this was a really cool idea and I hope to see more telepresence training. I'm excited that I can go back to the archived materials to learn more on my own time."

- "I think we were looped in a bit late. It would have been better to see more of the pre-pre-cruise planning. It was hard to jump into the science cold. I know it's very difficult, but it's easiest to tune into things when they are scheduled at least 24 hours in advance. It would also be great if the remote participants could be given specific tasks to complete. Whether it's species identification or social media campaigns a more concrete set of objectives for the remote team would increase the participation."

- "Info via email and Slack was most useful. I plan on watching the archived videos of the training ASAP. I would have liked to have seen a list of the participants and their research goals, in order to facilitate collaborative opportunities. I ended up figuring out who to talk to about some samples I was interested in, and then talking them directly, and it worked out well. But I would've liked to have been more aware of the scientific goals of the cruise, not just the training aspects. My sense is that the cruise was a great opportunity to build collaborations and networking among early career scientists, and so maybe having a Google Doc/webpage/? that has a profile for each participant and their scientific goals for the cruise, even including the remote participants, would be useful. You could even also group and connect people by their broad interests (biology, geology, etc.)."

- "If possible, a portal should be developed were remote students can access all information and activities within one site plus archived videos and contents."

- “@SeafloorSci is the IODP twitter account, so I'd encourage coming up with a less generic hashtag if you decide to do that again. I'm encouraged that there has now been a Chief Sci training cruise that used NDSF assets, since that presents a whole other level of complexity that I don't think could have been addressed by some of the previous training cruises. I don't know if remote participation alone can really replace the "doing it" aspect.”

- “I thought this was an incredibly cool opportunity to be involved in training remotely. Emails were overwhelming but didn‘t have much information in them- perhaps the emails could have summaries of what was going on, tips and highlights, that kinda stuff. Im not a tweeter or on twitter but i enjoyed the Instagram updates.”

- “Content: understanding the pre-cruise needs and how cruises operate Structure: Each of the different participant levels: in land, onboard, interaction with ROV and sub crews Duration: the timing was fine Training: mechanisms need to be tuned a bit but otherwise excellent Planning and Debriefing notes for followup would be useful.”

- “It's really useful to be able to be a "fly on the wall" and see how people make decisions when on the cruise. Learning by observation and osmosis, in a sort of "unsanitized" way. it would have been helpful to have a short written thing somewhere from each of the teams with similar content to their 5-minute presentations. A short paragraph each would do. This would be more accessible to anyone with visual/hearing limitations, and would be easy to refer back to later in the cruise. The telepresence was quite good for giving an idea of what we might be getting ourselves into if we had the opportunity to do research using Atlantis or similar vessels in future. I liked seeing both sides of the Inner Space Center and the ship crew during discussions. From my perspective, the remote training doesn't even need to be quite "training". More letting us watch and see how things really work, in real time.”

- “If this could be done as an added day or two to regular cruise, along with telepresence for the entire cruise, this could be quite a valuable way to do this, and as a senior scientist, I would support it.”

- “Once we missed the first day, it seemed that everyone there knew what was going on so too late to ask basic questions. Use of Slack typed notes/ summaries were invaluable as they allowed remote people to keep up even if the feed was lost or they had to be elsewhere. I was able to engage directly with some participants when I saw through Slack that they were point people for specific objectives.”

Figure 10. A) Karl Bates, Nicholas St Fleur; B) Donna Blackman; C) Alvin Team Jefferson Grau, Logan Driscoll, Josh Sisson, Danik Forsman, Fran Elder; D) Amanda Netburn, Chiara Borelli, Katlin Bowman, Jeff Marlow; E) Julianne Fernandez, Bridgit Boulhanis.

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Appendix 1 Announcement of Opportunity

UNOLS Research Training Cruise with Deep-Submergence Assets

Opportunity: A 2016 Deep Submergence Training Cruise on the R/V *Atlantis* is being proposed to include a 2-d pre-cruise workshop (26-27 July), 11 d at sea with telepresence (28 July to 7 Aug), with HOV *Alvin* (5 science dives) and AUV *Sentry*, plus a 1 d post-cruise follow-up (8 Aug); sailing Woods Hole MA to Morehead City NC. This will be the first-ever leadership training cruise for national deep-submergence assets. It is also the first-ever 'telepresence' training cruise; participants will rotate between the Inner Space Center at the University of Rhode Island (http://innerspacecenter.org/) and the R/V *Atlantis*.

Key objectives include providing experience in:

i. collaborative, multidisciplinary and interdisciplinary research and proposal strategies for deep-submergence science
ii. leadership in cruise and dive/mission planning and execution
iii. integration of instrumentation with *Alvin/Sentry/*other deep-submergence assets
iv. telepresence research and communication: seafloor-to-ship-to-shore
v. data management, sharing, reporting
vi. science communication

Preference will be given to researchers who have significant potential to write proposals to use the National Deep Submergence Facility (NDSF) assets *Alvin, Jason*, or *Sentry* in the next five years. We target postdoctoral researchers, assistant professors/scientists with less than 7 years since their PhD. A limited number of spaces may be available to advanced PhD students. More established researchers may be invited to participate if they have not used (NDSF) assets in the past. All disciplines of deep-submergence science are targeted, including biological, geological, chemical, and physical oceanography.

Small stipends are provided for participant travel costs, research supplies, and shipping. Space is limited. To apply you must be an employee or student (U.S. Citizen or permanent resident) at a U.S. institution or a U.S. citizen working abroad.

To be considered, applications must be received by 30 March 2016.

1. Please provide the following contact information:
Institution and year (or expected year) of PhD degree:

2. Please explain why you are interested in this program. Do you see yourself leading a research cruise in the future?

3. What is your primary discipline? What is your secondary discipline?

4. Please indicate any prior experience you have using (or requesting) UNOLS research vessels and deep-submergence assets.

5. Please indicate how your research and training goals would benefit from sampling opportunities afforded by this training cruise program. Numerous seeps (Skarke et al. Nature Geoscience 2014) and

canyons (e.g., Quattrini et al. PLoS one 2015) are within easy reach along the transit routes. Emphasis should be on objectives to be accomplished using *Alvin* and *Sentry*, including through telepresence, although there is scope for some use of other shipboard assets (e.g., CTD, multibeam). Useful resources are the *Alvin* users manual and the Sentry web pages. (250 words)

6. Please provide a description of *Alvin* or *Sentry* instruments or sampling tools that you need. Indicate if you plan to supply any specialized equipment.

7. Please indicate your collaborators (including other early career scientists who may also be applying to participate in the training cruise). Graduate students should include their thesis advisors.

8. Please indicate any special ship equipment or facility needs you may have (e.g. vans, freezers, winches, etc.).

9. Please submit a brief budget for travel, shipping as needed), and supplies (including >/= 6TB hard drive) up to ~$1000.

10. Please indicate your plans for future NDSF use over the next 5 years (especially any plans for which this training opportunity can help you prepare).

11. List the names, phone numbers and emails of two people who would be able to comment on your suitability for this program: the importance of your research goals and how crucial ship time is; the feasibility of your project; your potential as a member of the shipboard team; and leadership qualities that you would bring to the effort.

APPENDIX 2. Participant Bios

Co-Chief Scientists:

Anne Dekas

Anne Dekas is a geomicrobiologist interested in how microbial life affects the chemistry and climate of our planet today and throughout time. Her research focuses on the diversity, activity and interactions of microorganisms in the deep sea, and how their metabolisms affect nitrogen, carbon and sulfur cycling. Her recent projects include investigating the magnitude, mediators, and controls on nitrogen fixation in diverse deep-sea sediments, understanding the activity and interactions of methanotrophic archaea and sulfate-reducing bacteria at methane seeps, and probing the metabolic diversity and flexibility of pelagic marine archaea (e.g., Thaumarchaeota and Euryarchaeota). She utilizes tools from both molecular biology and isotope geochemistry, and specializes in measuring the activity of uncultured bacteria and archaea on the single-cell level using nanoscale secondary ion mass spectrometry (nanoSIMS). She has participated in six research cruises utilizing deep submergence assets, including DSV/ROVs Alvin, Jason, and Doc Ricketts.

Anne is currently an Assistant Professor in the Earth System Science Department at Stanford University. She received her A.B. in Earth and Planetary Sciences from Harvard University (advisor: Ann Pearson), and her Ph.D. in Geological and Planetary Sciences from the California Institute of Technology (advisor: Victoria Orphan). She was a Lawrence Postdoctoral Fellow in the Chemical Science Division at Lawrence Livermore National Laboratory (advisor: Jennifer Pett-Ridge). Anne's interest in the deep sea stems from a long-held interest in space sciences, and before beginning her graduate work she performed research at three NASA centers: Goddard Space Flight center, Ames Research Center, and the Jet Propulsion Laboratory. She is passionate about exploration at both the molecular and macro scales, and sharing her enthusiasm for discovery with the next generation of explorers. More information can be found on her website: https://earth.stanford.edu/dekaslab/.

Adam Skarke

Adam Skarke is a geologist with broad research interests in the fields of marine geology and geophysics. His research is focused on understanding the fundamental physical relationships between fluid dynamics, sediment transport processes, morphological expression, and the stratigraphic record in marine environments that span the continental margin from coastal waters to the deep sea. Specifically, his research quantifies how those relationships evolve and are linked across a wide range of spatial and temporal scales. His technical approach is field based and focused on the analysis of geophysical and oceanographic data collected with innovative environmental observing sensors and platforms. His recent research efforts have focused on quantifying the spatial distribution and temporal variability of methane seep systems on the northern US Atlantic margin, as well as related processes of hydrate dissociation and gas transport.

Adam has participated in 23 research cruises including nine UNOLS cruises, five research cruises utilizing deep submergence vehicles, and three cruises fully incorporating telepresence technology. Additionally, he has led five ocean exploration cruises on NOAA ship *Okeanos Explorer*. Adam is an Assistant Professor of Geology in the Department of Geosciences and a Research Fellow in the Geosystems Research Institute at Mississippi State University. Prior to his current appointment, he was a scientist with the NOAA Office of Ocean Exploration and Research. He earned a B.A. (2003) in geology from Colgate University and a M.S. (2008) as well as Ph.D. (2013) in marine geology from the University of Delaware. Additional information can be found on Adam's website: http://www.adamskarke.com

Participating Scientists:

Laura Bagge

Laura Bagge is a PhD candidate at Duke University in Sönke Johnsen's visual ecology lab. She is broadly interested in sensory biology and in understanding the morphological and physiological changes an animal goes through to camouflage itself from predators, especially in the open ocean where avoiding being seen can be the difference between life and death. She studies transparent crustaceans, specifically pelagic hyperiid amphipods, to understand how these animals structure their tissues to achieve invisibility in their ocean environment.

Roman Barco

Roman Barco, Ph.D., is a National Science Foundation Postdoctoral Fellow at the University of Southern California and Bigelow Laboratory for Ocean Sciences. Broadly, his research focuses on deciphering the function of chemolithoautotrophic microbes. He approaches this task by isolating microorganisms from the environment and by using molecular techniques in conjuction with genomic and proteomic analyses to infer metabolism. One of his major interests is the close relationship between microbes and rocks/minerals in the marine environment.

Dr. Barco received his Ph.D. in Biology (2014) from the University of Southern California under the mentorship of Dr. Katrina Edwards. His dissertation was on the chemolithoautotrophic, marine, iron-oxidizing bacteria. As a graduate student he was a Center for Dark Energy Biosphere Investigations Graduate Fellow (2011-2013) and Wrigley Institute for Environmental Studies Fellow (2011).

Chiara Borrelli

I am a Postdoctoral Research Associate at University of Rochester. My research interests encompass a wide range of topics in the fields of biogeochemical cycles, paleoceanography, Earth's climate, and molecular biology. In particular, my research focuses on a group of organisms called foraminifera. Foraminifera are single cell organisms, many of which build calcareous shells that have a very high preservation potential in sediments (i.e., we can study foraminifera that are million of years old). Because the isotopic and chemical composition of foraminiferal shells can be related to environmental parameters at the moment of calcification, it is possible to use foraminifera to reconstruct changes in ocean circulation and climate through geological time. In the past years, I worked on several projects involving foraminifera. These projects allowed me to develop an interdisciplinary knowledge, broadening my initial background in Marine Biology (B.S. and M.S.) into Geology (Ph.D.).

Recently, I became interested in investigating the possible role of methane released from sedimentary environments in driving or influencing climate change today and in the geological past. In order to do so, I am exploring the possibility of using "non-traditional" isotopic ratios in benthic foraminifera to study methane fluxes in marine sediments. In addition, I seek to understand how methane release and oxidation and availability of dissolved oxygen in sediments influence the carbon, sulphur, iron, and manganese cycles and how these changes can be monitored through the investigation of benthic foraminiferal carbon isotope ratio and trace element composition.

Bridgit Boulahanis

I am a second year Ph.D. student at Columbia University, where I study Marine Geophysics at the Lamont-Doherty Earth Observatory. My research focuses on Mid-Ocean Ridge dynamics, submarine volcanic eruptions, and seismicity at spreading centers. Thus far in my research I have gotten to use of a variety of marine geophysical techniques, including analysis of physical samples, reflection seismic studies and multibeam data. My current project involves long time series analysis of crustal thickness variations extending from the East Pacific Rise and Juan de Fuca ridge.

Katlin Bowman

Katlin Bowman is a Postdoctoral Research Scholar at the University of California, Santa Cruz. She received her B.S. and Ph.D. in Environmental Sciences from Wright State University in Dayton, Ohio. Her research focuses on the global biogeochemical cycle of mercury in the ocean. She has participated in multiple U.S. GEOTRACES transects in the North Atlantic, eastern tropical South Pacific, and Arctic Oceans, and process studies in the northwest Atlantic (at-sea blog: hginthesea.wordpress.com). Her work focuses on the chemical transformations of mercury in the marine water column. Microorganisms in the ocean alter the chemistry of mercury, creating a toxic compound called methylmercury that accumulates in marine mammals. Humans are exposed to mercury primarily through the consumption of marine fish.

The ocean contains a mixture of mercury from natural and anthropogenic sources and the deep ocean holds valuable information that can be used to quantify how much mercury human activity has added. Mercury is sequestered from the atmosphere during deep water formation and deep-sea corals can be used as an archive to document patterns of natural and anthropogenic mercury accumulation with time. Measuring mercury in hydrothermal vent plumes can also be used to constrain estimates of natural mercury to the deep ocean.

Mercer R. Brugler

Mercer R. Brugler, Ph.D., is an Assistant Professor of Organismal Biology in the Biological Sciences Department at New York City College of Technology (CUNY) and an Adjunct Assistant Professor at NYU's School of Professional Studies (Paul McGhee Division). Dr. Brugler is an evolutionary biologist that specializes in the phylogenetic systematics and molecular evolution of deep-sea black corals and sea anemones. He is also a Research Associate at the American Museum of Natural History (AMNH) where he mentors students from underrepresented racial and ethnic groups, as well as students with disabilities, in his molecular laboratory. Dr. Brugler teaches *General Biology I & II* for non-majors at City Tech, and *Darwin to DNA: An Overview of Evolution* at NYU-SPS. He received a B.S. in Marine Biology at the University of Miami (Coral Gables, FL), an M.S. in Marine Biology at the College of Charleston (Grice Marine Laboratory), and a Ph.D. in Environmental & Evolutionary Biology from the University of Louisiana at Lafayette. Dr. Brugler has attended three different Next-Generation DNA Sequence Analysis courses and recently published the complete nuclear genome of the common bed bug *Cimex lectularius* (*Nature Communications*; doi:10.1038/ncomms10164). He is currently sequencing the complete genome of the Hawaiian black coral *Antipathes griggi* on a PacBio RS II and the complete genome of *Relicanthus daphneae* (a representative of a new Order of Anthozoa) using multiple Illumina platforms. The type specimen of *R. daphneae* (formerly *Bolocerоides daphneae*) was collected in 2003 by the submersible DSV *Alvin* at 2,565 meters depth along the East Pacific Rise.

Stephanie Bush

I was introduced to deep-sea research as a 2013 summer intern in Dr. Bruce Robison's Midwater Ecology Lab at the Monterey Bay Aquarium Research Institute (MBARI). My enthusiasm about the deep ocean led me to expand that project on ink release by mesopelagic squid into a dissertation on deep-sea squid defensive behaviors at UC Berkeley. Since then, I've explored the metabolic demands of open water squid in the Gulf of California to determine the affect oxygen minimum zone expansion will have on their diel vertical migrations. I continue to collaborate with scientists at the Smithsonian Institution's National Museum of Natural History examining speciation in the open ocean, using pteropods as a model in combining morphology and genetics to determine species boundaries.

I returned to MBARI and the Monterey Bay Aquarium in 2012 and hold a joint post-doctoral fellow at these sister institutions. As the chief scientist on cruises collecting deep-sea, cirrate octopuses, I am an integral part of bringing the diversity of the world's cephalopods to the public eye. We are carrying out research on the ecology and behavior of our local flapjack octopus species, which was featured in an online video that went viral around the world due to its 'adorable' appearance.

Through this work I've developed an interest in cirrate octopus diversity and distribution, and am thrilled at the possibility of encountering one during an Alvin dive. I'm also excited by the opportunity to expand my experiences in science communication with telepresence capabilities.

Anni Djurhuus

Anni Djurhuus is a postdoctoral researcher at the University of South Florida. Anni is originally from the Faroe Islands where she completed her BSc at the University of the Faroe Islands in 2011. While she lived on the Faroe Islands, Anni worked for the Faroe Marine Research Institute where she was responsible for identifying zooplankton, phytoplankton, and participate on research cruises. After getting some research experience on the Faroes Anni did her PhD at the University of Oxford in the Ocean Research and Conservation group led by Professor Alex D. Rogers. For her PhD thesis she worked on marine microbiology of deep-sea hydrothermal vents and seamounts in the Southern and Indian Oceans. The main focus of her work was on microbial biogeography on local and regional scales.

After finishing her PhD in 2015 Anni was employed in the viral genomics group led by Dr. Mya Breitbart. She currently works on the Marine Biodiversity Observation Network (MBON) project investigating microbial communities of the Florida Keys and Monterey Bay national marine sanctuaries. Work for the MBON project includes environmental DNA (eDNA) ground-truthing methods, biogeography of organisms from microbes to whales using eDNA techniques, and ecosystem health and management.

Anni is very interested in connecting the work from her PhD with experience she has gained during her postdoctoral research applying it to samples collected on the upcoming cruise to the northwest Atlantic seeps and canyons. This is a great opportunity to collaborate on environmental data and how this possibly affects the microbial communities.

Julianne Fernandez

Growing up in a northwest suburb of Chicago, I developed an early interest in nature and my surrounding environment. After obtaining an Associate's in General Arts from the College of DuPage in Illinois, I became captivated by science and moved to northern California to earn my Bachelor's of Science in Oceanography from Humboldt State University. During my undergraduate studies, I gained an understanding of the various contributing elements relating to the carbon cycle and their effects on climate change. I am currently pursuing my Doctoral degree in Geology from the University of Cincinnati under Dr. Amy Townsend-Small, where my studies aim to investigate gas exchanges within Lake Erie between sediments, water, and atmosphere, and how they ultimately contribute to climate change. My research utilizes stable isotope biogeochemistry in order to determine the relative contributions of hypoxia and natural gas production and transport to methane emissions in Lake Erie. Expanding on this project, I am also investigating seasonal fluxes of methane and carbon dioxide. After receiving my PhD, I am determined to pursue a post-doctoral experience and continue to investigate hydrocarbon behavior throughout the Great Lakes system.

Robinson "Wally" Fulweiler

Wally Fulweiler is a biogeochemist and ecosystems ecologist. She is an Associate Professor in the Department of Earth and Environment and the Department of Biology at Boston University. She will assume the position of Director of the Boston University Marine Program in summer 2016. Her research focuses on answering fundamental questions about energy flow and biogeochemical cycling of nutrients (nitrogen, phosphorus, and silica) carbon, and oxygen in a wide spectrum of environments. Current projects examine the influence of warming water temperature and low oxygen conditions on nitrogen cycling in estuarine and shelf systems, and how anthropogenic activities alter nutrient cycling along the land–ocean continuum. She was awarded a Sloan Fellowship in 2012, the first time this award was given in Ocean Sciences. In 2013, she was awarded the Cronin award from the Coastal Estuarine Research Federation (CERF). Dr. Fulweiler is an Associate Editor for Estuarine, Coastal and Shelf Science, Frontiers of Marine Science – Global Change and the Future Ocean, and Journal of Geophysical Research: Biogeosciences. She is a Member-at-Large and Chair of the Publications committee for the Association for the Sciences of Limnology and Oceanography (ASLO).

Colleen L. Hoffman

Colleen Hoffman, a Ph.D. Candidate in the Earth Science Department at the University of Minnesota, studies the mineralogy and speciation of deep-sea hydrothermal plumes and underlying sediments. Her research has mainly focused on the particulate iron and carbon chemistry within the ~4300km non-buoyant hydrothermal plume at East Pacific Rise (EPR) 15°S. As an undergraduate at the University of Southern California, she studied Chemistry and researched siderophore production in high iron environments. After college, she decided to turn her love of chemistry, iron, and the ocean into a career. Her dissertation aims to understand how carbon affects the bioavailability and longevity of particulate iron within the non-buoyant plume and sediments. Using synchrotron techniques developed by her advisor, Dr. Brandy Toner, she is able to visualize and investigate these fine-scale interactions between iron and carbon within the hydrothermal plume at EPR, and the underlying sediments. Her dissertation will aid in understanding the impact of hydrothermal vents on global iron and carbon budgets in the deep ocean. Looking forward, Colleen has three main objectives: (1) expand her understanding of the important biogeochemical processes at hydrothermal vents, (2) explore bulk (particulate or dissolved) chemical measurements as well as modeling, and (3) further exploration and characterization of hydrothermal vents in the global ocean. When she is not researching hydrothermal vents, Colleen enjoys exploring the outdoors, SCUBA diving, and volunteering at the local Animal Humane Society.

Sean Jungbluth

My work explores the nature and extent of microbial life underground and below the seafloor using tools rooted in microbiology, bioinformatics, molecular biology, and biogeochemistry. As a young scientist, I've participated in six oceanographic research expeditions involving manned and unmanned submersibles. Using samples collected from the deep subsurface volcanic rock environment, I previously conducted a dissertation research project focused on elucidating the diversity and genomic potential of extreme microbial life found deep below the seafloor. I am currently working at the University of Southern California as a post-doctoral research scholar and pursuing additional research activities related to understanding the physiology of microbial life in the deep subsurface. In the near future, I hope to initiate my own academic laboratory focused on using UNOLS deep submergence assets to pursue investigations of deep-sea and subseafloor microbial life. My career goal is to use my training as a microbial ecologist and oceanographer to continue inspiring the next generation of sea-going scientists and to continue discovering novel insights into life's most extreme microbes.

Joanna D. Kinsey

Joanna D. Kinsey is interested in the marine biogeochemistry of contrasting environments utilizing an interdisciplinary approach to gain better understanding of chemical cycling. She is currently a postdoctoral research scholar with Dr. Christopher Osburn in the Marine, Earth and Atmospheric Sciences Department at North Carolina State University. Her current research investigates phytoplankton-derived particulate organic matter (POM) transformed through microbial degradation and disaggregation, as a potential source of autochthonous chromophoric dissolved organic matter (CDOM) and its impact on carbon cycling throughout the water column. Joanna received her Ph.D. in December 2014 with Dr. David Kieber at the State University of New York, College of Environmental Science and Forestry in Syracuse, New York. Her doctoral research examined how changes in iron limitation, irradiance intensity, and spectral quality affected the growth and dimethylsulfoniopropionate (DMSP), dimethylsulfoxide (DMSO), dimethylsulfide (DMS), and acrylate concentrations in *Phaeocystis antarctica*. In addition to her dissertation research, Joanna has participated in several research cruises investigating aerosol production from bubble bursting, dimethylsulfide photochemistry, and biological consumption of DMSO and acrylate. While attending the University of San Diego for her bachelor's degree, Joanna examined anthropogenic impacts of a fish cannery on the Magdalena Bay ecosystem and participated in an Antarctic expedition studying the effect of free-floating icebergs on the surrounding chemistry and ecology.

Kevin Kocot

Kevin Kocot is an organismal biologist whose research focuses on systematics and evolutionary genomics of marine invertebrates using high-throughput sequencing and bioinformatic tools. Kevin's work has primarily focused on molluscs and he is particularly interested in the worm-shaped aplacophoran molluscs. Kocot's dissertation work showed that aplacophorans along with chitons (Polyplacophora) form a clade called Aculifera, which is the sister taxon to all other extant molluscs. Thus, these animals are important for understanding the early evolution of this diverse and important phylum. Kevin is also interested in the evolution of biomineralization and the rapid evolution of the gene regulatory network orchestrating this process in the eight major lineages of molluscs and other animal phyla. In addition to molluscs, Kevin has worked on numerous diverse invertebrate groups including meiofauna of all sorts, hemichordates, ctenophores, and spiders just to name a few. Kevin is interested in participating in the UNOLS Deep-Submergence Science Leadership Cruise to gain experience in the use of submersibles such as Alvin for collecting specimens of aplacophorans and other invertebrates for systematic and evolutionary genomic research.

Jeffrey Marlow

Jeffrey Marlow is a postdoctoral scholar at Harvard University, where he studies molecular profiles and microbial community structure to better evaluate and manipulate methane-associated metabolisms. More broadly, he seeks to understand the limits of microbial life - through physical, biochemical, and energetic lenses – with a focus on metabolic activity-based metrics. Through a series of studies at the Hydrate Ridge methane seep complex, Jeff was part of a team that discovered active methanotrophic communities within carbonate mounds and used stable isotope probing techniques to specifiey the metabolically active subset of a complex microbial community. Previously, he has served on NASA's Mars Exploration Rover, Phoenix Mars Lander, and Mars Science Laboratory teams, and worked for Google's marketing division. As a journalist and science writer, he has reported on science, the environment, and international development for publications including *The New York Times*, *Slate*, and *Wired*, and is currently a contributing writer at *Discover* Magazine. Jeff is also the founder of the Mars Academy, a nonprofit organization that uses the inspirational power of exploration to overcome academic apathy among disadvantaged youth. Most importantly, Jeff is a past *Atlantis* table tennis tournament champion, and he looks forward to defending his title.

Doreen McVeigh

Doreen McVeigh received her B.S. Biology from Sweet Briar College in 2009 and her M.S. Environmental Biology from Hood College in 2012. She is completing her Ph.D. in Biological Oceanography at North Carolina State University under the supervision of Dr. David Eggleston and defends this summer. Doreen uses a coupled bio-physical model to predict spatiotemporal variability and potential population connectivity of deep-sea methane seep invertebrates in the Gulf of Mexico and U.S South Atlantic Bight. Species-specific biological parameters, such as pelagic larval duration and larval swimming behavior, were assigned to particles simulating the deep-sea polycheate, *Lamellibrachia luymesi*, gastropod, *Bathynerita naticoidea*, crustacean, *Alvinocaris muricola*, and bivalve, *Bathymodiolus childressi*. Model simulations quantified larval particle dispersal distance, dominant dispersal pathways, and the potential connectivity for each species among five known methane seep sites. In addition to her research, Doreen is an active science communicator delivering over 30 scientific talks to the public at the North Carolina Museum of Natural Sciences, as well as online lesson plans and outreach activities that encourage everyone to learn more about the deep sea.

Michael Navarro

Michael is a postdoc working with Dr. Corey Garza in the Marine Landscape Ecology Laboratory, CSUMB, and is funded through the NSF OCE PRF program. He studies sandy habitat geomorphology on the continental shelf to identify areas with vertical complexity. Habitat complexity is a known driver for species spatial patterns. Despite the fact that sand sediments cover major portions of continental shelves globally, sandy plains remains an area that is data poor in many respects. Sandy plains were once thought to lack a three-dimensional surface structure however with the use of side-scan sonar, ecologists now understand that relatively small vertical habitat structure of 20 - 40 cm in height can drive distributional patterns of species (i.e. rippled-scour depressions). Michael uses side-scan sonar and tow-camera video surveys to identify spatial patterns of rippled-scour depressions and bed-forming organisms and how their dynamics change across seasons. This science facilitates - but is not limited to - ongoing research initiatives such as those directed towards ocean acidification, marine debris/plastics and seafood security as well as for use as a student training platform to meet national calls towards diversifying the workforce. Michael is looking forward to the UNOLS deep-submergence leadership training for many reasons including to learn more about the AUV Sentry and its side-scan sonar, still photograph and georeferencing capabilities.

Amanda N. Netburn

Amanda N. Netburn received a PhD in Oceanography and a Masters in Marine Conservation and Biodiversity from Scripps Institution of Oceanography. For her dissertation research, she studied effects of deep hypoxic waters in limiting individual fitness and constraining suitable habitat for mesopelagic fish populations off of the California coast. Her interest in mesopelagic fishes started years ago on an expedition with Stanford@SEA where she studied changes in myctophid feeding selectivity between Hawaii and Palmyra Atoll. Amanda has an enduring passion for the ocean, and in the intervening years between her undergraduate degree and graduate school, she researched sustainable seafood at a NGO, taught SCUBA, captained small boats, and cultivated finfish for a sustainable aquaculture start-up. Amanda is an active member of the Deep Ocean Stewardship Initiative, an interdisciplinary and multi-stakeholder group that advises on best-practices for human activities in the deep sea. Amanda currently holds a position as the Knauss Fellow in Marine Policy at NOAA Office of Ocean Exploration and Research. There, she is leading the effort to develop water column priorities and sampling protocols within the exploration context. While Amanda has worked with ROVs before, she has never even seen an AUV or HOV, and is greatly looking forward to this opportunity to learn the capabilities of these deep submergence vehicles for observing the ocean.

Alexis Pasulka

Alexis Pasulka is a NSF postdoctoral fellow at the California Institute of Technology. The overall goal of her research is to characterize the composition, distribution, diversity, and interactions of microbial predators (heterotrophic protists and viruses) over a variety of spatial and temporal scales to better understand their influence on community structure and ecosystem function. During the UNOLS Deep-Submergence Science Leadership Cruise, her research will focus on integrating heterotrophic protists into our understanding of microbial community dynamics and trophic relationships in deep-sea methane seep ecosystems. One aspect of this research will involve examining the distribution and diversity of heterotrophic protists in relation to geochemical and biological variables within methane seep ecosystems. Another aspect of this work will focus on determining if and how heterotrophic protists are involved in transferring methane-derived carbon within seep food webs.

Katrina Twing

Dr. Twing is a postdoctoral researcher at the University of Utah with interest the in microbial ecology in extreme environments. Her PhD work at Michigan State University focused on identifying diversity and metabolic potential of microorganisms within the continental serpentinite environment. She was a ship-board scientist on IODP Expedition 357: Atlantis Massif Serpentinization and Life, where she helped collect drill core samples from the hard-rock subseafloor adjacent to the Lost City Hydrothermal Field. Dr. Twing's postdoctoral research focuses on identifying the metabolic potential and activity of microorganism within hard rock cores from the Atlantis Massif using 'omics approaches.

Amy Wagner

I am in just completing my first year as an Assistant Professor in Geology at California State University Sacramento (often referred to as Sac State). I earned my Ph.D. from Texas A&M University in Oceanography, with a focus in paleoceanography and paleoclimate. My paleoceanographic work has primarily focused on using geochemical analyses of tropical, hermatypic corals as a proxy for sea surface conditions. Last year, I participated in a research cruise aboard the Korean icebreaker, *RVIB Araon*. We collected numerous deep-sea coral samples using a bottom dredge to study changes in ocean circulation around Antarctica during the last 1000 years. Some of our initial radiocarbon dates of the samples indicate some of the slope samples to be much older than we expected. However, collecting these samples with a bottom dredge poses a number of problems, including the samples being broken into many small pieces and not being able to specify whether the corals were collected *in-situ* or if the dredge happened to be pulled through a rubble pile that was transported from elsewhere leaving us to wonder where these old samples are really from. My interest in participating in the UNOLS Deep-Submergence Science Leadership cruise is two-fold: (1) any further sampling of Antarctic deep-sea corals will require either a manned or unmanned (ROV) submersible to carefully select samples of specific species and know the environment from which they are being collected and (2) collecting a few samples of the same family (Stylasteridae) from a less harsh and corrosive environment off the east coast to compare some of the skeletal mineralogy and morphology. I hope to learn about the proposal/planning stages of requesting submersible time and the execution of such a cruise.

Joseph B. Zambon

Joseph B. Zambon is a Postdoctoral Research Associate from North Carolina State University. His research is focused around numerical modeling of air-sea interaction. His Ph.D. dissertation (2014) and M.S. thesis (2009) were related to tropical cyclones impacting coastal ocean environments. Recently his research has been the design and implementation of a Coupled Ocean-Atmosphere-Wave-Sediment Transport (COAWST) model as a quasi-operational nowcast/forecasting system. He also teaches an undergraduate course in oceanographic instrumentation and methods of data analysis.

Joe has participated on 9 research cruises as a student, physical oceanographer, team lead, and lead scientist. These cruises, on 6 different research vessels, have been in various geographic regions covering the entire U.S. east coast, Gulf of Mexico, Caribbean Sea, and the South American coastal shelf. While aboard, his duties typically revolve around physical oceanography data collection, deploying gliders, eXpendable BathyThermographs (XBTs), Conductivity-Salinity-Depth (CTD) rosettes, and assisting other research scientists. In 2012 he was involved in a cruise using ROV Jason and in 2015 he participated in an 8-hour Alvin dive.

Outside of research, Joe has very diverse interests. He has been a volunteer firefighter since the age of 18, currently serving as a Duty Officer with the Swift Creek Rural Fire Department outside of Raleigh, NC. He has a private pilot's license and volunteers his time for Pilots 'n' Paws, an organization of pilots that flies dogs from shelters to their forever homes. He is also an avid ice hockey player, fan and team captain.

Appendix 3. Pre-Cruise Training Sessions (26-27 July 2016)

Pre-Cruise Training Agenda and At-Sea Programming
Tan-shaded windows were streamed live and are archived (see Appendix 4).

Date/Time	EVENT	Lead	Location
25 July (M) Travel Day			
Afternoon	Arrive in Falmouth/Woods Hole		
6 pm	Reception and dinner		Fenno House
26 July (Tuesday) TRAINING Day			
Pre-0800	Mobilization	Open to all hands	R/V Atlantis
0730	Continental Breakfast		SMITH CONF. ROOM
0800	Welcome, Introductions, Discussion of Program Goals	Mentors	SMITH CONF. ROOM
0830	NSF/NOAA/ONR Partners	Midson, Leonardi Schnoor (at sea)	SMITH CONF. ROOM
0900	UNOLS – University National Oceanographic Laboratory System • Brief History, Purpose, and Structure of UNOLS and the UNOLS Fleet • Intro to DESSC and ECS programs (Girguis) • Intro to Ship Time Request System, including foreign clearances	UNOLS Office Staff, Girguis	SMITH CONF. ROOM
0945	Introduction to the National Deep-Submergence Facility	Fornari	SMITH CONF. ROOM
1015	Break: Coffee and Pastries		SMITH CONF. ROOM
1045	Ship Time Request System II, including requests for NDSF assets	UNOLS Office Staff	SMITH CONF. ROOM

1145	Science Communication I	Bates	SMITH CONF. ROOM
1230	Working Lunches (French Bakery) – Science teams and mentors • Review and discuss interests, partnerships, sampling needs	Science team leads	SMITH CONF. ROOM
1330	Sample team presentations (5 minutes each)	Sample team leads	SMITH CONF. ROOM
1400	*Atlantis* Tour, *Alvin* Tour, *Sentry* Tour Break into 3 groups that rotate; 30 minutes per tour	TBD	R/V Atlantis
1530	Enabling telepresence research: Situational awareness and team planning and effort	Coleman German Girguis	SMITH CONF. ROOM
1600	Video Access and Duplication	McCue, SSSG	Main Lab
1630	Mobilization		
1800	Science Meeting • Agenda to include draft Dive I Plan and Sentry I Plan, Q&A, issues to be resolved; PLUS a 15-minute science talk by Skarke or Dekas?	Skarke & Dekas	SMITH CONF ROOM
1900	Dinner on your own; mobilization as needed		
27 July (Wednesday) TRAINING Day			
0730	Breakfast onboard Atlantis for all		R/V Atlantis Mess Deck
0800	Data Management Requirements and Delivery	Fornari	Smith Conference
0900	Distributed leadership: Opportunities for ship and shore leadership in making team recommendations to co-chief scientists (structured discussion)	Mentors	Smith Conference
0930	SSSG and telepresence orientation (incl chain of command, communication protocols, mobile video unit)	SSSG Techs and Coleman	Smith Conference
1000	Science Communication II: Intro to social media tools and tactics	Bates	Smith Conference
1100	Introduction to Officers (who does what)	*Atlantis* Crew	Smith Conference

1130	Lunch onboard Atlantis for all		R/V Atlantis Mess Deck
1230	Introduction to Alvin and Sentry Teams (who does what)	Alvin and Sentry ELs	Smith Conference
1300	Plenary Discussion • Science objectives, sampling needs, questions arising		Smith Conference
1400	*Alvin* Briefings continue	Alvin Group	Alvin
1400	Finalize cruise/Alvin/Sentry plans etc	Dekas, Skarke et al.	TBD
1500	Meet with Ship's Captain and officers, Alvin and Sentry Expedition Leaders to discuss cruise plan	Dekas, Skarke et al.	Smith Conference Room
1800	Science Meeting • Agenda to include Q&A, issues to be resolved PLUS a 15-minute science talk by Skarke or Dekas?	Dekas, Skarke	Smith Conference Room
1900	Dinner on your own		
28 July (Thursday) SAILING Day			

APPENDIX 4. Training Video Archives

ECS Day 1 links (26 July 2016)	ECS Day 1 links (27 July 2016)
1A Van Dover Intro https://youtu.be/0hTR5tEPLPE 1B Blackman Intro https://youtu.be/iNJWpDtgJdA 1C Foranri Intro https://youtu.be/SW8vNS_Ld2s 1D Bates https://youtu.be/TqM8JydYaYE 1E Midson Intro https://youtu.be/qGZmAAW1Iio 1F Leonardi Intro https://youtu.be/93JoVSt1bOc 1G Schnoor Intro https://youtu.be/SEgDkawaa9A 2 Annette UNOLS https://youtu.be/0DWaYKlDr3I 3 Girguis https://youtu.be/Vu68VRzqM5I 4 Fornari NDSF https://youtu.be/QSoICeZnwDg 5 DeSilva https://youtu.be/JjyN_WuWC0Q 6 Bates Communicating Science https://youtu.be/n-gtGIVddRg 7 Team Sentry https://youtu.be/nKM2cioNvcU 8 Team Water https://youtu.be/KF6Wnq1qMh8 9 Team Sediment https://youtu.be/SCISG5ppHOY 10 Team Benthos https://youtu.be/BOWxEiHLxLE 11 Coleman Telepresence https://youtu.be/CD3dJ75RuWg 12 Chris German https://youtu.be/XDb3YQ7zmI0 13 Pete Girguis https://youtu.be/QCa-HbSx0yw 14 Science Meeting https://youtu.be/aWX4TjUubk8	1 Data Management https://youtu.be/6I68y2u3i_s 2 Distributed Leadership 1 https://youtu.be/kieZawSlE7U 3 Distributed Leadership 2 https://youtu.be/1pNYkxVsCDw 4 Karl Bates Social Media for Science https://youtu.be/BsunMdmsWmg 5 Alvin and Sentry crews https://youtu.be/sTHKquFB5-Q 6 Dekas and Skarke cruise plans https://youtu.be/ClsaxS0fEKA 7 Dekas and Skarke Science Meeting https://youtu.be/FqcpEA-wqW4 8 Atlantis crew https://youtu.be/-ekDhDhKDDw 9 Logging Data https://youtu.be/8lhwovZUzk4 10 Science Meeting Wrap Up https://youtu.be/ur7thtoAkLg

APPENDIX 5. 'Remote' Participants (n=56)

Amanda Waite	University of Florida
HASHIM	UNIVERSITY OF NAIROBI
Marina Fernandez	Universidade de São Paulo
Hongzhi Song	Texas A&M University Corpus Christi
Nicole Bellaflores-Mejia	American Museum of Natural History and New York City College of Technology
Craig Dawes	American Museum of Natural History & New York City College of Technology
Sajjad Abdullajintakam	Texas A&M University Corpus Christi
Sheila Moaleman	American Museum of Natural History & NYC College of Technology
Samantha Goldman	American Museum of Natural History & University of Maryland, College Park
Travis Washburn	Texas A&M University - Corpus Christi
Caitlin Plowman	Oregon Institute of Marine Biology - University of Oregon
ELVA ESCOBAR	UNAM ICML
Erin E. Easton	Ecology and Sustainable Management of Oceanic Islands
Jamie Wagner	Duke University
Frine Cardone	Department of Biology, University of Bari (Italy)
KALYAN DE	CSIR-NATIONAL INSTITUTE OF OCEANOGRAPHY, INDIA
Donna Brugler	parent of scientist
Barbara de Moura Neves	Memorial University of Newfoundland
Luciano Gomes Fischer	Federal University of Rio de Janeiro (UFRJ)
Alastair Brown	University of Southampton
Stephanie Martinez-Rivera	University of Maryland Eastern Shore
kaiem frink	Virginia Union University
Kiana Frank	University of Hawaii
Phillip Turner	Duke University
Adelaide Rhodes	Oregon State University
Emily Young	University of Hawaii at Manoa
Katie Taladay	University of Hawaii at Manoa
Amy Gartman	USGS
Susan Lang	University of South Carolina
Santiago Herrera	Lehigh University
Erin Field	East Carolina University
Emily McCullough	Dalhousie University
Kiefer Forsch	Scripps Institution of Oceanography
Diane Adams	Rutgers
Michael Rappe	University of Hawaii
Matthew J Kupchik	Louisiana State University
Taylor Heyl	Woods Hole Oceanographic Institution
Claudia Geib	Nautilus Magazine
Andrew Mullen	UC San Diego, Scripps Institution of Oceanography
William Zachary Billings	RSMAS
Stephanie Sharuga	U.S. Fish and Wildlife Service
Abigail LaBella	Duke University Program in Genetics and Genomics
Alex Thornton	University of Alaska Fairbanks
Katherine Inderbitzen	N/A

Ryan Gasbarro	University of Victoria
David Emerson	Bigelow Laboratory
Lynn Waterhouse	Scripps Institution of Oceanography
Erin Eggleston	St Lawrence University
Luis O. Pomales Velázquez	University of Puerto Rico at Mayagüez
Guangyu Xu	Woods Hole Oceanographic Institution
Roxanne Beinart	Woods Hole Oceanographic Institution
Allyson Tessin	University of Michigan
Shima Abadi	University of Washington
Tim Shank	Woods Hole Oceanographic Institution
Heidi Waite	Duke University

APPENDIX 6. NOAA Office of Ocean Exploration: Educator Telepresence Immersion Workshop

University of Rhode Island, Narragansett Bay Campus
Inner Space Center
August 4, 2016
8:30 am - 4:00 pm

DRAFT AGENDA

Before Educators Arrive

0600	*Sentry dive complete; data analysis for next day's dive*
8:00	*Alvin launched from R/V* Atlantis

Educators Arrive

8:30 – 8:45	Introductions (P. Keener)
8:45 – 8:50	Day-at-a-Glance and Objective (P. Keener)
9:00	*ISC comes on-line with R/V* Atlantis
8:50 – 9:15	Review of NOAA Ship *Okeanos Explorer's* Systematic Ocean Exploration Strategy with a Focus on Telepresence (S. Haynes and P. Keener)
9:15 - 9:45	Overview of Shallop Canyon East Mission (D. Fornari and A. Skarke)
9:45 – 10:00	Break
10:00 – 11:00	Immersion into Shallop Canyon East Mission; conversation with Cindy Van Dover from R/V *Atlantis*; welcomes educators and converses with Dan Fornari (1 hr. training/planning session over link between ISC and R/V *Atlantis*) (D. Fornari, A. Skarke, C. Van Dover)
11:30	Recover Alvin Dive 1
12:00	Remove samples from Alvin
12:00 – 12:30	Lunch
12:30 – 1:00	Interaction with Young Scientists – Training the Next Generation (D. Fornari, P. Keener)
13:00	*1 hr. training/planning session over link between ISC and* Atlantis
1:30 - 1:45	*Launch Alvin Dive 2*
1:45 – 2:45	Group Reflections on Immersion Experience (P. Keener, S. Haynes)
2:45 – 3:00	Break
3:00 – 3:30	Group Reflections on Immersion Experience (con't.) (P. Keener, S. Haynes)
3:30 – 3:45	Final Reflections (S. Haynes, P. Keener)

Appendix 7 ECS Cruise Evaluation NOTES

Prepared by A Dekas, A Skarke based on 1.5-h group discussion

TRAINING

Two types of training: formal (lectures) and informal (conversations as needed). Competition for time and attention made the formal trainings difficult (especially the 11:15 daily session and during pre-mob). Informal trainings were more successful. Some sessions at the ISC (for just the people at the ISC) were really great. Doing it as the ISC is more effective than trying to do it simultaneously while sampling on board.

Webinars leading up to the cruise instead of packed pre-cruise training could be better. Alvin pre-brief worked well to do in advance – lots of agreement.
Having real data to work with makes learning even in seminars easier. So some of this would be hard to do effectively in advance.

Give people an opportunity to be chief scientist for the day? Or simulations of making hard choices in advance. [I like this idea!]

Maybe the co-chief scientists could talk about the experience and what was surprising, useful, etc.

Very helpful to have the mentors around to ask questions and discuss things one-to-one was really helpful.

Additional areas of training? More time to work with Sentry team to brainstorm and pitch ideas. Maybe even before the cruise we could have had more contact with the Alvin and Sentry teams to make sure we had the right equipment and fully use the equipment.

Note: Perhaps we should have a post-cruise assessment with ship leaders, chief scis, mentors, etc.

We could have used more formalized training in map making, especially the group that was on the ship second. This perhaps could be addressed before the cruise, maybe with a homework assignment to plan an Alvin Dive before the program starts. Maybe Adam Soule could be responsible for putting this information out there, a webinar, etc.

SCHEDULING / TELEPRESENCE

We were very ambitious regarding sampling. Did this compromise the training goals, or even safety?? Not everyone felt over-extended, but most did. If the cruises were longer, this would

have been an even bigger issue. Important to think about what is reasonable when planning a cruise. Important for good science, also to respect the crew.

If you have an extensive shipside deployment plan you can request an extra SSSG on proposals. NSF facilities people can help think through that.

We might not have had too may activities, but maybe not enough people for the activities. (Good to think about for cruise planning.) Also, get more efficient over time, so might have gotten easier.

Telepresence was a net time loss. There were many objectives to the cruise – maybe too many. Meeting fatigue.

The first telepresence group didn't know for sure how to be spending our time.

The idea of working through Sentry data to help plan Alvin dives was one of the original goals for telepresence that didn't really work out. So if we were to plan it again we might take a different approach to the ISC time.

If the work flow had worked out, with Sentry data going to shore and working through the data there to send back and inform Alvin dives, the ISC time would have worked out really well.

Technical issues made the bandwidth lower on this cruise – not a fundamental problem of telepresence.

People run the show differently on ships – sometimes everyone is invited to both daily meetings, other times only a smaller group. Trade-off is more time in lab, less awareness of cruise planning. For this experience, having everyone at the meetings is important, but can be done differently in other cruises depending on objectives / shifts, etc.

Hard to fully engage in all of the meetings due to how much was going on.

Hard to decide how much is necessary to bring everyone together versus let people work in labs.

SHIP CREW / SSSGs / CREW

The crew was great. People sat down with participants and explained things, very appreciated. Everyone was very professional and accommodating. Alvin and Sentry teams were particularly accommodating.

Some issues with SSSGs – a few instances on second leg when people were made to feel bad for things that were honest mistakes / misunderstandings / things no known. One example is the paper towel misunderstanding.

INTRANET

Intranet was mostly good, but some times were slow. Maybe a full day when elog was inaccessible. More information on where particular datasets are stored. Donna thinks it was one of the worst intranet experiences she had had.

Getting access to data is a problem. Only a couple people have access to dive videos at any one time; it should be easier to get. Not set up well to deal with the datasets coming off Alvin.

Writing letters to the DESC committee members about areas of improvement is a good idea.

SCIENCE COMMUNICATION

Activities at the ISC with the museums was really good – being thrown into a live interaction was a good growth experience. One leg wished they had more time with Karl, but it still seemed to work okay. Great to have Karl with us, good practice interviews. Would have been nice to have more, but can't have more of everything.

How about social media? Would we consider using social media on a cruise ahead of time? Some people here would. Our effort looked great, easy on our part and big impact. Where to highlight effort on social media? Lab websites are a good place to put that information. Also on CV, can have a section on news coverage of research. Faculty searches look for people who are savvy with modern technology / options so beneficial to have track records on these tools. Social media is important to scientists both to communicate with each other and to the public. Time of tweeting is important.

Based on this discussion…maybe more time to discuss the role of social media in science?

WHAT WOULD WE DO / NOT DO

Thinking more about how to use telepresence. A more specific strategy for how to utilize would be good.

What material do we send out? Live feed all the time, or shorter, more produced snippets?

There's a competition between what we want to do with data and outreach for time and band width. Need a definite plan in advance.

Both this conversation and the science in social media conversation show that there is still a lot to discuss here. Maybe more pre/post-cruise time?

Valuable to write a one page summary of what we each got out of this, for ourselves. Share if we want to with mentors, UNOLS, etc.

As our groups/teams we might work together to debrief what could be better, changed, etc.

Mentors could stay in same place so all participants get exposure to all mentors.

Could we have different chief scientists every day? Dan thinks unreasonable for making the ship work, but maybe we could have different people shadowing the chief sci each day. Also, was this is a specific chief scientist training cruise?

Being transparent is important for the training process.

APPENDIX 8 ECS Assessment Survey

Early Career Scientist (ECS) Assessment

Participant Information

Type of institution
- major oceanographic institution
- university
- state college
- other

Career stage
- graduate student
- postdoc
- assistant faculty
- associate faculty

Field of Expertise
- Major Field
  - Biological oceanography
  - Marine geoscience
  - Chemical oceanography
  - Physical oceanography
- Specialty (write in)
- *Open Comment Box*

Prior Seagoing Experience
- none
- 1-2 UNOLS cruises
- 1-2 non-UNOLS cruises
- 1-2 National Deep Submergence Facility (NDSF) cruise
- more than 2 cruises
- *Open Comment Box*

Prior NDSF Experience (all that apply)
- none
- HOV
  - Alvin
  - other
- ROV
- AUV

Open Comment Box

Prior proposal writing experience

none
1-2 proposals
1-2 seagoing proposals
more than 2 proposals, including seagoing
more than 2 proposals, none seagoing

Open Comment Box

Part 1. General Knowledge
Likert Scale: 1 - strongly disagree, 2 - disagree, 3 - neutral, 4 - agree, 5- strongly agree
THEN AND NOW

I was familiar with UNOLS, their website, and the UNOLS shiptime request system.
I understood what was required to obtain a foreign clearance.
I knew about the National Deep Submergence Facility and the assets it offers.
I was aware that cruise planning took place over the course of several months and included completion of a pre-cruise questionnaire and a meeting with ship operators.
I knew the capabilities of *Alvin, Jason, Sentry* and the process through which I could integrate my instruments to these vehicles, including pressure testing, gas testing (for in-Alvin components) power, data delivery, etc.
I understood how to develop a draft cruise plan, including mobilization, transit times, ways to maximize science outcomes related to the proposed effort using the ship and assets 24/7, demobilization.
I knew how to log samples, develop a useful cruise report, and meet NSF data management obligations.
I understood that work with the NDSF and ship operators was a collaborative effort that would benefit from really good communication beginning with the proposal preparation, during the cruise, and followed by constructive feedback after the cruise.
I knew that a seagoing NSF proposal should include statements of the research question(s), objectives, approaches, timeline, project coordination, and a data management plan, among other things.
I understood that I could discuss ideas for use of NDSF assets with the NDSF Chief Scientist during the proposal development process.
I knew that a shiptime request accompanied the proposal and that in it, I would also request the total number of days on station for Alvin, Jason, Sentry ops required, the size of the science party, and NDSF science berths required.
I understood the different roles of individuals in the NDSF teams.
I understood the different roles of individuals in the ship's crew.
I understood how NDSF vehicle position is determined and what affects the accuracy.
In my previous cruise experience(s), I was not able to observe most or any of the major decision-making processes.

Open Comment Box

Part II. Leadership
Likert Scale: 1 - strongly disagree, 2 - disagree, 3 - neutral, 4 - agree, 5- strongly agree

Since participating in this leadership program:

I am now better prepared to generate straw plans to guide team discussions toward a workable plan using NDSF assets.
I have a better understanding of how to develop and maximize sampling and data priorities of all scientific teams involved in a multidisciplinary cruise.
I appreciate better the benefits of delegating responsibilities to promote initiative and to achieve team goals.
This program gave me a new understanding of the value of transparency in how critical decisions are made regarding operations and how science prioritization takes place at sea.
I now understand the scope of planning that can be done during proposal preparation and in preparing for a field expedition.
I now realize that NSF, UNOLS, ship operators, and the National Deep Submergence Facility all are eager to work with me to develop credible proposals and to get the most out of the vehicle.
I feel I will be a more capable Chief Scientist at sea as an outcome of this experience.

Part III. Telepresence
Likert Scale: 1 - strongly disagree, 2 - disagree, 3 - neutral, 4 - agree, 5- strongly agree

I am now familiar with the potential of telepresence-enabled science.
I will likely use telepresence approaches in my field research within the next five years.
After this experience, I realize I cannot or do not wish to engage in telepresence-enabled research from shore.
Open Comment Box

Part IV. Science Communication
Likert Scale: 1 - strongly disagree, 2 - disagree, 3 - neutral, 4 - agree, 5- strongly agree

I have a better sense of the difference between communicating with scientific peers and communicating with members of the public.
I have a better appreciation of the value of working with my institution's news office.
I feel ready to tackle a science café or live museum presentation, talking about my experience with sea floor science assets such as Atlantis, Sentry and Alvin.
I feel I could handle an interaction with a policy maker or a funder who lacks my scientific background.
This cruise gave me more experience speaking in plain language with a bright light and a camera in my face.
I feel better about my ability to handle a video interview, should the opportunity arise.
I expanded my understanding of social media as a tool for scientific outreach.
I used social media to share my science with new audiences during this cruise.

Part V Knowledge Assessment: Details
Multiple responses for a question are allowed.

A UNOLS Ship Time Request (STR) form should be submitted

- ○ Before proposal is written
- ○ As proposal is being developed
- ○ After proposal is submitted to NSF
- ○ After proposal has been approved for funding

The most important criteria for a successful research proposal are:

- ○ clear definition of scientific goals and motivation
- ○ experiment design (both field and laboratory)
- ○ low budget

In selecting team members for your multi-disciplinary project, you should emphasize

- ○ scientific needs and a person's expertise in relation to project goals
- ○ a person's standing in the field
- ○ whether you agree scientifically with a potential collaborator

What control, if any, do you have over who might review your proposal?

- ○ none
- ○ I can suggest reviewers
- ○ I can indicate people who should be excluded

Who is responsible for scheduling shiptime for a funded NDSF proposal?

- ○ NSF science program officer
- ○ Institutional ship operator
- ○ PI of the proposal
- ○ NDSF Team
- ○ OCE facilities program officer

What should you do upon notification that your seagoing NDSF proposal will be funded?

- ○ Check/update STR
- ○ Start lobbying institutional ship operator for your time slot
- ○ Tell NDSF when you want to sail
- ○ Discuss scheduling options with science program officer
- ○ Start lobbying OCE facilities program officer for your time slot
- ○ Contact UNOLS office to discussion options

What is the difference between proposing use of NDSF vehicles vs other deep submergence (DS) assets?

- ○ Nothing
- ○ The NSF science program covers costs of other deep-submergence assets, the NSF-OCE facilities program covers costs of NDSF vehicles
- ○ NSF facilities program covers costs of other deep-submergence materials/transport and NSF science program covers costs of personnel for other deep submergence groups

You want to bring your own equipment/instrument on Alvin, what needs to be done?

- ○ Show up at departure port 2 days early to work with NDSF to integrate it with the vehicle
- ○ Pressure tests for pressure vessels and gas tests for in-hull equipment must be conducted to Alvin standards in a rated facility months before cruise

- Discuss plugs/connectors with NDSF group

Approximately how much terrain can Alvin cover in a single dive?

Approximately how much area can Sentry cover in a single swath bathymetry mapping mission?

Approximately how much ground can Sentry cover in a single photomosaicking mission?

What is/are the key factor(s) that determine the limit of resolution (size of object/feature detected) of observations achieved by a deep submergence vehicle?

What is the main role of telepresence for science?

- Save money by sailing fewer scientists
- Provide wider access to the seafloor
- Allow multi-disciplinary teams to work efficiently on research in remote regions
- Conduct marine research in a modern technological manner
- Distribute initial findings of a study in the fastest possible manner

What are the advantages of telepresence-enabled science?

Are there disadvantages associated with using telepresence-enabled science?

Evaluation of the training experience

most important thing(s) learned:
most important thing(s) still unclear:

What part(s) of training experience were effective

What part(s) of training experience were not effective and why?

What is the likelihood that you will continue a multi-disciplinary collaboration with ECS co-participant(s)

- unlikely
- possible
- likely

When do you plan to submit a proposal to NSF for a field program with deep-submergence assets?

- never
- within 1-2 yr
- within 3-5 yr
- several over next decade

To which agencies do you expect to submit proposal(s) using deep-submergence assets in the next 5 years? Check all that apply

- ○ NSF
- ○ ONR
- ○ NOAA
- ○ DOE
- ○ USGS
- ○ BOEM/MMS
- ○ Other (please name)

Did this program change your perception of the purpose, capabilities and availability of the UNOLS Fleet?
Very much
Moderately
Very little
Not at all

Did this program change your perception of the purpose, capabilities and availability of Deep Submergence facilities?
Very much
Moderately
Very little
Not at all

How did this program affect the likelihood that you will request ship time for future research? Increased
No change
Decreased

Were you able to complete useful research sampling or measurements on this cruise?
Very much
Moderately
Very little
Not at all

Did this cruise/telepresence help you to form new collaborations with other scientists?
Yes
No
Not sure

Did this cruise broaden your knowledge of oceanographic methods or techniques used by other disciplines?
Yes
No
Not sure

Were the mentors of the cruise helpful before and during the cruise/telepresence?
Very much

Moderately
Very little
Not at all

Do you feel you are now prepared to lead an oceanographic research cruise/telepresence?
Yes
No
Please explain your response

Would you recommend that the NSF and ONR support more training cruises of this kind?
Yes
No
Please explain your response

Please use the space below to give any other feedback on this program.

APPENDIX 9. Assessment, Remote Participants

I. PRE-CRUISE TRAINING (26-27 July)

1. To what extent did you tune in to the live feeds of the pre-cruise training sessions?
    - A few minutes
    - Most of Day 1
    - Most of Day 2
    - Most of both days

2. Have you or will you likely watch any of the archived video of the pre-cruise sessions?
    - Yes
    - No
    - If yes, please indicate which topics/sessions are likely to be most important to you as an ECS?

3. If you did watch the pre-cruise training sessions (archived or live), which content was most useful to you?
    - UNOLS content
    - NDSF content
    - Telepresence content
    - Science communication content
    - Science content
    - Other (please explain)

II. AT-SEA TRAINING

LEG 1 (Telepresence <<50% functional)

4. To what extent did you tune in to live feeds during the **first** leg?
    - 1 time
    - 2-5 times
    - 6-10 times
    - >10 times

LEG 2 (Telepresence >90% functional)

5. To what extent did you tune in to live feeds during the **second** leg?
    - 1 time
    - 2-5 times
    - 6-10 times
    - >10 times

6. If you tuned in more than a few times, which sessions were most useful to you as an Early Career Scientist?
    - Science planning sessions (usually around 1300h EDT; sometimes ad lib)
    - Training sessions (usually around 1115 h EDT)

Science debriefs (usually around 1830 h EDT)
Live feeds of launch and recovery
Other

Email updates

7. How useful were email updates of what was going on?
   Very useful; wish there were more of them
   Too much in-coming mail!
   Spotty – would have been of better use if updates were more regular.
   Please elaborate.

Twitter Feed

8. Did you follow #SeafloorSci?
   All the time
   Checked in every day
   Didn't look at all

9. If you did follow #SeafloorSci, was it
   Useful for following the science?
   Useful for outreach and science communication?
   Other value? Please comment.

GENERAL FEEDBACK

Please help us understand if you imagine a remote training opportunity for ECS during a cruise could be useful to ECS. What training would you find most valuable, that you could not get through some other means? For example, what recommendations do you have for the content, structure, and duration of such training during a cruise?