

I. Introduction and Overarching Goals

As a significant national and federally-funded science endeavor, IODP has an important role to play in its corresponding public outreach and science education. While the U.S. Science Support Program (USSSP) has a limited budget, its strength is in providing broad, specifically selected resources and opportunities that strategically target a wide range of audiences. Each component of the E&O program is firmly rooted in science education best practices and designed with these best practices, as well as past experience, in mind. This approach includes use of authentic data, inquiry-centered activities, and interdisciplinary explorations drawing from the activities of the IODP platforms (primarily the *JOIDES Resolution*) and related technologies.

The primary goals of the Outreach and Education program are to:

- A. Raise awareness of Earth science in general, and IODP in particular, and its central role in our understanding of the Earth's past, present and future. The primary audiences for these objectives are the general public, stakeholders (e.g., politicians and taxpayers), and students at all levels.
- B. Promote and support the science of IODP *specifically*, and assure a steady influx of future IODP leaders, by encouraging and providing opportunities for students and educators to participate in IODP expeditions and/or research. This activity targets primarily graduate and undergraduate students and their professors, and to a lesser extent K-12 students through their teachers.
- C. Inspire and help prepare students for careers in *general* fields of science, technology, engineering and math (STEM). The primary audience for this activity is K-12 students, again mostly through their teachers.
- D. Empower science educators to incorporate data and observations from deep ocean cores, allowing them to develop learning materials based on fundamental Earth system science concepts. This activity targets K-16 and informal science educators.
- E. Increase ethnic and gender diversity in IODP and geosciences in general.

Budget constraints dictate that our programs be carefully chosen, relatively small in scope, and as impactful as possible. Figure 1 (next page) maps each of our programs to the objectives described above. Figure 2 (page 3) maps each program to the audiences to which it is targeted.

	Raise awareness of IODP	Promote/support IODP science	Inspire/promote STEM learning	Utilize IODP data in classrooms	Increase Diversity
Onboard Outreach Program	✓	✓	✓	✓	✓
Ocean Discovery Lecture Series		✓			
School of Rock		✓	✓	✓	✓
Schlanger Fellowship Program		✓			
LDEO Summer Intern Program		✓			✓
AMNH Collaborations	✓	✓	✓	✓	✓
JOIDESresolution.org	✓	✓	✓	✓	
Social Media	✓	✓	✓	✓	
Community Update / Ocean Discovery Newsletter	✓	✓			
Conferences	✓	✓	✓	✓	✓
LDEO Open House	✓	✓	✓		
In Search of Earth's Secrets Exhibit	✓	✓	✓		✓
Port Call Outreach & Press Releases	✓	✓			
Core Loan Program	✓	✓	✓	✓	

Figure 1: USSSP E&O Programs mapped to overarching goals/objectives.

Because IODP is an advanced scientific program, it is sometimes argued that educational efforts should be geared exclusively toward higher level (i.e., undergraduate and graduate student) educational audiences. However, the importance of reaching pre-college audiences for science education, awareness and inspiration has long been extensively documented in the science education literature, pointing to the critical need to tap into natural youthful curiosity, establish habits of mind, expose young minds to possibilities and resources for the future, and future workforce possibilities and skills (Koballa & Crawley 1985; Rutherford, J. & Ahlgren A., 1990; National Research Council, 2012; Venville, G., et al., 2013; Jones, G., et al 2011). As the position statement of the National Science Teachers Association (2002) states, “In the last decade, numerous reports have been published calling for reform in education. *Each report has highlighted the importance of early experiences in science so that students develop problem-solving skills that empower them to participate in an increasingly scientific and technological world.*” [Emphasis added.]

USSSP provides both opportunities to sail and fellowships to graduate students, and maintains an undergraduate summer intern program. In addition, it encourages and supports its many sailing undergraduate faculty to create materials and opportunities for their students. But it also seeks to

promote science literacy, plant seeds, and build a STEM pipeline in high school and middle school audiences.

Similar rationales exist for reaching lifelong learners through informal science methods and venues (NSTA 2009), including museum exhibits, articles in popular media, and high quality multimedia products such as e-books, websites and video. Education of the general public remains critically important for public support of this federally-funded science program and needs to remain a high priority.

	K-12 Students	K-12/Informal Educators	General Public	Undergraduate	IODP Community/ Undergraduate Instructors	Stakeholders/ Policy Makers
Onboard Outreach Program	✓	✓	✓	✓	✓	✓
Ocean Discovery Lecture Series		✓	✓	✓	✓	
School of Rock	✓	✓		✓		
Schlanger Fellowship Program					✓	
LDEO Summer Intern Program				✓		
AMNH Collaborations	✓	✓	✓			
JOIDESresolution.org	✓	✓	✓	✓	✓	✓
Social Media	✓	✓	✓	✓	✓	✓
Community Update / Ocean Discovery Newsletter	✓	✓	✓	✓	✓	✓
Conferences		✓		✓	✓	
LDEO Open House		✓	✓			✓
In Search of Earth's Secrets Exhibit	✓	✓	✓	✓	✓	✓
Port Call Outreach & Press Releases	✓		✓	✓		✓
Core Loan Program	✓	✓		✓	✓	

Figure 2: USSSP E&O programs mapped to audience. (Note: stakeholders/policy makers refers to funders, local and national senators and representatives, and others in positions of influence.)

Assessments and evaluation

While USSSP does not have an overall external evaluator for its E&O programs, it is continually soliciting feedback from its users and advisors, including teachers, workshop participants, live event participants, sailing scientists, and E&O alumni to adjust and evaluate program quality and effectiveness. These assessments are conducted through online surveys, web analytics, in-person surveys, and informal discussions. In addition, starting in fall of 2018, USAC’s membership now includes an “outside” (i.e., non-IODP) *ex-officio* member with expertise in outreach and education who will provide external input and perspective on USSSP’s portfolio of E&O-related activities.

A comprehensive external evaluation of the outreach effort was conducted in 2011 while the program was still at Ocean Leadership. This evaluation included extensive review by an NSF-style external evaluation panel and was both time-consuming and expensive. If the program determines that the time is right to conduct this kind of review again, and budget permits, we can explore that possibility in the future. Several key findings are below, and it is based on these and recommendations by several prior iterations of USAC that have guided the development of the E&O program since that time:

“Our overall evaluation is that, within the limits of funding and staff, [IODP E&O] has been very successful. The wise decision to focus resources on the School of Rock (SOR) and Onboard Education Officer [now the Onboard Outreach Officer] has achieved two major goals. SOR has exposed teachers and their students to the science of IODP and stimulated the development of curricula and activities that place IODP in the context of STEM (science, technology, engineering, and mathematics) education for K-12 students. The Onboard Education Officer has filled an expanded function to serially bring the science, technology, and human elements of each expedition to a large constituency that includes the K-12 cohort, colleges, and universities as well as informal science educators and the general public. Both program elements serve a major fraction of IODP’s education and outreach constituencies.”

This report makes suggestions and recommendations that must be seen in the context of advice. The details should be considered by [IODP E&O] in making prioritized strategic decisions, but we accept the limitations imposed by budget constraints. It is apparent that current funding levels and staffing fall far short for optimizing the potential for, and value of, E&O impacts for the US Science Support Program (USSSP) program.

Recommendations for the School of Rock were as follows:

- *Attempts should be made to have at least six SORs per year.*
- *The number of teachers trained is small. To maintain momentum and expand the teacher base, more regularly scheduled SORs per year are desirable.*
- *From the perspective of IODP, SOR is an excellent base from which the science goals of the program may be widely understood.*

For Informal Science Education, the recommendations were as follows:

Because other budget priorities limit the amount of funds that may be dedicated to Informal Science Education (ISE), success will rely on the ability to leverage IODP resources through the development of partnerships. If expansion of the ISE platform is to occur, [USSSP E&O] must expand its current pool of committed

partners. New partnerships with science centers and museums, organizations such as Boy Scouts and Girl Scouts, public media outlets, public library associations, and others will enable the Deep Earth Academy [DEA, the E&O program of the U.S. Implementing Organization] to advance and sustain its ISE initiatives. These partnerships offer DEA an opportunity to engage multiple audiences, including those underrepresented in STEM fields, as well as the general public and lifelong learners.

It should be noted that while conducting continuous, long-term and wide-ranging external evaluations would be ideal, relying on the research literature and best practices in the field related to specific types of programs is an appropriate and widely accepted strategy in a resource-limited environment.

II. Overview of Each Component of the USSSP Outreach and Education Portfolio

A. Onboard Outreach Program

Key audiences: general public, science students and educators at all levels

The Onboard Outreach Program (OOP) gives formal and informal educators, artists, writers, videographers and other participants the opportunity to spend an entire expedition with an IODP shipboard party and translate their experiences for students and the general public via blogs, videos and other methods of outreach. One of the most successful components of this program, based on sheer numbers of people reached, is ship-to-shore live videoconferencing to classrooms, museums and professional conferences. Although we utilize this program with all audiences, these videoconferences are particularly popular with younger students, who do not often get to interact directly with scientists in the midst of the research process.

The overall objectives of the OOP program are to:

- Share the science stories of IODP expeditions to shore-based non-technical audiences in creative ways and raise general awareness of IODP science among students, teachers, families and the general public.
- Create synergistic relationships and projects between scientists and outreach personnel that lead to meaningful broader impacts for IODP science.
- Provide unique opportunities for education and outreach professionals to participate in IODP expeditions.

Recruitment strategies

Historically, the overwhelming majority of those sailing in the outreach role on the *JOIDES Resolution* were educators. Over the last several years, there has been a strategic pivot in the program toward outreach to the general public. As a result, recruitment efforts have expanded beyond purely education-oriented pools of candidates. New OOPs applicants are currently recruited through:

- IODP community listservs
- Education and mentoring listservs
 - National Science Teachers Association (NSTA)
 - NESTA and National Marine Education Association (NMEA)
 - Earth Science (ESPRIT)
 - Science Teachers Association of New York State (STANYS)
- IODP and related social media channels
- Word of mouth
- Museum and university mailing lists
- Columbia Earth Institute and Journalism School

The program continues to pursue new channels for recruitment. Recently we have begun using several science communication websites and groups to extend our reach.

Selection Process

USSSP E&O staff meet with the expedition management (Expedition Project Manager, co-chiefs) for each expedition at the pre-cruise meeting to discuss their needs and ideas about E&O prior to selection of the Outreach Officer. Special requests (e.g., for videography or other special skills) are considered. Similar to the process of staffing the shipboard science party, applications are reviewed by USAC and the USSSP E&O staff and a spreadsheet with rankings, along with the applications, are forwarded to expedition staff for review. The top few candidates are interviewed by the expedition co-chiefs, EPMs and USSSP staff via Zoom, and the *JOIDES Resolution* Science Operator (JRSO) issues the final invitation based on these interviews, in consultation with USSSP and in the context of the overall needs of the program.

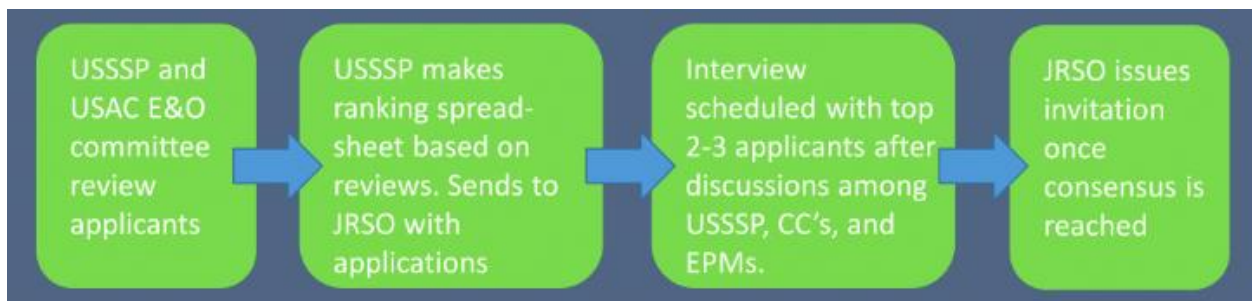
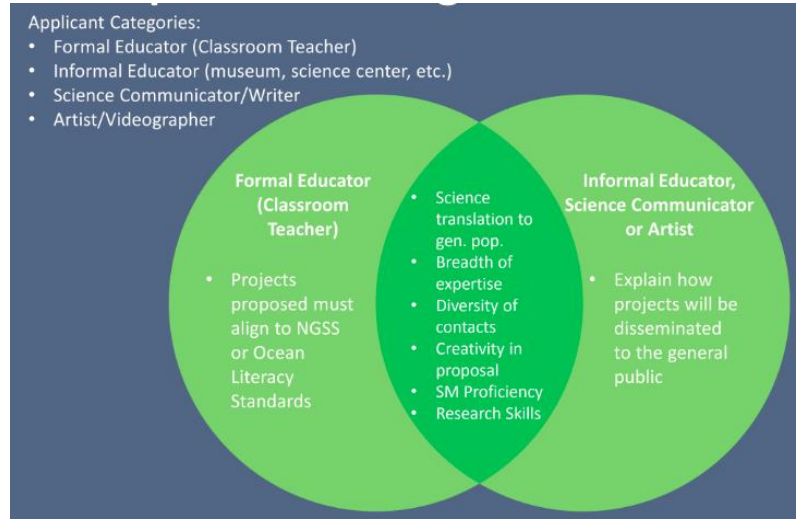


Figure 3: Summary of the Onboard Outreach selection process.

Once selected, Onboard Outreach Officers take part in an intensive 2.5-day training workshop conducted at the JRSO. This training, conducted by E&O staff, includes modules on how to use the joidesresolution.org website, how to conduct video broadcasts, rules and best practices onboard, existing resources and how to find them, and social media. Onboard Outreach Officers are also connected to E&O Officer alumni and the scientists involved in their expedition to ask questions beforehand. Holding the training of Onboard Outreach Officers at the JRSO allows them to meet technical staff, tour the repository, and become generally more familiar with IODP ahead of time.



In addition, all sailing Onboard Outreach Officers are furnished with an extensive how-to manual that contains a range of useful reference documents for everything they need to know while serving as an Onboard Outreach Officer on board. This manual is updated regularly with new information and ideas/feedback from Onboard Outreach Officers as they complete their assignments. A printed copy of the manual is given to them at the training prior to their expedition and is also stored on board in the Education office on the JR.



Figure 4: Introductory pages from the Onboard Outreach Officer training manual.

Since 2016, Onboard Outreach Officer staffing has comprised the following specialties:

- Formal Educator - 6 (1 from US, 5 from other PMOs)
- Informal Educator - 5 (3 from US, 2 from other PMOs)
- Science Communicator/Writer - 6 (2 from US, 4 from other PMOs)
- Artist/Videographer - 3 (all from US)

Metrics:

One key metric for the OOPs program is the number of viewers of ship-to-shore video events conducted during each expedition. (These events require significant bandwidth and can be inconvenient for the science party, so a careful balance must be struck between reaching the largest possible audience and respecting the wishes and needs of individual shipboard science parties. “More” does not always equate with “better.”)

	Number of Events	Countries	Total People Reached
Exp 356	28	5	1,300
Exp 359	32	13	1,378
Exp 360	129	15	5,753
Exp 361	67	9	5,600
Exp 362	62	8	2,804
Exp 363	72	9	2,754
Exp 366	38	3	1,678
Exp 367	102	6	6,986
Exp 368	49	9	2,290
Exp 369	41	9	1,514
Exp 371	60	13	2,583
Exp 372	35	10	1,256
Exp 374	68	11	2,726
Exp 375	41	9	2,531
Total	824		41,153

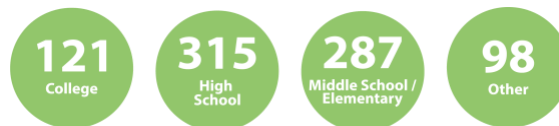


Figure 5: Statistics for ship-to-shore video events by expedition.

In addition, surveys are sent afterward to all live event shore-based group leaders to evaluate the quality of the programs from the user side. These data are used to continually evaluate and improve the video broadcasting component of the program. Over the last several years (sample size = 163 event leaders), the data have been as follows:

- Overall broadcast event experience: 4.78 (out of 5)
- Appropriate level of info presented: 4.59 (out of 5)
- Objectives were clear: 95%
- Met or exceeded expectations: 98.2%

Suggestions for improvement are mostly technical (e.g., improving sound/video quality) or making the event longer.

An open-ended question on the survey also asks group leaders to declare what local, state or national learning standard/objective was addressed through this video event. Since the viewing audiences range over many states and countries, it is a long list of individualized standards. It is clear from this feedback, however, that these events are helpful to almost every teacher in meeting the local standards for which they are responsible.

Additional metrics for the Onboard Outreach Program are collected in a number of ways. All OOPs participants submit a report of their accomplishments, along with feedback and suggestions for improvement. The reports are confidential because they contain specific names; however, they are used by staff to continually tweak the program and many changes have been implemented as a result of this feedback. The reports also provide a summary of broadcast and social media data for the expedition preliminary report, which is available online when published by JRSO.

A three-year summary report of the onboard education & outreach program was conducted in 2012 to gauge impact and effectiveness and solicit feedback on the program from the perspective of the onboard participants. It was based on focus groups, surveys and interviews. It is available online at <https://bit.ly/2lX6jWI>.

To evaluate the perception of the program from the science party side, the JRSO includes an E&O question in its standard survey sent to all the science party participants at the end of each expedition. The average rating (on a scale of 1-5) by recent expedition science party members for onboard E&O programs is shown on the next page. For all expeditions since LDEO assumed management of USSSP, the most common ranking has been “Excellent.”

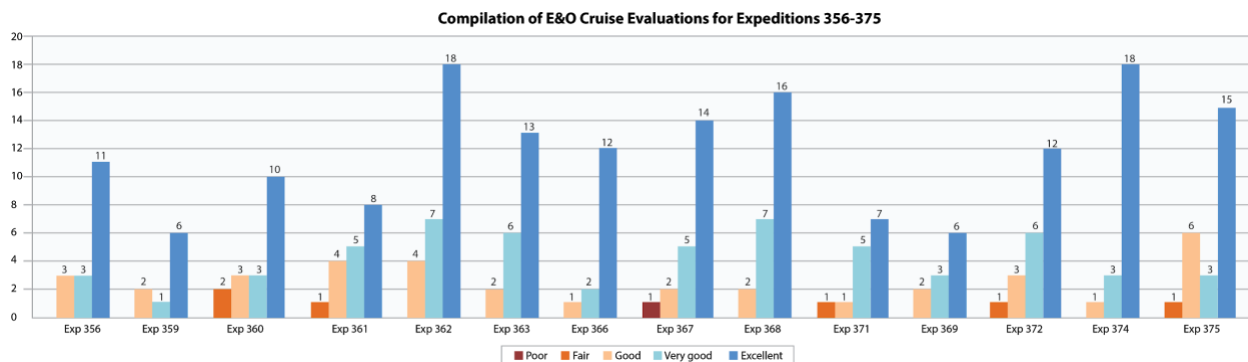


Figure 6: Compilation of E&O cruise evaluations for Expeditions 356-375.

Outreach Officer Products

Every Onboard Outreach Officer prepares a plan in which they propose the projects they will pursue onboard and afterwards. These plans are shared with the co-chief scientists and EPMs prior to the expedition and USSSP staff work with the OOPs to assist them in conducting their projects, ensuring they do not reinvent existing wheels and connecting them to other people with similar interests. Since Onboard Outreach Officers have in the past been paid very little relative to other science party members, and their post-cruise access to funds is also quite limited (i.e., they are not eligible for Post Expedition Activity award funds), USSSP has not always been in a position to enforce completion of these projects. That said, many useful products have been created, and Outreach Officer salary has recently been significantly increased. These products are peer-reviewed by both education and science experts, and best practices for that particular kind of product are utilized (e.g., for classroom activities, inquiry-based, data-centered, standards-based frameworks are used.) The joidesresolution.org website redesign has provided clearer access to these products (at least ones that are web accessible) along with the relevant expedition, and makes them searchable by topic as well.

In addition to the previous Onboard Outreach Officer products available on the joidesresolution.org website, a searchable hard drive database is now available for upcoming Officers. This hard drive is organized with the use of a cloud based spreadsheet service with filterable database features. Each resource is tagged with information, including a reference number, product type, intended audience, grade level, year produced, subject/topic, excerpt summary, and link to the webpage on the joidesresolution.org site or YouTube channel where the resource is found. This searchable database gives future Outreach Officers the ability to easily find previous resources to utilize for new projects.

Some recent and notable projects include podcast series, 360 degree ship tours, new classroom activities, board games, and a Climate Detectives module in collaboration with SERC. All of these products are available on joidesresolution.org.



Figure 7: Breakdown of products and resources produced by Onboard Outreach Officers.

B. Ocean Discovery Lecture Series

Key Audiences: Science Community/Researchers, Undergraduates

The Distinguished Lecturer Series was initiated in 1991 to bring the discoveries of the Ocean Drilling Program to students at the undergraduate and graduate levels, and to the geosciences community in general. It has continued through the Integrated Ocean Drilling Program and International Ocean Discovery Program, reaching thousands of students and scientists in all 50 states. Now called the Ocean Discovery Lecture Series (ODLS), it takes about two years for full implementation from speaker selection through the completion of all lectures within a given cycle. USSSP facilitates the program, maintains the records, assures quality speakers are selected, and selects host institutions that meet the program's goals.

Nomination and selection process

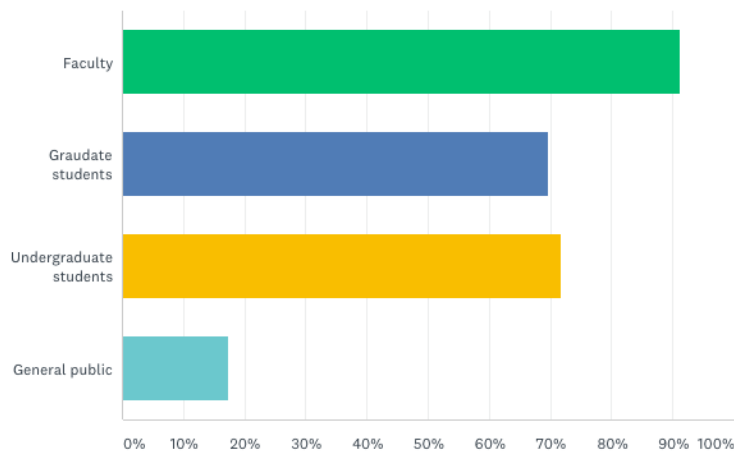
Each spring the IODP community is invited by USSSP to submit nominations for lecturers (and topics for lectures). Six lecturers are chosen from this group by USAC at its summer meeting. Care is taken to ensure that in the aggregate the full range of IODP themes is represented within the lecturer group. In addition, diversity of career length, gender and geography are pursued.

Preference is for a researcher to serve as an Ocean Discovery Lecturer only once, but scientists can serve more than once if they will speak on a new topic and if there has been a suitable amount of time (generally more than ten years) since their previous selection.

The following late winter/early spring, USSSP opens the application period for hosting a lecturer. The application period lasts 8-10 weeks. Once all applications to host a lecturer are received, USSSP reviews the pool and attempts to match requests with speakers, emphasizing institutions with little previous involvement with ocean drilling, geographic diversity, and, if possible, focusing on minority-serving institutions. This is a somewhat iterative process that involves back-and-forth with both lecturers and hosts. Once this process is complete, lecturers work directly with hosts to schedule the individual lectures, and then contact USSSP to travel to arrange their flights.

Metrics

USSSP received lecture requests from 61 potential hosts for the 2016-17 academic year, and 47 events were scheduled. For the 2017-18 series, there were 55 requests and ultimately 45 events that reached ~920 faculty, students, and members of the general public. For 2018-19, USSSP received requests from 74 institutions; final lecture schedules are not yet complete, but we anticipate there will ultimately be around 55 lectures.



ANSWER CHOICES	RESPONSES
▼ Faculty	91.30% 42
▼ Graduate students	69.57% 32
▼ Undergraduate students	71.74% 33
▼ General public	17.39% 8
Total Respondents: 46	

Figure 8: Audiences of the Ocean Discovery Lecture Series, as reported by the lecture hosts.

Host evaluations of lecturers are uniformly superior. On a scale of Excellent/Good/Average/Poor, responses have been 93.5% Excellent, 6.5% Good, and 0% Fair or Poor (weighted average 3.93/4, n = 46). Audience breakdown is shown above, on page 12.

In addition to presenting talks, Ocean Discovery Lecturers often meet informally with graduate and undergraduate students at group meals or elsewhere. These informal gatherings are often cited by hosts as being inspiring and extremely beneficial to the students.

C. School of Rock

Key Audiences: K-12 Educators, Informal Science Educators

The School of Rock (SOR) is a professional development program that has provided training to over 200 formal and informal educators since its inception in 2005. Strategically scheduled to capitalize on *JOIDES Resolution* transits, tie-ups or brief shipboard scientific programs when extra berths are available, the program provides participants the opportunity to work intensively with scientists, staff and educators to learn about the process and utility of scientific ocean drilling. During the program, “Rockers” work directly with the cores, characterizing and interpreting them as if they were scientists themselves. Most shipboard School of Rock programs last 9-14 days. If the drilling vessel is unavailable for a shipboard program, SOR events are held at the Gulf Coast Repository at Texas A&M University or another university. Curricula for the School of Rock vary from year to year depending on the specific cores available, the expertise of the instructors, or the program being carried out at sea. During and after the School of Rock, participants collaborate or work individually on educational products or programs for later use by themselves, their colleagues and educators worldwide; many of these products are archived on the joidesresolution.org website.

The School of Rock Program aims to:

- Provide educators with increased knowledge of IODP, Earth science, and ocean drilling processes, while highlighting related STEM (science, technology, education, and math) careers.
- Assist educators in becoming familiar with how IODP Earth science research relates to Next Generation Science Standards, Ocean Literacy Principles, and societal relevance by focusing on one or more of the IODP science plan themes.
- Create a cadre of ambassadors for IODP throughout the education community and a pathway through which to reach thousands of students

Educators are encouraged to share their experiences and translate IODP data, samples, and science into useful teaching resources for a wide variety of audiences, including K-12 students, museum visitors, families, undergraduate students, and the general public. IODP science and education resources are disseminated through one or more of the following: teacher workshops,

public lectures, presentations and demonstrations in classrooms or science/education conferences, social media, journal publications, or multi-media/internet-based products.

Recruitment and selection

School of Rock participants are recruited through announcements on IODP listservs, science education listservs (NSTA, NMEA, etc.), promotion at national and regional conferences, and via word of mouth. Candidates apply through USSSP’s FluidReview system and are selected through evaluation by the current program’s instructors (IODP scientists) and E&O staff in the context of the specific criteria for that year’s program, which may be related to a specific theme, target audience, partnership development and/or diversity goals. Diversity in geographic area and career level (early, mid, late) are factors in applicant evaluation. International applicants are usually included as well, though they are funded by their home country.

After the workshop, each participant creates products or programs useful to the audiences with whom they personally work. State standards are addressed within these individual products. Because IODP is a national program, no attempts are made to address individual state standards in published activities. (This is standard practice among similar national programs.) Instead, the focus is on addressing Next Generation Science Standards and Ocean Literacy Principles, since these are nationally-recognized and widely-used education standards.

An evaluation report was conducted in 2012 to gauge effectiveness and impact of the School of Rock; it is publicly available here: <http://joidesresolution.org/school-of-rock-2018/>. E&O staff rely on established best practices in professional development (Loucks-Horsley, et al 1998) when designing SOR and follow-up activities. By doing so, and continually soliciting feedback from our alumni, we ensure its ongoing effectiveness and impact.

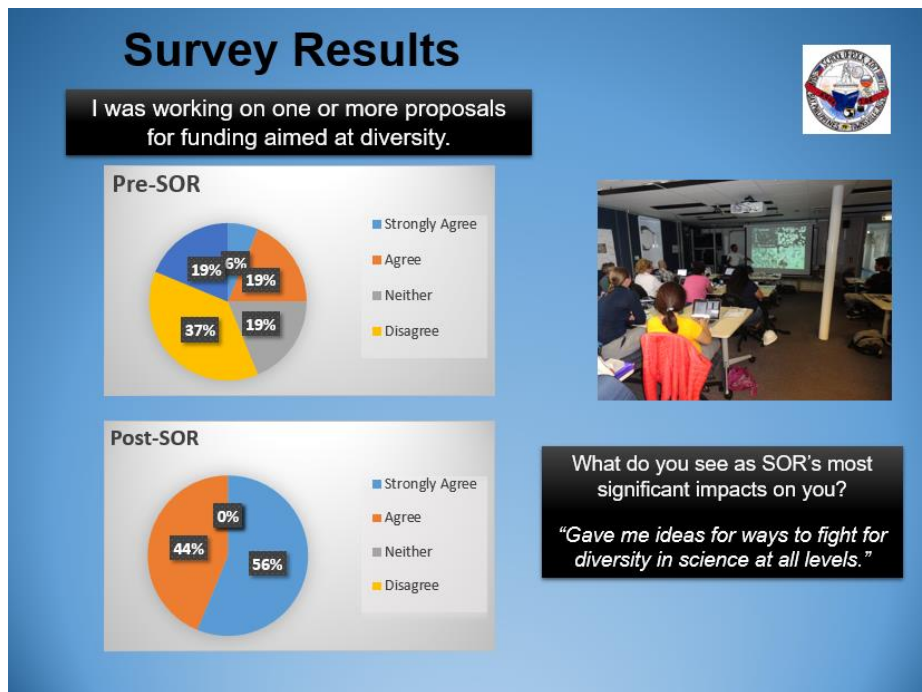
Evaluations of the School of Rock experience by program participants are universally positive. For example, the participant rankings for the 2016 SOR(n=16) included the following findings:

SOR “exceeded expectations”	100% of participants
Length of workshop “just about right”	100% of participants
Quality of instruction	4.8 (scale of 1-5)
Living on the ship	4.9 (scale of 1-5)
Quality compared to other professional development workshops	4.9 (scale of 1-5)

Many of the educator resources available on the joidesresolution website were produced by SOR alumni and vetted by the scientists with whom they worked, as well as USSSP staff. And significantly, School of Rock produces benefits not only for its participants, but for its instructors

as well. Instructors repeatedly mention how much they learn from workshop participants, and collaborations between scientists and educators have sometimes evolved from these workshops. By way of example, St. John and Leckie et. al. produced a comprehensive undergraduate-aimed textbook through a supplementary grant and as a direct result of their work on School of Rock. Entitled *Reconstructing Earth's Climate History: Inquiry-based Exercises for Lab and Class*, it is available through Wiley and Amazon and has been widely used: <https://bit.ly/2L3Aqqh>.

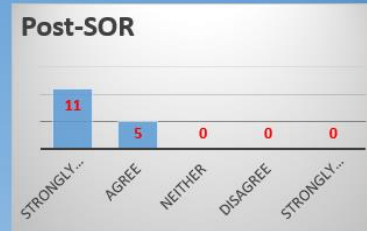
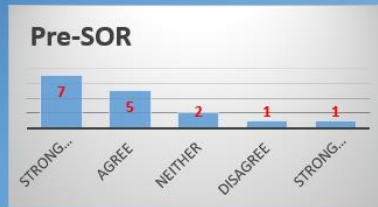
The 2017 School of Rock had specific diversity goals and action plans. The report from this workshop is available at <http://joidesresolution.org/wp-content/uploads/2017/06/SOR-2017-initial-report.pdf>. Preliminary results from the 2017 School of Rock have also been presented at several conferences (including GSA, AGU and Ocean Sciences and ASLO annual meetings in 2017 and 2018). It is clear participation in the School of Rock increases the profile of IODP in the classroom and that the focus on reaching underserved audiences in the 2017 School of Rock will likely advance the goal of bolstering the pipeline of a diverse group of scientists for IODP.



Survey Results



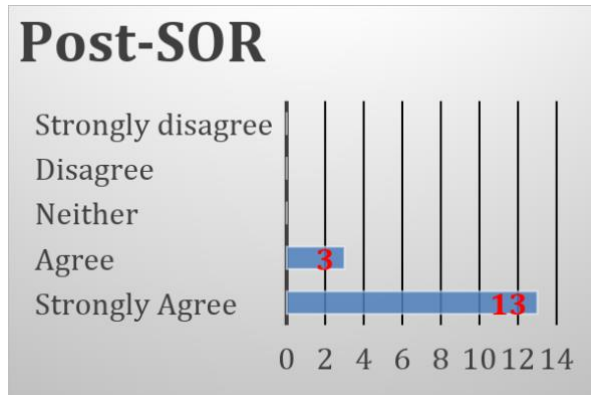
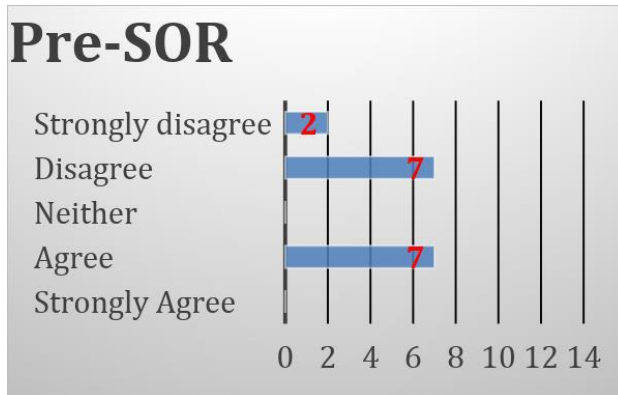
I plan to work with a nearby scientist/teacher to broaden STEM participation among underrepresented communities



What impacts do you see yourself having on others as a result of your experience during SOR?

“Striving for greater diversity among the geosciences.”

“I use IODP science in my teaching”:



Survey results from SOR 2017 evaluation surveys

It is a professional development best practice to hold follow-up workshops and activities after any given PD program. Although USSSP does not always have the funds to do so, we were able to hold a follow-up workshop from the 2017 SOR with supplementary funds available. This meeting was held in Victoria, British Columbia in mid-June 2018 and produced some exciting new ideas and developments, in addition to updates on the action plans developed by participants at the actual SOR. A report on this follow-up workshop will be available soon, but the updates given indicate that significant diversity/IODP-related activities are taking place at all of the sites from which the participants came.

In recent years, USSSP has been fortunate in securing supplementary funding from other sources to support School of Rock. This has been accomplished through cost-sharing, supplemental workshop requests to different directorates at NSF and through international collaboration. The result has been that *USSSP has not had to bear the full cost of Schools of Rock*, yet is still able to provide this unique and popular program. In 2018, LDEO received an NSF grant that will partially support School of Rock for the next three years, entitled “Ambassadors for STEM Training to Enhance Participation (A-STEP).” It is focused on enhancing diversity and participation in the geosciences and involves the University of California Museum of Paleontology (UCMP) and Stanford’s Consortium for the Public Understanding of Science (COPUS) as partners. The external evaluation that is a part of A-STEP will allow USSSP to integrate a fully-vetted evaluation into these Schools of Rock and produce subsequent papers and presentations from these data.

It is also worth noting that as a result of inviting international participants to past Schools of Rock, IODP’s European partners at ECORD/ESSAC have held a series of their own Schools of Rock funded by individual ECORD member countries. By sharing this program with its European counterparts, USSSP has contributed to the subsequent training of many more international teachers.

D. Schlanger Fellowship Program

Key Audiences: Science Community/Researchers

The Schlanger Fellowship Program, now in existence for over 30 years, provides exceptional students with a stipend of \$30,000 per year to pursue IODP-related graduate studies related either to specific IODP expeditions or broader themes of the program. Typically, these fellowships are awarded to 3-5 students per academic year. This program remains one of the linchpins of the IODP education effort and provides a critical mechanism for encouraging and developing young scientists with an interest in IODP.

Selection Process

Once per year in early autumn, USSSP issues a call for fellowship applications from graduate students. The call is announced via the electronic Community Update to the IODP mailing list, on the USSSP website, and on social media (Twitter and Facebook). In the last few years applications have numbered between 20-30.

A review committee comprised of a subset of USAC members, plus one or more outside reviewers, is tasked with providing initial rankings of the applications. The review committee then meets on the day before the winter USAC meeting to discuss, further evaluate, and reach

consensus on the candidates who will be offered fellowship awards. The decisions are presented to USAC during the winter meeting for further discussion and ratification.

Metrics

USSSP is incorporating all past Schlanger fellowship awardees into a comprehensive database that will also include the additional IODP activities in which they have participated.

Preliminarily, it is clear that many past winners have gone on to participate in IODP in numerous capacities, including on expeditions, as panel/committee members (including panel chairs), and as IODP lecturers.

E. LDEO Summer Intern Program

Key Audience: Undergraduates

Each summer, approximately 20-30 undergraduate students who are U.S. citizens or permanent residents are given the opportunity to be matched with LDEO mentors to work on scientific research in Earth or ocean science. In order to qualify for the program, students must be in their sophomore or junior year of college with a major in Earth or environmental science, biology, chemistry, physics or mathematics. Topics for study range over the entire Earth science spectrum, from sedimentary geology to petrology to the carbon cycle to volcanism. At the end of the summer, the students participate in a group poster session to present their findings to the LDEO community at large.

Since 2016, USSSP has provided funding for three undergraduates per summer to work with LDEO mentors on research that uses IODP cores or logs. Typically, two of these students are selected in part with the specific goal in mind of increasing diversity in scientific ocean drilling; targeting underrepresented minorities at the undergraduate level for early exposure to IODP is an effective way to provide opportunities to underserved populations and to cultivate future diversity within the program.

Selection Process

Each winter LDEO solicits project abstracts from prospective mentors, which are then published on the LDEO website for viewing by applicants. Applicants can apply for specific projects or simply express an interest in a certain facet of Earth science. Applications are reviewed by the mentors. Competition for the intern program is keen; around 150 applications are typically received for around 20-35 total intern openings. All applicants must have at least a B+ grade average.

Metrics

This program has an NSF-funded external evaluator. In addition, all USSSP-supported interns are individually tracked after they leave the program. However, because USSSP's involvement with the program is so recent, most of the USSSP-supported students are still undergraduates. Of the 2016 interns, one is now in a paleoceanography/geochemistry Ph.D. program at Rutgers University, and another will be attending graduate school (for a Master's degree in Earth and Energy Resources) at the University of Texas at Austin in the fall of 2018. Still another is a GIS Technician in Austin, TX.

USSSP also provides partial support for interns to present their findings at GSA, AGU or another professional conference. Most interns take advantage of this opportunity.

F. AMNH Collaboration

Key Audiences: General Public, Informal Science

Since 2015, USSSP has collaborated with the American Museum of Natural History (AMNH) in Manhattan to provide IODP-related speakers and participate in outreach efforts at various AMNH public events, both large and intimate. USSSP staff recruit and select IODP speakers and coordinate their participation in the events. These have included at least four events annually, such as:

- *Sun/Earth Day* (typically over 7,000 attendees). Past IODP speakers have explored topics such as Milankovitch cycles, climate change, ocean acidification, and the effect of ocean currents on climate. All have emphasized the crucial scientific and societal role that IODP plays in exploring these issues.
- The *Milstein Science* public lecture series (also typically over 7,000 attendees) presents three Sunday afternoon programs during the spring that provide visitors an opportunity to interact with scientists, learn about the ocean, and celebrate science under the iconic blue whale in the Milstein Family Hall of Ocean Life. This free series explores topics in biological, physical and chemical oceanography. The Milstein Series traditionally highlights the technology used to explore the ocean floor.
- Several youth enrichment programs for teens (typically 40-100 students). These involve talks by IODP scientists to student groups as well as booth displays that provide hands-on activities and the opportunity for the students to speak individually with IODP scientists.
- *Educator Evenings* (~200 educators) provide curriculum materials, demonstrations, and resources for the New York-area education community. Recent presentations by IODP scientists have focused on climate change and the impressive technology on the JR.

- *Dinos After Dark* is an adults-only annual event that provides after-hours access to the museum's fossil hall and sees on average ~700 guests. Since the inception of the event, USSSP has supported an IODP scientist each year to present preliminary results of IODP Expedition 364 to the Chicxulub crater.

This partnership provides IODP with a highly-visited venue through which to have contact with tens of thousands of members of the general public over the course of each year. The AMNH is a deeply respected and beloved institution in New York City that receives 5 million (extremely diverse) visitors through its doors annually, around 180,000 of whom attend some of the public programs described above. Over the course of each year, IODP is able to reach virtually all of its target audiences—students, teachers and the general public—with this carefully curated and collaborative series of programs.

G. Website (joidesresolution.org)

Key Audiences: General public, K-12, informal science

In 2017, the joidesresolution.org website underwent a significant redesign to address inconsistencies in page layouts and content hierarchy, difficulty finding educational resources, and ambiguity in audience priority. A committee was formed consisting of past Onboard Outreach Officers and School of Rock participants to assist in the redesign. The feedback and critique provided by this committee helped inform a cohesive and easily searchable database of our resources and content.

The new site launched in Summer 2017. A few notable improvements to the site include expedition hub pages which link to all resources developed by the outreach team and can be easily filtered by a set of parameters (expedition location, topic, year); an updated classroom and activities resources section; a comprehensive Research Vessel Tour section, including 360-degree videos and descriptions; and a Google Calendar with instructions for ease of use in signing up for live ship-to-shore broadcasts.

Metrics

The website is intended to reach the full range of IODP's target audience, including the general public, teachers and students. (The home page provides several gateways through which to explore the site's contents, depending on the user's needs.) Traffic averages around 120,000 page visits and 30,000 users per year. Users are of course primarily from the United States but analytics show that the site is accessed from populations in virtually every country in the world. In 2017 the website was named a "Top 50 Oceanic Blog" (#17 out of thousands) by Feedspot (https://blog.feedspot.com/oceanic_blogs/).



Figure 9: Expedition overview page on joidesresolution.org. Site visitors can filter expeditions via topic, region, or year. Each expedition button leads to an “expedition hub” page where all of the specific blogs, videos, and educational resources are stored in addition to information about the expedition objectives.

The joidesresolution.org website collects information on page visits for each educational resource. Overall, the books, craft activities, posters, and core kit products receive higher page visits compared to lesson plans because they have wider audience accessibility.

The top 10 viewed resources are:

1. Book, [Uncovering Earth's Secrets](#)
2. Lesson plan, [Sediment Deposition Supports Seafloor Spreading](#)
3. Core Kits, [Cretaceous Impact Kit](#)
4. Craft Activity, [Microfossil Knitting Patterns](#)
5. Book, Where [Wild Microbes Grow](#)
6. Lesson plan, [Understanding Seafloor Spreading with Nannofossils](#)
7. Games and Interactives, [Research Vessel Tour](#)
8. Core Kits, [Glacial/Interglacial Core Model](#)
9. Posters, [How Science Works](#)

10. Posters, [The “Hole” Story about Ocean Cores](#)

The lesson plans and resources available on the *JOIDES Resolution* website are also available on the Science Education Resource Center at Carleton College and the Carnegie Science Center resource portals.

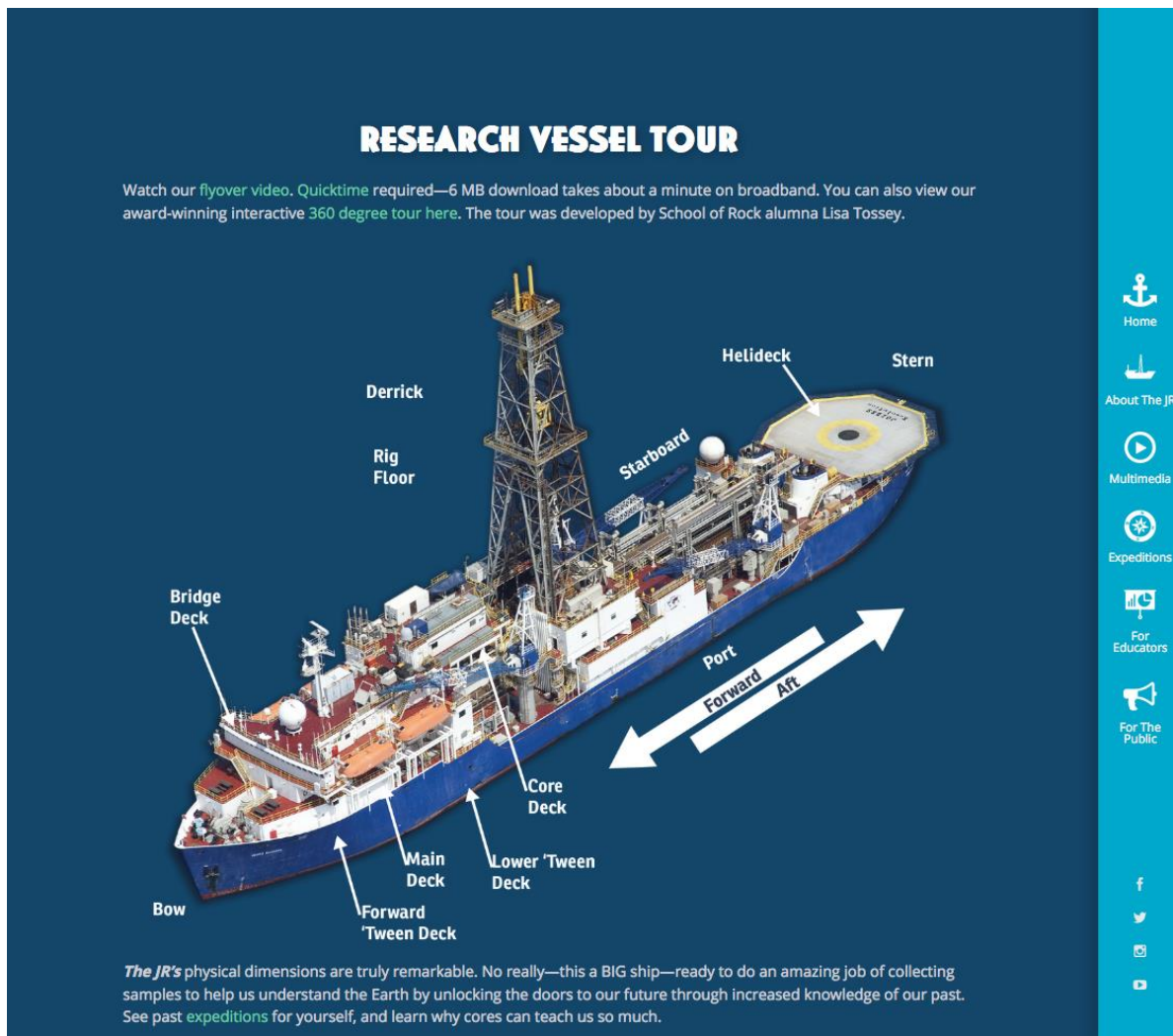


Figure 10: The Research Vessel Tour page houses interactive 360 videos and descriptions of the ship.

H. Social Media

Key audiences: general public

USSSP’s social media channels work in concert with the website and e-newsletters to keep the IODP community and general public informed about program opportunities and the science

taking place on the ship, as well as related activities (workshops, conferences, etc.). Social media offers a tool to quickly reach large numbers of interested members of the public to inform and educate them about our science, science process, life at sea, and upcoming opportunities to be involved. Content on all social media channels is produced by USSSP staff and by the Outreach Officers and various scientists aboard the current expedition.

USSSP runs a Facebook account, reaching 8,484 followers. Content on this page features short videos about life on board, directs followers to current blog posts written by scientists and Outreach Officers, and highlights new educational resources available on the website. The Facebook page is also used to promote calls for applications and other opportunities for the community.

The USSSP Twitter account (@TheJR) currently has 4,200 followers. Similar to Facebook, the JR Twitter handle is used to promote opportunities, links to the JR website, and “live” updates from the ship.

USSSP is also working to increase the audience base through Instagram. Starting at 641 followers in 2016, the JR Instagram account now has 1,176 active followers. This photo and video based platform provides the Outreach Officers with a means to share visually appealing content from the JR.

The JR YouTube channel houses 190 video resources grouped by expedition and topic. These videos often link back to the joidesresolution.org site for additional information. To date, the YouTube channel has 275 subscribers with the most frequently watched video receiving over 14,000 views. (Visitors to the JR YouTube channel may note that some of the “views” numbers are quite low; this is simply an artifact of the fact that most of the videos were (and still are) also housed on the Ocean Leadership YouTube channel, where they have many more views. When they were moved over to the JR channel, the counts began again from zero.)

The USSSP social media portfolio also includes expedition-related “Ask Me Anything” (AMA) events, hosted on the Reddit platform. Here, co-chiefs and other expedition scientists interact directly with interested members of the general public who ask questions that are upvoted/downvoted in order to prioritize them based on public interest. AMA interactions are then archived by Reddit for permanent access; links to the events can be found on the joidesresolution.org website.

I. Community Update E-mail list/Ocean Discovery Newsletter

Key Audiences: Science Community/Researchers

USSSP distributes a biweekly electronic newsletter to inform subscribers about current research activities of the *JOIDES Resolution*, *Chikyu*, and mission-specific platforms, as well as

community meetings and events and opportunities to apply to sail and attend community workshops. Additional targeted mailings are sent out on an ad hoc basis. There are currently about 1800 national and international subscribers. During the 2017 reporting year, around 100 messages were issued to mailing list subscribers.

USSSP also publishes a twice-yearly newsletter for the U.S. IODP community, entitled *Ocean Discovery*. This is available digitally from the USSSP website, and paper copies are distributed at outreach venues such as scientific and educational conferences, museum events, and open houses. The newsletter provides previews and reviews of upcoming and recent expeditions, workshop reports, letters from community leaders, outreach reports, ship tracks and schedules, and other information of interest to the U.S. IODP community.

J. Conference Outreach/Presence

Key Audiences: Science Community/Researcher

USSSP staff maintain a presence at major science and education conferences annually. These include: the annual Fall meeting of the American Geophysical Union, the annual meeting of Geological Society of America, the annual National Science Teachers Association (NSTA) conference, and several regional and state meetings.

Specifically at NSTA, USSSP regularly participates in “share-a-thons” which are high-energy venues for science education colleagues to share their favorite classroom-ready lessons, activities, labs, and interactive games with colleagues from around the country. Attendees of these events receive a brief synopsis of IODP, available activities and opportunities. Share-a-thons typically see 200 teachers during a 1-hour session. At each NSTA conference, USSSP participates in the following share-a-thon events: National Earth Science Teachers Association (NESTA), NSTA High School Educators, Community Connections, NOAA Ocean Climate and Weather, and Cultural Connections: eARTH Science.

In addition to the share-a-thon events, USSSP staff also chair conference sessions and give presentations relating to improving undergraduate STEM education, advancing diversity in the geosciences, expanding the geoscience pipeline, and reaching underserved communities through art and the geosciences—all with IODP connections. These presentations allow IODP to create, maintain, and showcase leadership in the national and international issues facing geoscience education broadly. They also provide opportunities for IODP Outreach alumni and scientists working on outreach projects to present their work within the context of nationwide science education discussions. Recent examples include:

- Cooper, SK and Lewis, J.C., 2017. *Improving Undergraduate STEM Education and Advancing Diversity in the Geosciences—How Are We Doing?*, co-convener of this session for the GSA Northeastern Annual Section meeting, Pittsburgh, PA.

- Cooper, SK, Lewis J.C., Leckie, R.M., Hovan, S.A., White, L.D., 2017. *Workshop Initial Report: Expanding the Geoscience Pipeline by Connecting Educators with Early Career IODP Scientists*, abstract to be presented at the GSA Annual Meeting in Seattle, Washington, 22-25 October.
- Lewis, J.C., Cooper, SK., Jones, B, ED22B: Diversity in the Geoscience Community: Expansion Is Necessary: AGU Fall Meeting Dec. 2017
- Ellins, Kathy, Brey, J., Waller, J., Cooper, S., The Role of the Arts in Geoscience Learning and Teaching, AGU Fall Meeting Dec. 2017

These meetings provide the opportunity to do in-person outreach to the community, promote upcoming opportunities to apply to sail, serve on committees, propose or attend workshops, apply as Outreach Officers, and to participate in the program in other ways. Although no formal evaluations are held, the IODP booths at these events usually see steady traffic and continuous engagement of attendees throughout their duration. Numerous applications to sail in all capacities and new collaborations are results of conversations held at these booths.

K. Core Loan Program

Key Audiences: K-12 and Informal Science Educators

USSSP loans core models and interactive kits to educators for use in formal and informal education settings. A full list of core models, descriptions, and associated materials/lesson plans available for each core can be found at <http://joidesresolution.org/teaching-kits-and-models/>. The core loan program aims to provide models to assist teachers and other educators in investigations of IODP data.

The Core Loan Program and policy was updated in Fall 2016 and saw a sharp increase in activity after the launch of the new website. In 2017, USSSP loaned these cores to 15 different venues around the United States and has fulfilled 23 requests to date in 2018. Venues that request these core models vary from university/community colleges to high school and elementary schools to museums/festivals.

Metrics

Once the replicas are returned, borrowers are asked to fill out a survey describing how the cores were used with the intended audience. Most frequently, core replicas are used with students learning about the *JOIDES Resolution* and studying data sets from IODP research. The models help students better relate to the coring process and how scientists observe sediments to collect data.

L. In Search of Earth's Secrets / Public Science Events

Key Audiences: General public, stakeholders, informal science audiences

Stemming from earlier recommendations to expand its reach through partnerships and informal science education efforts, IODP E&O was able to secure a \$2.7 million grant from NSF's Advancing Informal Science Learning (AISL) program under the EHR directorate. This project – *In Search of Earth's Secrets* – is a partnership between Ocean Leadership, LDEO/USSSP, TAMU, University of Hawaii, and Rutgers, in addition to a variety of small museums, libraries and Girl Scout/youth serving organizations nationwide.

The project uses the JR and its science to intrigue, engage, and inspire informal science audiences across the nation. The hypothesis of *Earth's Secrets* is that well-designed and facilitated “Pop-Up Blitzes” (“PUBs”) and “Drill Down” opportunities at museums and libraries in carefully selected locations will provide an effective mechanism for increasing STEM learning access among underserved minorities, rural populations and girls—and create a broadly applicable model for doing so in other science fields.

The goals of the project are to:

- Increase access to and awareness of ocean/earth science and careers, especially in disadvantaged communities, by bringing the activities, exhibits and scientists themselves to non-traditional venues ranging from block parties, local festivals, malls and parking lots to libraries, museums, and science centers.
- Create a sustainable model for STEM learning in informal environments.
- Increase interest in the scientific drilling and research activities of the *JOIDES Resolution* among the general public (children, teens and adults) who attend the PUBs and Drill Down events.
- Foster partnerships between educators and scientists that lead to broader dissemination of scientists' research and the larger vision of NSF.

Earth's Secrets consists of a set of 6 interactive kiosks focused on individual IODP-related science topics, a giant floor map of the ocean floor with associated graphics and activities, and a 45-foot inflatable replica of the JR with a video wall presentation inside. Each community that receives the exhibit also works with local Girl Scout and youth-serving organizations to train them on exhibit content so they can serve as docents for events with the public. These events also provide opportunities for scientists to participate as volunteers to help interpret the content, give evening lectures at local partner libraries and small museums, and be a part of live ship-to-shore connections with the JR. *Earth's Secrets* has its own advisory committee made up of IODP scientists, museum/informal educators, and science education professionals.

After a year of development and exhibit fabrication, the project launched in 2018 for a tour at three locations: Martinsville, VA, New Brunswick, NJ, and Brooklyn/Queens, NY. It has been met with enthusiasm and excitement at all of the locales. At the present time, the number of people who have experienced the exhibit numbers in the thousands for this year alone.

In addition to participation in *Earth's Secrets*, USSSP facilitates IODP content as a part of other public events, including the Lamont-Doherty Earth Observatory Open House each fall and other public events in the New York area. The LDEO Open House receives around 4,000 visitors per year.





Metrics

A professional evaluation team is an integral part of the project and is conducting surveys on impact and effectiveness. These reports will be available after the first full year of implementation. Applications for three new sites for 2019 are currently being reviewed.

Several articles on the project have appeared in local media:

https://www.martinsvillebulletin.com/news/a-deep-dive-martinsville-plays-host-to-national-exhibit/article_8e0a8b61-89a2-5613-a516-dce6ca696e07.htm

<https://www.tapinto.net/towns/summit/articles/rock-stars>

M. Port Call Outreach and Press Releases

Key audience: General public, media

As currently organized, IODP has no centralized structure for issuing press releases. However, when possible, USSSP facilitates collaboration between the public relations/outreach teams at selected universities and NSF/MGG's media office. This process results in press releases that are issued jointly by both parties and can significantly increase interest in *JOIDES Resolution* expeditions, especially on the part of the media. This approach reached its apotheosis for Expedition 371 (Tasman Frontier), in which members of the media were informed about upcoming drilling at "Zealandia" and invited to access video footage shot by the Onboard

Outreach Officer, a professional videographer. Over 153 different media outlets from around the world ran stories on the expedition.

III. Conclusions

This white paper was prepared with the intention of shedding light on the processes, frameworks, and assessments through which the USSSP outreach and education departments operate. Though constrained by budget limitations, these departments has created and maintained a set of diverse and high quality programming over the 15+ years of their formal existence within IODP. The strength of the overall approach lies in strategic focus on a specific set of programs, forming partnerships, maintaining relationships with its alumni network, searching out supplementary funding sources, and seeking leveraging possibilities wherever possible. Improvements and feedback are constantly solicited and the small size of the program means that it can be responsive and flexible. Input, new ideas, and creativity are always welcome.

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