

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) outreach and education program 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. As the position statement of the National Science Teachers Association 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, 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 will include an “outside” (i.e., non-IODP based) *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.

II. Overview of Each Component of the USSSP Outreach/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

	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

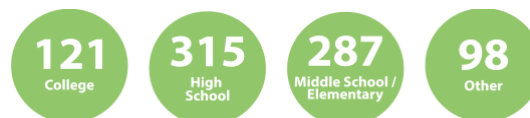


Figure 3: Statistics for ship-to-shore video events by expedition.



Figure 4: 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.

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.

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 this 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.

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.

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, reaching tens of thousands of visitors, students and teachers.

G. Website (joidesresolution.org)

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

The joidesresolution.org website has recently undergone 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.



Figure 5: 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.

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, (~9,000 followers), Twitter account (@TheJR; ~4200 followers) and Instagram account (~1200 followers). The JR YouTube channel houses 190 video resources grouped by expedition and topic.

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.

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.

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.

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 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.





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 150 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 frameworks and programs through which the USSSP outreach and education department operates. 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.