

Communicating Ocean Sciences to Informal Audiences (COSIA)

Case Studies

Introduction to Three COSIA Case Studies	1
UC San Diego/Scripps Institution of Oceanography & Birch Aquarium.....	3
Hampton University & Virginia Beach Aquarium	16
Rutgers University & Liberty Science Center	31

June 2010

Inverness Research

Introduction to Three COSIA Case Studies

Inverness Research

June 2010

The following three case studies are descriptive and evaluative in nature, and are designed to describe, explain, and portray in some detail three examples of COSIA partnerships. These cases are context bound; the place-based aspect of these cases is critical to the phenomenon being explored. Consistent with the goal for employing a case study approach for COSIA (Communicating Ocean Sciences to Informal Audiences) is the approach of investigating a phenomenon within the context of the places and partners involved. While each of these COSIA partnership sites are involved in other important and related efforts—including the Centers for Ocean Science Education Excellence (COSEE) initiative—these cases focus on their COSIA work.

Purpose of these case studies

- To **provide a portrait of COSIA partnerships** that are illuminative to COSIA leadership, partners, and NSF, as the partnerships function on the ground. To illustrate the real benefits and challenges of such work, and perhaps most importantly, to capture what it is about the nature of the inner-workings of these partnerships that enables them to be effective, despite the variation among them
- To portray how institutions collaborate fruitfully despite different cultures and missions
- To **describe first-hand and through the work itself the nuances and working relationships of each context**
- To **illuminate different types of partnerships**, to show the range of forms that these partnerships can take
- To **clarify attributes of the partnerships** that contribute to or challenge their success
- To **shed light on the role the central organizing and administrative center**, the LHS, in creating and sustaining such a network of partners

Audience for these case studies

- The primary audience is the ***COSIA leadership*** at Lawrence Hall of Science. The case studies will inform their development of a future strategies and programs by describing the benefits and challenges of COSIA partnerships and identifying tools for effective partnerships.
- The **leaders and staff of both *IHEs* (Institutions of Higher Education) and *ISEIs* (Informal Science Education Institutions)** who are COSIA partners. The case studies will provide feedback and various perspectives on this particular form of partnership for participating and interested institutions. This information will allow participating institutions to reflect on their own work and to calibrate the nature of their work with that of other participating institutions.
- The **National Science Foundation**. The case studies will provide information on the initial investment, as well as make the case for NSF making additional investments.

Methodology

A naturalistic, qualitative approach was used in gathering data and generating these case studies. The data for these case studies includes direct observation from site visits, interviews, and review of documentation and archival records (including websites and reports). Primarily, these cases rely on interview data, including those with COSIA instructors from both ISEIs and IHEs, COSIA students, institutional administrators and department leads. Data was collected over time, from 2006 to 2010, through partner conference calls, telephone interviews, focus groups, and attendance at key orientation and annual partner meetings and workshops; however, the cases are significantly influenced by data collected during two to three day site visits in 2008, 2009, and 2010 during which we observed classes, aquarium activities, and in some cases, the typical workings of these marine science institutions.

Context and introduction

Again, one cannot discuss the workings of the COSIA partnership and course without carefully considering the context within which it is being offered. To orient the reader to each case we have organized some introductory material. Each case introduction includes: (1) a compelling quotation or two from individuals at the site that seem to capture an essence of the case; (2) an “At a Glance” overview of the case, which includes some general information; (3) and finally, there is a table of contents for the case that is intended to guide the reader in terms of how the case is organized (which is slightly different for each case). These introductions may enable readers to relate the cases to each other or to quickly identify cases of particular interest.

COSIA
Case Study
UC San Diego/Scripps Institution of Oceanography
& Birch Aquarium
June 2010
Inverness Research

No matter what, it doesn't have to be an outreach career in order to have an outreach component.

Most of the faculty assume that every single student is going to go onto an academic research position, which I don't think is necessarily true. And so the faculty struggle to see the value of a course like this, especially relative to other courses that they want their students to take. We are gradually trying to chip away at that mentality and help people have a better understanding of what the course is about.

Overview of this COSIA partnership
(At-A-Glance)

I. Background Information

- Collaborating Institutions: Birch Aquarium and Scripps Institution of Oceanography at the University of California, San Diego
- Engagement with COSIA began: 2007
- Leadership
 - From Scripps: Science Education Specialist (a hybrid position); Co-Director, Scripps Center for Educational Outreach Connections
 - From Birch Aquarium: Education Manager, Public Programs Coordinator, Executive Director, Interpretive Coordinator
- Course Characteristics/Audience
 - Course is held at the Aquarium
 - Course is taught by the Education Manager from the Birch Aquarium and the Science Education Specialist from Scripps
 - Students are both undergraduates and graduate students
- Affiliated/Leveraged projects and funding
 - COSEE California
 - COSIA Network
 - Two GK-12 projects
 - Sea Grant funding

II. Distinguishing/Defining Features of this Case

- Here COSIA is a partnership between a very large, world-renowned ocean science research institution and an aquarium that exists to serve as an outreach facility for Scripps
- COSIA helps pull students into using the Birch space in a different way
- Prior to COSIA, the relationship between Scripps and Birch was primarily a one-way relationship

III. Core benefits/outcomes/returns on the investment

- The course is a natural Broader Impact opportunity offered through Birch
- The course has influenced some scientists' thinking
- Student demand for the course has been overwhelming
- The course has increased the profile of Birch Aquarium for scientists at Scripps (they see the aquarium educators have professional expertise)
- The course has shifted the dynamic of influence in this partnership (it has increased Birch Aquarium's influence on Scripps, as opposed to Scripps always influencing Birch)

IV. Core Challenges/Lessons Learned

- Convincing some scientists at Scripps that the work of COSIA is valuable can be a challenge
- Scripps is first and foremost an institution that prepares future R1 science researchers
- Gaining institutional and financial support for the course has been a challenge
- Ten week "quarter" system at UCSD meant that the original COSIA course material had to be condensed
- COSIA Central (at Lawrence Hall of Science) supported the partnership and allowed the course to be adapted so that it could continue at this site

Table of Contents for this Case Study Report

Scripps Institution of Oceanography

Birch Aquarium

Partners in COSIA

Challenging long-held beliefs about preparing scientists

Reasons to be optimistic

Tangible benefits

Leveraging COSIA

Enduring partnership

This partnership as a case of...

Scripps Institution of Oceanography

For the past 100 years, the impressive Scripps Institution of Oceanography (SIO) has sat high on a cliff in San Diego, overlooking the Pacific Ocean. Scripps is steeped in history and it is arguably the most famous and iconic of all institutions for oceanography. Known for being the nation's first multidisciplinary oceanographic institution, SIO was also the first permanent, year-round marine laboratory established in the western hemisphere.

Scripps Institution of Oceanography is one of the oldest, largest, and most important centers for ocean and earth science research, education, and public service in the world. Research at Scripps Institution of Oceanography encompasses physical, chemical, biological, geological, and geophysical studies of the oceans and earth.

In 1844, the Scripps, a newspaper publishing family, left London for the US, where E.W. and his sister Ellen Browning Scripps (siblings) met William E. Ritter, a zoologist who sparked their interest in zoology and marine science. In 1903, together with Ritter and local civic leaders, E.W. and Ellen Scripps founded the Marine Biological Association (MBA)—which would become the immediate predecessor to Scripps—with the ultimate goal of creating a permanent marine biological institution, public aquarium, and museum. From 1903-1904, the MBA was housed at the Hotel del Coronado, and in 1905-1909, it occupied a small lab building near La Jolla Cove. In 1907, E.W. Scripps selected an undeveloped parcel of San Diego city land, north of the village of La Jolla, to be the permanent home of the institution. He persuaded the city of San Diego to auction the land and then convinced local developers not to bid against the institution. Ellen Scripps, donated the \$1,000 needed to pay for the land, which was appraised at \$30,000-50,000. As a single woman with no children, Ellen would continue as Scripps' most ardent supporter in the early days, serving on its board, leaving it a large endowment, and providing all the money needed to build the 1,000 foot long Scripps Pier. The Pier (and its newer replacement in 1988) have been used to collect daily water samples, which provide the longest continuous surface temperature record in the world, and it is still used to collect fresh seawater for the laboratories and aquaria.

Scripps is, in a sense, an institution within another institution. It became a keystone department of the University of California in 1912, and in 1925, it was renamed Scripps Institution of Oceanography, to acknowledge its evolution from a biological field station to an oceanographic institution. In 1932, Scripps received its first grant from a foundation—Rockefeller Foundation—to help build Ritter Hall, named after the first Director of the Marine Biological Association (MBA) of San Diego. A \$40,000 grant from the Rockefeller Foundation helped to create the organizational plan for a sister institution on the east coast, which became Woods Hole Oceanographic Institution (WHOI) in Massachusetts.

The mission of Scripps is to seek, teach, and communicate scientific understanding of the oceans, atmosphere, Earth, and other planets for the benefit of society and the environment.

It wasn't until 1960 that the UC Board of Regents established a San Diego campus of the University of California and associated itself with Scripps. Currently, SIO exists within UCSD, which exists within the system of the UC Regents. In 1995, The National Research Council named Scripps number one in faculty quality among oceanography graduate programs. Interim Director of Scripps in 1996, Wolfgang Berger was the first director to actively promote educational outreach to the community. Today, Scripps boasts a staff of more than 1,500, including approximately 100 faculty members, 300 scientists, and 225 graduate students. There are more than 300 research programs in more than 65 countries in effect through Scripps, which now has an annual budget of more than \$140 million. The Nimitz Marine Facility houses Scripps' four research vessels.

The vision for Scripps is to be an international leader in originating basic research, in developing scientists, and in advancing the science needed in the search for a sustainable balance between the natural environment and human activity.

Dr. Tony Haymet has been the Director of Scripps Institution of Oceanography, Vice Chancellor for Marine Sciences, and Dean of the Graduate School of Marine Sciences at the University of California, San Diego, since September 2006. He earned a Ph.D. from the University of Chicago and a Doctor and Bachelor of Science (Honors) from the University of Sydney. The education specialist at Scripps, who we interviewed several times for this case study has his master's degree in Ecology and Environmental Science.

Birch Aquarium

The Birch Aquarium at Scripps' (BAS) hilltop site provides a spectacular overview of the SIO campus and the Pacific Ocean. Going one step beyond SIO, the Birch Aquarium is an institution that serves an institution within an institution. The Birch Aquarium opened in September of 1992, with construction largely funded by a six million dollar grant through the Stephen and Mary Birch Foundation, in order to foster public support for Scripps research. According to the education specialist at Scripps, the primary goal of the aquarium is to promote ocean literacy, particularly within the context of research that is conducted at Scripps.

The mission of Birch Aquarium is to provide ocean science education, to interpret Scripps Institution of Oceanography research, and to promote ocean conservation.

Today, Birch Aquarium has more than 400,000 people visiting each year, to see a variety of exhibits, including (*excerpted from the Birch Aquarium website*):

- The Hall of Fishes with more than 60 tanks of Pacific fishes and invertebrates; the largest habitat is a 70,000-gallon kelp forest.
- Scripps Explorers Gallery, featuring cutting-edge discoveries of Scripps explorers in

- climate, earth, and ocean sciences through interactive exhibits
- Preuss Tidepool Plaza, overlooking the Pacific Ocean, with living tide pools for discovery
 - Smargon Courtyard, also overlooking coastal bluffs, features a 13,000-gallon shark reef tank and Wonders of Water play stations. Seasonal events take place here during the year.

Birch Aquarium also has a partnership with local Rancho Santa Fe School District to provide ongoing marine science curricula and activities to extend the weeklong MARE program the district has previously been a part of.

Partners in COSIA

How COSIA came to be in San Diego was through Rutgers University, the State University of New Jersey. The current education specialist at Scripps first became familiar with the Lawrence Hall of Science about eleven years ago when he attended a MARE (Marine Activities, Resources, and Education) workshop, to fulfill the responsibilities of his then-new position in education outreach at Rutgers University. His career in education outreach in the marine sciences began at Rutgers when he became involved in the teaching of the *Communicating Ocean Sciences* course. Shortly after accepting a position with Scripps, he was encouraged by COSIA leaders at LHS to implement the course with Birch Aquarium.

Though Scripps is not an official “sub-awardee” of the COSIA project, Birch Aquarium and Scripps have been partners in COSIA now for over four years. Of their partnership, the education specialist from Scripps said:

We are a little bit unique in some ways because the aquarium is an extension of Scripps and UC San Diego and so while in some other places the partnership can be somewhat estranged at first, in our case the partnership already existed.

However, while there was a prior existing connection between the two institutions (Birch and Scripps), it wasn't exactly a close or two-way connection -- prior to COSIA, Scripps really only looked to Birch to translate the Scripps' scientists' research. Currently, the partnership consists of the education specialist from Scripps, and at least three staff members from Birch Aquarium. Collectively, they serve as the instructional team for the course.

Like the Hampton University-Virginia Aquarium partnership, this team faced constraints in implementing the course as planned and made adaptations which ultimately worked well. Most UC campuses are on a quarter system, meaning each term is ten weeks long, and Scripps is no exception. The partners had to make adjustments to implement what is otherwise a semester (16-week) long curriculum.

This partnership has made several other adaptations of the course along the way. Like Hampton, the Scripps-Birch partnership holds their COSIA classes at the aquarium, as opposed to on the university campus. This decision was made after they struggled the first year with the logistics of holding half of the classes on the “upper” campus and half of the

classes at the aquarium. Another lesson these partners have learned from experience is that the Spring quarter is not the ideal quarter to offer the COSIA course. They are currently offering the course earlier in the year to maximize particular opportunities such as being able to maximize events at the aquarium and tap into new audiences. Yet another improvement the partners have made is incorporating more ongoing reflection, self-assessment, and evaluation of students' work throughout the course, so that students can continually refine their activities:

Something else that we did differently this year that we think worked really well was that we were better able to include some peer review, the students doing peer review of each other's projects. We weren't able to do that last time... we did one session on assessment and evaluation during the class session, but not on the aquarium floor at all. This year, we dedicated a class session to having students do their activities for one another on the floor, they got to see each other's activities in action and it gave them another chance to do their activity on the floor, because we only had two opportunities other than that, and so it gave them a third chance. It gave them a chance to think critically about how to be the visitor and look critically from the other side.

The first time the partners ran the course, they had a total of 12 students, of whom eight were graduate students at Scripps and four were undergraduate (junior and senior) students from different disciplines (oceanography, biology, environmental science, biodiversity and conservation, earth science, chemistry, etc.) at UC San Diego. As with Hampton, advertising for the course influenced enrollment; after the first year, the partners have focused more on the undergraduate community and billed it as a senior level course. The second time the course was offered, the proportions changed, with now a majority of students (11) being undergraduates and only 8 being graduates. The course has only recently been shifted from being described as a "special topics" course for undergraduates to a formal course cross-listed for undergraduates and graduates. Cross-listing the course is important because graduate students at Scripps are quite limited in terms of the number of official undergraduate courses they can take. By having the COSIA course formally established as a graduate level course also, it opens up more opportunities for graduate students to participate. Altogether, 38 graduate science students and 19 undergraduate students have taken the course over the past four years. Currently, the students enrolled for the fall 2010 quarter are half undergraduates and half graduate students, representing majors from: General Biology; Human Biology; Ecology, Behavior and Evolution; Environmental Systems and Earth Sciences; Biochemistry and Cell Biology; and Oceanography.

The past two years have seen an increasing percentage of COSIA students who are enrolled in the Center for Marine Biodiversity and Conservation (CMBC) professional masters program. As opposed to PhD students at Scripps, the majority of these professional masters students plan for careers involving policy, education, and communication. Therefore, COSIA is a natural fit and the partners from Birch and Scripps were able to garner the support of the DMBC director and faculty to promote the course to their incoming students. As a result, according to the Scripps' education specialist, in 2009, there was a marked increase in interest in the course:

For the first time, the course had a waiting list and we weren't able to accommodate all the students who wanted to participate.

In 2009, the CMBC program supported the COSIA course financially, in addition to philosophically.

Challenging long-held beliefs about preparing scientists

One challenge for offering the course to Scripps graduate students is their advisors' reluctance for them to participate. The partnership involving Scripps does not benefit from quite the same level of university support that the other two cases represented in this portfolio benefit from. One COSIA partner said:

I will be interested to see how the graduate student level involvement continues. There are always certain mixed feelings within the community of the faculty here, regarding the value of this course for graduate students. There is an assumption among them... and I don't really know the stats or how correct they are... but most of the faculty there assume that every single student is going to go onto an academic research position, which I don't think is necessarily true. And so the faculty struggle to see the value of a course like this, especially relative to other courses that they want their students to take. We are gradually trying to chip away at that mentality and help people have a better understanding of what the course is about. We even invite some key people to come sit in on a class section.

The Birch and Scripps partners in COSIA have been very strategic in promoting their course and doing presentations to students and faculty in different departments at Scripps. They have engaged in a substantial amount of information sharing completely on their own, in the spirit of promoting a course they believe is valuable. One person they've invited to attend a COSIA course has an influence on how courses are listed and categorized in the course catalog:

We invited the associate director of undergraduate programs to come sit in on one of our classes and she saw our students doing their activities on the floor and I think that was a good thing for her to see. She is in charge of the earth sciences and the environmental sciences program and so some of her students were in the class too. I think she has a better understanding now of what the class is about.

While the partners have tried to bridge the divide between faculty and students' concerns and desires, they recognize why it is still a challenge:

We still find it challenging. My impression is that at Scripps there is support for the course, at least in theory. I think a lot of people there recognize the value of the course and believe that it serves a purpose. What we struggle with a little bit is... getting back to the larger context of, what is the traditional mission of Scripps? It is to prepare academic research scientists. Scripps doesn't have master level programs, except for one professional level program. I think the mentality there is that they are preparing Ph.D. level scientists to do academic research. And as with most research institutions, often teaching takes a secondary role to the research element. I think there is a lot of support for the course in theory, but in practice, I think it is still a little bit of a struggle.

As the partners said in the Scripps-Birch Aquarium 2010 annual report for COSIA:

Gaining institutional and financial support for the course through UCSD-SIO has been a challenge. Despite securing a formal, cross-listed status for the course, and receiving feedback from the academic community that the course meets a need, we continue to struggle to identify a consistent source of funding for the course. This can be attributed in part to: 1) an institutional mentality that 'hard' science courses take intellectual and practical precedence over offerings such as COSIA (i.e., 'We're in the business of training scientists to do research'), and 2) a limited amount of funding to support courses, especially in light of significant budget cuts in recent years.

The partners realize that faculty's reluctance is not intended with malice. It is simply that they are working against a strong, long-standing tradition and way of doing things at Scripps:

There seems to be a cultural barrier but I am hoping that over time, that becomes less distinct and that we can find better ways to get more folks who are cautious about the course to become involved or attend. Again, I don't think it is necessarily the faculty saying, 'you shouldn't do this' or 'you can't do this,' I think they are balancing it against everything else that they think that students should be doing to prepare for a career in the field. It is not that they think the course is worthless, it is simply relative to everything from limited funding to time and the mission of Scripps, as some people see it.

Reasons to be optimistic

Even with some skepticism on the part of Scripps faculty, the COSIA partners have had at least seven graduate students, as well as post-doctoral fellows from various disciplines approach him several times to say they really want to participate in the course. There is high demand from the students and post-docs at Scripps for the COSIA course.

The COSIA partners have a few potential means to convince Scripps faculty of the value of the COSIA course. One is data from former COSIA participants that explicitly shows having the COSIA experience on their resume has helped former students get jobs in the field. As the Director of Undergraduate Programs at Scripps reported:

We have had students that have gone on after graduation, having taken that course to careers and work experiences and graduate opportunities that are directly related to skills that they learned in that course and probably no place else.

Also, scientists at other institutions can be a convincing force. Those who have been involved in COSIA for years have only positive reports on the influence of the course on their students, their own teaching, and perhaps surprisingly to some, their own science research. Scientists at Rutgers have spoken eloquently about many reasons a research scientist might benefit from working with students in a COSIA course.

Another convincing force is the Director of Birch Aquarium herself, who is a COSIA PI and a strong supporter:

The Director of the aquarium is an advocate of this program and she has the ear of the people down at Scripps. Her boss is the Director of Scripps and so it helps to have the aquarium Director speaking highly of and promoting this program to the Director of Scripps. There is a different level of respect and conversation that happens between the Directors [of Birch and Scripps] as opposed to the aquarium staff. That helped keep COSLA on the plate and keep it in the forefront of our work.

COSIA partners are optimistic that through the efforts of the course, scientists will increase their appreciation for the work of informal science education and informal science educators differently. An aquarium staff member said:

On the informal side of this equation, I think a cultural shift is really necessary... to be able to have a shift in attitudes from scientists, to see informal venues as a good platform for scientists to reach the public. It is important. I haven't worked in the field long, but so far, the experience has been an uphill battle, in terms of contacting the scientists and getting them to take aquarium educators seriously. Yes, we entertain, but we do education as well, and we see a huge number of visitors or guests. Because we are such broad or general educators, I don't think we get taken seriously enough because of our role and scientists don't realize how much we understand the science that is happening. I think informal education is a really powerful tool and maybe with this course, scientists will see that too.

The Director of the Birch Aquarium believes she has already seen change among the perceptions that Scripps faculty have of the role of education and outreach:

I think it is really helping the faculty of Scripps get more involved in outreach. Its not just the grad students, some of the faculty themselves are getting more involved and we have been trying to do that anyway, but COSLA is a very nice way for them to get involved.

The Director of Undergraduate Programs at Scripps also sees the value of education and outreach and the COSIA course for their students:

A course like this does have an important place in our curriculum because there are students, Environmental Systems students, science students, biology students, marine science students that get to their junior or senior year and they are starting to think about, 'what am I going to do, what am I interested in, what kind of career do I want to have?' and they are interested in trying out something that would have to do with education or outreach. Especially in the Environmental Systems program, this is something that students are interested in because there is an education outreach component to environmental careers. No matter what, it doesn't have to be an outreach career in order to have an outreach component.

Tangible benefits

Those who need no convincing of the value of the COSIA course and partnership are the aquarium staff. They have pointed out the value of the COSIA experience for those who are not directly involved in teaching the course. All aquarium staff is invited to sit in on any session they choose, for their own professional development. The partnership has also raised the profile of Birch Aquarium, in terms of Scripps. According to the Director of Education at the aquarium:

One benefit or impact of COSIA is the increasing integration of the aquarium into Scripps community and even the upper campus community, in a way in which we have never done before. That is huge. Personally, I feel that it allows us to demonstrate our professional expertise and prowess, in what is an unusual avenue for us to be able to get into. We can show we can be professors and we can teach courses at this higher academic content level. It is not always first grade or school field trips.

There is no doubt at Birch that the COSIA partnership has been worthwhile and will continue to be fruitful. As the Director of Education said:

There is buy-in and support across the entire aquarium for what we are doing with COSIA.

As was observed earlier (e.g. in the COSIA interim evaluation report), COSIA has several benefits on multiple levels. It has real advantages for the COSIA students themselves, for educators from both Institutes of Higher Education (IHEs) and the Informal Science Education Institutions (ISEIs), as well as for the institutions themselves (see Inverness' final evaluation report for additional information).

COSIA students from Scripps and Birch have demonstrated some of the impact of learning about education and outreach in that some have gone on to volunteer for Birch Aquarium, the Preuss charter school at UCSD, and the graduate-student organized Scripps Community Outreach Program for Education (SCOPE). Others have pursued careers in science education, as opposed to strict science research.

The Director of Birch Aquarium (a PI of this COSIA partnership) is clearly supportive and sees the wide-spread benefits of COSIA:

I have been thrilled at the response from the Scripps graduate and undergraduate students and from the campus in general at UCSD. This is clearly something that has been really welcomed and I think the students have gotten an enormous amount out of it at every level. I remember one student saying to me, 'I had no idea it was so difficult to prepare an activity for elementary kids,' for example. It is really hard and its also good preparation for any public interaction. It doesn't matter at what level you are learning, COSIA benefits the whole and so, all in all, it has been very successful and of enormous interest. That is my perception. I have actually been really thrilled at how much people have gained from this, in unexpected ways, really.

As the director of education from Birch said, there are benefits to the aquarium as well:

I think one of the things that has benefited the aquarium is that when the students do their activities with the public, effectively, those are extra public programs for us. We do some of those things, anyway but the students usually bring interesting projects to showcase and that is a great benefit to us—our regular members get especially very excited about that.

Benefits to educators from both the IHEs and the ISEIs include improved teaching skills and confidence as course instructors. In fact, the COSIA course instructors from Scripps and Birch were finalists for the Scripps *Undergraduate Educator of the Year* award in 2008.

Leveraging COSIA

As with the other COSIA sites highlighted in these cases, Scripps and Birch Aquarium are also part of a larger NSF-funded initiative called COSEE (Centers for Ocean Sciences Education Excellence). The Center based at Scripps is known as COSEE California. Birch Aquarium and Scripps have leveraged their partnership work in COSIA to lead to other grant and collaboration opportunities. They wrote a component of a successful COSIA Network grant proposal to NSF ISE with Lawrence Hall of Science (along with Rutgers/Liberty Science Center and Hampton/Virginia Aquarium). They have already developed workshops for informal science educators, called *Reflecting on Practice* workshops, and they plan to implement these in the fall of 2010. Another element of the COSIA Network work is to coordinate and facilitate workshops to introduce scientists to education theory and pedagogy aligned with the COSIA course. As of June 2010, the COSIA partners were well on their way to making these workshops a reality and were coordinating with Aquarium of the Pacific to make sure the two partnerships reached complementary audiences. In addition, the COSIA partners developed, based on COSIA, a component of a training experience for two separate GK12 programs at UCSD. This has led to the COSIA partners being recruited to support UCSD GK12 Fellows in informal learning pedagogies, while they participate in the San Diego Science Festival.

Enduring partnership

According to the current COSIA partners and leaders at Birch Aquarium, there is no reason to think this generative partnership will end anytime soon. Of course, Birch exists as an outreach component of Scripps anyway; however, prior to COSIA, there was relatively little interaction among the staff and students at either institution. COSIA has resulted in many benefits for Scripps and the Aquarium. According to the Director of Education at Birch:

COSIA is a great partnership in general, to be part of. To be linked up with Lawrence Hall of Science and to be linked up with these other phenomenal academic facilities and informal education facilities... it is huge for us to say, 'we are a part of this'. It's a big deal.

The Director of the Birch Aquarium feels that COSIA has provided a reason for Scripps students to come to the aquarium and recognize how valuable it could be for them:

I hope we can continue to do COSIA. I strongly encourage it. It has brought the Birch Aquarium closer to the Scripps students and I think made the students realize that Birch is a very useful facility for them, not just a place to come and look at fish and learn about Scripps' science... it is a place where they can actually learn important skills. It is great to have the aquarium as part of the campus and now it is being used in a new way. The aquarium is actually a department at the university, but this pulls students into using the space in a different way.

The education director at the Aquarium said:

The aquarium director was really adamant about making COSIA happen, regardless, and said, 'if we need to fund it, we will fund it and if we need to make it work, we will make it work'. I think it is perfect timing since Birch and Scripps are really trying to get 5 steps ahead of the game, and really strategically plan long term. Birch is in a big growth spurt—physically we may not grow in space, because we just don't have it—but we can plan for how we are going to grow in other ways. How do we extend our outreach? And through COSIA is one way that we are going to do it. I think this is a very timely and beneficial investment and in 5 years, if it moves into something else, great.

This partnership as a case of...

The Scripps Institution of Oceanography (SIO) at the University of California, San Diego—Birch Aquarium COSIA partnership is a case of a strong partnership with committed members who are working to slowly change the perceptions of faculty at a premier research institution, to see the value of all scientists being able to communicate effectively. Scripps is a large, very science-focused institution, with its own outreach program, which is Birch Aquarium. (Therefore, Birch is an institution within Scripps, and Scripps is an institution within the UC system). Through COSIA, students and faculty have been moved to see Birch as more than just a venue for their own science research to be disseminated to the public. An increasing number of Scripps students and some faculty are beginning to see how they can benefit personally and professionally by becoming involved in education and outreach, particularly through Birch. The COSIA work at this site has led to a high demand on the Scripps side, through students and post docs, and has raised the profile of Birch and its educators in the process. This partnership also demonstrates how genuine partnership and the contributions of partners from different professional communities can result in a win-win situation for all institutions involved. The COSIA work has led to additional funding and collaboration opportunities for both Scripps and Birch.

COSIA
Case Study
Hampton University & Virginia Beach Aquarium
June 2010
Inverness Research

When the COSIA partnership between Hampton and Virginia Aquarium began, they had had almost no previous interactions and worked on no other projects as a team. As a result of COSIA, they are now partners in three other funded grant projects, including coming together as a COSEE Center, working together on an ISE grant, and a successfully contributing to a GK-12 grant, and are in the process of proposing other projects together.

Overview of this COSIA partnership
(At-A-Glance)

I. Background Information

- Collaborating Institutions: Virginia Aquarium and Hampton University
- Engagement with COSIA began: 2006
- Leadership
 - From Hampton: Faculty scientist, Director Interdisciplinary Science Center (a hybrid position), Outreach Director and Facilitator
 - From Virginia Aquarium: Education Director and Education Specialist
- Course Characteristics/Audience
 - Course is held at Virginia Aquarium
 - Course is taught by the Education Specialist from Virginia Aquarium, a faculty scientist from Hampton University, and (now) a faculty member from Old Dominion University
 - Students are undergraduates and graduate students
- Affiliated/Leveraged programs and projects
 - COSEE Coastal Trends
 - COSIA Network
 - GK-12 project
 - Informal Science Education project
 - New partnership with Old Dominion University

II. Distinguishing/Defining Features of this Case

- Here COSIA is manifested as a small private university partnered with a large Aquarium, partially owned by the city
- Hampton is a university that has an institutionalized mission to broaden participation

and that has found its way into COSIA

- The COSIA course served as a catalyst for a substantive enduring partnership that did not exist previously
- There is mutual respect and equal participation on the part of the partners in COSIA

III. Core benefits/outcomes/returns on the investment

- The course has influenced scientists' thinking
- The course has served as professional development for Aquarium educators
- The course has influenced how university scientists teach their courses
- The course has broadened the Aquarium's audience

IV. Core Challenges/Lessons Learned

- One-time low student enrollment prompted the partner instructors to adapt the course for other contexts, such as after-school clubs
- COSIA Central (at Lawrence Hall of Science) supported the partnership and allowed the course to evolve so that it could continue at this site

Table of Contents for this Case Study Report

Hampton University

Hampton's Heritage in Diversity

History of Broadening Participation in Marine Sciences

Virginia Aquarium & Marine Science Center

Partners in COSIA

Addressing diversity through COSIA

Leveraging COSIA

Mentoring Young Scientists

COSIA Network

Enduring partnership

Impacts on scientists

This partnership as a case of...

Hampton University

The peninsula in the southeast of Virginia is a particularly watery place. It juts into the northern section of Hampton Roads, one of the planet's largest natural harbors, which includes the mouths of the Elizabeth River and the James River. The Hampton Roads itself empties into the Chesapeake Bay near the Atlantic Ocean. Surrounded by a dizzying number of bays, inlets, and waterways, it is a place that seems of the water, by the water, and for the water. Here, it is impossible to escape the influence of the aquatic environment—it is, therefore, a natural place to be driven to inquire about the marine and aquatic sciences. On this peninsula sits Hampton University, a co-ed, non-sectarian, private historically black university (HBCU), that offers both undergraduate and graduate degree programs.

Hampton's Heritage in Diversity

Founded in 1868 by Brigadier General Samuel Chapman Armstrong (who became the school's first principal), Hampton was a watershed opportunity for thousands of freshly emancipated former slaves who found themselves in Fort Monroe on the Union side of the symbolic Mason-Dixon line after the Civil War. There, students learned reading, writing, and arithmetic, and became teachers themselves. In 1870 the school became a legally chartered land grant school called "Hampton Normal and Agricultural Institute" ("normal" referring to establishing norms or standards). In 1872, Booker T. Washington came to Hampton as a student before going on to found Tuskegee in Alabama, which was modeled on Hampton. A decade after its founding, Hampton also created a formal education program for Native Americans.

Unlike Rutgers University or the Scripps Institution for Oceanography (SIO) at the University of California San Diego (UCSD), Hampton is a small university with a student enrollment of approximately 5,000 to 6,000, of which only about 600 are graduate students. The student to faculty ratio is a low 16:1. Among undergraduates, 36% are male and 64% are female. The vast majority (92% in 2008) of Hampton's students are African-American. Only 5% are white. While the campus draws some students (37.5%) from the state of Virginia, most (62.5%) students are from out-of-state, including from foreign countries. An amazing 80% of Hampton's students enroll in graduate school within 5 years of receiving their Bachelor's degree.

Hampton University is a community of learners and educators. It is a place that will challenge your intellect and nurture your spirit; broaden your outlook and expand your opportunities. A place where you can meet people from a diversity of backgrounds and establish friendships that last a lifetime. HU's strong roots reach deep into the history of this nation and the African-American experience. But the University's sights, like yours, are set squarely on the horizons of the global community of the 21st century. And like you, we are focused on the extraordinary challenges and opportunities that await those who prepare for them. You see, that is Hampton University's commitment to help you plan for the future and chart your course for the journey through life. (<http://www.hamptonu.edu/about>).

Hampton has its own Department of Marine Science, with research facilities (the Hampton University *Center for Marine and Coastal Environmental Studies*) that include a waterfront building with six research labs, classrooms, a conference room, and the offices of the department's faculty. The department's assets also include three larger research vessels, as well as smaller boats and canoes for exploring the shoreline of the Chesapeake Bay and surrounding waters. The university is one of few to offer a Bachelor of Science degree in Marine Science specifically. The science program is small, with only four faculty members and about 40 students; however it is noteworthy and powerful in that nearly all of those students are African-American.

History of Broadening Participation in Marine Sciences

The mission of the Department of Marine Science is to ensure that "a graduate of this department will be prepared to pursue a career in the interdisciplinary, eclectic field of environmental science or enter graduate school in a specific area of marine science, such as marine biology, ocean engineering, and chemical or physical oceanography".

Hampton has a long history teaching marine science to African American students. In the 1950s, the ichthyologist Dr. Anita Hall began teaching marine science at Hampton and her courses were the impetus for the creation of the Department of Marine and Environmental Science 30 years later. Dr. Robert Bonner, a retired marine botanist and former Dean of the School of Science at Hampton for 20 years, oversaw and completed the development of the Marine Science department and program. It was Dr. Bonner's master's degree students who produced the first marine research thesis projects to come out of Hampton.

Today, the *Hall-Bonner Minority Doctoral Scholars Program in Ocean Sciences* is named for these two pioneering scientists and educators. The program is a partnership among Hampton University, Old Dominion University (ODU), and The College of William and Mary, Virginia Institute of Marine Science (VIMS). The stated goal of this program is "to increase the diversity of students earning doctoral degrees in the marine and ocean sciences by creating a genuine community of minority ocean scholars". The program encourages students to pursue a career in marine science as well. In addition to the standard support that graduate students from VIMS and ODU typically receive, the Hall-Bonner program provides additional funding for tuition, research, and travel.

Former Dean Dr. Bonner was responsible for yet another impressive innovation at Hampton too—the creation of the *Interdisciplinary Science Center* in 1984, within the School of Sciences. This Center works to connect scientists—throughout the School and from a variety of disciplines—with each other and with opportunities to become involved in education efforts. According to the director of the *Interdisciplinary Science Center*:

Dr. Bonner had a goal for young, especially African-American students, to get into science and maximize their potential and he didn't see that happening. He saw some good sciences coming through, but he didn't see a connection to education. So when I came along and showed the interest, he had the vision to pull this center together, which made the scientists then feel more comfortable working with education. Typically, at other universities, scientists get tenure and promotion and they have to work within their discipline or school

[department] and they get no brownie points for working with a different school [department]. This, Dr. Bonner was aware of and he addressed it that way [by creating the Center]. So we work with a lot of scientists that are just doing fantastic, really cool things, but they need a little help connecting with education and the general public.

COSIA then, was a natural instantiation of the mission of the *Interdisciplinary Science Center* at Hampton University.

In partnership with ASLO (American Society of Limnology and Oceanography), Hampton University also offers a program titled the *ASLO Multicultural Program* (formerly the *Minorities in the Aquatic Sciences* program). With support from the National Science Foundation, this project offers full support for underrepresented minority students to participate in a variety of opportunities in aquatic science, including the annual ASLO meetings. At these meetings, students have the opportunity to present their own research, to hear about the most recent developments and advances in aquatic science, and to network with key professionals in their field. Since 1990, 650 students have participated in the *ASLO Multicultural Program*.

A marine science professor at Hampton also organizes MAST (*Multicultural Students At Sea Together*), a three-week research excursion for students on the Chesapeake Bay, through which students study marine science and policy, and the contributions of African Americans and Native Americans to the aquatic and maritime worlds.

One tenured professor from Hampton told us:

Something that I think is unique to Hampton is that there is a value-added here that you just don't see in a regular university that doesn't have special commitments. The students here—and faculty too, for the most part—are more personally committed to getting other students, other people, and other African-American students into science, into universities, into education. And faculty and students for the most part will go the extra mile without getting paid or extra help, and I think it is part of the reason why they are here. I think the time has come when most, and in fact almost all of our students could get into any university in the country, but they are here because either they or their parents really want them to learn more about their culture, their history, their background, as African-Americans and their place in the United States and that type of thing. Because of that, they also have more of an interest I think. If you get kids and you get faculty going above and beyond what they are paid for, amazing things happen. That is something that you can't really put a dollar figure on or a course number on... it is a personal commitment.

Virginia Aquarium & Marine Science Center

Drive southeast from Hampton University for 45 minutes (without traffic) and one will find oneself in Virginia Beach. In contrast to Hampton's atmosphere of rigor, standards, and academic excellence, Virginia Beach has a festive playful energy, common among vacation destinations.

The Virginia Aquarium & Marine Science Center is an impressive presence, known for its first-class facilities, varied collections, and engaging programs. It is a public/private partnership between the City of Virginia Beach and the foundation that oversees the

aquarium. The City owns and maintains the facilities, while the foundation is responsible for acquiring and caring for the aquarium's collections. The vision of the Virginia Aquarium & Marine Science Center is "to provide exceptional and innovative exhibit, program, and service experiences for our diverse audiences", while the mission is "to increase the public's knowledge and appreciation of Virginia's marine environment and inspire commitment to preserve its existence". According to an education specialist at Virginia Aquarium, the aquarium's board of directors "wants us to be cultivating strong relationships with the academic institutions in the area".

Partners in COSIA

Cultivating a strong relationship with local academic institutions is exactly what has transpired through the COSIA partnership between the Virginia Aquarium and Hampton University (and now, other additional academic institutions, such as Old Dominion University). Prior to COSIA, staff at Virginia Aquarium had talked about partnering with Hampton University but nothing came of it until Dr. Deidre Gibson, Assistant Professor in the Department of Marine Sciences and the Department of Biology contacted Karen Burns, the Education Specialist for Bay and Ocean Literacy at the aquarium. For the past four years, Burns and Gibson have been working together as close partners, and while the program did not always look the way they anticipated it would, the partnership is solid and their efforts have produced several innovations for COSIA and their partnership more broadly.

Karen Burns: My professional journey

As a child growing up in Western Connecticut, I had a great interest in the ocean and its inhabitants. Not thinking that I would leave that area of the country I decided to pursue a degree in Biology concentrating in Genetics at Western Connecticut State University. After graduating and moving around a lot, I ended up teaching at a private college in South Carolina and eventually life brought me to Virginia Beach in 1992. By chance my new neighbors were very active volunteers at the Virginia Aquarium and encouraged me to come with them to volunteer at a Girl Scout overnight program. Needless to say, I loved the place! With my science background and my never-ending interest in the oceans I decided to become a volunteer conducting education programs at various stations in the Aquarium. After a few weeks I was asked to join the education staff as a paid employee coordinating the Girl Scout overnight programs. Over time I was hired on as a full time educator and 16 years later I am currently the Education Specialist for Bay & Ocean Literacy. As part of my job duties, I am now responsible for the training and supervision of over 300 docents that work at the Aquarium exhibits. I have even learned to SCUBA dive and conduct programs while diving in the Aquariums where I work. I am actually working in the very field that I dreamed of as a child! The opportunity to teach COSIA has brought my career goals full circle. The partnership with Hampton University and especially working with my co-teacher Dr. Deidre Gibson, now gives me the opportunity to work directly with marine scientists, the very people that I looked up to as a child. The HU students who take the COSIA class are

aspiring scientists involved in research projects and through the class I am able to help them to learn proper techniques for making this information interesting to the public, no matter what the subject!

Through the COSIA experience, students are exposed to and engage with learning theory, and discover how to effectively communicate in informal environments. As their main project, students design an activity to use on the aquarium floor with visitors who might be of any age or background.

One COSIA instructor and Hampton professor described the appeal of the COSIA course for Hampton students:

One thing about the marine science students is, when they learn, they want to share and they want to talk to people about science. COSIA actually helps them do that and better prepares them. They know their limitations and that is why they took the class. They've said its 'because we don't feel comfortable speaking to the public'.

At the outset of their partnership, Hampton and Virginia Aquarium offered the COSIA course as a formal elective and found it to be quite successful. While some COSIA sites offer the course at the university, with students traveling to the aquarium only two to three times per semester (primarily to practice and present their final activities) Hampton delivers the course at the aquarium. Therefore, students drive to the aquarium once a week (typically every Friday), participate in the course, and get substantial, ongoing feedback on their ideas from a variety of sources, including ISE staff educators and visiting public. COSIA students actually come out of the course with more experience adapting their activities for and communicating with different audiences than they would if they were only on the aquarium floor two or three times during the entire semester.

In addition to the classes at the aquarium, COSIA students have several more opportunities to interact with audiences of different backgrounds and ages. 7th and 8th grade students from Booker T. Washington Middle School (a marine science magnet school in the Hampton area), local high school students, and African-American families come to the Hampton campus for various events. The COSIA instructors take advantage of those events, providing additional venues for COSIA students to practice their activities and communicate with different groups. These interactions are a direct result of the COSIA instructors responding to their students' feedback that they wanted more time to practice with the public. All participants have said that this approach is more effective for the COSIA students than if they only had 2 opportunities to practice (and only at the aquarium).

The second time the COSIA course was offered through Hampton, a Biology major, marketing major, advertising student, and graphic artist all participated, in addition to the marine science majors who were the more typical target audience for the course. The instructors felt this diversity among student interests was valuable in particular ways.

The COSIA instructors' grading system for the COSIA course parallels their own practice and beliefs that constant reflection, evaluation, and assessment are critical, in an effort to constantly improve ideas, activities, and programs. A good portion of the COSIA students' grade is based on their ability to reflect on their work and their activity, and to modify or adapt in an effort to always improve. As the Director of Education from the aquarium put it:

Did students recognize from the first time they did the activity, what didn't go right the first time and did they make the appropriate changes, so that by the time they got to the end, they got the best that they could out of this piece?

The instructors' deep reflection on their work and the lessons they learned in the process of developing and teaching COSIA as a formal course the first two times were helpful when they faced a challenge the third time they attempted to implement COSIA—student enrollment was too low to run it as an official course. The curriculum for Marine Science majors only allows students to take one science elective; therefore, the COSIA course has direct competition with courses such as molecular biology. In addition, during this particular semester, the chair of the Marine Science department was offering a competing course, which several students felt compelled to take—out of interest but also because the department chair was also their advisor. The COSIA instructors felt that poor promotion and advertising also played a role in the diminished enrollment: after the first two courses, a former COSIA student helped design flyers to advertise the course; however, due to logistical issues, it was impossible to print the flyers before students choose their classes. The following year, the instructors made sure to have the flyers ready on time, and to speak with the chair and other professors in the department regarding conflicting courses and recommending the course via word of mouth.

While unable to offer COSIA as a formal course on that third occasion, the partners made some adaptations and were able to offer COSIA for the students in the Marine Science Club. Their first COSIA meeting was held at the aquarium on a rainy Tuesday night at 6 pm in March of 2008. To the instructors' surprise, 16 students arrived; students in the Marine Science Club had brought their friends, including at least one aeronautics major. Revealing her surprise while satisfying her own curiosity, one instructor asked the students after the meeting, "why are you here?" They responded, "because this is a fun way to learn." That instructor responded, "there is no bigger compliment for what we are doing here."

The experience of teaching COSIA as an alternative offering and enhancement to an existing club, prompted the instructors to consider how the tools of the course might be used in different contexts, and how to broaden their conception of who the audience for the course could be. For example, the course has traditionally been listed as a marine science course but these instructors now believed there were opportunities to publicize it as a course about diversity and accessibility, or communication more broadly (though marine science students must already take a standard communications course, which is a general education requirement).

Addressing diversity through COSIA

Observing Hampton students working at the aquarium, one can't help but be struck by the fact that most of the aquarium educators are white. During a weekend event, regular aquarium staff directed visitors down a corridor to the promenade where COSIA students were presenting their activities. As visitors rounded the corner to the Promenade, they were greeted by a team of five young African American student scientists—quite a contrast to the educators they had just passed. Noting this discrepancy, one COSIA instructor reflected:

It is nice to see the role models of the African-American students at the aquarium doing science.

Dr. Deidre Gibson came to Hampton University in 2002, having completed two post-doctoral research fellowships at the University of Connecticut and Savannah State University. Her scholarship has taken her around the country—she received her PhD in Marine Sciences from the University of Georgia, and her Bachelor of Science degree in Oceanography from the University of Washington.

Currently, she is a biological oceanographer specializing in zooplankton whose research has been featured on Discovery Channel's *Science of the Deep: Mid-Water Mysteries* and published in the *Journal of Plankton Research* and *In Water: Science and Issues*. In 2005, she contributed to the work entitled *Autobiographical Sketches of Women in Oceanography*.

She has always been interested in education and she sees the value of scientists learning about education:

My background is science and I didn't know anything about education, really. I wanted to become involved in it as a grad student I asked my boss if I could get teaching experience and the Director of the Institute, my advisors, they all said no. I am not one of the scientists who thinks communicating with the public is not important. Actually, when I was a technician, that was one of the main things that I wanted to do, work with the public in south Louisiana where the people thought that the marine lab where we were working was an agency that shut down fisheries. We need to let people know what we are doing. That was where this whole interest started.

Gibson is known for her commitment to supporting students in conducting research, and pursuing graduate study and careers in the Marine Sciences. These programs include COSIA, COSEE Coastal Trends, and the *Hall-Bonner Minority Doctoral Scholars Program in Ocean Sciences* program.

Her motivation and enthusiasm for the cause is obvious:

We have this challenge to create diversity in marine science. I know that I didn't have anything like this when I was coming through—every step of the way, I was the only black person—and so, I really want to get these guys a holistic experience with doing research. And now they want to share their work and these students

really love outreach. They always say, 'we love to work with kids' but they really want to share this time too. So I believe in doing this [COSLA].

Dr. Gibson has also served on committees seeking to broaden participation in the ocean sciences, based on more than (but still building on) her own experiences:

Instead of just having anecdotal stories about how tough it was for little black girls to get into marine science, we actually are basing our recommendations on literature

Leveraging COSIA

The partnership between Hampton and Virginia Aquarium has led to new opportunities and the many different interactions between the two institutions are indicative of a partnership that will endure. As just a few examples, the two institutions are connected through a COSEE (Centers for Ocean Science Education Excellence) center called *COSEE Coastal Trends*, they work together through the *Mentoring Young Scientists* program, and individuals at both institutions are involved in several different research projects that also involve Old Dominion University and VIMS. The director of the interdisciplinary center in Hampton University's School of Sciences described even more far-reaching possibilities for building on COSIA:

I have been talking to even more people about leveraging what we are doing for COSLA. We are doing an international program in Puerto Rico where we've got teachers from the US and other countries coming together. This is not just about one program, and it is not even about one funding source, it is the idea of tying opportunities together with people who have the interest and the commitment to do that.

When the COSIA partnership between Hampton and Virginia Aquarium began, they had had almost no previous interactions and worked on no other projects as a team. As a result of COSIA, they are now partners in three other funded grant projects, including coming together as a COSEE Center, working together on an ISE grant, and a successfully contributing to a GK-12 grant, and are in the process of proposing other projects together.

Mentoring Young Scientists

Another example of how the aquarium and Hampton partners are leveraging the success of COSIA is the *Mentoring Young Scientists* (MYS) program, a year-long, out-of-school science enrichment program for underserved middle school students. The program draws from middle schools with a Free/Reduced Lunch rate higher than 90%.

By providing continuous mentor-student interactions throughout the year, the Mentoring Young Scientists program

- *Introduces under served populations to the life sciences and to careers in associated fields*
- *Instills a positive attitude towards science and increases confidence in science schoolwork*
- *Offers at-risk teens an on-going, supportive relationship with a caring adult (which has been proven statistically to lower incidences of high-risk behavior)*

Students from Hampton University who participated in the COSIA course serve as mentors for MYS participants. The mentor/mentee teams develop the Hampton University student's COSIA (such as seagrasses, deadzones, physics of dispersal, etc.) into an activity for visitors at the aquarium. The activities include demonstrations, experiments using real-time data, microscope viewings, and activities that appeal to a family audience such as a puppet show and a game show. MYS participants present the activities at the aquarium and other locations and some activities have even become a part of the aquarium's regular educational offerings.

Partners' constant consideration of additional opportunities to work together and leverage their work has resulted in a uniquely solid partnership. As one educator from the aquarium said:

In the big picture, this partnership has worked very well because we are both partners that are eager to build on this and so both sides are open to other opportunities.

COSIA Network

One recent development that will allow the aquarium and Hampton to continue their work in COSIA is their contribution to a successful ISE (Informal Science Education) proposal to NSF. Through the COSIA Network project, this COSIA partnership will help provide more local support for other COSIA partnerships. They will supplement and complement the work of the COSIA partnership at UC Berkeley by serving as a training site for new COSIA partners, most likely those in the southeastern quadrant of the country.

Staff at the aquarium see how the new COSIA Network opportunity will benefit the aquarium, as well as COSIA central at UC Berkeley. Said the Director of Education:

This is an opportunity for the aquarium to develop a reputation from an educational standpoint as a leader in informal education. There are a lot of informal science education institutions that have done a lot with curriculum development and that sort of thing. We have decided—because there is already so much stuff that is available on the internet—maybe that is not our niche... developing tons of school curriculum and things. Lets find a different niche. I think this is our niche—how do you develop educators so they can do informal programs, which is very different than doing school programs?

This partnership is also taking its experience offering COSIA as a program for the Marine Science Club at Hampton and building on it in the COSIA Network. They will work to formalize a more condensed version of the Communicating Ocean Sciences course to use in different settings such as clubs, workshops, or other events.

Enduring partnership

Every person we interviewed associated with this COSIA partnership was easily able to identify and articulate reasons why this particular partnership has been so durable and generative. Both Hampton and Virginia Aquarium partners described having different but very complementary sets of expertise and being very clear about their individual roles within the partnership. The Hampton professor has said that her role is to ensure that the science content of the course and the students' activities is correct, to handle the administrative logistics of the course at the university, and to assign final grades. In turn, the aquarium partner is responsible for knowing what works particularly well in informal science education settings, and for knowing what is appropriate in terms of dealing with varying audiences and collections. Yet, both partners participate in every course session together.

The fact that both the aquarium and university partner participate in each course is an example of how they have integrated their responsibilities for the course. While they have clear roles, they do not leave any one partner to run the course alone. Some partnerships operate as though the academic institution is responsible for teaching the course, while the aquarium serves as a simple test bed. Not so with the Hampton-Virginia Aquarium partnership. Said the Director of Education from the aquarium:

I have been involved with some partnerships with other universities where I found the academic staff to be a little close-minded about the possibilities of what the aquarium could do, what our role could be in it. They often wanted to tell us 'we are doing this and you do this', where our COSIA partnership is more integrated. The way that we teach the class, the aquarium staff are an integral part of teaching from the first day. It seems there are some other partnerships where it is the academic institution that is teaching and then towards the end, when it is time to do the project, they go to the aquarium. So the aquarium isn't particularly involved in teaching the course as much as we are. I think one of the strengths of our partnership is that the aquarium staff see the course as being a natural part of our job... that we need to be there in the COSIA classes.

Coupled with having clear roles and having mutual responsibility for the course, these partners also have a deep trust and respect for one another. This is essential for maintaining clear roles. As the Hampton scientist partner said:

The aquarium staff know what they are doing, as far as informal education goes and I don't jump in and say, 'no it should be done this way', because I know what they want to do will work. So I think that is why this partnership works so well.

These partners have a deep knowledge of their respective domains (i.e. marine science research and informal science education) and a mutual respect for their partners' expertise, and there is also an element of trust and safety present in this partnership. Both partners mentioned that they feel completely comfortable admitting something is beyond their expertise and comfort zone, and will defer to the other's strengths. As stated earlier, both sides of this partnership also believe strongly in the power of constant reflection, self-assessment, and evaluation. They are continuously striving to improve the course, listening

carefully to each other's and their students' feedback, and thinking carefully about the next most appropriate steps. Perhaps most importantly, both partners share a strong commitment to the work of the project. As the scientist partner said:

We could all be in different places, but we are where we are because we value what we do.

The aquarium's education specialist's comment was similar:

I have to comment that our scientist partner has a personal commitment to education and she is willing to put the time and the work in. It is kind of an unwritten thing and so... you know, you can't just go out and grab any scientist to do this.

The stability of this partnership has led to and is in turn supported by the institutionalization of the course at the Virginia Aquarium. First, the Director of Education explained how she fully perceives the work of COSIA as an integral part of her department:

I would say the other strength of the partnership is that we have fully institutionalized this course here. I look at this as being part of the education specialist's job and during the time that this course is going on, I am assuming that is what she is doing. So we are looking at how we can continue this, even when there is no funding anywhere... how can we make this work?

Similarly, the education specialist from the aquarium said:

Both the director of the education department and the director of the aquarium have already said that this is something that they want to continue, regardless of funding, for the most part. So we would find supply money and that sort of thing, if we had to.

The partnership has earned the support of the Executive Director of the aquarium as well, indicating that the value of the work extends beyond the education department. The aquarium's Director of Education said:

The aquarium's Executive Director was formerly a director of education and so she has no question about us doing this, and she will ask, 'you have the money to do it, you have the people to do it?' I would say 'yeah', and she turns us loose.

Impacts on scientists

The Hampton-Virginia Aquarium partnership is further strengthened by the benefits it brings to the scientists involved. Beyond being able to satisfy the Broader Impacts requirements on their NSF-funded projects, scientists involved with this partnership have reported experiencing a sense of satisfaction through working directly, in a tangible way, with students. An evaluator for this partnership explained the impacts that she hears about from scientists:

Some of the benefits that scientists have been telling us about directly include that they really enjoyed working with young, enthusiastic people.

Perhaps not surprisingly, scientists' ability to communicate with various audiences, including the general public, as well as middle school and college age students, is a benefit mentioned often. Being involved in COSIA forces scientists to take a different perspective on their work and to translate its relevance. Again, an evaluator for this partnership said:

Scientists also said that they had a different perspective on their work, because they weren't talking to their peers anymore, so they had to think about the same problems from different angles and they enjoyed that and found it challenging.

When asked, "when you think back to the time before you began participating in COSIA, how would you describe your views or perceptions of science education at that time?" the Hampton scientist partner in COSIA described how useful and valuable teaching the course has been:

My perceptions have changed a great deal; now I see how hard it is to translate science for public understanding. Once you learn, it is an invaluable tool and it is very important. I have always been an advocate for public outreach and education, and as a result of teaching this course, I can do a better job at communicating to the public.

Also, when asked whether her work in the COSIA course had prompted her to change her own practice in any way, this scientist said:

Yes, COSIA has given me the tools I need to be a more effective science communicator, in class and in public. In my marine science course, I do very little lecture and do mostly active learning... I am also making some changes in my zoology course.

Finally, when asked of what value the COSIA experience has been for her, beyond being able to meet Broader Impact requirements, she discussed the long-lasting impacts of having new opportunities for additional work and being mindful about what the public should understand about science:

Thinking about what the public should know and how to communicate it to them. And building collaborations for further work... the long lasting partnership with the aquarium and the communication skills I've gained are invaluable to me.

This partnership as a case of...

The Hampton University-Virginia Aquarium partnership is a case of several important dimensions and realities of COSIA work. First, the university involved is uniquely situated to further the goals of COSIA and in turn, COSIA helps the university further its goals. The *Interdisciplinary Science Center* within the School of Sciences at Hampton is the result of a visionary dean who created the Center over two decades ago, specifically for the purpose of helping scientists communicate with each other, with educators, and with the general public. Bringing two different organizations together in order to offer the COSIA course is a natural extension of that goal.

This is a case of a private university with a small student population providing exceptional resources for its students and therefore, addressing COSIA's objective to reach underserved students and broaden participation in the Marine Sciences. Hampton has long been committed to serving minority students and has existing strategies for broadening the participation of underrepresented populations in the sciences. Several programs exist within the Department of Marine Sciences that further the opportunities of diverse students to pursue graduate degrees, research, and careers in the aquatic sciences.

The Hampton University-Virginia Aquarium case illustrates that partners can come together around and do work together using a concrete tool—that being the COSIA course—and through their close work together, discover additional reasons to work together and innovate for the benefit of both the institutional and individual partners. It is a case of partners developing a trust and respect for one another that only deepens over time. The partners are committed to the work and are motivated to build on and leverage the work together.

This case also shows how the support of the COSIA network and COSIA Central (at Lawrence Hall of Science) enabled and facilitated the partnership to evolve to meet new challenges and therefore, survive. Even when the partners were not able to implement COSIA in the traditional manner, they figured out a way to adapt COSIA (with support from LHS) and continue their solid work together.

This is also a case of a scientist being changed and influenced by the process of working with an informal science educator... a scientist changed by providing additional opportunities for students through outreach opportunities.

Finally, this is a case of both institutions benefiting from the partnership to such an extent that it has become a priority for both. When asked what advice she would offer to potential COSIA partnerships around the country, the Hampton scientist partner said:

Do it. Try to be flexible. Worst case scenario, it is not going to work like you thought, but at least there was an attempt to communicate and do some things differently. You can't really lose, so just be flexible and be willing to give a little bit and try something different.

COSIA
Case Study
Rutgers University & Liberty Science Center
June 2010
Inverness Research

COSIA was by far the most valuable course I took at Rutgers. It didn't just teach you about ways of communicating—like tools and strategies—it actually gave you a chance to apply them. Most opportunities to communicate about science don't happen in the classroom—they happen when you don't expect it. It's good to know how to communicate in those different situations.

What is the point of doing your research if it is not going to have an impact and if all you want to do is publish it in a research journal that no one outside of your field will read—just so you can get another grant? I think that is something that scientists from every branch of science should do... they need to have that on their door or on a poster... a memo to themselves: 'What can I do today to make sure that my research is actually affecting the most amount of people that it can possibly affect?'

Overview of this COSIA partnership
(At-A-Glance)

I. Background Information

- Collaborating Institutions: Liberty Science Center and Rutgers University
- Engagement with COSIA began: Spring 2006
- Leadership
 - From Rutgers: faculty scientist, Education Director at IMCS (a hybrid position)
 - From LSC: Developer of Educational Resources, Educator, VP for Learning and Teaching, Director of Science Education
- Course Characteristics/Audience
 - Course is held primarily at Rutgers University but also at LSC
 - Course is taught by the Education Director from IMCS, a faculty scientist from Rutgers University, and educators from LSC
 - Students are undergraduates and graduate students
- Affiliated/Leveraged programs and projects (>12)
 - COSEE NOW (Networked Ocean Worlds)
 - COSIA Network
 - Office of Naval Research (ONR) funding
 - National Science Foundation (NSF) funding

- Department of Homeland Security (DHS) funding
- National Oceanic and Atmospheric Administration (NOAA) funding
- National Oceanographic Partnership Program (NOPP)
- US Department of Defense funding
- State of New Jersey funding
- New Jersey Department of Environmental Protection funding
- New Jersey Department of Transportation funding
- Public Service Enterprise Group funding
- G. Unger Vetlesen Foundation funding
- Gordon and Betty Moore Foundation funding

II. Distinguishing/Defining Features of this Case

- Rutgers is a large public state university
- This case clearly illuminates the many benefits of COSIA to scientists, students, research projects, and institutions
- This case shows how the nature of the COSIA course is aligned with the future directions of marine science
- This case illustrates the idea that innovation occurs at the edges of the boundaries of communities of practice
- At Rutgers, there is heavy involvement of undergraduates in research

III. Core benefits/outcomes/returns on the investment

- The course has created a space for cutting-edge marine science research to take place
- The COSIA work has been leveraged to bring in funding from nearly a dozen different sources
- The COSIA work has generated strong administrative support
- The course has influenced scientists' thinking and teaching
- The course has served as professional development for informal science educators

Table of Contents for this Case Study Report

Rutgers University: Jersey Roots, Global Reach

History of Strong Science Research

Diversity at Rutgers

Institute for Marine and Coastal Sciences (IMCS)

History with COSIA

Liberty Science Center

Leveraging COSIA

Impacts on young students

Impacts on COSIA students

Impacts on scientists

Facilitates research and exploration

Less activation energy required

Exposure and attention

Future directions and lasting legacy

Rutgers and a hybrid community of practice

This partnership as a case of...

Rutgers University: Jersey Roots, Global Reach

Known since 1945 as the State University of New Jersey, Rutgers may not be the first place one thinks of when it comes to marine science, located as it is across New Brunswick, Newark, and Camden, New Jersey. However, anyone familiar with the ocean sciences will know that it is the source of a good deal of innovative, highly respected, and high profile marine science and marine science education. Founded in 1766 as Queen's College, Rutgers is the eighth oldest college in the United States and is currently the largest and most dominant institution of higher education (IHE) in the state of New Jersey. The college was closed for the War of 1812 but reopened in 1825, when it was renamed Rutgers College, after the Revolutionary War hero, Colonel Henry Rutgers. It attained university status in 1924. There are five campuses on the Rutgers New Brunswick site alone: College Avenue campus, which is the original campus in downtown New Brunswick; Douglass campus and Cook campus, which are across town, adjacent to each other and often referred to collectively; and Busch campus and Livingston campus, which are located along the Raritan River.

History of Strong Science Research

Much of Rutgers' excellence in science *research* traces back to its establishment as a land-grant college in 1864, which lead to the creation of the Rutgers Scientific School. Rutgers is one of 76 land-grant institutions in the United States, along with MIT, Cornell, and Ohio State. An essential principle of the land-grant initiative calls for the institutions to share the knowledge gained through their research with the community in which the institution resides. New Brunswick is classified by the Carnegie Foundation as "RU/VH," which stands for "Research Intensive University/Very High" research activity. It is home to over 180 research centers and institutes and in FY 2009, it received over \$390 million dollars in new research grants and contracts. Rutgers is one of the 63 IHEs (and the only public IHE in New Jersey) in the Association of American Universities (AAU), institutions known as leading research universities, and recognized for the quality and scope of their research and educational programs. Stuningly, over 60% of Rutgers undergraduate students participate in original research during their time at the university.

Currently, Rutgers boasts an enrollment of 40,500 undergraduates and 14,100 graduate students (for a total of 54,600 students). The New Brunswick campus alone has 29,000 undergraduates and 8,200 graduate students (for a total of 37,200 students) enrolled.

The Mission of Rutgers University has three inter-related, inter-dependent components:

- Providing for the instructional needs of New Jersey's citizens through its undergraduate, graduate, and continuing education programs;
- Conducting the cutting-edge research that contributes to the medical, environmental, social and cultural well-being of the state, as well as aiding the economy and the state's businesses and industries; and
- Performing public service in support of the needs of the citizens of the state and its local, county, and state governments.

Diversity at Rutgers

Rutgers University is ranked by *Diversity Inc.* among the top five institutions of higher education (IHEs) within the United States, with a commitment to diversity.

More than half of Rutgers 2010's freshman class identified themselves as nonwhite.

Furthermore:

- Fifty percent of undergraduates are women.
- More than 3,300 international students from 125 countries come to Rutgers to study
- White comprise 48 percent of the student population
- Asians comprise 23 percent of the student population
- Latinos comprise 12 percent of the student population
- African Americans comprise 10 percent of the student population

Rutgers' commitment to diversity and global reach has powerful implications for the ocean sciences education efforts that take place there.

Diversity at Rutgers embraces the notion that we must be global educators, researchers, students, citizens, and partners—transcending boundaries to meet the challenges of a complex and interdependent world.
<http://www.rutgers.edu/about-rutgers/we-are-diverse>

Institute for Marine and Coastal Sciences

The history of Rutgers marine scientists taking responsibility for education began around 1989 when Fred Grassle started the Institute for Marine and Coastal Sciences (IMCS) on Dudley road at the Rutgers Cook campus in New Brunswick. Prior to IMCS, Rutgers did not even rank in Marine Science, even though it did have a program, since it was a land grant institution. Grassle recruited top scientists like Scott Glenn and Oscar Schofield, who were (according to current faculty), “people like us”—people who value collaboration in science, as well as education and outreach. Eight years after the establishment of IMCS, the program was ranked within the top ten marine science programs in the country.

The Institute of Marine and Coastal Sciences (IMCS) is a world-class oceanographic research institute dedicated to discovering and communicating exciting and critical science about our planet for the benefit of society. Our philosophy emphasizes the importance of understanding the processes that govern change and sustainability in the world's oceans to best use and protect our vital marine and coastal resources. Today, the institute remains true to the unique vision of Dr. Fred Grassle, whose founding principles established a tradition of pioneering research through integrative, inter-disciplinary approaches to ocean science, education and public service.

The current role of IMCS traces back to its heritage as a land-grant institution. According to Rutgers' scientists, the institution's leaders recognized that marine education extension is just as important as agricultural extension:

The dean was saying, 'we don't need another person to talk about string beans to farmers, we need to start talking about the ocean'. We are also aquaculture and we are also fishing.

When IMCS began, it was unique among academic marine science institutions. Even though its sole initial purpose was to serve as a research institution—and therefore, it did not have any students or classes associated with it—the founding scientists were visionaries, in terms of collaboration and outreach. As one senior scientist said:

We were a brand new place and interdisciplinary oceanography was still new and you couldn't do that and get tenure anywhere else. When I was a brand new professor [somewhere else] four years before, they told me, 'don't worry about the interdisciplinary stuff, it is not going anywhere, stick with physical oceanography, write your physical oceanography papers and that is going to get you tenure'. [IMCS] was that safe place where interdisciplinary oceanography could blossom... and so they gathered people who were interested in that... So it was all people who were going in that direction anyway... Fred made sure he got those people. Everybody was interested in education.

IMCS made its commitment to outreach and education all the more clear and concrete when they hired Janice McDonnell for a newly-created full-time position to oversee education and outreach opportunities and programs. According to all scientists we spoke with, McDonnell plays an important role within IMCS:

Janice has been part of that process since '93 or '94 and so early on, there was always this emphasis on having the research be linked with education and outreach opportunities. Having Janice in the building has made it so easy for us to participate in education and outreach and be part of it, from early on.

McDonnell herself recognizes the historical significance of her position and the precedent that Grassle's vision set:

Fred Grassle had a culture in his mind and built the institute around that... to my knowledge, we were the first institute, or marine science department to have a full time education liaison, which was me. He did it from day one and he did it to support the faculty... to create a culture of giving back to the community—the service piece. We are not just here to do research, but we are here to serve New Jersey. Fred would say that, every chance he got, every time he got the chance, he would make comments to that effect.

IMCS began with top marine scientists from MIT, Woods Hole Oceanographic Institution, University of California Santa Barbara, and Duke University. Rutgers University remains a case of scientists within a very strong, highly respected marine science program, becoming increasingly involved in science education.

Purpose of IMCS: to conserve the oceans through a combination of innovative research and technology, academic excellence, public outreach, and local engagement.

History with COSIA

Upon arriving at Rutgers in 1994, McDonnell connected with the Lawrence Hall of Science at the University of California Berkeley. She began her involvement with LHS by offering the MARE (Marine Activities and Resources Education) program, which is designed to be a whole-school interdisciplinary program, to schools surrounding Rutgers (which have since become over 50 schools served by Rutgers MARE). McDonnell first learned of the Communication Ocean Sciences (COS) course through Catherine Halversen at LHS. Since Rutgers began offering the COS and COSIA courses, they have expanded and evolved to include several other programs.

Liberty Science Center

Rutgers' partner in COSIA is the Liberty Science Center in Liberty State Park, Jersey City, New Jersey. The product of an intense capital campaign in the 1980s, Liberty Science Center officially opened in 1993. From 2005-2007, the Center underwent an extensive remodel and expansion, and in 2008, it ranked as one of the top ten science centers in the country in *Parents* magazine.

Liberty Science Center is a New Jersey nonprofit corporation dedicated to offering exceptional science learning experiences onsite, offsite and online. Located in Liberty State Park, Jersey City, NJ, we engage learners of all ages in science excitement, provide professional development for teachers, and actively connect people of all backgrounds to pivotal science and society issues.
<http://www.lsc.org/lsc/about>

Around that time, in 2007, the Vice President of Teaching and Learning at Liberty Science Center was instrumental in facilitating the collaboration with IMCS. He was “hunting for partners” according to one interviewee, and the relationship that Rutgers had with Liberty Science Center ended up superceding the relationship they had previously had with New York Aquarium. As Rutgers' partner for three years, the Liberty Science Center, according to all observers, has vastly increased its own capacity for providing quality education programs and professional development opportunities for its own science educators.

Liberty Science Center aims to serve African American families and other underserved groups in New Jersey. With support from the State of New Jersey, the Liberty Science Center collaborates with 30 of New Jersey's most underserved school districts (called the "Abbott Districts") to tailor science learning experiences for underserved students that meet the district's standards. Furthermore, all students in the Abbott Districts receive free Family Passes to they may visit Liberty Science Center with their families at any time, free of charge.

Leveraging COSIA

The COSIA course was an instrumental catalyst for scientists at Rutgers to seek out additional opportunities to combine cutting-edge ocean sciences research with education and outreach, and has led to nearly a dozen other projects combining ocean science research and education. As with the other COSIA sites highlighted in these cases, Rutgers University and Liberty Science Center are also part of a larger NSF-funded initiative called COSEE (Centers for Ocean Sciences Education Excellence). The Center based at Rutgers is known as COSEE NOW (Networked Ocean Worlds). Also similar to the other sites highlighted in these cases, Rutgers and Liberty Science Center have both become a part of the larger COSIA Network, an NSF-ISE funded project.

Rutgers has leveraged the COSIA course and its involvement with the Lawrence Hall of Science into over *ten* other projects, funded primarily by federal entities such as National Science Foundation (NSF), NOAA (National Oceanic and Atmospheric Administration), NASA (National Space and Aeronautics Administration), and the Department of Homeland Security (DHS), but also by private foundations, such the Geraldine R. Dodge Foundation and the Gordon and Betty Moore Foundation.

One prime example of how COSIA work has been leveraged for additional projects is the COOL (Coastal Ocean Observation Laboratory) room (<http://www.thecoolroom.org/>). Through this work, IMCS faculty and students send remotely operated gliders around the northeastern seaboard, and most prominently, across the Atlantic Ocean to Spain. The gliders, along with buoys, satellites, and underwater weather stations, record data on currents, fish locations, ocean temperatures, and wave heights in particular areas, as well as many more specific data, depending on the investigation at hand. This data is available to the public, to help them make more informed decisions on a range of issues. The COOL room is a part of MACOORA, the Mid-Atlantic Coastal Ocean Observing Regional Association, which is responsible for coordinating the observations of the ocean and coastal regions from Cape Hatteras to Cape Cod. These regional organizations exist nationally and internationally, in an effort to monitor the changing conditions of the ocean around our planet, and are part of the larger effort of the Ocean Observing Systems (OOS).

Not only is the COOL room sponsored by some obvious interests—such as the ONR (Office of Naval Research), NSF, NOAA, NASA, and NOPP (National Oceanographic Partnership Program)—it also receives support from the United States Department of Defense, the State of New Jersey Board of Public Utilities (BPU), the New Jersey Department of Environmental Protection (NJDEP), the New Jersey Department of Transportation (NJDOT), the Public Service Enterprise Group (PSEG), the G. Unger Vetlesen Foundation, and the Gordon and Betty Moore Foundation.

The Slocum RU 27 glider is a fine example of how ocean science research and education came together for Rutgers scientists and students

(http://rucool.marine.rutgers.edu/atlantic/about_atlantic.html).

The Slocum Glider was named after Joshua Slocum, the first man to sail around the world alone. IMCS launched the RU27 (it was the 27th glider they built and 1927 was the year Charles Lindbergh made his flight across the Atlantic) from Tuckerton, New Jersey and it traveled over 7,400 kilometers in 221 days (at ½ mile per hour) to reach its destination of

Cape Touriñán, Galicia (the westernmost point of Spain). Undergraduate and graduate students were heavily involved in the planning of the flight, as well as the launch and recovery of the glider.

Rutgers is building on its COSIA experience, to develop other programs that further their marine science research. Because of scientists' experience at Rutgers teaching COSIA, they (along with the Education Director at IMCS) have been able to leverage the course to further the research interests of the institution. For example, one scientist submitted a large proposal to the Department of Homeland Security (DHS), Center of Excellence for Port Security, and has been funded at annually increasing amounts (beginning with \$2 million a year) and will likely continue to be funded for the next five to six years. This funding paid for nine students to participate in flying the RU27 across the Atlantic. As one Rutgers scientist recalls:

DHS made me the director of education... they said our education program was really strong, because we concentrated on the whole pipeline and we had specific things for K through 12 that [the Education Director] was involved in, and there were specific things for undergraduates, and for graduate students, and we had the informal audiences, at Liberty Science Center and all of those groups were involved. We did the pilot study here at Rutgers for the DHS summer institute. We had about 9 summer interns funded by DHS last summer and it was a great success and so they mostly funded the students that did the flight of the glider across. They funded all 9 of those glider students.

As of this writing, Rutgers was considering submitting a climate change partnership program (CCEP) grant proposal to NSF with Liberty Science Center and an Integrated Ocean Observing Systems (IOOS) Education grant through NOAA.

The institution has a long tradition of collaboration, and serving and reaching out to the community.

Impacts on young students

On *Ocean Days* at Rutgers, COSIA students were participating in an event that brought together middle school children (who had participated in MARE, Marine Activities and Resources Education) from three different schools in the region (North Brunswick, New Brunswick, and Rockaway), undergraduate and graduate students in COSIA, and faculty from IMCS—all on the Rutgers campus. After the middle school students all arrived, they joined together to participate in an ice-breaker quiz with Scott Glenn and Janice McDonnell. Students used clickers to enter their responses to questions such as:

- How many oceans are there? (1, 4, 5, or 7)
- What determines how strong a hurricane will become? (Unstable air masses, warm ocean temperatures, how close the sun is to the earth, the sea level)
- Where does most of the Earth's oxygen come from? (Rain forests, the ocean, land plants, don't know)
- Most sea life... (Lives in the top 500 feet of the ocean, lives on the sea floor, lives in the great ocean basins, is evenly dispersed throughout the ocean depths)
- There are as many fish in the ocean today as there were before World War II (True or false?)
- About how much of the ocean has been explored by humans? (100%, 80%, 50%, 25%, 10%)

After the middle school students completed the quiz, they circulated among the six stations that the COSIA students had set up, with hands-on activities for the middle school students to try, in order to get across a particular message about ocean science. McDonnell encouraged the middle school students to ask the COSIA students hard questions. The titles of the six stations were:

To Sink or Not to Sink?

- Don't Get Tide Up
- Clean Up your Act (marine oil spills)
- Ports and Estuaries
- How Did That Get There? (Marine Pollution)
- Weeds in the Waterways

There were also questions written on large posters around the room for the middle school students to respond to:

- What is one way that climate change affects marine organisms?
- If you could live at the beach, where would you live? Use a sticker to mark this area on the map of NJ and then explain why you chose this spot
- Climate change is...
- What part of your MARE project did you enjoy the most?
- Today, I was surprised to learn... (text your answer to txt@coseenow.net)

The students filled out evaluation forms, rating the different activities and commenting on whether they learned more about the kinds of research that scientists at Rutgers are engaged in. To hear MARE students' perspectives on ocean science, collaboration with peers, and being at Rutgers, listen to the podcast here:

<http://coseenow.net/podcast/2010/05/positive/>

Impacts on COSIA Students

For over 15 years, Rutgers IMCS has been involved with MARE programs, which impact middle school students. When Rutgers started offering the COSIA course several years ago, IMCS started having a profound influence on Rutgers' own undergraduate and graduate students. On our site visit, we spoke with several former COSIA students who were inspired to continue their involvement with IMCS and ocean science education. One former student is now the director of the Aquarium of the Bay in San Francisco.

One scientist (and former COSIA student) who currently works on the coastal radar project for IMCS, explained what set the COSIA course apart from the other courses he took at Rutgers and the opportunities he had as an Ecology major:

Even though I was an ecology major, I never really left the classroom. You might do a little bit of fieldwork. So to have a class that not only gets you to go out of the classroom, it also gets you to go to Liberty Science Center, is great. It is more than just making up hypothetical projects—you actually get to design these projects and have interactions with the people. I didn't have that opportunity in any of my other classes... an opportunity to really have like a direct impact on people outside of the school. I am a scientist or a researcher, but I do a lot of technical work. I don't write a lot of academic research papers and that is not really my specialty. I like to talk to people. I spend all of my days doing very technical aspects of science and people ask me what I do and I have to stop a second and say, 'how am I going to explain this so they don't just tune me out instantly?' I think the COSIA class gives you really good perspective on how people learn and you realize that everyone learns differently.

Another former COSIA student explained that the course enabled him to adapt information he was trying to communicate for different audiences and therefore, be more effective:

Inevitably, when you start doing a presentation, you realize that people start latching on to this part or that part of your presentation and you have to be able to adapt on the fly. That is a skill that is invaluable. You might have an idea of what you want to happen, but you have to always be able to tweak it a little bit so you get your point across.

Another scientist who participated in the COSIA course as a senior during her undergraduate years, is now a glider technician for three different scientists at IMCS—one who is in charge of the gliders, one who is in charge of the moorings offshore, and one who is in charge of the coastal radar observation systems. She said:

COSIA was by far the most valuable course I took at Rutgers. It didn't just teach you about ways of communicating—like tools and strategies—it actually gave you a chance to apply them. We worked at a teacher conference in New York, we worked with community groups in the area, and with 4H... the learners were at all different ages. COSIA allowed you to understand why some tools work in some situations but not others. You didn't just talk about it—you did it. Most opportunities to communicate about science don't happen

in the classroom—they happen when you don't expect it. It's good to know how to communicate in those different situations.

One former COSIA student explained how the COSIA course has helped him translate his work to the general public and in turn, promote the research he participates in:

I often interact with people when I am out at the beach. People see me working and they ask, 'what are you doing with these antennas? We have seen these antennas out on our dunes.' They like to know. It is not my primary responsibility to talk to people, but it is a skill that is important for me to have, because people are always asking me these questions. I am the face of Rutgers when I am out in the field. I certainly want to come across as someone who has a purpose and knows what they are doing. And I would like to attract more attention to the research that we did and do.

Ultimately, the COSIA course empowered undergraduates and graduates alike, in that they were able to influence others by communicating about the work that they do:

Being able to go do these presentations... I got to go to the Liberty Science Center three or four times to run projects, and to this day, I think that was one of the best and biggest impacts that I have ever had on people.

The former COSIA students we talked with strongly believed that the COSIA course fills a niche that is otherwise not met—and that is, to prepare novice scientists how to effectively communicate with others. When asked whether there were any other courses at Rutgers offered to help scientists communicate or learn how to teach, one former COSIA student and practicing scientist said:

Not really and it is a point that I have brought up with dozens of people over the last few years in that—and this is not Rutgers specific, but this is research-institute specific—there are a lot of professors that are very bright or geniuses and they may have even written a textbook, but they never once had a class on how to teach.

Another former COSIA student said:

I have told so many people, I wish that COSIA was a prerequisite for scientists... that professors had to take a teaching class to become a professor, but it is not. There are a lot of professors, they can't teach, because they have become so involved in their field, their level of understanding is very different than a layman's understanding. So they have lost that connection. How do you get someone who doesn't know what a water molecule is or plankton is to understand acidification or climate change?

Former COSIA students see the value in scientists being able to effectively communicate with the public, in order to foster a sense of stewardship among the public:

How are you going to have people taking care of the world if they don't understand the science from as early as possible? You can't wait until they have master's degrees to address the real issues. So, it is scary to think that there are a lot of scientists that are like, 'oh, why should I have to talk to the public about my research?' Well what is the point of doing your research if it is not going to have an impact and if all you want to do is publish it in a research journal that no one outside of your field will read—just so you can get another grant? I think that is something that scientists from every branch of science should do... they need to have that on their door or on a poster... a memo to themselves: 'What can I do today to make sure that my research is actually affecting the most amount of people that it can possibly affect?'

Impacts on Scientists

The scientists we spoke with at Rutgers described many positive impacts that being involved in ocean science education (through COSIA and the wider COSEE Network) has had on them: the scientists' efforts with students furthers their research in several ways, they benefit from their work having broader impacts on the community, and they have a pre-existing foundation or infrastructure in place to help them do this work.

Facilitates research and exploration

Most scientists agree that it is important for them to be able to communicate effectively, in order to increase public support and interest in scientific research. As one Rutgers scientist (who is also a former COSIA student) said:

If you don't have public opinion on something, you are not going to get the government buy-in and you are not going to get money for your cause. If you are interested in getting grants, you really need to get public opinion in support of your cause and your research. So that is one reason to do more outreach. And also just to get people informed on what is going on, because you are talking to people every day and you can see that they really are interested in the science.

Similarly, another scientist said that being able to communicate well with diverse audiences allows them to get support for their research and to continue exploring.

Scientists do need to communicate. What is their interest? They are interested in the things that help their research. They are very much interested in how do they get funding, how do they find students and how do they continue exploring and how do they continue learning? We also want to get students and so how do we increase that pool of students... we are concerned about the pipeline.

When asked why having students in the pipeline helps scientists, they explained that through courses like COSIA and internships, students help with pilot studies. Students in classes that are funded through education programs allow scientists to have access to more inexpensive manpower to run their labs and projects and perhaps more importantly, to test technologies that might be considered too high risk to be funded by the science community. For example, no science organization would have funded the testing and piloting of the gliders. But

because it was seen primarily as an opportunity to get undergraduates involved in research, it was funded by education. The repeated trials and in fact, the successful crossing of the Atlantic by the glider RU27 served as “proof of concept” for the gliders and allowed the scientists to receive funding from science to continue their research:

Well it helps us get our research done. We are people-limited often. We could never have done some of these things without the undergraduates. We would never have flown a glider across the Atlantic. We were looking at it and said, ‘there was no way we are going to do this by ourselves. Nobody is going to fund it as research—it is too risky for research’. But it got funded immediately for education. Alumni gave us the money, because they wanted to have research experiences available to the undergraduates. They thought that was great and it didn’t matter if we lost the glider or whatever, because the students were having research experiences. I think that is a very important piece of it—getting those students involved.

Similarly, when a different Rutgers scientist proposed flying gliders in the waters around Antarctica, he was able to point to the work of the students as proof-of-concept:

I think the pilot brings credibility to other proposals. If we had written this proposal to take a glider by helicopter to the edge of an ice sheet and put it in the water, and fly it, the science community would have bashed it. They’d say, ‘this is not going to happen’. But because we were able to use the education pieces to fly a glider across the Atlantic... that brings credibility now from some of the other science research we want to do.

Speaking again of the COSIA course that allowed students to fly the glider across the Atlantic, a scientist pointed out that bringing in the education component, provides even more funding opportunities for ocean science research:

With that project, you really see how it is going to live on, beyond the scientific community because of that broader impact. It is going to reach a whole other group of people that it would never have touched, if it was just a science proposal and that was really interesting to see. What we see now is that the education starts to feed back on the research and that is closing that loop and that is very important for continuing this because there is not enough money in oceanography, but when we have education people funding us to do ocean science research with undergraduates, that then feeds back and they can test technologies that the research community is not ready to test. For example, they had never put lithium batteries in the Slocum gliders before, but we did, because it didn’t matter—we were students and it didn’t matter. There was no big research project dependent on it and so we could take risks that the research community can’t take. And so now that we have flown it across, now we are getting other science opportunities. The rapid climate change program wants us to be part of that.

Another similar example a scientist mentions took place at a meeting he had with the US Navy. They told him:

‘Oh no, you can’t use these gliders to tow acoustic tails, they have to be a propeller driven AUB, it can only stay out for 12 hours’. I said, ‘what do you mean you can’t do that? We

just had a student who, for her summer project, she tied a biological acoustic sensor to look for whales... she tied it to the glider and she went out and flew it all the way across the shelf, listening for stuff on the way. Now, the Navy is doing that... they took four of our gliders immediately and all we know is that they are doing acoustic stuff with tow tails.

This was entirely based on the fact that a student had tested the technology herself for a summer project:

Students are taking risks that scientists aren't going to take because they can't get it funded or they have to guarantee some level of success for the rest of the science program. Scientists have to be conservative, students don't.

Less activation energy required

The Rutgers scientists brought to our attention a previously unmentioned benefit of having a foundation and infrastructure in place to help them do more education and outreach. Traditionally, there has been such a wide separation between professional university science and education that many people just don't know how to go about doing it. It is daunting and they don't have the time to figure it out. The Rutgers scientists refer to this as "activation energy" and describe how COSIA helps reduce the amount of activation energy required to become involved in education and outreach on their behalf:

So scientists care about their research and they care about education on many levels, but they are overtaxed with their time and so there is a huge activation energy to get anything extra done, so anything that you can do to help relieve the burden and make it easy for scientists to interact with students, and easy for them to do these education things with schools. Scientists are usually willing to do it—whether there is a criteria to it or not—it is just that activation energy required. They are so busy.

A different scientist concurred:

I think the whole premise... I know why I am involved and why research scientists are involved is because COSIA is structured in a way that is very easy for us to participate.

The supports available through COSIA and the larger COSEE network enable scientists to develop and write much stronger broader impact statements than they might otherwise, without such support:

To me, 'Broader Impacts' is not just the students... it is broader than that. It is looking at state agencies that could benefit and it is looking at commercial fisherman or recreational fishermen—it could be anyone—and COSIA allows me to put stronger proposals together. When we write a broader impact statement, I don't want to just have it be a generic broader impact statement. I want to have it put as much effort into that as I put into the science part and COSIA and COSEE NOW enables me to efficiently do that.

One scientist said that the ability to put together a strong broader impact statement is actually becoming a discipline in itself and having supports have helped the scientist. He said that in turn, his science research is influenced by his education and outreach work:

The science, for me, is influenced by the experience that I have had through COSLA, COSEE, and interactions with the Education Director and others.

Exposure and attention

Another way that scientists' involvement in ocean science education and outreach has furthered their own research efforts is the increased publicity and promotion of their work that often comes from working with students. For example, the press loves to broadcast examples of students involved in scientific experiments (especially those that are international) so this increases the profile of the scientist and the research:

We have had more press on this event than anything else in Rutgers' history, this single event. There are bigger events, like a big football game or something, or a bowl game or something, but just the continuous press coverage for almost a year is unprecedented, including international press. Then there is going to be a documentary on it and the glider itself [RU27] is going to the Smithsonian. This is one of Rutgers' biggest outreach activities ever and the kids are so important to it and everybody sees that as just critical. The undergraduates being involved, the young K-12 students being involved—they're all out there and everyone wants their picture taken with it.

While press coverage may not appeal to all scientists, it is an increasingly present factor in being competitive. As the Education Director said:

It is a competitive world, you know, and it has to be both financially feasible and also get attention, because how much attention you get is directly tied to your promotion and tenure. That is just the way it is, your future depends on how much attention you get.

In turn, this attention and exposure furthers funding opportunities, collaboration opportunities, and other opportunities, such as support for additional facilities. The Dean at Rutgers agreed to give IMCS an additional building to use as classroom space:

COSLA certainly got the attention of the dean and some of the people in positions of power within the university recognize and appreciate what we have done with COSLA.

Another Rutgers scientist emphasized how the exposure available through COSIA fits into the university's mission:

We have important jobs here and so we need all of the tools that we can get. We need all of the help through COSLA, and we need all of the help from the agencies and the universities. We see the university supporting it—they have given us this building and they have given us the people. They see that impact can go beyond just Rutgers and you will ask

people and they'll say, 'Rutgers is Jersey roots and global reach' and that is our motto. Yes we learned this stuff in Jersey and we figured it out here and we tested it here, but how do we expand it to the entire globe? It just fits into our whole concept of life here at Rutgers and so yeah, it has definitely helped.

Future directions and lasting legacy

Currently, Rutgers is serving as a node in the COSIA Network. The Education Director described her vision for the future of education and outreach in ocean sciences:

I want to set up nodes of people who can, not just do what I do, but bring new things to the table. I have a certain span of expertise that I can provide scientists, and what I would like to do is not only get them to start providing it to each other, but also find others like myself. There are plenty of people out there who are more than capable of doing what I do, but just don't get asked and don't realize that they can do it.

Rutgers is engaging 4H educators to bring ocean science to the middle of the country. As the Education Director said:

If you look at the map, 4H has the opposite of what NOAA has. NOAA has the coast and 4H has the middle of the country. How do you combine all those? You use the networks that are in place and then build new ones and make bridges to these other groups. 4H is one of them.

Another strategy for expanding the work involves providing more professional development opportunities for informal science education providers, such as the educators at the Liberty Science Center:

One way is working more closely with informal education providers and whether they be people like 4H or people like museum educators... you need to do both, frankly, and so we want to do more powerful large-scale kind of work. We want to provide more intellectually stimulating reasons for people to engage in the sciences, more of a citizen science approach, and blend the climate change work with the ocean observatory initiative through data collection.

As part of that vision, COSIA will be taught for the ocean observing system (OOS) community, a community that is growing in number and in relevance. For the Ocean Observing System community, Rutgers compares their vision for providing support for the OOS community to how Lawrence Hall of Science has provided support for similar work over the years:

[LHS] has really talented people in that regard because they developed something and they incubate it and they get it to the point where it is disseminable, but they give you just enough input that you can be part of it and feel like you contributed to it. We need to figure that out for the observatory stuff. The next big thing we will do will be to develop

infrastructure for [OOS scientists] to do exactly that with observatory data... give them just enough to be able to adapt it to their use and still be able to say that we did that, we contributed to the bones of something.

The leaders of COSIA at Rutgers and of COSEE NOW see their role as that of “conveners.” They bring together ocean scientists from many different sub-disciplines, educators, and community members into a structure that is supportive but flexible. The work of Rutgers allows for individuals in different domains to do their work better and have more of an impact.

Rutgers’ role as conveners is critical for solving the challenges facing our oceans, the environment as a whole, and society. Over just the past ten years, “interdisciplinary” in oceanography has come to mean more than just “biological oceanography” collaborating with “physical oceanography” (which was revolutionary on its own 20 years ago). Now, “interdisciplinary” in oceanography is coming to mean drawing on disciplines such as anthropology, psychology (risk behavior analysis), economics, foreign language, writing, etc... to solve problems that science is increasingly recognizing are too complex for one discipline to solve. Problems such as pollution, over-fishing, overpopulation, under-nourished and impoverished communities, and rapid climate change cannot be solved by traditional oceanography alone. According to the Rutgers scientists we spoke with, all of the big major unsolved problems facing the world today are interdisciplinary and it requires different groups of people to work on solutions. One scientist said:

Even the definition of interdisciplinary has totally changed. It used to be just a physical oceanographer talking to a biological oceanographer and ‘look how interdisciplinary we are.’ Now you are getting a physical oceanographer or a biological oceanographer talking to an education professional, talking to an economics researcher and a social scientist. That is the interdisciplinary work that has to be done in the future. What is the science? What are the economic impacts? How do you implement these things with a population?

Not only is it necessary for professionals from different disciplines to collaborate in these circumstances, it is necessary for them to communicate their work to the general public. This is a crucial component of the work itself. One scientist explained how the work of COSIA and COSEE is different from other “education and outreach” projects because it is deep and sustained, which is the only way to convey the importance of the oceans:

Education and outreach are something that has to be sustained and so it is sustained outreach, sustained bridge building, and sustained interactions with these groups, because the groups that you need to interact with, are always changing. We can’t say, ‘okay, we have done our education and outreach, America is literate and ocean literate and we can just sit’. We can’t... we have to sustain this effort and we have to increase it and we have to adjust it every day and we have to sustain that into the future and keep doing this, because the ocean is critical to life on earth. It is vast, it is harsh, and it is under sampled. It is what we need and it controls climate and it controls our food and it controls our oxygen. The people need to understand that and it is a big globe with a lot of people.

Rutgers and a hybrid community of practice

As we acknowledge that oceanography has become more truly interdisciplinary, so to have the sciences begun to recognize the important role of outreach. So as the nature of the field has changed, there has been a parallel increase in the number of “people like us” (as McDonnell, Glenn, Kohut, and others described themselves). “People like us” are scientists who now work as science educators, and educators, anthropologists, language specialists, economists, and others who now participate in science. They are part of a hybrid community that brokers relationships among professionals from different communities of practice. All of our interviewees discussed this issue. One scientist explained, “the edges of the boundaries are also where the exciting stuff happens”. Rutgers recognizes the need for the scientists and their science to reach the community and have the community feed back into the science. One scientist described how ocean science has changed over the years:

COSLA and COSEE have really broadened the number of people, the support that it is getting, and the groups that it is influencing and so it has just grown more and more. That is very important. It is getting really accepted as an important piece of what we do. As a scientist, when I was younger, you would learn your one little piece and they said, ‘you have to be the best at that piece’ and you get pigeon-holed and that is all you would do. They finally started to see the value of collaboration between this person and that person, well if we work together, we can do something we couldn’t do before.

He also explained how Rutgers is growing and contributing to a larger network and a movement:

And now these educators have these different things that they know how to do and then it has value and so, the network is just growing. And I would say that is going to continue in that direction and it can really help us open up these whole new areas of science and collaboration with groups that we have never thought about before and that is an advantage of being here on this campus, because there are collaborators in economics and social sciences and stuff like that, where it is not quite allowed to collaborate yet at other campuses.

Again, the idea that innovation occurs at the edges of the boundaries between communities of practice resonated with the Rutgers scientists:

We see a lot of important advances and they are at the boundaries between disciplines and those are the exciting places to work. And bridging those boundaries and finding ways to tunnel under the walls or go around or something like that. That is so important for the big problems that are still out there and to have that impact. We learned those skills through work like COSLA. You learn how to communicate in ocean science. I am a much better communicator now that I have taught that class.

One final, very meaningful statement from a Rutgers scientist regarding crossing the boundaries between communities of practice:

Crossing these boundaries is very, very important now for the future of our kids, and for these generations with all of the things that are going on with climate change and with growing populations and people are worried about economies and so, you have to bring those people in. There is important research that can be done collaboratively and sometimes those traditional scientists don't understand that but some of us like to live at the boundary. Some of us thrive at the boundaries. I enjoy learning from other people, and these people are experts, but just in a different field and they speak a totally different language and learning that language and learning how to communicate is exciting. It is a challenge, but it broadens your view so much and so there is a real personal gain that I feel from being part of this and there are other people that are like that too, that also enjoy that piece. I think that is a very important role for COSIA and COSEE—continuing to expand and continuing to work at these boundaries and build those bridges and make it easier for us to talk.

This partnership as a case of...

The Rutgers University-Liberty Science Center partnership is a case that illuminates the important future directions of ocean science and the critical role that science collaborating with other disciplines plays—and especially how important education and outreach are for solving the challenges that face our planet and society. The *Institute for Marine and Coastal Sciences* (IMCS) is the result of a visionary founder who valued interdisciplinary collaboration and education and outreach. IMCS has a long and strong legacy of innovation and not only recognizing, actually promoting the necessity of communicating with the public and the community about science.

This case also shows how the partnership with Liberty Science Center has only grown and become stronger over the years, in no small part because of the support of LHS and others in the COSIA Network.

This is the case of a large public state university—one of the oldest in the country—with a cadre of exceptionally skilled ocean scientists that provides unique opportunities for its students to have authentic research opportunities. The dean, the founder of IMCS, and the faculty strongly believe in and support giving students hands-on experience in research. That research experience comes together with education and outreach through the work of COSIA. Students learn how to communicate about science while participating in cutting edge research projects. These skills have proven to serve past COSIA students well as they enter the workforce upon graduation.

Meanwhile, highly successful and highly visible ocean scientists benefit from teaching the COSIA course, as well as from the students' participation in their research. Scientists are able to try experiments that may be considered too risky for big science to fun in the name of providing research opportunities for students. Scientists benefit from having additional manpower on their research team and their research received additional attention and exposure due to students' involvement. Perhaps most importantly though, scientists learn to communicate their own research and address issues of cultural and learning diversity.

The partnership between Rutgers and Liberty Science Center is uniquely situated to expand in ways that may not happen at other institutions. The work has the full support of the LSC education staff and the university administration (to the extent that the university has provided an entire building for the COSIA course). When asked whether the work of COSIA had impressed university officials, one scientist said:

Yeah, they see a network, they see a national network and they see that impact that can go beyond just Rutgers and you will ask people, Rutgers is 'Jersey roots and Global Reach' and that is our motto. Yes we learned this stuff in Jersey and we figure it out here and we test it here, but how do we expand it to the entire globe? It just fits into our whole concept of life here at Rutgers.