U.S. Department of the Interior
STEM Education and Employment Pathways
Strategic Plan Fiscal Years 2013—2018

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Preface

In response to the America COMPETES Act, the White House Office of Science and Technology Policy (OSTP), National Science and Technology Council (NSTC) launched the Committee on STEM Education (CoSTEM) in March 2011 to create a Federal strategy for STEM education. The Department of the Interior (DOI) serves as an active member on that committee. DOI recognized the need to better understand DOI's STEM education activities and to create a strategy to effectively coordinate and focus the extensive contribution DOI makes to STEM education in support of teachers, students, and the American public.

In May of 2011 a DOI STEM Education Working Group, with membership from across DOI and under the Leadership of the DOI Office of Youth, Partnerships, and Service, was brought together to create a *U.S. Department of the Interior Science, Technology, Engineering, and Mathematics (STEM) Education and Employment Pathways Strategic Plan: Fiscal Years 2013–2018*. The working group was charged with creating a plan that (1) identifies DOI's role in STEM education and employment among Federal science agencies; (2) supports the goals of DOI's strategic plan to build a 21st century workforce with a focus on science literacy and STEM careers; and (3) supports the goals of the NSTC CoSTEM Federal STEM education strategy. The following is a list of the working group members who shaped this plan.

DOI STEM Education Working Group

Maria Arnold, DOI Office of Youth, Partnerships, and Service
Fredericka Joseph, Bureau of Indian Affairs (BIA)
Jeffery Hamley, Bureau of Indian Education (BIE)
Sandra Poolaw, Bureau of Indian Education (BIE)
Elizabeth Wooster, Bureau of Land Management (BLM)
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Contents

An Alaska Volcano Observatory Remote Sensing specialist acquires Forward Looking Infrared Radiometer (FLIR) imagery of the lava dome in the summit crater of Redoubt Volcano from a research hut, located 7.5 miles north of the lava dome.

1. Executive Summary

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The *Department of the Interior's Strategic Plan for Fiscal Years 2011–2016* presents the Department of the Interior's vision for a 21st century Department whose highly skilled workforce reflects the diversity of the Nation, optimizes youth engagement throughout its programs, promotes sustainable operations, and applies effective and efficient management.[1]

Since its inception more than a century ago, the Department of the Interior (DOI) has relied on the integration of research and education to carry out its mission, engaging millions of Americans in conservation and natural resources science through its resource management, recreation, natural hazards, and education programs on our Nation's public lands and in partnership with Tribal Nations, U.S. Territories, and Freely Associated States. Current trends in Science, Technology, Engineering, and Mathematics (STEM) education and employment, along with changes in demographics and youth interests, suggest that the skilled workforce needed by DOI to fill mission-critical positions and support the engagement of citizens in informed decisionmaking can best be obtained by increasing science literacy and engagement.[2] Intentional and strategic alignment of existing resources, leveraging of current programs, and expansion of partnerships will allow DOI to strengthen those education and career pathways that will attract and prepare the future workforce and contribute to the development of a scientifically literate public with whom DOI must engage daily to address complex issues in their communities.

The Geoscientists-in-the-Parks Program provides on-the-ground learning experiences for students studying the geosciences or those just beginning their Earth science careers. The program places geoscientists in parks on a short-term basis, where they provide much-needed assistance with geoscience research, inventory, monitoring, impact mitigation, interpretation and education. This intern works with National Park Service staff and park visitors collecting paleontological data at the quarry at Wyoming's Fossil Butte National Monument.

This STEM education and employment pathways strategic plan supports DOI's strategic plan by providing a framework for building a 21st century Department that focuses on strategies to increase science literacy and strengthen the education and career pathways to STEM fields of study that support DOI's mission. The National Science Education Standards define *scientific literacy* as "… the knowledge and understanding of scientific concepts and processes required for personal decisionmaking, participation in civic and cultural affairs, and economic productivity."[3]

Vision and Mission

The ***Vision*** for DOI's STEM Education and Employment Pathways Strategic Plan is:

- Support a science-literate public and prepare students and professionals from all backgrounds to understand and value the role of science and science inquiry in the stewardship of America's natural resources and cultural heritage.

The ***Mission*** is to:

- Build an inclusive 21st century workforce and increase science literacy by connecting the public with the Nation's natural and cultural resources through outdoor developmental experiences and long-term engagement, education, employment, and service on and in support of public lands and waters. Through these actions, advance the science, engineering, and technology that inform natural and cultural resource management, natural hazards response, and decisionmaking on critical issues that impact our Nation, the world, and society.

Five-Year Goal and Guiding Principles

The ***Five-Year Goal*** is:

> ► That our youth and the American public become scientifically literate stewards of our natural and cultural heritage and that today's youth, especially those underrepresented in STEM fields of study, become inspired to choose career paths at DOI or related agencies and partners.

Four ***Key Strategic Areas*** are defined in this strategic plan to strengthen DOI's current STEM education and employment pathways:

1. Facilitate Access to Coordinated DOI Resources
2. Engage Students and Citizens;
3. Support Educators;
4. Strengthen Career Training and Workforce Development

The plan includes guidelines for coordinating actions across bureaus and specific, actionable objectives for each of the four Key Strategic Areas, as well as next steps for planning small-scale, intensive STEM engagement and service-learning demonstration projects with middle and high school-age students and their educators. Demonstration projects will emphasize three critical, multi-disciplinary issues that are DOI priorities: climate change, sustainable energy, and invasive plant and animal species. Additionally, the plan highlights opportunities to better engage Bureau of Indian Education students (including federally funded Haskell Indian Nations University and Southwestern Indian Polytechnic Institute) in DOI and partner field and research-based internship and mentoring opportunities.

The plan also will help implement the Federal STEM education strategic plan developed by the National Science and Technology Council's Committee on STEM Education (CoSTEM) (http://www.whitehouse.gov/sites/default/files/microsites/ostp/nstc_federal_stem_education_coordination_report.pdf). The *DOI STEM Education and Employment Pathways Strategic Plan* directly supports the four strategic areas identified by the CoSTEM: effective K-12 STEM teacher education, engagement, undergraduate STEM education, and serving groups traditionally underrepresented in STEM fields. Objectives contained in the DOI plan also support implementing, where appropriate, the CoSTEM design principals, ensuring that STEM education investments have sound learning goals, management plans, and evaluation strategies and use evidence-based practices.

Finally, this plan is designed to utilize DOI's unique strengths to advance STEM education in the United States. The plan:

- ***Capitalizes on STEM-rich assets***—expanding opportunities to connect students and educators with public lands, waters, and cultural resources, via outdoor classrooms and laboratories, and collections of data sets.

Through "BioDiversity Discovery" programs, the National Park Service engages visitors in scientific discovery of living natural resources while connecting them with scientists on public lands. Through "BioBlitzes," for example, participants document the presence of species within a specified geographic area during a short time frame. The National Park Service partners with Federal and State agencies, universities, and communities to help fill in knowledge gaps and foster stewardship.

Students in the Fish and Wildlife Service (FWS) Career Discovery Internship Program help pull water chestnut at the Eastern Massachusetts National Wildlife Refuge Complex. The activity was part of a week-long orientation and introduction to the FWS held before the students headed for their summer work stations.

- ***Promotes STEM-related career paths and opportunities for American Indian and Alaska Native students***—expanding opportunities for students to pursue high quality associate and baccalaureate degrees, as well as coursework in STEM fields (including Environmental Science, Natural Resources, Natural Science and Pre-Engineering) and specialized areas such as Geographic Information System (GIS), Geo-Spatial Information Technology, and Robotics
- ***Contributes to a STEM-skilled and science-literate workforce***—providing meaningful, experiential learning opportunities especially for middle school through post-secondary students.
- ***Incorporates research-based best practices***—focusing on quality programming to achieve the most impact for the effort invested.
- ***Increases our relevancy and appeal to young people***—making DOI's resources available through new technologies.
- ***Supports DOI-wide inclusiveness goals***—advancing DOI's efforts to reach populations underserved and underrepresented in our programs and in STEM fields of study.
- ***Leverages partners***—expanding DOI's reach through mutually beneficial strategic partnerships with those whose expertise enhances our efforts.
- ***Aligns with Department and Bureau-level Memoranda of Understanding such as the agreement between DOI and the Department of Education***—maximizing the use of Federal lands and our natural resources and monitoring systems to enhance educational opportunities.
- ***Connects with the Next Generation Science Standards***—ensuring educators associate DOI with students' hands-on field investigations.
- ***Promotes accountability through evaluation***—assessing progress and results to inform next steps.
- ***Reflects DOI's Youth Initiative and America's Great Outdoors***—connecting young people with the outdoors while building 21st century conservation leaders.

An innovative partnership with the Office of Surface Mining and AmeriCorps placed this Summer Program Member with the Morris Creek Watershed Association, recruiting youth group volunteers to conduct a fish shocking as a part of monitoring trout stocking in Morris Creek, West Virginia.

2. Introduction—A Call to Action

Public and private sector representatives have long called for the United States to improve STEM education in order to remain competitive and innovative in a global economy.[4] Research findings consistently document the underrepresentation of large segments of the population in STEM fields of study. To ensure that DOI attracts and retains an inclusive workforce for mission-critical positions, we have focused on key findings in three areas to strengthen our existing efforts and to provide a basis for future actions involving science literacy and workforce development.

STEM Education and Employment Trends

Patterns in STEM education and employment inform strategies for engaging populations typically underrepresented in STEM fields of study—primarily Hispanic or Latino Americans, African Americans, and Native Americans and Alaska Natives—along with women and persons with disabilities.

- Although DOI employs the third largest number of scientists and engineers (14,700) among Federal agencies, it has the lowest proportion (11%) of minority scientists and engineers.[5]
- Minorities underrepresented in STEM fields of study become even more disproportionately underrepresented—from kindergarten through doctoral programs—in school enrollment and science and engineering degree attainment, compared with their counterparts in other fields.[6]
- Minorities underrepresented in STEM fields of study are less likely than their peers to meet math and science benchmarks for college readiness. Figure 1 shows results, by race/ethnicity, for 2011 high school students reported through ACT College Readiness testing.[7] Minorities who are underrepresented in the science and engineering workforce in the United States comprise less than 10% of this workforce.[8]

Demographic Changes

Demographic changes play an important part in successfully informing young people from all segments of society about DOI's mission and attracting them to positions at DOI.

- Young people today comprise the most diverse generation in U.S. history.[9] By 2043, minority populations, many of whom are underrepresented in STEM fields of study, will become the majority.
- Census projections indicate that the U.S. population will reach 400 million people by 2043,[10] an increase of 100 million in the span of 37 years. Some regions are growing faster than others, especially in the west and south.[11] Such population growth increases stress on natural and cultural resources and presents more complex management challenges related to water supply, habitat loss, sea level rise, energy needs, pollution, and other resource and environmental issues.

Patterns in Youth Interests and Activities

Youth trends raise concerns about who will serve as future stewards of our natural and cultural resources[12] and thus may deeply affect DOI now and in the future. Some trends, such as increased use of technology at earlier ages, however, can provide a venue for reaching youth. DOI needs to continue developing strong partnerships with schools so that DOI assets and strengths can support STEM curricula.

- Young people are spending less time outdoors in nature. Factors contributing to this trend include the increased use of social media and computer "screen time,"[13] parents' concerns about personal safety outdoors, and transportation, cultural, and financial barriers to accessing public lands.
- Minority youth populations spend relatively less time outdoors than their peers.[14]
- Decreased exposure to the outdoors is associated with decreased familiarity with, understanding of, and appreciation of the environment.
- The increased interaction of youth with technology in nearly every aspect of their lives provides an opportunity to engage them in science and technology and provides a strong venue in which to connect with them.

An Alaska Native Science & Engineering Program intern studies Emperor Geese at Manokinak, a bird research field camp operated by the U.S. Geological Survey in Alaska's Yukon Delta National Wildlife Refuge.

The Southwestern Indian Polytechnic Institute's Intelligent Cooperative Multi-agency Robotics Systems (ICMARS) Robotics Team members test their mobile robot platform on the Lunar Yard at the NASA Johnson Space Center.

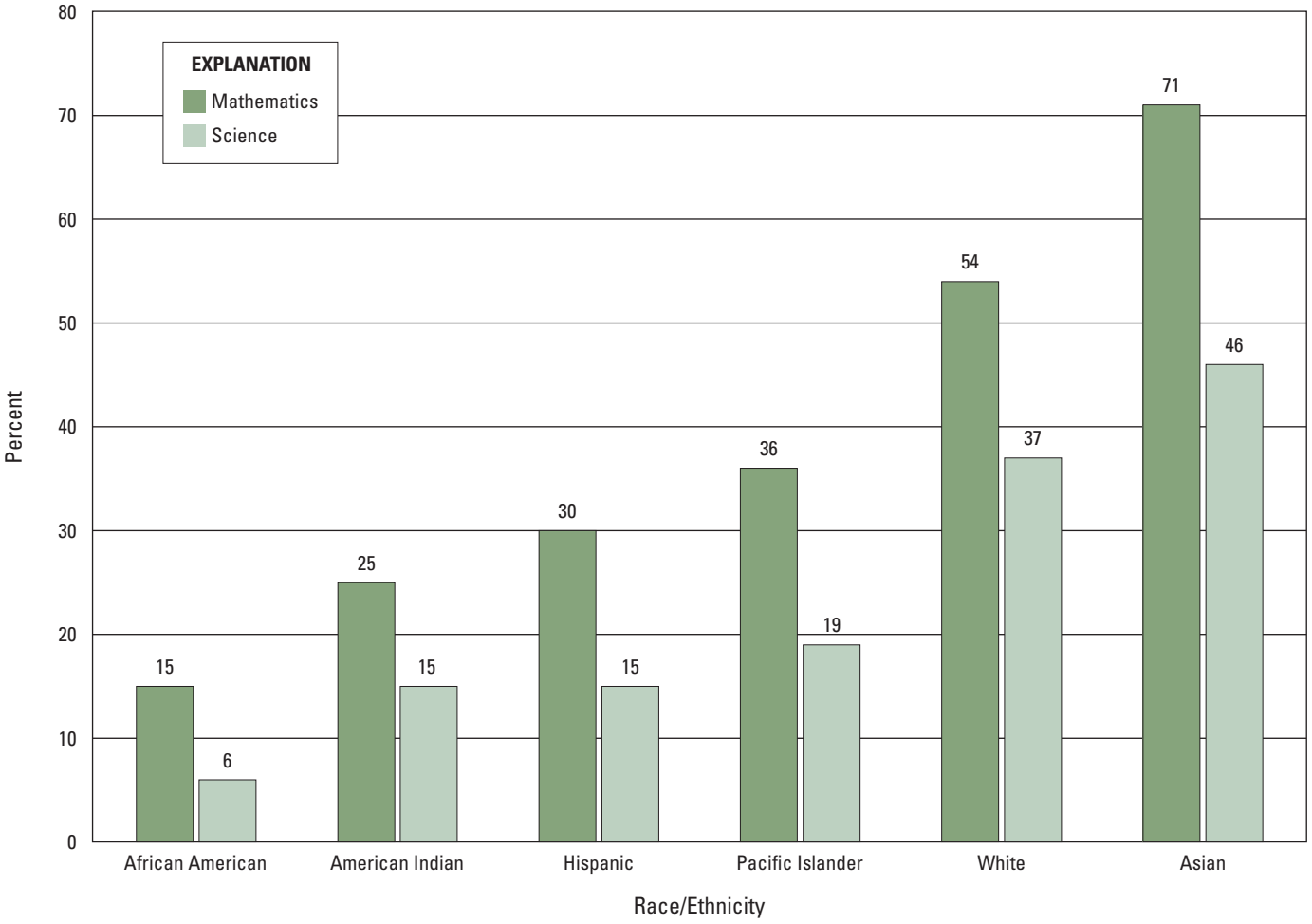

Figure 1 Percent of ACT Tested High School Graduates Meeting ACT College Readiness Math & Science Benchmarks by Race/Ethnicity, 2011.

3. Department of the Interior's Role and Strengths

The foundation for this plan rests upon DOI's mission of environmental stewardship, which includes the study, management, and care of our natural and cultural resources. The DOI mission provides the context for engaging students and the public; DOI's workforce is its most critical asset in implementing this plan. Other unique and powerful assets include the Nation's public lands and waters, DOI's diverse partners, real-time and archived data sets, world-class scientific laboratories that support research in biology and the geosciences, and the experiential education and employment offerings we provide as detailed below:

- ***Current STEM Workforce.*** Mission-critical positions in STEM fields comprise a significant portion of DOI's workforce.[15] STEM employees provide knowledge, mentoring, research opportunities and training through the science they conduct.

- ***Living Laboratories.*** Because DOI oversees one-fifth of the Nation's land mass and 1.7 billion acres offshore, we can provide unparalleled opportunities for outdoor STEM education in "living laboratories." With offices in all 50 States and U.S. trust territories, DOI scientists and engineers monitor our dynamic natural hazards and care for a diverse set of resources that can inspire people's curiosity about the natural world as well as about the great depth and variety of human interactions with the land.

- ***Real-Time and Archival Data Sets.*** DOI national monitoring systems have collected resource and natural hazard data across the decades related to earth, sea, and sky. Longitudinal data sets encompassing human ecology and archaeology, geologic processes, endangered species, aquatic resources, magnetic fields, and more, provide endless opportunities for real-world study.

- ***Citizen Science.*** DOI taps into the natural curiosity and innovation of the American public by engaging them in critical monitoring and data collection activities. For example, "Did You Feel It," is a U.S. Geological Survey web site that allows citizens to report and track in real time the effects of earthquakes. The National Phenology Network is another web site where citizens, schools, and students can monitor key climate-related events such as bud burst to help us better understand our changing climate.

- ***Citizen Preparedness.*** DOI provides training, educational material, warnings, and situational awareness to citizens before, during, and after natural hazards such as floods, wildfires, earthquakes, volcanic eruptions, and landslides to increase public safety and community resilience.

- ***Place-Based Experiential Education.*** DOI connects people with experiential learning outside of the formal classroom and beyond the school years. DOI's national parks and historical sites, wildlife refuges, fish hatcheries, and other public land sites extend school learning through educational and interpretive programming, summer science camps, and field studies. For example, *Hands on the Land*, an interagency network of outdoor classrooms on the Nation's public lands and waters, connects schools with Bureau of Land Management, Fish and Wildlife Service, and National Park Service sites, some of which involve collaboration with other Federal agencies.[16] Programming at *Hands on the Land* sites connects hands-on learning in living laboratories with the curriculum standards that educators use.

- ***Culturally Relevant STEM Learning Opportunities.*** Very little STEM curricula include culturally relevant content for underserved and underrepresented audiences. DOI can provide opportunities for underrepresented youth to engage in STEM learning through culturally relevant content such as archaeology or ethnobotany. Existing DOI programs, such as Project Archaeology or Teaching with Historic Places, contain culturally relevant content and can be used in both schools and informal learning settings. Underserved youth could engage in service-learning through archaeological site steward programs operating in some States.

- ***Bureau of Indian Education.*** This Bureau provides quality education opportunities from early childhood through life in accordance with tribal needs for cultural and economic well-being, in keeping with the wide diversity of Indian tribes and Alaska Native villages as distinct cultural and governmental entities. It supports 174 elementary and secondary schools as well as 10 dormitories, a university, and a technical institute.

Facing Page. Young people learn about educational and employment pathways in resource management and park stewardship while participating in *Branching Out*, a program offered by the National Park Service, Northeast Regional Office, Olmsted Center for Landscape Preservation.

- ***Office of Insular Affairs.*** This Office provides grants and support for programs and infrastructure across multiple disciplines, including education, health, energy, and conservation for U.S. Territories and Freely Associated States.
- ***Internships and Youth Employment.*** Recent investments at DOI in youth employment resulted in a 31% increase from FY2009 to FY2011.[17] These experiences expose young people to the career opportunities DOI provides.
- ***Partners.*** In partnership with a variety of public and private entities ranging from professional associations to university researchers to public partners at all levels, DOI works across sectors and in communities in service to the Nation.

The Bureau of Land Management, the Fish and Wildlife Service, and the National Park Service participate in Hands on the Land, a national network of outdoor classrooms on public lands and waterways that enhances K-12 education. These outdoor classrooms provide field-based opportunities that connect students to the outdoors while exposing them to issues confronting 21st century managers, introducing them to natural resources careers, and fostering stewardship.

For example, students explore tide pools along the "Lost Coast" in California's King Range National Conservation Area.


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DOI offers a continuum of learning opportunities that align with this plan:

1. ***Facilitate access to coordinated DOI resources:*** Students use data collection kits, developed by the Fish and Wildlife Service's Alaska Region, to facilitate field and classroom sessions with school groups and others.
2. ***Engage students and citizens:*** Students collect plant data as part of curriculum-based field exploration programs for middle and high school students at Great Smoky Mountains National Park.
3. ***Serve educators:*** K-12 teachers learn to integrate science and history through classroom archaeological investigations at the Bureau of Land Management's Project Archaeology professional development field school.
4. ***Strengthen career training and workforce development:*** Students participating in the U.S. Geological Survey's Educational Component of the National Cooperative Geologic Mapping Program (EDMAP) apply skills in the field.


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4. Pathway to a 21st Century Workforce

People spend barely 2% of their time, in a 75-year lifespan, in school.[18] For most Americans, STEM learning occurs outside formal classrooms in informal settings, such as parks, zoos, science centers, aquariums, and museums.[19] This kind of engagement is a critical component of the learning process and is one of the primary objectives of the OSTP CoSTEM strategy. As the first step along a path for both formal and informal learning, it is where learners begin to construct concepts for themselves as they apply new knowledge and skills. When learners are motivated to investigate topics further, they are inspired to choose related fields of studies and careers. DOI wants to promote student interest and achievement in STEM and help direct young people along a pathway to STEM careers that support the DOI mission of resource management and conservation. DOI programs engage people in STEM education at any age anywhere along a continuum of education settings from formal to informal (see Figure 2). By intentionally engaging young people of all ages, especially middle school-age students, in learning opportunities on public lands and waters and by continuing to provide opportunities for them through high school and beyond, DOI provides career training opportunities that capitalize on its unique assets and prepares its future workforce. The following are the STEM education learning models that DOI will continue to support and improve.

Place-based learning in nature is powerful and transformative. Students retain information more readily, grasp meanings, and adopt new behaviors and values when directly involved with cultural and natural heritage resources and sites.

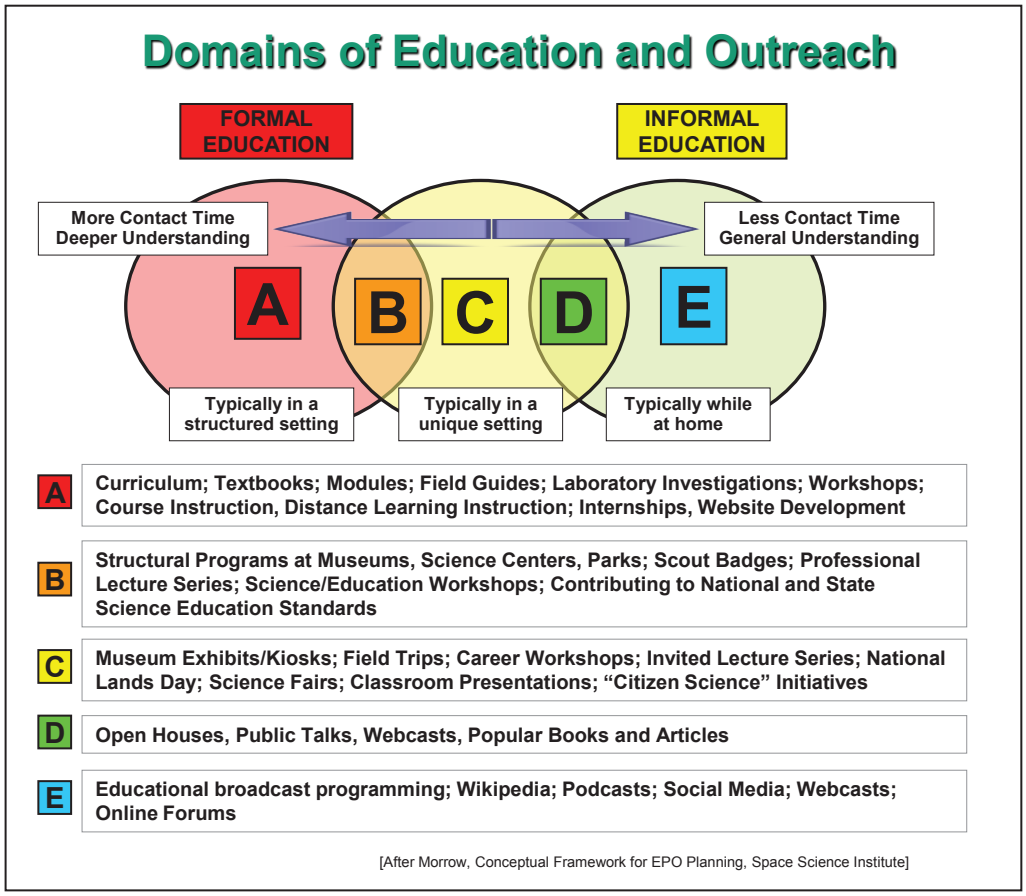

Figure 2. Illustration of the Domains of Education and Outreach associated with STEM programs within DOI. Between the realms labeled Formal Education to Informal Education, it distinguishes purpose, products produced, and where audiences are typically reached. While education and outreach may conjure up a host of meanings arising from one's own values and experiences, in principle, these realms are all part of a single continuum of activity that may be called engagement whose larger purpose is to increase science literacy, appreciation, and understanding.

Facing page. A biology graduate student and a field scientist take a water sample from Niskin bottles that collected contents from deep below a research vessel over a coral community at a depth of more than 1,000 feet. Results from this first-time study of Roberts Reef are being used to develop the Bureau of Ocean Energy Management policy to protect sensitive biological and archeological resources. Image courtesy of Lophelia II 2009: Deepwater Coral Expedition: Reefs, Rigs, and Wrecks.

Experiential learning is learning through hands-on experience that engages the learner in a personal way. As participants reflect on their experiences, they gain knowledge and skills, generalize outcomes, and apply thinking and practices in other settings.[20]

Place-based learning "uses all aspects of the local environment, including local cultural, archaeological, historical, and socio-political situations and the natural and built environment."[21] The National Park Service has reported numerous benefits derived from place-based education programming in national parks, including higher test scores and grades, more advanced critical thinking skills, increased science learning, increased community service, greater achievement motivation, improved student attitudes, more responsible behavior, increased environmental stewardship, and equalized academic progress amongst groups.[22]

Citizen science combines place-based learning with civic engagement and service. Scientific data collection by volunteers dates back to at least the early 1800s.[23] Participants learn to use scientific investigations in a variety of ways, ranging from forming questions to collecting, analyzing, and reporting data in partnership with scientists. Citizen scientists may use existing data, collect data for study, or provide real-time data for monitoring of hazards or phenomena. Land managers and others benefit from networks of volunteers who can collect more data than available resources allow, and volunteers in turn make personal connections with the environment and science.

Service-learning "…integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities."[24] It differs from other teaching approaches particularly in its emphasis on self-directed learning and reflection while collaborating with others to plan and implement a service project to address a problem they identified. Research-based quality standards for K-12 service-learning define the key elements and criteria for implementing service-learning.[25]

K–12 Service-Learning Standards for Quality Practice:

- Meaningful Service
- Link to Curriculum
- Reflection
- Diversity
- Youth Voice
- Partnerships
- Progress Monitoring
- Duration and Intensity

A member of the Passamaquoddy Tribe of Maine works as a park ranger in Acadia National Park demonstrating the art of making Passamaquoddy birchbark canoes with his father.

The benefits are many when service-learning connects formal and informal education. Students are empowered and motivated as they experience a variety of learning styles and take an active role in setting learning goals and applying them in relation to their environment. They learn effective communication and cooperation skills, along with democratic values and rights as they work with others who have different perspectives.[26] Reflection helps participants evaluate their experiences and apply them in the future; they learn to analyze and solve problems as they gain a deeper understanding of the issues at hand and about their role and impact on the world.[27]

DOI engages learners of all ages. Programs for even the youngest children can nurture that "sense of wonder" about the natural world that inspires future learning. In building upon this vital foundation, DOI is choosing intentionally and strategically to focus on early adolescent through post-secondary student populations to advance STEM goals. Engaging students in middle school—when they are at a critical point in their cognitive, emotional, and social development—can increase the student population interested in and prepared for STEM.

- Early adolescents develop complex thinking and reasoning skills, including the abilities to think abstractly and to consider multiple points of view. They become more independent as they use new skills to make personal decisions about who they want to be and how they want to spend their time.[28]
- Middle school students show some predictability regarding their career choices. For example, 8th grade students who expected to pursue science careers were more likely than their peers to later receive baccalaureate degrees in science-related fields.[29]
- Engaging middle school-age youth in meaningful service-learning opportunities can also reduce high school drop out rates. Students from groups typically underrepresented in STEM fields are more likely to drop out of school than their peers.[30]
- Experiential and culturally relevant learning opportunities make learning germane and keep students engaged in their education.[31]

Finally, mentoring—from recruiting to hiring to retaining—is a highly effective strategy for assisting a young person along a career path. This is especially true for minority populations and for minorities in STEM fields of study.[32] Mentoring can strengthen experiential learning through internships by exposing students to employment opportunities, expanding their professional networks, and aiding their transition from education to the workforce. Mentors also benefit from sharing their expertise and knowledge as they support the next generation of conservation stewards.[33]

Native Youth in Science—Preserving Our Homeland. The Education Department of the Mashpee Wampanoag Tribe partnered with U.S. Geological Survey staff and the Woods Hole Coastal and Marine Science Center in Massachusetts to pilot a basic summer science program for sixth, seventh, and ninth grade Mashpee Wampanoag tribal youth. The program helped re-connect these youth with the ecology and geology of their traditional homelands. Here, members display posters they made to highlight their participation in the program at the closing ceremony.

A Summer AmeriCorps Member works with the Wrangell Institute for Science & Environment and the Bureau of Land Management on a stream assessment survey. This survey helped to determine the quality of the habitat for spawning salmon.


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5. The Strategic Plan

This section of the plan provides the Vision, Mission, Five-Year Goal, Key Strategic Areas, and detailed objectives that provide the strategic pathway for carrying out this plan.

The ***Vision*** for DOI's STEM Education and Employment Pathways Strategic Plan is:

- Support a science-literate public and prepare students and professionals from all backgrounds to understand and value the role of science and science inquiry in the stewardship of America's natural resources and cultural heritage.

The ***Mission*** is to:

- Build an inclusive 21st century workforce and increase science literacy by connecting the public with the Nation's natural and cultural resources through outdoor developmental experiences and long-term engagement, education, employment, and service on and in support of public lands and waters. Through these actions, advance the science, engineering, and technology that inform natural and cultural resource management, natural hazards response, and decisionmaking on critical issues that impact our Nation, the world, and society.

The STEM education and employment ***Five-Year Goal*** is:

- That our youth and the American public become scientifically literate stewards of our natural and cultural heritage and that today's youth, especially those underrepresented in STEM fields of study, become inspired to choose career paths at DOI or related agencies and partners.

Four Key Strategic Areas frame the objectives for implementing the Five-Year Goal:

1. ***Facilitate Access to Coordinated DOI Resources***. Coordinate and facilitate access to DOI's extensive array of data sets and educational materials, as well as DOI managed facilities, lands, and waters, to increase public use of these STEM-rich Federal resources.

2. ***Engage Students and Citizens***. Strengthen and expand DOI's capacity to deliver high-quality experiential, place-based, and service-learning opportunities on DOI managed facilities, lands, and waters, with a particular emphasis on middle and high school-age students, and thereby foster connections with the natural world and STEM fields of study and inspire lifelong stewardship.

3. ***Support Educators***. Strengthen and expand STEM educator professional development programs for teachers, administrators, and program coordinators using DOI managed facilities, lands and waters, and our extensive data sets.

4. ***Strengthen Career Training and Workforce Development***. Recruit, retain, and advance qualified STEM interns to DOI employment through strategic partnerships and effective mentoring.

Key Strategic Area 1—Facilitate Access to Coordinated DOI Resources

Coordinate and facilitate access to the DOI's extensive array of data sets and educational materials, as well as DOI managed facilities, lands, and waters, to increase public use of these STEM-rich Federal resources.

Data and Materials

Objective 1.1: Showcase and make readily available DOI STEM educational materials and educator professional development opportunities, especially those designed for teachers of middle and high school-age populations.

Objective 1.2: Identify data sets—especially those that inform multidisciplinary study of climate change, sustainable energy development, and invasive species—that can be made available for use by citizens, corporations, and educators in developing science projects, innovative technology, and curriculum.

Citizen Science

Objective 1.3: Identify opportunities for citizen science data collection that will help land managers and natural hazard emergency managers make decisions and provide important data for scientific research.

Facing page. The U.S. Geological Survey (USGS) partners with the National Association of Geoscience Teachers to provide summer research internship opportunities for college students who have completed a field-based course. Soon to enter its 50th year, this program is one of the longest, continuously running science internships in the country. Field camp directors nominate their top students for summer positions with USGS scientists. Interns engage in STEM research projects relating to all USGS mission areas. Over 2,200 students have participated in this program, with many participants going on to have distinguished careers with the USGS, with academia, or with industry.

A student in the Fish and Wildlife Service's Maine Phenology Program observes and records information on local plants.

Students use Fish and Wildlife Service Phenology Project kits to observe, monitor, and record data on nature and environmental conditions in their local areas.

Objective 1.4: Recognize and share best practices in STEM programs and tools that increase access to data sets and/or actively engage the public as citizen scientists.

Objective 1.5: Explore ways to coordinate the development of innovative tools to enhance citizen science and integration into DOI-wide data systems or shared platforms that may include partners.

Partnerships and Collaboration

Objective 1.6: Expand Federal and private partnerships to ensure broad access to data sets via new media and technology.

Objective 1.7: Leverage partners to establish a STEM education transportation fund to increase support for field trips and extended service-learning opportunities on DOI lands and waters.

Objective 1.8: Partner with the U.S. Department of Education, State boards of education, and local schools to make DOI public lands and waters available to educators looking for science and engineering field investigation opportunities. Align curricula with forthcoming *Next Generation Science Standards*.[34]

Objective 1.9: Establish a DOI STEM education community of practice, as a subgroup of the DOI Youth Task Force, to enhance coordination and communication of lessons learned and evaluation efforts in STEM education across the DOI as well as best practices across DOI through an annual DOI STEM education forum and creation of a digital clearinghouse.

Objective 1.10: Within DOI, share best practices for promoting DOI careers (including the coursework needed for career paths at DOI) and share STEM education and employment opportunities.

Key Strategic Area 2—Engage Students and Citizens

Strengthen and expand DOI's capacity to deliver high-quality experiential, place-based, and service-learning opportunities on DOI managed facilities, lands, and waters, with a particular emphasis on middle and high school-age students, and thereby foster connections between the natural world and STEM fields of study and inspire lifelong stewardship.

Build and Improve DOI Capacity

Objective 2.1: Share within DOI and disseminate standards, best practices, learning materials, and resources to increase the quality and effectiveness of DOI education resources.

Objective 2.2: Foster a culture of evaluation by providing resources and implementing DOI-wide assessment tools to better measure and document the impact of the DOI STEM education programs. Test, use, and improve the DOI Youth

Students from Galileo Academy of Science and Technology in San Francisco, California, set out into the marsh at Crissy Field and in the Golden Gate National Recreation Area to conduct field observations for their year-long Environmental Studies , conducted in partnership with Crissy Field Center.

Program Evaluation Toolkit to provide easy-to-use assessment techniques.

Objective 2.3: Support field-level adoption (at parks, refuges, hatcheries, dams, archaeological and historic sites, and other facilities) of experiential, place-based, and service-learning programs, such as *Hands on the Land*, and promote formal partnerships with schools to ensure development of curriculum-compatible programs.

Objective 2.4: Build DOI staff professional competencies in mentoring and multicultural education.

Partnerships and Collaboration

Objective 2.5: Host periodic experiential, place-based, and service-learning summits with Federal, state and local public and private partners to promote natural hazards awareness and the increased use of public lands and waters as living laboratories for a broad variety of learning experiences and education.

Objective 2.6: Identify partners with technical expertise in State education standards and science and environmental literacy to enhance Federal-State communication channels and to build a network of education experts who can collaborate with DOI scientists, engineers, researchers, educators, and technicians in offering quality experiential, place-based, and service-learning opportunities.

Objective 2.7: Identify and leverage partners to support the alignment of existing experiential, place-based, service-learning materials and curricula, in the three selected issue areas (climate change, sustainable energy development, and invasive species), with State education standards, and the *Common Core State Standards Initiative* where appropriate, in communities that participate in demonstration efforts.

Key Strategic Area 3—Support Educators

Strengthen and expand STEM educator professional development programs for teachers, administrators, and program coordinators, using DOI managed data, facilities, lands and waters, and our extensive data sets.

Share and Improve Education Resources

Objective 3.1: Share best practice standards for experiential, place-based, and service-learning within existing DOI STEM teacher and professional development offerings.

Objective 3.2: Work with educators to improve DOI learning materials and resources for educators and students.

K-12 teachers work as rangers in national parks during summer months through the National Park Service (NPS) Teacher-Ranger-Teacher Program. Educators learn and perform tasks alongside park rangers and then take their knowledge and skills back to the classroom. The NPS reaches underserved audiences by offering this educator professional development opportunity to teachers in Title I schools.

Objective 3.3: Share evaluation tools, methods, and findings related to the quality and impact of existing DOI STEM teacher professional development offerings to increase coordination and standardization of evaluation practices and to improve program planning and assess program impact.

Partnerships and Collaboration

Objective 3.4: Leverage partners to develop, update, and implement educator training that emphasizes the use of DOI data sets and tools and provides pre-service and in-service teachers with the skills to coordinate experiential, place-based, and service-learning programs.

Objective 3.5: Develop new strategic partnerships with environmental/cultural educator training organizations and networks to reach underrepresented audiences with DOI educator training opportunities.

Objective 3.6: In partnership with the U.S. Department of Education, engage new middle and high school STEM educators and program coordinators in professional development opportunities in DOI facilities and on DOI managed lands and waters.

Objective 3.7: Leverage partners to update STEM educator professional development training materials and programming to address areas of improvement identified through evaluation efforts.

Key Strategic Area 4—Strengthen Career Training and Workforce Development

Recruit, retain, and advance qualified STEM interns to DOI employment through strategic partnerships and effective mentoring.

Increase Diversity

Objective 4.1: Increase the percentage of STEM interns from underrepresented communities by working with faculty and institutions to more effectively recruit and engage diverse students in DOI's mission.

Objective 4.2: Plan and implement incentives for DOI STEM-skilled employees to enter into mentoring relationships with high school through post-secondary education-level interns typically underrepresented in STEM fields, resulting in new formal mentoring relationships.

Early Career Development

Objective 4.3: Assess existing mentor training opportunities, and redesign as needed, to equip employees with best-practice

tools for nurturing and sustaining positive mentoring relationships with secondary and post-secondary education interns from underrepresented populations.

Objective 4.4: Coordinate resources across bureaus to create, enhance, and disseminate clear guidance regarding STEM-field coursework required for specific entry level and advanced positions in DOI.

Objective 4.5: Implement best practices for mentoring STEM early career employees (in their first 3 years of service) to increase retention, especially for employees who converted from internships through the channels outlined herein.

Partnerships and Collaboration

Objective 4.6: Establish new formal connections with Federal partners (such as the National Oceanic and Atmospheric Administration's Educational Partnership Program and the U.S. Department of Agriculture's National Institute of Food and Agriculture [NIFA]) to create a pipeline through which qualified STEM field students from Minority Serving Institutions and colleges and universities can access DOI internships.

Objective 4.7: Develop and support consistent implementation of a system for evaluating the quality of internship experiences, including periodic post-internship tracking for 3 years, to document and measure program impact in terms of STEM field education and employment choices.

Objective 4.8: Develop and implement partnerships with higher education institutions, including 2-year institutions and community colleges, to create a career pathways program that supports continuing education, internships, work/study, and employment opportunities at DOI for students and develops curricula that supports the skills needed for both entry-level and permanent positions. Develop connecting programs with 4-year institutions to support advanced degrees.

Objective 4.9: Coordinate and expand connections to STEM-field professional organizations and associations, state and local governments, and regional and local schools and boards in order to provide more internship and employment recruitment opportunities and career day events for secondary through post-secondary education students in STEM fields.

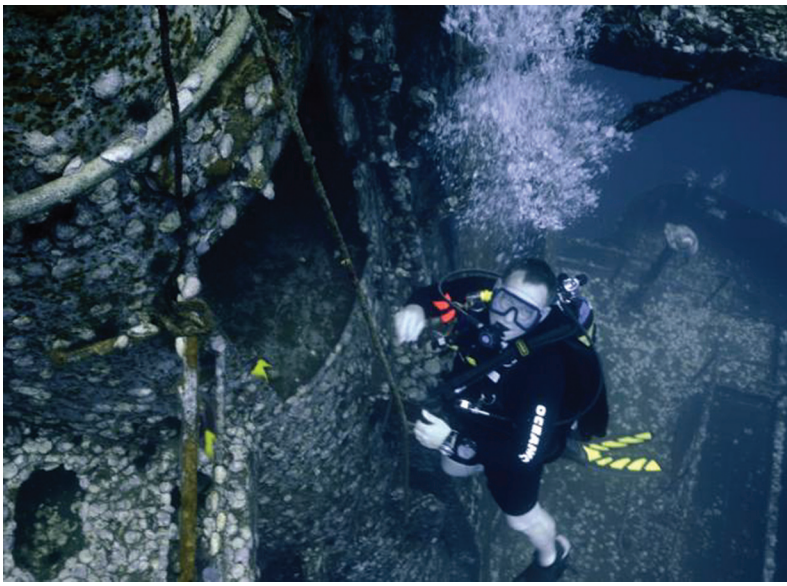
Conservation and Land Management (CLM) Interns, hired through a partnership with the Chicago Botanic Garden, assist the Bureau of Land Management and other DOI agencies with a wide range of resource programs. CLM interns collect Soaptree Yucca (*Yucca elata*) using the "shake it and watch'em fall" method in New Mexico.

6. Implementation

The DOI STEM Education and Employment Pathways Strategic Plan: Fiscal Years 2013–2018 provides guidance for intentionally and strategically advancing DOI's STEM goals by building on DOI's strengths and maximizing communication and coordination to achieve shared goals within our current capacity. The plan does not obligate current or future funding but lays the foundation for action and may inform future budget planning.

The Office of Youth, Partnerships, and Service will coordinate planning and implementation of this strategic plan. To best support bureaus in their efforts to increase science literacy and develop the pipeline of young people who will fill STEM positions at DOI in the future, initial steps will build upon existing efforts, including:

- Supporting the bureaus in implementing the new Memorandum of Understanding between DOI and the U.S. Department of Education (DOI-ED MOU);
- Developing an Office of Management and Budget clearance package for DOI youth education and employment programs;
- Expanding relationships with organizations and associations that support higher education for underserved populations—such as the American Indian Science and Engineering Society (AISES), the Society for Advancement of Chicanos and Native Americans in Science (SACNES), the American Indian Higher Education Consortium (AIHEC), the Society of American Indian Government Employees (SAIGE), and the National Association for Equal Opportunity in Higher Education (NAFEO)—as well as with Minority Serving Institutions;
- Capitalizing on current experiential, place-based, and service-learning training and training material development;
- Supporting as appropriate the development of the 21st Century Conservation Service Corps;
- Aligning existing bureau strategic plans and priorities (such as the National Park Service's *A Call to Action—Preparing for a Second Century of Stewardship and Engagement*);
- Supporting State education standards, and the *Common Core State Standards Initiative* where appropriate, and exploring how DOI can be a resource for education systems regarding the forthcoming *Next Generation Science Standards*;
- Providing guidance on the regulations for the Office of Personnel Management's new Pathways hiring authority, so that bureaus are knowledgeable of the process when recruiting underrepresented populations;
- Implementing evaluation tools to understand the impact of our programs, evaluate best practices, and support continuous improvement;
- Engaging with CoSTEM to support annual inventories of DOI STEM education investments; and
- Supporting the implementation of the CoSTEM Federal 5-year strategic plan, including working with the new Interagency Informal Science Education Group to connect DOI with other Federal informal education programming and evaluation efforts.



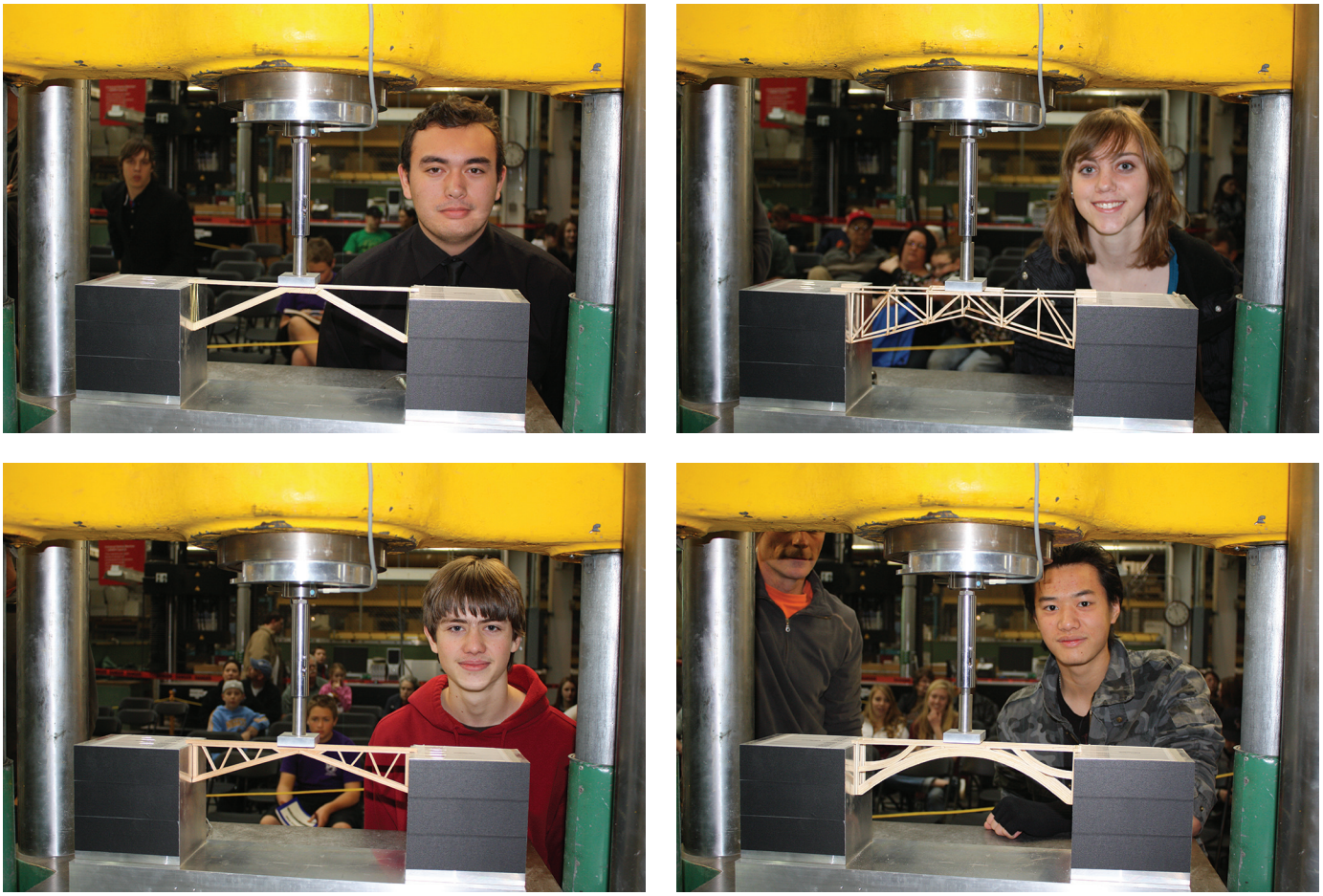
A Bureau of Safety and Environmental Enforcement Scientific Dive Team member conducts a practice dive at the site of the USS Oriskany off the coast of Florida.

Facing page. Bureau of Indian Affairs summer interns hike to their next sampling site to collect vegetation production and condition data on Navajo Reservation rangelands.

Year 1 Planning and Implementation

The Office of Youth, Partnerships, and Service will:

- Work with bureaus to identify STEM-related educational materials and professional development offerings (in line with DOI-ED MOU).
- Coordinate the development of an internal STEM Advisory Subcommittee of the Youth Task Force to:
  - Facilitate bureau-level planning, commitments, and implementation;
  - Develop an approach to better understand STEM education across DOI and conduct an inventory of activities focused on middle school-age learners;
  - Identify priority actions for Year 1 and out years consistent with current budget and resources and identify gaps and needs for future capacity building; and
  - Define expectations and timelines for STEM engagement and service-learning demonstration projects.



The Bureau of Reclamation supports bridge-building contests for students in Las Vegas and Denver to promote engineering excellence and innovation. Students apply science and math lessons learned in the classroom to a hands-on project where they compete to design, build, and test highly efficient model bridges.

STEM Engagement and Service-Learning Demonstration Projects

This strategic plan includes voluntary site-level participation in small-scale, intensive STEM engagement and service-learning demonstration projects with middle and/or high school students. Once the STEM Advisory Subcommittee has outlined expectations for these demonstration projects, YPS will:

- Convene a DOI STEM Engagement and Service-Learning Peer Network (1.9) to enhance coordination and communication of lessons learned and evaluation efforts across DOI; and
- Support participating sites in continuous improvement efforts to achieve research-based quality standards in STEM engagement and service-learning.

2011 summer interns learn about range clipping and range production under the instruction of a Bureau of Indian Affairs Rangeland Management Specialist.

Endnotes

[1]The *United States Department of the Interior Strategic Plan for Fiscal Years 2011–2016* is available at *http:// www.doi.gov/bpp/upload/DOI_FY2011-FY2016_StrategicPlan.pdf*. See Mission Area 5, pp. 36 and 37, and Interior Principles, "Make Interior the Best and Most Inclusive Place to Work in America," on p. 39.

[2]DOI posts mission critical and high population occupations within DOI at *http://www.doi.gov/public/findajob.cfm*. At least 25% of the primary occupations listed require STEM skills in more than four bureaus.

[3]From National Research Council. "2 Principles and Definitions." *National Science Education Standards*. Washington, DC: The National Academies Press, 1996 (p. 22). Other widely accepted definitions of science literacy incorporate knowledge and understanding of science with reflection and application as engaged citizens. For more, see:

1. Rutherford, F. James & Ahlgren, Andrew. (1989). *Science for all Americans*. *A project 2061 report on literacy goals in science, mathematics, and technology*. Washington, DC: American Association for the Advancement of Science. Available at *http://www.project2061.org/publications/sfaa/online/sfaatoc.htm*.

2. OECD [Organization for Economic Development]. (2010). *PISA [Programme for International Student Assessment] 2009 Results: What Students Know and Can Do—Student Performance in Reading, Mathematics and Science (Volume I)*. *http://dx.doi.org/10.1787/9789264091450-en*.

[4]In *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5* (National Academy of Sciences, et. al., 2010), the authors compiled an array of statistics to illustrate a crisis in our nation's ability to remain competitive in a global economy. A few are noted here:

- "The United States ranks 20th in high school completion rate among [36] industrialized nations and 16th in college completion rate." (p. 8). Original source: Tables A2.1 and A3.1 at *http://www.oecd.org/education/highereducationandadultlearning/educationataglance2009oecdindicators.htm*.
- "The United States ranks 27th among [36] industrialized nations in the proportion of college students receiving undergraduate degrees in science or engineering." (p. 8). Original source: Table A3.5 at *http://www.oecd.org/education/highereducationandadultlearning/educationataglance2009oecdindicators.htm*.
- "Forty-nine percent of United States adults do not know how long it takes for the Earth to revolve around the Sun." (p. 8). Original source: Appendix table 7–9 at *http://www.nsf.gov/statistics/seind10/appendix.htm*.

[5]A National Science Foundation study indicates that in 2009, DOI employed 14,700 scientists and engineers—the third largest number among federal agencies studied, following DOD and USDA. However, DOI employed the lowest proportion of minority scientists and engineers (11%) of all agencies studied. From: *Diversity in the Federal Science and Engineering Workforce*, presented by Jaqui C. Falkenheim, Ph.D., National Center for Science and Engineering Statistics, National Science Foundation on September 20, 2011 at the 3rd Annual EEO and Diversity Conference for STEM Agencies Promoting Diversity in Federal STEM Agencies, Alexandria, VA.

[6]See National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (2011). *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*. Washington, DC: National Academies Press, especially pages 3 and 36–37. In addition, as of 2008, underrepresented minorities in STEM fields of study enrolled, disproportionately compared to their counterparts, in 2-year colleges. Further, historically black colleges and universities (HBCUs) have awarded small fractions disproportionally of science and engineering degrees to Black/African American, Hispanic, and American Indian/Alaska Native students. For more, see National Science Foundation, Division of Science Resources Statistics. (2011). *Women, Minorities, and Persons with Disabilities in Science and Engineering*: 2011. Special Report NSF 11-309. Arlington, VA. Available at *http://www.nsf.gov/statistics/wmpd/*.

[7]See *The Condition of College and Career Readiness* 201, by ACT (2011), p. 5. Available at *http://www.act.org/research/policymakers/cccr11/index.html*. (TBD – inc. Reading & English).

[8]See, again, *Women, Minorities, and Persons with Disabilities in Science and Engineering*: 2011 (p. 8).

[9]From "Distribution of U.S. Population by Race/Ethnicity, 2010 and 2050,," Kaiser Family Foundation, based on data from U.S. Census Bureau, 2008, Projected Population by Single Year of Age, Sex, Race, and Hispanic Origin for the United States: July 1, 2000 to July 1, 2050 (slide dated March 22, 2010, available at *http://facts.kff.org/chart.aspx?ch=364*).

[10]U.S. Census Bureau. "An Older and More Diverse Nation by Midcentury," U.S. Census Bureau press release CB08-123, August 14, 2008. Available at *http://www.census.gov/newsroom/releases/archives/population/cb08-123.html*.

[11]Mackum, P. & Wilson S. (2011). "Population Distribution and Change: 2000–2010 – 2010 Census Briefs" by U.S. Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau, C2010BR-01, retrieved from *http://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf*. Nevada, Arizona, Utah, Idaho, Texas, North Carolina, Georgia and New Mexico are the states experiencing the most rapid population growth.

[12]Richard Louv documented concerns about the increasing disconnect between young people and nature in his book, *Last Child in the Woods: Saving our children from nature-deficit disorder*, published in 2005 by Algonquin Books of Chapel Hill. His work helped launch concerns across sectors about the implications for the environment.

[13]A recent study by the Kaiser Family Foundation about media use reported that 8- to 18-year olds spend an average of 7 hours and 38 minutes a day, 7 days a week, using media. Here, too, data show different patterns for minority populations that are also underrepresented in STEM fields of study. Compared to White youth, Black and Hispanic youth consumed more media daily—about 4½ hours per day. These differences remained when

controlling for age, gender, parent education, and other variables. See Rideout, Victoria J., Foehr, Ulla G., & Roberts, Donald F. (2010). *GenerationM2: Media in the Lives of 8- to 18-Year Olds, a Kaiser Family Foundation Study January 2010*. Menlo Park, CA: Henry J. Kaiser Family Foundation. Available at *http://www.kff.org/entmedia/8010.cfm*.

[14]See The Outdoor Foundation's *Special Report on Youth—The next generation of outdoor champions*. Boulder, CO: The Outdoor Foundation. Seventy nine (79.3) percent of youth outdoor participants studied were Caucasian; 7.4% were African American, 5.8% were Hispanic, 4.6% were Asian/Pacific Islander, and 2.9% were "Other." See pp. 8–9. Available at *http://www.outdoorfoundation.org/pdf/ResearchYouth.pdf*.

[15]See, again, *http://www.doi.gov/public/findajob.cfm*.

[16]*Hands on the Land* is a network of outdoor classrooms on public lands and waters that enhance K-12 education. Partners in Resource Education (PRE), comprises multiple federal agencies and a non-profit organization – including DOI, the U.S. Forest Service and Natural Resources Conservation Service at the U.S. Department of Agriculture, National Oceanic and Atmospheric Administration at the U.S. Department of Commerce, the Environmental Protection Agency. The National Environmental Education Foundation (NEEF) coordinates PRE, and The Keystone Center oversees the Hands on the Land website, See *http://www.handsontheland.org/*.

[17]See *U.S. Department of the Interior 2012/2013 Annual Performance Plan & 2011 Report (APP&R)*, February 13, 2012, p. 189, available at *http://www.doi.gov/bpp/upload/FY2012-2013-Annual-Performance-Plan-and-FY2011-Report.pdf*.

[18]Ellenbogen, K.M. & Stevens, R. (2005). Informal *Science Learning Environments: A Review of Research to Inform K–8 Schooling*. National Research Council (p. 5).

[19]Falk, John H., Dierking, Lynn D. (2010). "The 95 Percent Solution: School is not where most Americans learn most of their science." Published in *American Scientist* (v. 18, pp. 486–493). See also National Research Council (2009). *Learning Science in Informal Environments: People, Places, and Pursuits*. Committee on Learning Science in Informal Environments. Philip Bell, Bruce Lewenstein, Andrew W. Shouse, and Michael A. Feder. Board on Science Education, Center for Education. Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

[20]Fenichel & Schweingruber (2010) indicate that the National Science Foundation (NSF) invested more than $60 million in recent years to fund studies connecting science learning between formal and informal environment. See Fenichel, M. & Schweingruber, H.A. (2010). *Surrounded by Science: Learning Science in Informal Environments*. Board on Science Education, Center for Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. Available reports, from NSF and elsewhere, build on the body of literature that supports programs and practices that extend classroom learning in meaningful ways, and highlight strategies for best reaching young people, including those underrepresented in STEM fields. Reflecting on a case study involving museum visitors using laboratory equipment while conducting experiments, Fenichel & Schweingruber noted, "The opportunity to have such an authentic, or real-world, experience is one of the hallmarks for informal learning environments." (Fenichel & Schweingruber, 2010, p. 43).

[21]Clark, Delia. (2008). *Learning to Make Choices for the Future—Connecting Public Lands, Schools, and Communities through Place-based Learning and Civic Engagement*. Prepared by The Center for Place-based Learning and Community and A Forest for Every Classroom, p. 5.

[22]National Park Service, Interpretation and Education Associate Directorate (2010). *Place-Based Education Programs Fact Sheet*.

[23]See Droege, Sam. "Just because you paid them doesn't mean their data are better," presented at the Citizen Science Toolkit Conference, June 20–23, 2007, Ithaca, NY (available at *http://www.birds.cornell.edu/citscitoolkit/conference/toolkitconference/proceeding-pdfs/Droege%202007%20CS%20Conference.pdf*). U.S. Geological Survey Patuxent Wildlife Research Center Biologist Sam Droege discussed the value of citizen scientists and provided some history of citizen science. In the 1800's, Droege reported at least two citizen science studies: bird strikes into lighthouses, and bird migration in the Midwest.

[24]See *http://www.servicelearning.org/what-is-service-learning*, Retrieved 1/18/12. For more of an overview of service-learning, see also "Service-Learning in Action" at *http://www.servicelearning.org/sites/default/files/download/bring-learning/service-learning-in-action.pdf*, Retrieved 8/10/12.

[25]See *http://www.servicelearning.org/instant_info/fact_sheets/k-12_facts/standards/*. Also, service-learning experts have developed a "continuous improvement" scoring rubric for programs to assess their level, from novice to advance, along each of the standards. See pp. 26–27 for an example in *High Quality Instruction That Transforms—A Guide to Implementing Quality Academic Service-Learning* by the Wisconsin Department of Public Instruction. Retrieved 1/18/12 at *http://www.dpi.wisconsin.gov/sl/pdf/high_quality_learning_web.pdf*.

[26]See *Impacts of Service-Learning on Participating K–12 Students* by RMC Research Corporation (Dec. 2002, Updated May 2007). Retrieved 1/18/12 at http://www.servicelearning.org/instant_info/fact_sheets/k-12_facts/impacts/.

[27]RMC Research Corporation (March 2003, Updated September 2007), *Fact Sheets—Reflection in K–12 Service-Learning*, retrieved from the National Service-Learning Clearinghouse, *http://www.servicelearning.org/instant_info/fact_sheets/k-12_facts/reflection*, Retrieved 1/18/12.

[28]Resources documenting the stages of adolescent development include the following:

- Spano, Sedra. (May 2004). "Stages of Adolescent Development" in *ACT for Youth Upstate Center of Excellence Research Facts and Findings*." Published by the Cornell University Family Life Development Center in collaboration with the University of Rochester, and the New York State Center for School Safety; available at *http://www.actforyouth.net/resources/rf/rf_stages_0504.pdf*.

- Lucile Packard Children's Hospital at Stanford, "*Cognitive Development*" available at *http://www.lpch.org/DiseaseHealthInfo/HealthLibrary/adolescent/cogdev.html* (retrieved 10/25/11).

• Larson, Reed, and Hansen, David. (2005). "The Development of Strategic Thinking: Learning to Impact Human Systems in a Youth Activism Program," in *Human Development*. Vol. 48, pp. 327–349, 2005.

[29]Using the *National Education Longitudinal Study (NELS)* of 1988, researchers found that about one-half of 8th grade students (in 1988) who anticipated having a science-related career earned a science-related baccalaureate degree. By age 30, students who expected to pursue science-related careers were nearly two times (1.9) more likely than their peers who did not expect to pursue science-related careers to earn a degree in life sciences. The findings were more pronounced for those who earned degrees in the physical sciences or engineering. They were 3.4 times more likely to earn these degrees than students who did not expect to pursue careers of this nature. Interestingly, students who were high achievers in mathematics by 8th grade were more likely than their counterparts to earn physical science/engineering degrees; this was not a significant finding for those who pursued life sciences. For more, see Tai, Robert H., Liu, Christine Q., Maltese, Adam V., & Fan, Xitao. "Planning Early for Careers in Science," in *Science*. (Vol. 312, pp. 1143–1144), May 26, 2006. In a later, more comprehensive study of students, using NELS (1988), researchers found that student interest in science and math and student confidence in these areas of study during high school were significantly associated with pursuing science-related degrees. See Maltese, A.V. & Tai, R.H. (2011). "Pipeline persistence: The effects of school experiences on earning degrees in STEM." *Science Education*, 95 (5), 877–907.

In another study, Maltese and Tai interviewed scientists and graduate students, in chemistry and physics, about how they first became interested in science. Sixty-five percent indicated their interest began before middle school. There were some gender differences. Women were more likely to report external, such as school-related activities, while men were more likely to report internal or intrinsic interest. See Maltese, A.V., & Tai, R.H. (2010). "Eyeballs in the fridge: Sources of early interest in science." *International Journal of Science Educator*, 16 (1), 22–28.

[30]In the 2008/2009 school year, nearly 1 million (or 24%) students did not graduate high school on time. The rate of students not graduating on time was twice the rate for African American students compared to non-Non-Hispanic white students, which was 18%. From Annie E. Casey Foundation (2012). *2012 KIDS COUNT Data Book—State profiles of child well-being*. Baltimore, MD: Annie E. Casey Foundation, p. 31.

[31]Dropping out of school because classes were not interesting was reported most frequently (47%) by ethnically and racially diverse high school dropouts when they were asked about the major reasons they left school. When they were asked what would have helped them stay in school, their most frequent responses were opportunities for real learning, such as internships and service-learning projects, to make classes more relevant (81%) and "better teachers who keep classes interesting" (81%). See Bridgeland, John M., DiIulio, Jr., John J., and Burke Morison, Karen. (2006). "Silent Epidemic: Perspectives of high school dropouts." A report by Civic Enterprises in association with Peter D. Hart Research Associates for the Bill & Melinda Gates Foundation. Washington, DC: Civic Enterprises (pp. 3–7). Following this report, the authors focused on students' perspectives on service-learning. Recommendations include using service-learning as a strategy for reducing high school dropout. This is in part due to students' interest in hands-on learning with real-world application. See Bridgeland, J. M., DiIulio, Jr., J. J. & Wulsin, S. C. (2008). *Engaged for Success: Service-Learning as a Tool for High School Dropout Prevention*. A Report by Civic Enterprises in association with Peter D. Hart Research Associates for the National Conference on Citizenship. The body of literature on service-learning supports the effectiveness of service-learning and its impact on resiliency among students. For more about how service-learning helps students face adversity, see RMC Research Corporation (May, 2004). *Fact Sheets: Resilience*, retrieved 11/20/12 at *http://www.servicelearning.org/instant_info/fact_sheets/k-12_facts/resilience*.

Culturally relevant learning opportunities also stimulate interest and academic achievement among students from underrepresented populations in STEM fields of study. For example, researchers assessed interest in science among 8th grade African American science students in 1994 and 1997. Findings indicated students are more interested in studying culturally inclusive than in studying traditional science topics. See Key, Shirley Gholston. (2003). "Enhancing the Science Interest of African American Students Using Cultural Inclusion." In *Multicultural Science Education: Theory, Practice, and Promise*, edited by S.M. Hines, pp. 87–101. New York, NY: Peter Lang.

[32]See the American Speech-Language-Hearing Association's "Minority Student Recruitment, Retention and Career Transition Practices: A Review of the Literature," available at *http://www.asha.org/practice/multicultural/recruit/litreview.htm* (retrieved 11/13/12).

[33]Resources on mentoring are many. "Mentoring Resources and References" are available at *http://tulane.edu/provost/Faculty/mentoring/upload/mentoring-references.pdf*. The United States Office of Personnel Management's "Best Practices Mentoring" is available at *http://www.opm.gov/hrd/lead/BestPractices-Mentoring.pdf*. USGS employs a full-time mentoring specialist for early and career transitional hires. For more see, *http://www.usgs.gov/humancapital/ecd/mentoringhome.html*.

[34]The National Research Council (NRC) convened a committee to update K–12 science standards. The framework includes "engineering, technology, and the applications of science" among the core ideas for four disciplinary areas. The framework also calls for experiential field investigations. For more about the framework, see National Research Council. (2012). *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. Committee on Conceptual Framework for New K–12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press (available at *http://www.nap.edu/catalog.php?record_id=13165*). A team—which includes 26 states, NRC, the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve—drafted the "Next Generation Science Standards for Today's Students and Tomorrow's Workforce." NRC expects to complete review processes and release the standards by the end of 2012. For more, see *http://www.nextgenscience.org/six-more-states-join-effort-write-next-generation-science-standards*.