



National Oceanic and
Atmospheric Administration
U.S. Department of Commerce

NOAA Education Accomplishments Report

ADVANCING NOAA'S MISSION THROUGH EDUCATION



FISCAL YEAR 2018

CONTENTS

Introduction 2

- Advancing NOAA's mission through education 2
- NOAA Education reaches people at every age and every stage 3

Goal 1: Science-Informed Society 4

GOAL HIGHLIGHTS //

- Students take on the roles of scientists 5
- Outreach events bring NOAA research nationwide 6
- NOAA fosters the next generation of STEM innovators 7
- Educators bring NOAA resources into the classroom for students of all ages 8
- Zoos, aquariums, museums, and science centers amplify NOAA science 10

FEATURED STORIES //

- Estuary reserves extend science education to deaf and hard-of-hearing students 11
- High school students bring renewable energy to their Colorado community 12
- Mentoring works: Teachers engage year-round with Lake Superior 13
- Gray's Reef National Marine Sanctuary partners with Rotary to foster STEM innovation and entrepreneurial development 14

Goal 2: Conservation and Stewardship 15

GOAL HIGHLIGHTS //

- Students become stewards by connecting with their local environment 16
- NOAA Education bridges science, art, and culture 18
- On the coast and far inland, teachers and students help tackle marine debris 19
- NOAA celebrates maritime heritage through interdisciplinary education 20
- Stewardship toolkits help educators deliver meaningful environmental experiences 21
- Partnerships increase stewardship across the country 21

FEATURED STORIES //

- After tracking local marine debris, students convince restaurant to help stop the problem at its source 23
- Student videos offer a glimpse into climate change 24
- Community mural inspires salmon conservation in Seattle 25



Goal 3: Safety and Preparedness 26

GOAL HIGHLIGHTS //

- Education programs respond as communities recover from disasters 27
- NOAA cultivates resilience through green infrastructure education 28
- Outreach prepares communities for safety hazards 29
- Educators improve their understanding of safety and resilience 30
- NOAA fosters community resilience through creative partnerships 31

FEATURED STORIES //

- Montana forecasters become partners in preparedness with Assiniboine and Sioux tribal elders 32
- Science and education partners reveal the hottest places in Washington, D.C., and Baltimore 33
- Texas educators shadow meteorologists to help their students take on weather preparedness 34
- Maine's coastal communities use NOAA data to prepare for sea level rise 35
- Neighborhoods of the future: Students design solutions for communities prone to flooding 36

Goal 4: Future Workforce 37

GOAL HIGHLIGHTS //

- NOAA scientists serve as role models to engage students in STEM 38
- Partners and programs advance early-career learning and research 40
- NOAA scholarships recruit more diverse applicants 42
- What's next? NOAA-supported students enter the workforce 43

FEATURED STORIES //

- Aspiring ocean explorers get hands-on experience through the Explorers-in-Training program 44
- Teacher at Sea alum connects students in Alaska to NOAA science 45
- NOAA scientists engage students at Destination SPACE Satellite Week 46
- Partnerships with minority serving institutions enhance the NOAA workforce 47

Goal 5: Organizational Excellence 48

GOAL HIGHLIGHTS //

- NOAA educators and partners are recognized for excellence 49
- Evaluation makes our programs effective and accountable 50
- Programs work together to strengthen the NOAA Education community 50
- Expanding our reach to underserved audiences 51

Index 52

Acknowledgments 53

◀ Young students explore a hiking trail on Santa Cruz Island during their visit to Channel Islands National Park and Channel Islands National Marine Sanctuary. (Claire Fackler/NOAA)

LETTER FROM THE DIRECTOR

Friends of NOAA Education,

On behalf of the NOAA Education community, I'm pleased to present our 2018 Accomplishments Report. This report highlights some of the ways that our education efforts help advance NOAA's mission of science, service, and stewardship.

This year, we focus on the places and faces of NOAA Education. Our programs span from Alaska to American Samoa, reaching people in big cities and rural towns alike. We introduce you to an educator working with his students to install solar panels at their Colorado school, Virginia architecture students designing solutions to protect their communities from flooding, and at-risk youth in Hawaii finding empowerment through local environmental stewardship. These are the types of people and communities who put meaning into the work we do and continue to drive us forward.

Our programs capitalize on new technologies and innovations. These tools not only bolster what our scientists can do, but also bring new life to our education efforts. We have expanded our programs to incorporate 3D printing, underwater acoustics, aquaculture, and exploration through remotely operated vehicles. These tools and techniques create opportunities to engage the next generation of leaders in the pressing challenge to understand our world, keep people safe, and use our natural resources wisely.

We continue toward our goal of having the places and faces we serve mirror the composition of our nation. We strive to reach people of all backgrounds and ability levels, whether they use our programs as a first step towards pursuing a career in Earth science or simply engage with us to enrich their lives through a greater understanding of our planet. Going forward, we will continue to identify and break down barriers to inclusion, making our programs more diverse and equitable than ever before.

We deeply appreciate the contributions of our partners and the people we serve. Without these innovative organizations, talented students, and passionate educators, we would not be able to accomplish so much in support of NOAA's mission. We thank you and look forward to many years of future collaborations.

Sincerely,



Louisa Koch
Director of NOAA Education

INTRODUCTION

Advancing NOAA's mission through education

The [National Oceanic and Atmospheric Administration](#) (NOAA) is a scientific agency that observes and predicts conditions in our ocean and atmosphere. From daily weather forecasts to long-term climate monitoring and from fisheries management to marine commerce, NOAA provides communities, decision-makers, and people across the country with the information they need when they need it.

Education extends NOAA's role in environmental research, forecasting, management, and protection. The complex task of improving economic and social well-being through Earth science would not be possible without an engaged public. It is not enough for NOAA to study the ocean and atmosphere; our agency must also educate so that individuals can use this information to support robust economies, resilient communities, and healthy ecosystems.

NOAA takes an “all hands on deck” approach to education. Our educators and partners work in different offices, programs, states, and even countries, covering topics that span from the surface of the sun to the depths of the ocean. NOAA Education reaches preschoolers through retirees both inside and outside the classroom. We rely not only on full-time educators, but also on scientists, resource managers, and others who volunteer their time to share their expertise and passion for their work.

We continue to strengthen this community of educators within NOAA. At its core is the [NOAA Education Council](#), composed of representatives from education programs throughout the agency. It is our forum for coordinating efforts and developing new ideas. The council provides direction and leadership to the NOAA Education community.

In 2015, the NOAA Education Council released an updated [Education Strategic Plan](#). In this guiding document, we outlined five goals and supporting objectives that help us advance NOAA's mission through education. These ambitious goals give the NOAA Education community a shared focus across a wide range of activities.

The NOAA Education Council developed a two-year implementation plan in fiscal year (FY) 2018 that documented the steps NOAA educators would take to expand and improve our current set of programs. The implementation plan outlined 42 high-priority actions. The NOAA Education community chose ambitious actions that were above and beyond business-as-usual. This report highlights many of our successes in FY 2018; however, it is not a comprehensive catalog of our activities.

To learn more about NOAA Education, visit www.noaa.gov/education.



Summer science campers get a close-up look at what lives along the floating docks near the mouth of the South Slough estuary in Charleston, Oregon. (Makinna Miles/Oregon Sea Grant)

INTRODUCTION

NOAA Education reaches people at every age and every stage

Each year, NOAA Education connects millions of people to Earth science. Our programs take place both inside and outside the classroom, reaching people of all ages. To quantify our impact, we collect information from the [NOAA Education Council](#). These numbers capture the combined efforts of educators across the agency, spanning all of NOAA's mission areas.

61.9 million people

visited informal education institutions hosting NOAA-supported exhibits or programs.



478 institutions

increased educational capacity through NOAA-funded centers, exhibits, or programs.



458,000 P-12 students

participated in NOAA-supported formal education programs.

38,100 educators

participated in NOAA-supported professional development programs.

3,310 postsecondary students

were trained through NOAA-funded higher education programs.

709 postsecondary degrees

were awarded to NOAA-supported students in higher education programs.



2.6 million youth and adults

participated in NOAA-supported informal education programs.

37.4 million visits

were made to NOAA Education websites that host valuable activities and information.

GOAL 1

Science-Informed Society

An informed society has access to, interest in, and understanding of NOAA-related sciences and their implications for current and future events.



Jim Foley/NOAA

OVERVIEW //

From satellites in space to submersibles in the deep ocean, NOAA observes our planet to understand its ever-changing environment. NOAA Education makes these assets more accessible so people can understand our science and learn how to use our resources. We encourage everyone — from preschoolers to retirees — to develop a greater understanding of Earth and its diverse systems.

OBJECTIVES

- 1.1. Youth and adults from all backgrounds improve their understanding of NOAA-related sciences by participating in education and outreach opportunities.
- 1.2. Formal and informal educators integrate NOAA-related sciences into their curricula, practices, and programs.
- 1.3. Formal and informal education organizations integrate NOAA-related science content and collaborate with NOAA scientists on the development of exhibits, media, materials, and programs that support NOAA's mission.

GOAL HIGHLIGHTS //

Students take on the roles of scientists

Scientists use systematic observations, measurements, and experiments to answer hypothesis-driven questions. NOAA provides opportunities for students to engage in science, technology, engineering, and math (STEM) by helping them design experiments and conduct original research.

- ▶ The Nature Activities for Learning and Understanding (NALU) Studies program serves at-risk and high-need students, often recruiting from Hawaii Family Court's Juvenile Drug Court and Girls Court. This transformative program uses nature as viewed through Native Hawaiian culture to empower youth. With support from the [Bay Watershed Education and Training \(B-WET\) Hawaii](#) program, NALU students learned about their watershed from *uka* to *kai* (from the mountains to the sea). They surveyed streams to calculate water flow, conducted water quality analyses, surveyed corals, and helped with community agriculture projects. To wrap up their studies, the NALU students presented their work to parents, the public, and community leaders, including Kauai Mayor Bernard P. Carvalho Jr.
- ▶ Want to know if a water body is polluted? Ask the insects. Because water quality shapes the communities of macroinvertebrates that can live in streams, rivers, and lakes, sampling them can give a quick assessment of the health of the ecosystem. With support from [Illinois-Indiana Sea Grant](#) and local partners, 20 teachers and 950 students studied how to classify macroinvertebrates to determine whether their local water body was clean or polluted. After, Sea Grant staff were invited to visit two schools to talk to 73 students about water quality, nonpoint-source pollution, and assessment.
- ▶ In addition to offering middle schoolers a week of hands-on science activities, [NOAA Science Camp](#) in Seattle runs a two-week Junior Leadership Program for 20 teens entering grades nine through 12. The teens gain experience in youth leadership, communication, and team-building while learning about the scientific research taking place throughout NOAA's [Western Regional Center](#). In 2018, scientists at the [Pacific Marine Environmental Laboratory](#) connected students with the technical side of NOAA, including an interactive tour of engineering facilities and a workshop to build and deploy water quality monitoring buoys. Junior Leaders got more than background information; they built their own buoys to collect data in nearby Lake Washington.

OBJECTIVE 1.1.

Youth and adults from all backgrounds improve their understanding of NOAA-related sciences by participating in education and outreach opportunities.



A mentor and student with the Nature Activities for Learning and Understanding (NALU) Studies program take measurements to calculate the flow rate of Waipa Stream on the island of Kauai. (NALU Studies)

GOAL HIGHLIGHTS //

Outreach events bring NOAA research nationwide

Across the country, our experts and educators step out of their labs or offices and into their communities to share NOAA science with the public. These outreach events give students, teachers, and community members the chance to learn about our work and how to take advantage of our opportunities.

OBJECTIVE 1.1.
Youth and adults from all backgrounds improve their understanding of NOAA-related sciences by participating in education and outreach opportunities.

- ▶ The [Ocean Plastics Lab](#) is an outdoor, interactive, and free exhibit designed to increase the visibility and awareness of marine debris around the world. Built out of four shipping containers, the traveling exhibit highlights the global problem of ocean plastic pollution and features NOAA's [Marine Debris Tracker App](#), an easy-to-use and simple tool for marine debris data collection. The lab was created by the German Marine Research Consortium and is supported by Germany's Federal Ministry of Education and Research and the European Commission. It began its tour of marine debris outreach last year in Turin, Italy. NOAA's [Marine Debris Program](#) and other partners helped bring the lab to the National Mall in Washington, D.C., where over 20,000 people visited the exhibit.
- ▶ The [National Centers for Environmental Information](#) (NCEI) partnered with the Northern Gulf Institute (NGI) to participate in the Celebrate the Gulf Marine Education Festival in Pass Christian, Mississippi. NOAA staff provided students, particularly those from underrepresented groups, with experiential learning. NCEI and NGI used a tray of rice, a mock trawl, and marine animal figurines to demonstrate how scientists collect data on marine ecosystems and as a platform to teach about factors impacting our coasts and ocean.
- ▶ Scientists estimate that only 450 North Atlantic right whales remain in the world. To raise awareness of this critically endangered species, [NOAA Fisheries Southeast Regional Office](#) Protected Resources Division and partners organized the [10th Annual Right Whale Festival](#) in Jacksonville Beach, Florida. The festival celebrates the North Atlantic right whales and their annual return to the waters off Florida and Georgia, the only known right whale calving area. The event brings together nonprofit organizations, artists, musicians, marine mammal scientists, as well as state and federal agencies with the common goal to raise awareness and promote ways to protect these whales from extinction. Each year, over 8,000 attendees enjoy live music, arts and crafts, a beach clean-up, and educational exhibits and lectures.
- ▶ NOAA's [Atlantic Oceanographic and Meteorological Laboratory](#) hosted an open house in Miami, Florida, on May 10-12, 2018. Visitors learned about local NOAA offices during an interactive scientific adventure centered around oceanic and atmospheric research and joined NOAA in celebrating the third International Year of the Reef. Guests rotated throughout the NOAA facilities on Virginia Key and the University of Miami Rosenstiel School's Experimental Fish Hatchery. Participants talked with NOAA weather forecasters and visited the Maritime and Science Technology Academy's mobile labs. The open house hosted local school groups on field trips, reaching 900 students over two days.



The Ocean Plastics Lab visited Washington, D.C., on its world tour. This international, interactive, and free exhibit highlighted the global problem of ocean plastic pollution. (Karen Sayre/German Federal Ministry of Education and Research)

GOAL HIGHLIGHTS //

NOAA fosters the next generation of STEM innovators

New technologies like remotely operated vehicles, underwater acoustics sensors, and 3D printers have changed how NOAA explores and understands the ocean and atmosphere. From academic competitions to physical teaching tools, our programs bring these innovations to students and educators, better preparing them to solve this century's STEM challenges.

OBJECTIVE 1.1.
Youth and adults from all backgrounds improve their understanding of NOAA-related sciences by participating in education and outreach opportunities.

- ▶ The [National Centers for Environmental Information](#) developed an Advanced Placement® computer science course to help students learn to code while working with weather and climate data. This course taught technical skills on how to tackle the rapidly changing climate to 20 students in 11th and 12th grade at Christ School in Arden, North Carolina.
- ▶ Acoustic sensors and remotely operated vehicles are NOAA's eyes and ears below the sea. [Oregon Sea Grant's Hatfield Marine Science Visitor Center](#) in Newport, Oregon, installed new displays that highlight the [Pacific Marine Environmental Laboratory's](#) Earth-Ocean Interaction (EOI) and Acoustics Programs. The EOI display includes a touch screen with remotely operated vehicle videos from recent research expeditions. The acoustics display includes a moored hydrophone and a graphic about sources of ocean noise in the SOFAR (Sound Fixing and Ranging) channel. More than 150,000 people pass through its doors every year.
- ▶ Animal, mineral, or vegetable: are corals animals, plants, or something else altogether? It's complicated. Coral polyps are animals that create mineral structures and often host symbiotic, plant-like algae. The small size of the individual polyps makes it challenging to teach young audiences about these creatures. [NOAA Office for Coastal Management](#) and [NOAA Coral Reef Conservation Program](#) staff designed large model coral polyps that can be 3D-printed. These models — showing a coral polyp with tentacles, mouth, and stomach — demonstrate how similar they are to jellies and anemones, their other close relatives in the ocean. Models have been sent across the Pacific and Caribbean regions, an instructional web page was visited over 3,240 times, and digital 3D models have been downloaded over 350 times.
- ▶ It's rare for middle and high schools to teach specialized subjects like oceanography and meteorology, so many students are not exposed to career opportunities in these STEM disciplines. In FY 2018, [NOAA Office of Education](#) supported the [National Ocean Sciences Bowl](#) (NOSB) and [Science Olympiad](#) competitions, which help spread the word about NOAA-related sciences. Over 1,750 students from 231 schools in 32 states competed in 23 regional competitions leading up to the NOSB. Students demonstrated their knowledge of the ocean and its role in Earth system science by exploring the theme, "Our ocean shaping weather." Over 7,500 teams from all 50 states competed to advance to the national



These 3D models show the structure of coral polyps. Using thermosensitive material during printing, the coral polyp models can mimic real-life interactions to changes in the environment, like warming ocean temperatures. When exposed to warm water, this model turns white to demonstrate coral bleaching, in which the animals expel their symbiotic algae. (NOAA Coral Reef Conservation Program)

GOAL HIGHLIGHTS //

Science Olympiad. NOAA Education sponsored the middle school meteorology event and supported the high school remote sensing competition.

- ▶ Many marine animals, including whales, fishes, and crustaceans, use sound to communicate. Sounds from human activities like ship traffic and sonar can disrupt and stress these animals. [Cordell Bank National Marine Sanctuary](#) helped California teachers use this phenomenon to implement the Next Generation Science Standards. Participants attended a workshop and field trip on the [R/V Fulmar](#) that brought them closer to local sanctuary phenomena through the [NOAA Noise Reference Station Network](#). Teachers reported that one of the most rewarding parts of the experience was seeing scientists communicate and solve problems while aboard the *R/V Fulmar*, skills they hope to inspire in their students.



Cordell Bank National Marine Sanctuary brought educators on a field trip on the *R/V Fulmar*. (NOAA)

Educators bring NOAA resources into the classroom for students of all ages

Professional development opportunities give educators the tools they need to meet learning standards while helping their students understand the world around them. When teachers are well-versed in NOAA science, they can pass that knowledge on to their students.

- ▶ Experiential learning is a powerful way to engage students from all backgrounds in science, but activities can be difficult for school districts or educators to implement. The [Bay Watershed Education and Training](#) (B-WET) program supported [Meaningful Watershed Educational Experience](#) (MWEE) professional development for 2,459 teachers in seven regions across the country. After professional development, 76% of teachers who responded to a survey reported that they intended to implement B-WET's signature MWEEs without additional support from a professional development provider. In a follow-up survey, 85% of teachers indicated that they had conducted MWEE activities with their students. With increased teacher integration of MWEEs, more students get to experience quality STEM-based watershed education.
- ▶ The [National Ocean Service](#) expanded their monthly [NOAA Planet Stewards](#) webinars to include topics like marine debris, natural resource management, and severe weather, engaging more than 3,750 formal and informal educators in their broadcasts. Planet Stewards also held face-to-face workshops in Illinois, Arizona, Texas, Hawaii, and at the National Science Teachers Association National Conference in Atlanta, Georgia. Follow-up evaluations indicated that 95% of webinar and workshop participants learned from their experiences. Respondents reported that they planned to implement what they learned at some point in the next year and share Planet Stewards information and resources with more than 133,000 youth, adults, and colleagues. The program engages over 2,100 educators nationwide through its [email list](#).
- ▶ The [National Ocean Service](#) collaborated with the National Earth Science Teachers Association to host four elementary-level webinars followed by a series of live online discussions that focused on topics ranging from oyster ecology to meteorology. Over 3,000 educators were reached through these efforts, and attendees indicated that

OBJECTIVE 1.2.
Formal and informal educators integrate NOAA-related sciences into their curricula, practices, and programs.

GOAL HIGHLIGHTS //

they intend to share the content from these professional development opportunities with almost 105,000 youth, adults, and colleagues.

- ▶ NOAA's [Teacher at Sea Program](#) provides unique and life-changing ocean research experiences for educators, but its real value comes when teachers share what they have gained with their students, schools, and communities. Michigan teacher Stephen Kade surveyed sharks along the southeastern U.S. coast on [NOAA Ship Oregon II](#) in 2018. While at sea, Stephen painted the creatures he saw. Returning to the classroom, his students combined art and science to learn about ocean species.
- ▶ The [National Centers for Environmental Information](#) (NCEI) participated in the Mountain Science Expo in Asheville, North Carolina. NCEI distributed materials related to bee pollination, the water cycle, cloud types, nighttime lights, and the GOES-R satellite series. NCEI interacted with 2,000 teachers at the conference, and 135 signed up for additional resources to advance their knowledge about NOAA-related sciences.
- ▶ Sturgeon, an ancient group of fishes, are sometimes called living fossils. But after 200 million years on Earth, their future is uncertain. The Students Collaborating to Undertake Tracking Efforts for Sturgeon ([SCUTES](#)) program from [NOAA Fisheries Greater Atlantic Region](#) engaged “K through gray” learners in sturgeon life history and conservation. In FY 2018, approximately 1,184 students learned about the movements and behavior of Atlantic and shortnose sturgeon along the East Coast of the United States, as well as the threats to these endangered species. The program was also adapted for senior citizens and children with special needs. Additionally, over 75 formal and informal educators participated in workshops to learn about integrating sturgeon-inspired lesson plans into their classrooms. Participation in SCUTES lessons and activities promotes awareness of the Endangered Species Act and sturgeon conservation initiatives.
- ▶ NOAA's [Office of Ocean Exploration and Research](#) (OER) added new Education Alliance Partners to help share ocean exploration science and discoveries with educators around the country. New partners include the Loveland Living Planet Aquarium in Draper, Utah; the Great Lakes Aquarium in Duluth, Minnesota; and the Albuquerque BioPark in New Mexico. By expanding the partner network, OER is broadening its reach to more inland portions of the country and populations not historically served by the program.
- ▶ Ocean acidification is impacting Dungeness crab, an economically valuable species found throughout the West Coast. West Coast [national marine sanctuaries](#) (Channel Islands, Monterey Bay, Greater Farallones, Cordell Bank, and Olympic Coast) developed the [Ocean acidification communication toolkit: Dungeness crab case study](#) in partnership with scientists from the [Northwest Fisheries Science Center](#) and [NOAA Ocean Acidification Program](#). The toolkit summarizes NOAA research and includes a fact sheet, infographic, presentation with talking points, references, resource list, video clips, and photos. As a result, educators have access to scientifically accurate resources to communicate about Dungeness crab and its vulnerability to ocean acidification.
- ▶ Not everyone can visit a national marine sanctuary in person, but formal and informal educators around the globe have connected with sanctuaries through a virtual classroom. The [National Marine Sanctuaries Webinar Series](#) provides educators with resources to support ocean and climate literacy in the classroom. In FY 2018, the Office of National Marine Sanctuaries offered eight webinars for 929 educators. Based on post-webinar evaluations, 67% of webinar attendees plan to integrate these materials into their work within the next year. In addition, 95% are likely to attend a future presentation in the series and 97% are likely to recommend it to others.



Dr. Jolvan Morris coordinates the Students Collaborating to Undertake Tracking Efforts for Sturgeon (SCUTES) program, which engages people of all ages in the science and conservation of these endangered species. The term “scutes” refers to the bony plates that line sturgeons’ bodies, shown here on an Atlantic sturgeon (second fish from the bottom). (NOAA)

GOAL HIGHLIGHTS //

Zoos, aquariums, museums, and science centers amplify NOAA science

Informal learning institutions — like zoos, aquariums, and museums — are our important partners. These institutions help spread the word about NOAA science to their visitors, reaching an audience of over 60 million people annually.

- ▶ Recent advancements in aquaculture have made farmed seafood a sustainable option. To help share the facts on seafood farming to potential consumers, NOAA's [Office of Education](#) mobilized 27 partner aquariums and science centers across North America through the [Coastal Ecosystem Learning Center \(CELC\) Network](#), which collectively reaches over 20 million people every year. In FY 2018, the Office of Education hosted three webinars for CELC institution staff and partners that reached more than 100 people from 43 institutions. Topics ranged from the health benefits of seafood to the newest NOAA science on sustainable seafood farming methods, helping aquarium staff prepare to engage in similar discussions with their guests.

OBJECTIVE 1.3.

Formal and informal education organizations integrate NOAA-related science content and collaborate with NOAA scientists on the development of exhibits, media, materials, and programs that support NOAA's mission.



Members of the public toured NOAA Ship *Reuben Lasker* during Ocean Discovery Month at the Exploratorium in August 2018. (Exploratorium)

- ▶ NOAA's partnership with the [Exploratorium](#), an innovative science museum in San Francisco, California, led to Ocean Discovery Month in August 2018. Using NOAA resources, the Exploratorium hosted a series of public programs focused on the ocean. Over 92,000 visitors attended the Exploratorium that month to participate in hands-on activities, view films, and engage with interactive exhibits. The Exploratorium is also an "educational port of call" for NOAA ships, providing dock space and research facilities while allowing the public to tour ships and meet scientists and crew members. During Ocean Discovery Month, the crew of [NOAA Ship Reuben Lasker](#) hosted 351 visitors, explaining their important work supporting our nation's fisheries.

FEATURED STORY //

Estuary reserves extend science education to deaf and hard-of-hearing students

Until recently, educators of the deaf had limited resources for teaching about ecology. Not only were materials scarce, but American Sign Language (ASL) did not have a shared vocabulary for many ecological terms, including “estuary” and “watershed.” If members of the deaf community wanted to discuss these concepts, they would generally fingerspell terms like “e-s-t-u-a-r-y” or “w-a-t-e-r-s-h-e-d,” a barrier that forced native ASL speakers to think in another language, English.

To expand opportunities for STEM learning in New England’s deaf community, NOAA’s [National Estuarine Research Reserve System](#) created a new partnership to help educators of the deaf teach their students about estuaries.

The members of this partnership — many of whom were deaf themselves — included subject matter experts and educators from the Center for Research and Training at The Learning Center of the Deaf, Boston University, and three national estuarine research reserves: Wells, Waquoit Bay, and Narragansett Bay. They aimed to create new ASL terms and also place those terms in context through hands-on activities and experiences out on the estuary.

Together, the collaborators developed instructional modules about estuaries and watersheds that incorporate new ASL terms. Deaf scientists developed the ASL terms following linguistic principles in which the signs communicate information about the concepts they represent. For example, estuaries are places where rivers meet with the ocean or large lakes. “The new estuary sign symbolizes the movement and mixing of two bodies of water,” explained Mandy Houghton, a deaf scientist at the Center for Research and Training. “Both hands approach each other from opposite directions, and moving fingers represent the flow of water.” Instructional videos were made available through [ASL Clear](#), an online STEM app.

After the team created the ASL materials, it was time to share them with teachers and students. “We trained several cohorts of educators from Boston University’s Deaf Education program and five schools for the deaf in Rhode Island, Massachusetts, and Maine,” said Joan Muller, education coordinator at the Waquoit Bay Reserve. At [Teachers on the Estuary](#) workshops, educators and interpreters learned new signs, experienced the estuary, and piloted hands-on activities they could bring back to their students. “The ASL Clear materials were received enthusiastically by all participants because the signs themselves help to explain the scientific concepts,” said Muller. Equipped with these tools, educators returned to their classrooms to immerse their students in watershed-focused lessons, which will culminate in field trips to research reserves in spring 2019.

Coining new ASL terms provides no guarantee that they will permanently enter the ASL lexicon. “In any language, new words are introduced, adopted, and rejected over time,” acknowledged Muller. But the team was hopeful that the signs, instructional videos, and workshops were a significant first step toward reducing this barrier to science learning for deaf and hard-of-hearing students. Barbara Spiecker, another deaf scientist on the project, said, “Educators will leave our workshops feeling confident and successful by learning the ecology-related signs and supplementing the language with content knowledge via hands-on activities and field trips.”



Workshop participants demonstrate the new American Sign Language term for “estuary.” The sign represents mixing between the river and the sea. (National Estuarine Research Reserve System)

FEATURED STORY //

High school students bring renewable energy to their Colorado community

In a Western Colorado community, decades of drought have left lasting impacts on the surrounding forests, and extreme weather events frequently destroy local fruit crops. Coal mines once supplied the region with abundant fuel, and recent natural gas discoveries in deep shale formations bring the promise of additional fossil fuel resources. However, stagnating oil prices and the recent closure of two of the three coal mines prompted one high school teacher to prepare his students for a different future.

With funding from the [NOAA Planet Stewards Education Project](#), environmental science teacher Ben Graves set out to train his students in the burgeoning field of solar energy. Delta, Colorado, has one of the highest potentials for solar photovoltaic (PV) electricity in the state, and Graves saw this as an opportunity to help his community adapt to changing climate and economic conditions.

“Reinvention starts with generating community awareness, changing attitudes, and providing opportunities to master new skills through hands-on technical training,” he said.

The students in Graves’ 2017-2018 Solar Energy Training vocational course learned all phases of solar electric design and installation. Then they put that knowledge to use by building a solar array in the new Solar PV Lab Yard. Students led every stage of the process. They planned the layout of the solar panels, diagrammed the wiring, and installed the 2.4 kW pole-mounted array to power the science wing of the school building.

Fully embracing their roles as engineers, the students collected data on panel performance and created a set of standard operating procedures to maximize production across different seasons. Advanced Placement® environmental science students monitored the array to predict the annual amount of electricity generated and quantify the climate benefit of the project. Finally, the 2017-2018 class of students helped lay the groundwork for future solar installations at their school and in their community. After completing this project, Graves successfully wrote a proposal to the local electrical cooperative, Delta-Montrose Electric Association, to install solar arrays at all of the high schools in the county.

As a result of Graves’ Planet Stewards Education Project, 1.38 tons of carbon dioxide were kept out of the atmosphere in 2018 alone. Fourteen students graduated from the training program, and 20 are enrolled in the 2018-2019 school year. The program is slated to continue growing: 10 teachers from the surrounding counties completed a professional development program to bring solar energy and technology into their own classrooms in 2018 with more to follow in 2019.

“The student-built array is a visible reminder to the community and its leadership that solar electricity is a viable way to reduce the community’s energy demand while having a positive impact on climate change, saving money in the long run, and transforming the community into a renewable energy hub,” said Graves.

Graves became a NOAA Planet Steward in 2018. Through his Solar Energy Training class, students will leave high school not only prepared to become technicians in the solar or electrical industry but also equipped with engineering, design, and problem-solving skills that will help them navigate a changing world.



High school teacher Ben Graves received funding from NOAA Planet Stewards to develop a solar energy training course. His students designed and installed the 2.4 kW solar array to power the science wing of their school. (Ben Graves/NOAA Planet Stewards)

FEATURED STORY //

Mentoring works: Teachers engage year-round with Lake Superior

For the past six summers, teams of teachers have met in Superior, Wisconsin, to kick off a week of watershed exploration. From tracking lake sturgeon and sampling cyanobacteria to monitoring water quality, they were immersed in the science and conservation of Lake Superior, the town's namesake and the largest surface of freshwater in the world.

Educators left the [Rivers2Lake](#) Summer Institute energized to share local, hands-on science experiences with their students, but back in the classroom, the realities of the busy school year set in. "I was overwhelmed when I left the institute," said one teacher. "I loved everything I was exposed to, ... but I was intimidated because I knew I had a scope and sequence back in my classroom and didn't know how to make what I learned at the institute fit."

Deanna Erickson, education coordinator at the [Lake Superior National Estuarine Research Reserve](#), was determined to find a better way to support teachers. She knew she had a successful program on her hands. Before Rivers2Lake, there was extensive scientific research taking place in the community, but little connection to local schools. Rivers2Lake filled that gap in 2012, supported over the years by NOAA's [Great Lakes B-WET](#) (Bay Watershed Education and Training) program and [Wisconsin Sea Grant](#). But it was clear that the program would need to go further to make sure that students gained the full benefit of their teachers' participation in this award-winning experience.

Looking back at successful education programs she had studied in graduate school, Erickson found the answer: In addition to training 12 educators at a five-day Summer Institute, reserve staff would spend the rest of the school year acting as mentors, connecting classrooms to the scientific community and helping teachers integrate the place-based and outdoor learning they were introduced to over the summer.

Sustained support throughout the school year did the trick. Teachers reported that mentoring helped them navigate barriers and gain confidence with the skills they learned. In the words of one teacher, "It encouraged my perseverance through accountability in the most positive sense of that word. My belief was already there, but mentoring helped keep it at the forefront."

When teachers are engaged, they are better able to share their passion with their students. To date, 78 teachers in the Lake Superior watershed have participated, and as a result, approximately 2,450 students now have stronger skills in environmental literacy and stewardship. A three-year evaluation of the program, which was recently published in the *Journal of Environmental Education*, found that students in Rivers2Lake classrooms had levels of academic engagement that were consistently higher than their peers.

In some cases, the benefits of this holistic approach have extended far beyond improving teachers' comfort level with environmental science. The ongoing support of a mentor increased their sense of confidence, competence, and value as educators. "Truth be told, this program helped restore my passion for teaching," said Amanda Guttormson, a pre-school teacher in Superior, Wisconsin. "I feel that this program has transformed... the way I stand up for what I believe to be the best practice."



Teachers perform a dissolved oxygen test on the banks of the St. Louis River near Meadowlands, Minnesota, during the 2018 Rivers2Lake Summer Institute. (Lake Superior National Estuarine Research Reserve)

FEATURED STORY //

Gray's Reef National Marine Sanctuary partners with Rotary to foster STEM innovation and entrepreneurial development

Deep in concentration, teams of students gathered at the edge of a swimming pool near [Gray's Reef National Marine Sanctuary](#) (GRNMS) in Georgia, remote controls in hand. They carefully guided their homemade underwater robots — more scientifically known as remotely operated vehicles or ROVs — through a series of exercises simulating the tasks that the robots' real-world counterparts might complete as part of a NOAA mission. Each team hoped that their ROV might be the one that judges would name the 2018 competition winner.

In the background, representatives from the regional Rotary district's leadership team looked on. They had come to the competition last year as spectators to determine whether it could support their organization's goal of cultivating young leaders and entrepreneurs in Georgia. After seeing the students' innovations firsthand, they were back to see how Rotary might be able to get more involved this year.

Both the Rotary district and the competition host organization, GRNMS, recognized the value of hands-on ROV training in coastal Georgia. The competition's home city of Savannah is also home to the nation's fourth-busiest container port. As this port and others increase their use of ROVs for port security, ship inspections, and other maritime needs, a new workforce capable of engineering and operating these devices must rise to meet the demand.

To build up this workforce, GRNMS and Rotary decided to work together to support the ROV competition. The Rotary district now provides funding, mentorship, and capacity-building scholarships to student ROV teams. Each year, they also volunteer some of their 3,000 members to help staff the competition and invite student teams to showcase their ROVs at the annual Rotary District All Clubs Conference. In turn, GRNMS provides local Rotary members with foundational skills development for mentoring local ROV teams and exciting new connections with schools across the region.

By engaging Rotarians in this ROV competition, the Gray's Reef National Marine Sanctuary helps build the future blue economy workforce while simultaneously increasing ocean awareness among one of America's most active service organizations.

Back by the pool at the 2018 competition, the Rotarians watched as North Paulding High School's underwater robotics club was named this year's champion. While only this team moved on to the international competition, all competitors walked away more prepared to tackle the challenges the maritime industry might face in the future.

"To properly protect marine life and special areas like Gray's Reef, we need tools to help us explore and understand the mysteries of the ocean," said former GRNMS superintendent Sarah Fangman. "These students — future engineers and scientists — will create the next generation of instruments used at NOAA, NASA, and the maritime industries."



The Aquarisers team from the STEM Academy at Bartlett Middle School received the Duct Tape Award for "outstanding troubleshooting" during a 2018 remotely operated vehicle competition. (Gray's Reef National Marine Sanctuary)

GOAL 2

Conservation and Stewardship

Individuals and communities are actively involved in stewardship behaviors and decisions that conserve, restore, and protect natural and cultural resources related to NOAA's mission.



Chris Bowser/Hudson River National Estuarine Research Reserve

OVERVIEW //

NOAA's science lays the foundation for stewardship and conservation, but everyone has a part to play in protecting our coastal and marine resources. NOAA Education provides a framework of science literacy so people and communities can make informed choices and take actions to protect the resources they care about, whether that's a favorite fish to catch, a community's famous beach, or a Civil War shipwreck.

OBJECTIVES

2.1. Youth and adults from all backgrounds are knowledgeable about conservation and stewardship practices and skilled in applying them to address local, regional, national, and global issues related to NOAA's mission.

2.2. Formal and informal educators integrate NOAA-related conservation and stewardship concepts and activities into their curricula, practices, and programs.

2.3. Formal and informal education organizations establish guidance and provide support toward increasing participation of education audiences in conservation and stewardship activities related to NOAA's mission.

GOAL HIGHLIGHTS //

Students become stewards by connecting with their local environment

Stewardship education helps students develop a sense of place and a feeling of responsibility for their community's natural areas and resources. Activities like removing invasive species, reducing the use of plastics, and learning to participate in fisheries management all help students to make changes in their communities while building leadership skills.

OBJECTIVE 2.1.

Youth and adults from all backgrounds are knowledgeable about conservation and stewardship practices and skilled in applying them to address local, regional, national, and global issues related to NOAA's mission.

- ▶ Scientists and educators in Juneau, Alaska, needed a forum to make it easier for teachers to bring real-world science into the classroom. Staff at the [Alaska Fisheries Science Center](#) worked with local educators and community members to create the [SouthEast Exchange](#) (SEE). SEE connects educators with STEM professionals to create authentic STEM experiences in Juneau classrooms. In one collaboration, teachers and scientists created a unit on ecosystem-based fisheries management. Over 100 seventh-graders researched the Bering Sea ecosystem and presented fisheries quota recommendations to a panel of experts during a mock fisheries management process.
- ▶ Earth Day isn't always about planting trees; sometimes it's about removing invasive species to restore native forests. Every month, the [Narragansett Bay National Estuarine Research Reserve](#) hosts several groups of elementary- through high school-aged homeschooled students, many of whom have been attending reserve programs for several years. What do they ask to do the most, sometimes for hours a day? Battle the invasive European larch trees with clippers, loppers, and hand saws! Despite the ever-present threat of thorns, ticks, and blisters, these industrious young adults, along with other volunteers, have removed 500 invasive trees from Rhode Island's rare, native pitch pine forest.
- ▶ A healthy marsh prevents erosion, improves water quality, and creates habitat. Restoring the saltmarsh at [Apalachicola National Estuarine Research Reserve](#) is an ongoing mission for the local fifth-grade students in Franklin County, Florida. Starting in 2011, every fifth-grader has come to the site, put on their boots, and gotten in the mud to plant *Spartina* grass. Students also measure the previous year's growth to track the development of the marsh over time. In 2018, they planted over 250 plants, which help reduce erosion and create a living shoreline.
- ▶ What has 10 eyes, legs that chew, and blood that saves lives? A horseshoe crab, of course. Due to over-harvesting of the horseshoe crab into the 1990s, management controls were put in place in Atlantic states, and populations are now surveyed each year. Elle Gilchrist, an undergraduate intern, worked with [Delaware National Estuarine Research Reserve](#) educators, state scientists, and 120 volunteers to conduct the survey on three Delaware beaches. Information from the annual horseshoe crab survey affects management decisions that keep the horseshoe crab population thriving.
- ▶ Appreciation for the natural environment starts at an early age. [Channel Islands National Marine Sanctuary](#) partnered with California State University Channel Islands



The Narragansett Bay National Estuarine Research Reserve hosts groups of elementary- through high school-aged homeschooled students who help with restoration projects, including removing invasive trees. (Narragansett Bay National Estuarine Research Reserve)

GOAL HIGHLIGHTS //

Boating Center Watersports Camp to show campers how to become stewards for the marine environment. Participants took part in a NOAA marine debris trash audit at a local beach, identified invasive species growing under the dock in Channel Islands Harbor, and observed plankton under a video-microscope. By connecting with their environment early in life, campers developed conservation and stewardship ethics and skills that will carry them into adulthood.

- ▶ The [National Marine Sanctuary of American Samoa](#) deeply engages with the communities that surround it. Since 2016, the sanctuary has led Sanctuary Summer Science in the Village in the nearby communities of Aunu'u, Vaitogi, and Leone. This one-week learning experience teaches students the value of conserving natural and maritime resources, both in their local village and in Samoa as a whole. The program's activities encourage students to use critical thinking, creativity, and problem-solving skills while building flotation devices, boats, submarines, or conducting debris surveys. The program has empowered more than 300 students from elementary through high school to become local stewards to protect and preserve marine resources and ecosystems in their villages.
- ▶ An [Ocean Guardian School](#) commits to protect and conserve its watershed, the world's ocean, and special ocean areas like national marine sanctuaries. Every Ocean Guardian school implements a school- or community-based conservation project. Through these projects, students not only learn about the environment but also participate in stewardship activities to make their school or community a better place. In FY 2018, over 6,698 students and 249 teachers from schools in Washington, California, and Texas participated in the program. The combined result of these stewardship programs shows strength in numbers. During the 2017-2018 school year, there were: 58 recycling and 27 compost bins installed; 1,115 pounds of trash removed; 938 reusable bags distributed; 3,273 reusable bottles distributed; 307,496 single-use plastic bottles not used due to the use of refill stations; 4,516 gallons of water reclaimed through catchment systems; 592 native trees planted; 136,755 square feet of native plants planted; 120,669 square feet of non-native invasive plants removed; 16 wildlife habitat structures installed; and 65 bike to school days.
- ▶ Invasive ice plant in Seabright State Park, in Santa Cruz, California, displaces native plants and animals. Through their [Ocean Guardian School](#) project, Gault Elementary students made a difference for the beach, one ice plant at a time. These students removed ice plant and replaced it with native dune plants. Once covered in the non-native ice plant, these beach dunes are now thriving. The students' work has been so successful that threatened and endangered animals like snowy plovers and burrowing owls have returned to these dune ecosystems to nest and flourish. (ONMS)
- ▶ The Grand Calumet River was once one of the [most polluted](#) rivers in America. With funding from the Great Lakes Legacy Act, the river is being restored. However, many nearby students never get the chance to explore it. In FY 2018, [Illinois-Indiana Sea Grant](#) co-hosted the Grand Calumet River Stewardship Day in partnership with The Nature Conservancy. About 70 middle and high schoolers visited Seidner Dune and Swale Nature Preserve in northwest Indiana to experience science in the outdoors. Scientists and experts guided students through stations for bird watching, identifying fish and macroinvertebrates, and planting oak trees. Evaluated before and after the visit, the students increased their sense of place related to the Grand Calumet River. When people develop a connection to a place, they are [more likely](#) to engage in acts of environmental stewardship at that location.



Students' restoration efforts have created habitat for threatened and endangered species, including the snowy plover. (U.S. Fish and Wildlife Service)

GOAL HIGHLIGHTS //

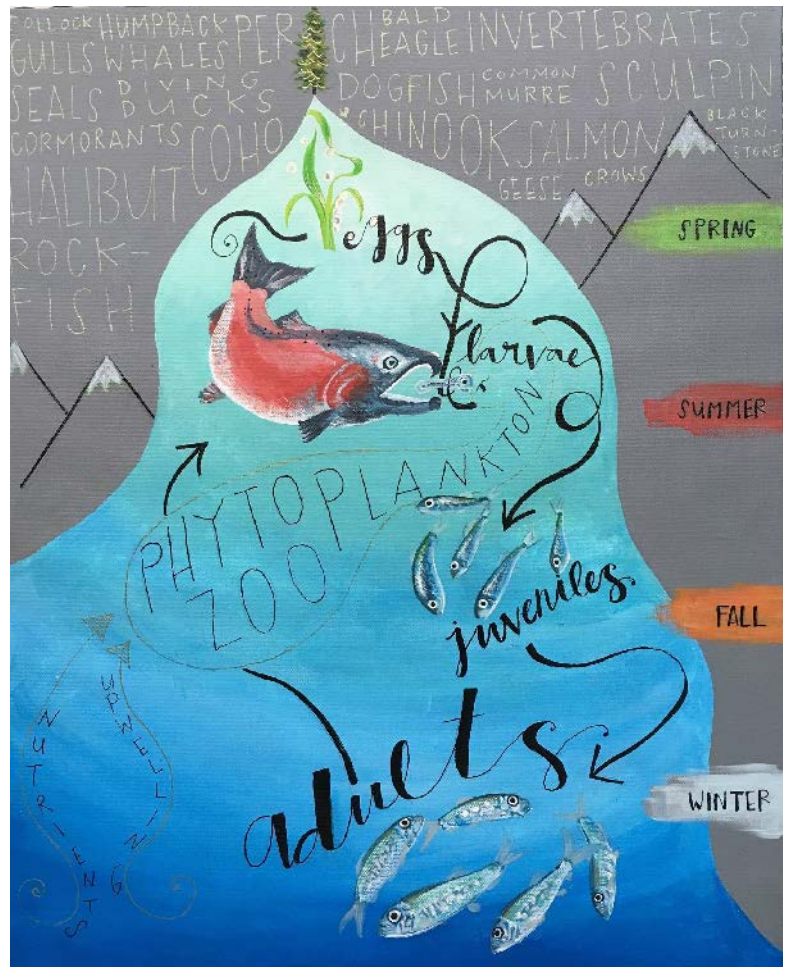
NOAA Education bridges science, art, and culture

NOAA partners with artists and chefs to explore the intersections between people and the environment. These interdisciplinary collaborations connect natural resource management issues with everyday life, providing ways for community members to engage in conservation and stewardship.

- ▶ The Gulf of Alaska experienced anomalously cold conditions in 2012 followed by a prolonged ocean heat wave from 2014-2016 known as “the Blob.” [Hollings scholar](#) Adrian Teegarden looked at these conditions during a summer internship with NOAA’s [Kasitsna Bay Laboratory](#) in Alaska. The goal of her research project, “ARTiculate: Visualizing zooplankton, fish, and oceanography data in Kachemak Bay, Alaska,” was to find creative effective ways to visualize changes in the zooplankton population in a cold (2012) and a warm (2016) year. Teegarden’s artwork shows how conditions impact zooplankton and forage fish, which in turn impact commercially valuable species, marine mammals, and seabirds.
- ▶ Many consumers do not understand the supply chain that brings seafood to their plates. In 2018, the [Southwest Fisheries Science Center](#) and partners brought together NOAA researchers, fishermen, chefs, seafood processors, and students for five “ocean-to-table” events in San Diego, California. This series helped participants understand the local seafood supply chain, learn from one another, and develop collaborative “culinary engineering” approaches to sustainable seafood. Topics included demonstrations of the diversity of local seafood, connections to the science behind sustainable fisheries, and ways to reduce waste and bycatch. About 100 people attended each event.
- ▶ While salmon spend most of their lives at sea, they hatch and breed in our streams and rivers. NOAA Fisheries [Southwest Fisheries Science Center](#), Sea Studios, and the National Marine Sanctuary Foundation partnered with artist Ray Troll to launch the California Salmonscape project. This colorful art project brings to life native salmon and their habitats, which extend from ridgetops, through valleys, to coastal wetlands and the ocean. The art pieces are inspired by research conducted at the Southwest Fisheries Science Center, which works to improve our understanding of the vital ecosystems defined and enriched by Pacific salmon. The launch for the project was held at the University of California Santa Cruz in June 2018 and was attended by 150 members of the public.

OBJECTIVE 2.1.

Youth and adults from all backgrounds are knowledgeable about conservation and stewardship practices and skilled in applying them to address local, regional, national, and global issues related to NOAA’s mission.



Adrian Teegarden, 2017 NOAA Hollings scholar, interned in Kachemak Bay, Alaska. The goal of her project was to use scientific graphs and art to visualize marine ecosystem data collected under different climate conditions. She focused on the Pacific herring life cycle. (Adrian Teegarden/NOAA)

GOAL HIGHLIGHTS //

On the coast and far inland, teachers and students help tackle marine debris

From derelict fishing vessels to tiny microplastics, marine debris is a serious global environmental threat. NOAA Education helps teachers and students lead the way in creating solutions to ocean pollution.

- ▶ Each September, volunteers in the Alabama Coastal Cleanup come out to local beaches, bays, and rivers to “get the trash out of the splash.” In the past 30 years, the program has grown from originally cleaning up two sites to now reaching 30 sites and engaging over 5,000 volunteers. Volunteers transform into citizen scientists as they collect data on trash types and amounts. Staff at [Weeks Bay National Estuarine Research Reserve](#) and the Alabama Coastal Area Management Program use the data to develop education strategies that help stop litter from reaching waterways. Volunteers have picked up more than 1.6 million pounds of trash, including 640,000 cigarette butts, 190,000 plastic bottles, and 103,000 plastic bags.
- ▶ [Olympic Coast National Marine Sanctuary](#), working with Washington CoastSavers, is dedicated to keeping the state’s beaches free of marine debris through coordinated beach cleanups, education, and prevention. The annual Earth Day beach cleanup in April and International Coastal Cleanup in September focus on removing debris from Washington coast beaches. These community efforts help preserve the beauty of ocean beaches, reduce impacts of marine debris to wildlife, and make shores safer for recreation. For Earth Day, more than 1,400 volunteers removed more than 30,000 pounds of debris off 65 beaches along the Strait of Juan de Fuca and Washington coast. Over 500 volunteers participated in the 2018 International Coastal Cleanup, collecting another 7,500 pounds of debris from the Washington coast.
- ▶ In the Great Lakes, shoreline communities struggle to clean up the vast amounts of marine debris that harm humans and the environment. To educate residents about how to reduce marine trash, [Ohio Sea Grant](#) developed an interactive curriculum for classrooms and outreach events. Staff attended 67 outreach events educating 52,555 people about this issue along the coast of Lake Erie. Ohio Sea Grant also organized several beach cleanups that allow students and coastal residents to see the effects of marine pollution first-hand. Through Ohio Sea Grant beach cleanups, 8.25 acres of shoreline have been restored. Of students and coastal residents surveyed after classroom visits and outreach events, 71% say they have taken steps to alter their actions to reduce marine debris.
- ▶ Erosion, sedimentation, and eutrophication from changing weather patterns are significant issues for [Weeks Bay National Estuarine Research Reserve](#) in Alabama. Weeks Bay Foundation manager and NOAA Planet Steward, Yael Girard, used funding from [NOAA Planet Stewards](#) to assess and restore areas of the waterway. Fifty-eight people, ages nine to 79, volunteered a total of over 300 hours to this project. Participants included students, educators, community members, and representatives from partner organizations. Amongst these partner organizations were Team River Runner, which serves wounded veterans using kayaking and canoeing as therapeutic activities, and Compass II Life, which helps young men from urban communities who have faced significant challenges to get back on track through leadership training and community service. Volunteers gathered hundreds of pounds of trash and recyclable materials, assessed three miles of the waterway, and planted 500 native plants that decrease erosion and increase filtration of minerals and nutrients going into Weeks Bay.

OBJECTIVE 2.1.

Youth and adults from all backgrounds are knowledgeable about conservation and stewardship practices and skilled in applying them to address local, regional, national, and global issues related to NOAA’s mission.



A NOAA Planet Steward implemented a project to assess and restore areas of the waterway and remove trash to combat these issues in the Weeks Bay National Estuarine Research Reserve. (NOAA Planet Stewards)

GOAL HIGHLIGHTS //

NOAA celebrates maritime heritage through interdisciplinary education

From studying underwater archaeology to preserving the rich history of NOAA’s own fleet of vessels, maritime education creates windows into the past. Our programs connect audiences to our seafaring legacy and inspire them to protect these resources for the future.

OBJECTIVE 2.1.
Youth and adults from all backgrounds are knowledgeable about conservation and stewardship practices and skilled in applying them to address local, regional, national, and global issues related to NOAA’s mission.

► **Monitor National Marine Sanctuary** (MNMS) leads efforts to conserve the first Civil War ironclad, **USS Monitor**, and over 50 shipwrecks from both world wars. To share these exciting underwater national treasures, sanctuary educators created three new curriculum guides about the important scientific research conducted at sanctuaries to protect maritime heritage sites. The guides cover the *Monitor*, World War I, and World War II and can be used by formal and informal educators. They motivate students to understand these significant periods in our history while learning STEM and social studies concepts through shipwrecks. The guides offer educators a unique way to engage students, making them more aware of our maritime heritage and how to protect these resources for future generations.

► Daily logs from historic ships contain a trove of climate and weather data, but these paper records are hard for scientists to use. At the **Joint Institute for the Study of Atmosphere and Ocean**, a partnership between **NOAA Research** and University of Washington, the **Old Weather Project** harnesses volunteers to mine data from historic vessel records. Old Weather brings together climate researchers and citizen scientists with experts from the U.S. National Archives. The team won a \$480,000 grant from the Council on Library and Information Resources to digitize data from U.S. naval vessels from 1861 to 1879, a period with sparse climate records. This will allow volunteers, who have already transcribed 3 million records, to supplement and extend the available data on past conditions.

Hour	Knots	Current strength	WIND		BAROMETR.		TEMPERATURE		State of the weather by appearance	Force of Wind by gusts
			Direction	Force	Height in Ther. and	Bar.	Air	Water at surface		
A.M.										
1	4		W. by E.	11	5	29.74	43	46	43	72
2	4		"	"	5	29.74	42	45	44	dr.
3	4		"	"	5	29.75	41	45	44	dr.
4	3		"	"	5	29.75	41	45	44	"
5	3		"	"	5	29.76	41	45	44	"
6	2		"	"	5	29.76	41	45	44	"
7	3		"	"	5	29.76	41	45	44	"
8	4		"	"	5	29.76	41	45	44	"

Through the Old Weather Project, volunteers help scientists recover weather observations recorded in ships’ logs. (Old Weather Project)

► A large part of the maritime industry workforce in Washington’s Puget Sound region is **planning to retire** in the next five to 10 years. To generate awareness and educate youth on careers in the maritime industry, the Youth Maritime Collaborative and Seattle Maritime Academy hosted the second annual Maritime and Marine Science Exploration Day, SO²UND Day. NOAA offices in Seattle, including NOAA Research’s **Pacific Marine Environmental Lab** and the **Office of Coast Survey** Pacific Hydrographic Branch, participated in SO²UND Day to provide marine science experiences and education on marine careers to more than 200 underrepresented high school students. PMEL led hands-on activities on ocean acidification and talked to students about careers in building oceanographic instruments. The Pacific Hydrographic Branch brought their augmented reality sandbox and charting activities to engage students about nautical charts and hydrography.

► The **Teacher at Sea** (TAS) program helped celebrate the 50th anniversary of NOAA Ships **Oregon II**, **Fairweather**, and **Rainier**. In 1990, *Oregon II* was the first ship to host a Teacher at Sea, Debora Mosher; in the intervening years, the ship hosted another 75 teachers. At the Pascagoula, Mississippi, ceremony, TAS honored Mosher and Captain Dave Nelson. TAS alumna Jenny Goldner presented Nelson with a certificate from the Cherokee Nation for “contributions in educating Cherokee Youth attending Jay, Oklahoma, Public Schools.” During the ceremony for *Rainier* and *Fairweather* in Newport, Oregon, alumni Lisa Battig and Denise Harrington presented the commanding officers with plaques. These three ships continue to make valuable contributions that support NOAA’s science and represent “the last of a generation of truly beautiful ships,” said Rear Adm. Shep Smith.

GOAL HIGHLIGHTS //

Stewardship toolkits help educators deliver meaningful environmental experiences

NOAA conducts inquiry-based projects that engage students in thinking critically about their environment. Our programs develop tools that make it easier for educators to bring these effective learning opportunities to their students.

- ▶ The [NOAA Chesapeake Bay Office](#) and partners in the Chesapeake Bay Program published [An Educator's Guide to the Meaningful Watershed Education Experience](#) and launched a new comprehensive online training course for K-12 environmental educators. The Meaningful Watershed Educational Experience (MWEE) is a learner-centered experience that serves as a foundation of the NOAA Bay Watershed Education and Training (B-WET) Program. The course provides an overview of the origin and drivers for the MWEE, along with video examples and step-by-step instructions for developing and maintaining MWEEs. The guide and the course help teachers provide high-quality environmental education experiences for all students, leading to student-driven stewardship actions. In the mid-Atlantic, these resources also help teachers meet the environmental literacy commitment required under the Chesapeake Bay Watershed Agreement.
- ▶ With funding from [Chesapeake B-WET](#), Earth Force analyzed the problems and barriers that prevent the implementation of stewardship action projects in environmental education. Barriers include the perception that student action projects are not integral to the educational experience and limited time and money. This project will identify best practices and inform the development of tools to help formal and informal educators integrate NOAA-related conservation and stewardship concepts and activities into their curricula, practices, and programs.



OBJECTIVE 2.2.
Formal and informal educators integrate NOAA-related conservation and stewardship concepts and activities into their curricula, practices, and programs.

Local teachers and staff from Michigan Natural Features Inventory collect seeds from native plants for prairie restoration at Lake Erie Metropark in Michigan. This workshop was supported by the Bay Watershed Education and Training (B-WET) program. (Daria Hyde/Michigan Natural Features Inventory)

Partnerships increase stewardship across the country

NOAA works with many different organizations to mobilize environmental stewards and protect coastal resources. NOAA has also expanded successful stewardship education programs to help more teachers bring their local watershed into the classroom and their students into the watershed.

- ▶ With funding from [Chesapeake Bay Watershed Education and Training](#) (B-WET), the Stroud Water Research Center assembled a task force to boost community environmental literacy and stewardship of the 86,000 miles of streams and rivers in Pennsylvania. The Pennsylvania Watershed Education Task Force brings the

OBJECTIVE 2.3.
Formal and informal education organizations establish guidance and provide support toward increasing participation of education audiences in conservation and stewardship activities related to NOAA's mission.

GOAL HIGHLIGHTS //

Pennsylvania Department of Education together with approximately 20 collaborators in formal and informal education, government, and business to increase the use of Meaningful Watershed Educational Experience (MWEE) programming in local schools. With a three-year capacity-building grant, the task force will expand partnerships and provide training for approximately 400 watershed education professionals and K-12 educators all throughout the commonwealth.

- ▶ The [Ocean Guardian School](#) program supports stewardship projects that address watershed or ocean health at schools. In collaboration with the [Gulf of Mexico B-WET](#) program, the Ocean Guardian School program expanded to reach schools in Galveston and Harris Counties in Texas and Monroe County in Florida. With funding coordinated by the National Marine Sanctuary Foundation, NOAA provided in-kind support or mini-grant funding to five schools in Texas and five schools in Florida throughout the 2017 and 2018 academic years. Increasing the geographic range of the program helps youth from diverse backgrounds become knowledgeable about conservation and stewardship practices and skilled in applying them to local issues.
- ▶ The Tijuana River is home to one of California's largest remaining salt marshes, but it flows through highly urbanized areas. The [Tijuana River National Estuarine Research Reserve](#) participated in the eighth annual Tijuana River Action Month (TRAM), a series of events coordinated with seven agencies and nonprofits from Mexico and the United States. From September 16 to October 14, these partners hosted 10 events in the United States and Mexico, including cleanups, habitat restoration activities, and environmental workshops. Since 2010, volunteers have removed 261 tons of trash. Volunteer Steven Wright stated, "Through TRAM, the Tijuana Estuary has proven vital as it connects people on both sides of the border, prepares them for action, and improves the region by catalyzing sustainable solutions."
- ▶ Young American eels (glass eels) migrate from the Atlantic to the fresh waters of the Hudson River each year and are critical members of the aquatic ecosystem. However, dams like the one on Sparkill Creek in Piermont, New York, present a serious obstacle to their upstream journey. The Hudson River Eel Project, supported by 44 partner organizations, builds awareness of environmental issues and trains volunteers to monitor the eel population at 14 sites. Citizen scientists in the Sparkill Creek community worked with [Hudson River National Estuarine Research Reserve](#) and partners on an innovative solution — an "eelevator" — to transport eels over the dam and on their way. In the last year, over 700 volunteers donated 3,000 hours to catch, count, and release 146,000 juvenile eels past upstream barriers to their migration.
- ▶ A community of volunteers helps protect our [national marine sanctuaries](#) while connecting with visitors and learning from world-renowned scientists. These volunteers work in close collaboration with many other local groups including boat operators, academic institutions, federal agencies, tribal agencies, nongovernmental organizations, and researchers. During FY 2018, over 12,000 volunteers helped to protect and conserve America's underwater treasures. These individuals worked 127,983 hours in a variety of activities including cleaning up beaches, staffing visitor centers, and monitoring wildlife. Their work is the equivalent of \$3.16 million dollars of in-kind support or the value and time of 64 full-time employees. An additional 9,312 volunteers supported citizen science efforts, such as Beach Watch, Spotter Pro, and Stellwagen Sanctuary Seabird Stewards, and worked a total of 82,637 hours, the equivalent of \$2 million dollars or 41 full-time employees.



Ocean Guardian Ambassadors from an elementary school visited restaurants in Santa Barbara, California, to encourage them to "skip the straw" by only offering plastic straws upon request. (Claire Fackler/NOAA)

FEATURED STORY //

After tracking local marine debris, students convince restaurant to help stop the problem at its source

From afar, the iconic sandy beaches of Santa Barbara, California, appeared pristine. Up close, students from Goleta Family School could see that the data they collected for the [Marine Debris Monitoring and Assessment Project](#) (MDMAP) told a different story.

These students had been monitoring their beaches every month using the protocols laid out in NOAA's [Marine Debris Monitoring Toolkit](#). Developed through a partnership between [NOAA Marine Debris Program](#) and the [Office of National Marine Sanctuaries](#), the toolkit enables teachers to work with their students to contribute to the MDMAP. This global citizen science project helps scientists and communities document the magnitude of the marine debris problem and set targets for addressing it.

The MDMAP and other assessments show that marine debris is one of the most widespread pollution problems facing the world's ocean and waterways. Huge amounts of consumer plastics, derelict fishing gear, vessels, and other lost or discarded items enter the marine environment every day. In Santa Barbara, the litter and detritus in one beachfront area started to show a pattern. The students from Goleta Family School observed and recorded the same items over and over again: plastic wrappers from toothpicks and mints.

The students realized that the plastic wrappers came from the same source, a local beachfront restaurant. So they talked to the owners and asked them to stop giving away individually packaged toothpicks and mints. The restaurant agreed, and as the students continued to monitor, they began to see tangible results. Over time, they documented fewer wrappers on the beach.

Marine debris is a pervasive problem that everyone plays a role in perpetuating. But as the students at Goleta Family School learned, anyone can be part of the solution. By teaching educators how to contribute to a rigorous citizen science project through the Marine Debris Monitoring Toolkit for Educators, they in turn empower their students to contribute to science and make a difference in their community.

Since the toolkit was released at the end of 2017, it has been downloaded by 300 educators and has been featured in NOAA's award-winning Ocean Today video series. Data contribute to the worldwide MDMAP database where professional scientists can use the information to look at larger trends in marine debris around our shores. And as the students participating in the program have seen, it's a powerful tool for tracking — and making — change.



Students survey washed-up trash in Santa Barbara, California, using the Marine Debris Monitoring Toolkit. (NOAA)



Students from Scotts Valley High School monitor their local beaches in Santa Cruz, California. (NOAA)

FEATURED STORY //

Student videos offer a glimpse into climate change

A group of teens headed down to fish at a shady stream in the American Southwest. But in addition to rods and tackle, they also carried professional-grade video cameras, microphones, and recording equipment. Erik Morales, a student from Gadsden High School in Anthony, New Mexico, shared his story with the camera: “I used to go fishing all the time,” he said. “But things have changed over the past decade... there isn’t enough water to sustain, kind of, the amount of fish we used to catch.”

In June, 15 middle and high school students from across southern Colorado and New Mexico journeyed to the NOAA-supported [Cooperative Institute for Research in Environmental Sciences](#) (CIRES) at the University of Colorado Boulder. The students were there for a week-long program to explore the effects that environmental change has on their lives and in their communities.

The Lens on Climate Change (LOCC) program, funded by the National Science Foundation’s Innovative Technology Experiences for Students and Teachers, allowed these students to take a deeper look at climate change topics and use their new knowledge to create short, educational movies. This group was from Upward Bound Math Science, a program that targets low-income students and those who may be the first in their families to attend college.

CIRES and Colorado Film School mentors worked with LOCC students throughout the week as they explored environmental issues through research and filmmaking. Students split themselves into teams based on common interests. Morales’ team formed from a group of outdoors enthusiasts; all four team members shared a love for outdoor recreation like hiking, camping, and fishing.

With support from two graduate students, the team worked together to create a concept map and script for their film on the effects of climate change on recreational fishing. They interviewed Jeff Lukas, a researcher in CIRES’ Western Water Assessment program, and toured Colorado Parks and Wildlife’s Bellvue Watson Fish Hatchery to learn about sustainable fishing practices.

Over the course of the project, teachers and mentors observed their students expanding their horizons. “The project really demanded students to get out of their comfort zone,” a LOCC middle school teacher said. “They had to interview professionals and discuss with experts.” Patrick Chandler, a graduate student who supported the project, added, “The students quickly found a topic that they all truly cared about and were not afraid to bring their emotion and vulnerability into the film.”

To celebrate the students and their successful projects, the LOCC team held a public film screening attended by mentors, students, and community members. Film topics ranged from water quality in Flint, Michigan, to drought in the West. This program in Colorado was just the first stop for LOCC in 2018; afterward, the CIRES team traveled to Gunnison, Colorado, and Arecibo, Puerto Rico.

“LOCC is about giving middle and high school kids the tools to investigate climate change effects in their community and start dialogues about those effects,” said Erin Leckey, program manager of LOCC. “We hope that through making their films that kids learn to be change makers and build resilience for their communities.”



A Lens on Climate Change team films a segment on water in the West featuring an interview with Jeff Lukas, a scientist from the Cooperative Institute for Research in Environmental Sciences (CIRES). (Katie Weeman/CIRES)

FEATURED STORY //

Community mural inspires salmon conservation in Seattle

Pacific salmon fuel a \$3 billion industry, supporting tens of thousands of jobs. From grizzly bears to killer whales, at least 137 species depend on these important fishes. But their annual migrations between stream and ocean — sometimes more than 1,000 miles — place salmon in direct contact with human development.

In Thornton Creek, Seattle's biggest urban stream, salmon struggle for survival. The creek winds through a watershed that is home to more than 70,000 people. Untreated waste from camp sites, leaking side sewers, and runoff of polluted stormwater plague this waterway. In addition to water quality challenges, salmon are up against barriers from undersized culverts and large sections of stream that are piped underground.

[NOAA Fisheries West Coast Region](#) and the Pacific Northwest College of Art worked with artists and community groups to put a spotlight on salmon in Thornton Creek, encouraging urban salmon stewardship through the [Science in Studio](#) program. Through public art and community workshops, the program inspired Seattle residents to reduce urban runoff and protect endangered salmon while bringing vibrant artwork to an underserved neighborhood.

A 14-by-85-foot mural was installed at the Low Income Housing Institute's new family housing unit along the highly trafficked Lake City Way. This LEED-certified building features a solar array, resident gardens, and a preschool operated by the Refugee Women's Alliance. The mural was designed and painted by the Lake City Community Center, Lake City Young Leaders program, Lake City Seniors, and Lake City Future First.

The mural depicts a Chinook salmon and the many factors that influence its survival. Chinook salmon depend on snow pack, which produces the clean water that flows through mountains, rivers, bays, estuaries, and finally, to the ocean. The image shows these habitats interwoven with human activities, including those — like washing cars and fertilizing lawns — that bring toxics into waterways. "The salmon is a metaphor for the cycle of life in the Pacific Northwest. The overall picture is positive, but it also shows the consequences of our activities," explained the artist, Esteban Camacho Steffensen.

A diverse cross-section of the community came together to bring this mural to life. More than 30 community members from 22 different countries helped Steffensen localize the mural. Several intergenerational groups — including the Lake City Young Leaders, Sound Generations, and Lake City Seniors — brought their vision and talents to the bilingual design. Participants brainstormed positive and negative attributes of their community to incorporate into the mural and worked alongside Steffensen for three weeks as he painted.

To engage the broader community, NOAA Fisheries West Coast Region hosted a series of talks and informational booths at the unveiling of the new mural. Six talks highlighted the importance of stewardship, the relationship between art and science, and the power of community engagement. Eight community partners hosted booths to talk about local sustainability issues and ways that community members can get involved.

This mural is one of six installations throughout California, Oregon, and Washington. Each mural relies on community involvement and serves as a visible reminder of our connection to local watersheds and our cumulative effect on endangered species.

Artist Esteban Camacho Steffensen addresses community members during an event to celebrate Seattle's new salmon mural. (NOAA)



GOAL 3

Safety and Preparedness

Individuals and communities are informed and actively involved in decisions and actions that improve preparedness, response, and resilience to challenges and impacts of hazardous weather, changes in climate, and other environmental threats monitored by NOAA.



Aileen Devlin/Virginia Sea Grant

OVERVIEW //

In 2018, the United States experienced **14 disasters** that each resulted in damages of \$1 billion or more, including hailstorms, wildfires, and a major landfalling hurricane. After each event, communities have had to come together to rebuild lives, strengthen physical infrastructure, and improve policies — all of which depend on public engagement. NOAA Education programs not only help people improve their understanding of science, but also engage them in the process of keeping themselves, their families, and their communities safe.

OBJECTIVES

3.1. Youth and adults from all backgrounds are aware of, prepare for, and appropriately respond to environmental hazards that impact health, safety, and the economy in their communities.

3.2. Formal and informal educators use and produce education materials and programs that integrate and promote consistent science-based messaging on hazards, impacts, and societal challenges related to water, weather, and climate.

3.3. Formal and informal education institutions integrate water, weather, and climate hazard awareness, preparedness, and response information into curricula, exhibits, and programs that create learning opportunities for youth and adults.

GOAL HIGHLIGHTS //

Education programs respond as communities recover from disasters

NOAA educators and experts weather storms alongside their communities. Recovery brings change, and with that, the opportunity for creativity and innovation.

- ▶ Hurricane Irma blew trash and debris into much of the coastal environment near Naples and Marco Island in Florida. [Rookery Bay National Estuarine Research Reserve](#) teamed up with Red Bull to host a Henderson Creek cleanup. Nearly 100 stand-up paddlers, kayakers, and water enthusiasts from all over Florida joined forces to help remove and load more than 60 cubic yards of debris into dumpsters, restoring the creek's pristine beauty and making the shoreline safer for wildlife and recreation.
- ▶ How would you save your house from flooding? With support from the [Jacques Cousteau National Estuarine Research Reserve](#), New Jersey educators created an interactive game to help citizens learn about the environmental consequences of rising sea levels and what to do about it. In a short survey, 59% of participants indicated an increase in knowledge after playing the game, and 64% stated that they plan to adopt more sustainable behaviors.
- ▶ While the [Mokupāpapa Discovery Center](#) in Hilo, Hawaii, primarily connects visitors with the [Papahānaumokuākea Marine National Monument](#) in the remote and volcanically inactive Northwestern Hawaiian Islands, hazardous eruptions and lava flows from the Kilauea volcano in 2018 brought the focus closer to home. During this national disaster, Hawai'i Volcanoes National Park was forced to close for four months. National Park employees and visitors were hosted by the Discovery Center. Staff from both institutions collaborated on new outreach and engagement programs for environmental hazards. They also took the opportunity to improve understanding of the Hawaiian Islands — from their fiery beginnings on the seafloor to their eventual erosion into atolls and seamounts like those in the Papahānaumokuākea Marine National Monument. Since then, the Discovery Center has seen a 30% increase in visitation and offered 60% more programs, including providing 130 safety and volcanic activity eruption updates to residents and the general public.
- ▶ On October 29, 2012, Hurricane Sandy swept ashore, disrupting the lives of countless residents along the East Coast. Inflicting nearly \$70 billion in damage, it was the second-costliest hurricane on record in the United States at the time. To mark the fifth anniversary of Hurricane Sandy, [New Jersey Sea Grant](#) collaborated with Monmouth University and the Monmouth County Historical Association to create a public exhibition that explores the impact of Sandy and its effects on the people and communities of Monmouth County and the surrounding region. Staff participated in a crowdsourcing initiative launched in 2016 to compile the story of Hurricane Sandy. Outreach to the county's libraries, churches, schools, community centers, leaders, and citizens resulted in the donation of artifacts, photographs, videos, and the recording of oral histories. These materials were incorporated into the exhibit Tracking Sandy, which opened in October 2017.

OBJECTIVE 3.1

Youth and adults from all backgrounds are aware of, prepare for, and appropriately respond to environmental hazards that impact health, safety, and the economy in their communities.



When the Kilauea volcano eruption closed Hawai'i Volcanoes National Park for several months, the Mokupāpapa Discovery Center in Hilo, Hawaii, took in the national park's staff and visitors. (U.S. Geological Survey Hawaiian Volcano Observatory)

GOAL HIGHLIGHTS //

- ▶ In the wake of Hurricane Irma, [Florida Keys National Marine Sanctuary](#) developed an education program called *Goal: Clean Seas Florida Keys* to train and permit scuba diving operators and other businesses to remove submerged marine debris. The Florida Keys National Marine Sanctuary advisory council's Marine Debris Working Group developed protocols to guide skilled divers in proper marine debris removal and reporting techniques. Sanctuary staff trained 48 dive professionals who have removed approximately 4,600 pounds of submerged marine debris and over 4,000 feet of derelict trap line from sanctuary waters. Additionally, sanctuary staff worked with volunteers and local kayak operators to lead monthly land-based cleanups, removing an additional 5,400 pounds of debris from local mangroves and beaches.



After Hurricane Irma, divers removed derelict fishing and trap line from the Florida Keys National Marine Sanctuary. (John W. Nussbaum)

NOAA cultivates resilience through green infrastructure education

Green infrastructure uses vegetation, soil, and other features to restore natural processes like infiltration and stabilization to manage water in urban and suburban settings. NOAA Education helps community members understand and implement green infrastructure alternatives to make their homes and cities more resilient to runoff, flooding, and storm surge.

- ▶ With funding from the [Bay Watershed Education and Training \(B-WET\)](#) program, the Groundswell Program in Grand Rapids, Michigan, taught educators and students about coastal adaptation to climate change. Students and teachers participated in field trips to implement green infrastructure solutions, such as planting native dune plants and removing invasive species, and saw examples of living coastlines managed by working professionals. This project increased students' awareness about climate change while introducing them to green infrastructure as an important component of the coastal adaptation process.
- ▶ The [Waquoit Bay National Estuarine Research Reserve](#) hosted two Landscaping for Resilience workshops. Russell Norton, an agriculture and horticulture educator with the Cape Cod Extension, spoke "All about trees." This workshop focused on assessing people's yards for hazards, handling tree damage, and finding tree professionals to do work beyond the skills of the homeowner. Kristin Andres with the Association to Preserve Cape Cod presented, "Wrangling rainwater on the homestead and other landscaping choices for a changing climate," which focused on managing stormwater to avoid property damage and protect water quality.

OBJECTIVE 3.1

Youth and adults from all backgrounds are aware of, prepare for, and appropriately respond to environmental hazards that impact health, safety, and the economy in their communities.

GOAL HIGHLIGHTS //

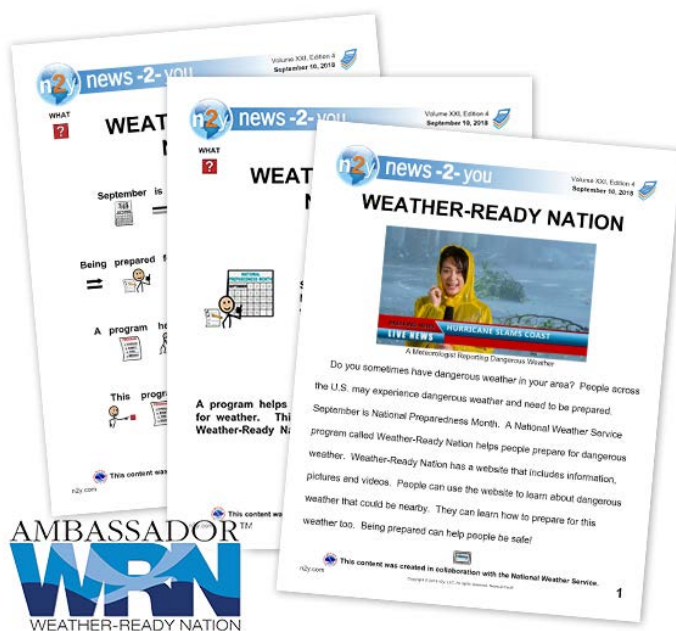
Outreach prepares communities for safety hazards

Community preparation involves developing relationships between educators, forecasters, emergency managers, and people of all backgrounds. Through resilience education, it is important to reach underserved audiences who may be disproportionately at risk to environmental hazards.

- ▶ The [National Weather Service](#) partnered with News-2-You, a [Weather-Ready Nation Ambassador](#), to develop [weather safety materials](#) for people with intellectual disabilities. News-2-You distributed supplemental newspapers, symbol-based communication tools, games, and other materials that were developed to suit people of different abilities. News-2-You also trained teachers to use these tools with their students. By working with News-2-You, NWS is now able to better serve an audience that the organization had not traditionally been able to reach, taking an important step toward their goal of making weather safety materials accessible to everyone.
- ▶ The NWS [Weather Forecast Office in Pocatello, Idaho](#), attended two water festivals in FY 2018. NWS staff educated approximately 250 students about flooding using a watershed model. Participants placed a small house or car in this model and then ran water through it to simulate flooding. Students were taught the importance of flood-plains and “turn around, don’t drown” safety messages.
- ▶ The [Joint Polar Satellite System](#) (JPSS) program collaborated with NASA to educate students and interns about the role that Earth-observing satellites play in weather safety and preparedness. JPSS participated at the Flight Projects Directorate Intern Showcase at Goddard Space Flight Center in Greenbelt, Maryland, to help students improve preparedness, response, and resilience to weather and climate hazards. The program taught students how NOAA satellites provide a continuous stream of global weather data to support accurate weather prediction and how they can contribute to a Weather-Ready Nation.

OBJECTIVE 3.1

Youth and adults from all backgrounds are aware of, prepare for, and appropriately respond to environmental hazards that impact health, safety, and the economy in their communities.



The National Weather Service partnered with News-2-You to develop safety and preparedness resources for people with intellectual disabilities. (National Weather Service, News-2-You)

GOAL HIGHLIGHTS //

Educators improve their understanding of safety and resilience

NOAA works with educators to help them teach their students about the science behind environmental hazards. When students learn about these risks, they not only become more informed and inspired, but safer as well.

- ▶ The [National Weather Service \(NWS\) Flagstaff, Arizona, Weather Forecast Office](#) hosted educators participating in a NOAA Planet Stewards workshop, “The changing Southwest environment: Trends and challenges.” This professional development event was a joint effort between the [NOAA Planet Stewards Education Program](#), Flagstaff Unified School District, and Flagstaff STEM City. The workshop targeted local elementary through high school educators, helping them gain a deeper understanding of Southwestern environmental issues, such as extreme weather, fire, drought, flooding, and ecosystem dynamics. The 30 participants were given tours of forecasting operations and participated in a weather balloon launch. After the workshop, one educator said, “I live in a very rural area. It’s wonderful to meet and interact with so many experts, as I don’t have access to these folks on a regular basis. I look forward to staying in contact with them.”
- ▶ NOAA’s [Flower Garden Banks National Marine Sanctuary](#) hosted a NOAA Planet Stewards educator workshop on climate change and ocean acidification. In partnership with Artist Boat, a local non-profit organization, the event provided educators with the necessary knowledge and skills to feel confident about including these topics in their curricula. During the four-day workshop, 48 educators participated in a combination of classroom and field work focusing on various aspects of climate change. Conducting water quality monitoring and examining vegetation helped the educators understand climate change indicators. Participants visited the local National Weather Service forecast office, the Coastal Heritage Preserve, and the Port of Houston to learn more about the impacts of climate change.
- ▶ In response to increased demand from many schools and organizations for visits from [National Weather Service](#) forecasters, a group of meteorologists turned to technology to help them connect with more people than they could reach in person. The School Outreach via Video team, a group of 41 forecasters from 33 different offices across the country, reaches out to schools through video chat (on Google Hangouts or Skype) to teach students about the weather in the United States and around the world. In the last year, the team offered over 75 presentations, reaching over 3,000 students. This effort also reached schools in Mexico and Great Britain.

OBJECTIVE 3.2

Formal and informal educators use and produce education materials and programs that integrate and promote consistent science-based messaging on hazards, impacts, and societal challenges related to water, weather, and climate.



NWS Flagstaff Meteorologist-in-Charge Brian Klimowski prepares a radiosonde for a weather balloon launch during a workshop for educators. (NOAA)

Third-grade students from Illinois ask National Weather Service forecaster Tim Brice their weather questions during a video call. (Joni Harris/NOAA)



GOAL HIGHLIGHTS //

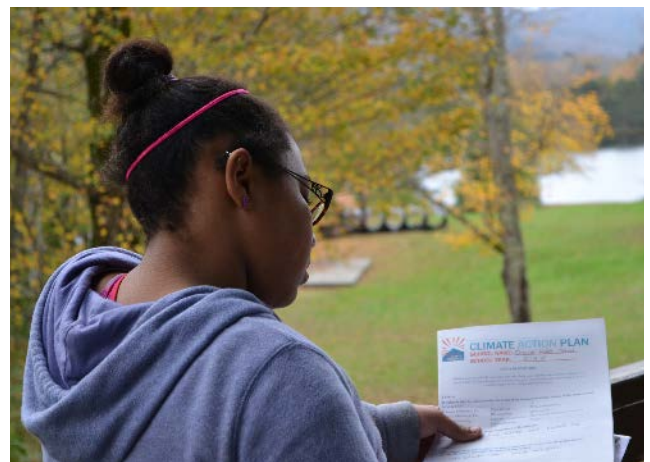
NOAA fosters community resilience through creative partnerships

Emergency management depends on effective partnerships. These relationships are established and maintained through year-round connections with community organizations, and education is an important piece of the puzzle.

- ▶ The [Climate Program Office Communication, Education, and Engagement Division](#) partnered with The Wild Center, a [NOAA Environmental Literacy Program](#) grantee, to educate and inspire people to use climate science and resources to increase community resilience to climate impacts. The Wild Center's Youth Climate Summit supported local students by providing guidance on how their communities can plan for climate action through students' educational campaigns. The campaigns also expanded New York's Climate Smart Communities program. These new program models will serve other communities by being highlighted in the U.S. Climate Resilience Toolkit and [Climate.gov](#) portal.
- ▶ How can education support climate action? Accelerating Climate Action: A Workshop for Community, Business, and Education Leaders brought the [NOAA Climate Program Office](#) together with cross-sector leaders to discuss challenges to community climate plans and actions. Collaborators explored how educational leaders could support community climate actions through engaging youth, partnering with museums and science centers, and preparing communities for clean energy jobs. Future collaborations will help communities build capacity at multiple levels, connecting local communities with businesses, nongovernmental organizations, and universities to implement climate actions.
- ▶ The [Environmental Literacy Program](#) provided federal funding and in-kind support to 22 grantees to build the foundations necessary to become more resilient to weather- and climate-related events. Grantees will use NOAA data and expertise to lead educational activities to increase awareness, knowledge, and understanding of these events and their implications. The program created a community of practice to capture and share best practices, lessons learned, and resources among past and current grantees. In collaboration with the community of practitioners, the program also promoted resilience education efforts at national conferences. Together, the Environmental Literacy Program and their partners have empowered people to understand and use NOAA-related science to create informed, safe, and actively prepared communities.
- ▶ Califa, a 2015 [Environmental Literacy Program](#) grantee, completed a 2.5-year project to integrate NOAA climate resilience toolkit assets and other resources into book clubs at local libraries, introducing adults to topics they otherwise might not explore. Forty-three libraries completed three book clubs each. Summative evaluation findings indicated that a majority of attendees had increased concern about climate threats and their community's resilience planning, had greater intentions to act individually or collectively to build climate resilience in their communities, and were more knowledgeable about climate and adaptation planning. Librarians reported gains of 70% or more in awareness, and three-quarters of them planned future climate-related events or activities beyond the Public Libraries Advancing Community Engagement (PLACE) book clubs.

OBJECTIVE 3.3

Formal and informal education institutions integrate water, weather, and climate hazard awareness, preparedness, and response information into curricula, exhibits, and programs that create learning opportunities for youth and adults.



A student working with the Wild Center reviews a climate action plan as part of a program supported by an Environmental Literacy Program grant. (Erin Griffin/The Wild Center)

FEATURED STORY //

Montana forecasters become partners in preparedness with Assiniboine and Sioux tribal elders

Montana has one of the most extreme climates in the country, with [record-breaking temperature swings](#) of more than 100 degrees Fahrenheit over the course of a single day. In February of 2018, a blizzard sent three Indian reservations and two counties into a state of emergency. [Twenty-foot snow drifts](#) pushed up against house doors, [blocking those inside](#) from reaching food, water, and vital medical services. Although the Fort Peck Indian Reservation in northeastern Montana was not one of the areas hit by this disaster, elders from the Assiniboine and Sioux tribes worry that extreme winter weather could threaten their own reservation in the future.

Throughout 2018, the National Weather Service's [Weather Forecast Office \(WFO\) in Glasgow, Montana](#), worked collaboratively with the Fort Peck tribal elders to help prepare their community for extreme weather and spark interest in meteorology among the younger generation. This collaboration is the result of several years of work establishing mutual trust and respect between the WFO and the reservation's Tribal Elders Program.

Patrick Gilchrist, Glasgow WFO's Warning Coordination Meteorologist, worked alongside the tribal emergency manager to increase the resiliency of the Fort Peck Indian Reservation to weather hazards. The WFO collaborated with the tribal elders to create extreme weather strategies, designing tornado and severe weather preparedness plans for the community. The Fort Peck Reservation established an emergency operations center, developed a system to monitor local weather conditions, and created a way to communicate weather information with their community, becoming the second [NWS Storm-Ready](#)® tribal nation in the country.

To provide older members of the community with at-home hazard warnings, the office also distributed 60 NOAA Weather Radios. "The NWS recognizes the vulnerability some of the tribal elders have, especially those living in more rural parts of the Fort Peck Reservation, and are proud to support efforts to keep those elders safe," said Gilchrist.

In addition to serving the elders within the reservation, Glasgow WFO also reached out to its youth. During the annual Tribal Earth Day celebration, hundreds of students from reservation schools interacted with NOAA scientists to learn the math and physics behind local weather hazards as well as how to prepare for these events. Through learning about these meteorological phenomena, the students began to see how their academic subjects could be used in real-world careers.

After many years working with tribal leaders to understand how to effectively serve the community's youth and adults, the Glasgow WFO has become the reservation's partner in preparedness, a trusted source of information to be approached when the need arises. With this partnership, the Fort Peck Reservation stands better prepared for whatever conditions the Montana weather might send its way.



The Weather Forecast Office in Glasgow, Montana, gave 60 NOAA Weather Radios to the tribal elders of the Fort Peck Indian Reservation. (Patrick Gilchrist/NOAA)

FEATURED STORY //

Science and education partners reveal the hottest places in Washington, D.C., and Baltimore

August 21 through 23 were three of the hottest days of summer 2018 in the mid-Atlantic. Heat shimmered above the pavement, children sought refuge in public spray parks, and commuters hurried between air-conditioned trains and offices. At the same time, a corps of citizen scientists took to the streets of Washington, D.C., and Baltimore, Maryland, with temperature sensors mounted on their cars and bicycles. Taking measurements every second, they set out to map their cities' hottest places.

The goal was to produce highly detailed maps of "urban heat islands," areas within cities that can run 10 to 20 degrees hotter than other areas. Unshaded roads and buildings absorb more heat during the day and radiate that heat back into the surrounding air, significantly increasing the local air temperature relative to greener or shaded areas. On days when local temperatures climb above 95 degrees Fahrenheit, the additional heat emitted by paved and concrete structures can produce dangerously hot conditions in certain neighborhoods.

Building on work funded in part by NOAA's [Environmental Literacy Program](#), the [Climate Program Office](#) partnered with the Science Museum of Virginia in Richmond and Portland State University in Oregon to identify these cities' heat islands. Volunteers drove three one-hour sessions throughout the day, recording air temperature on prescribed routes. Together, they collected over 75,000 temperature measurements from across each city.

Scientists at Portland State University processed the data and released detailed temperature maps of Washington and Baltimore. "The citizen scientists did a remarkable job at collecting data across both cities," said Vivek Shandas, professor of urban studies and planning at Portland State University. "They provide one of the highest-resolution descriptions of ambient temperatures for Baltimore and Washington." The team observed temperature differences of around 16.5 degrees in Washington and 17 degrees in Baltimore between the cities' hottest and coolest places at the same time of day. While some areas were 85 degrees, other neighborhoods soared to 103 degrees.

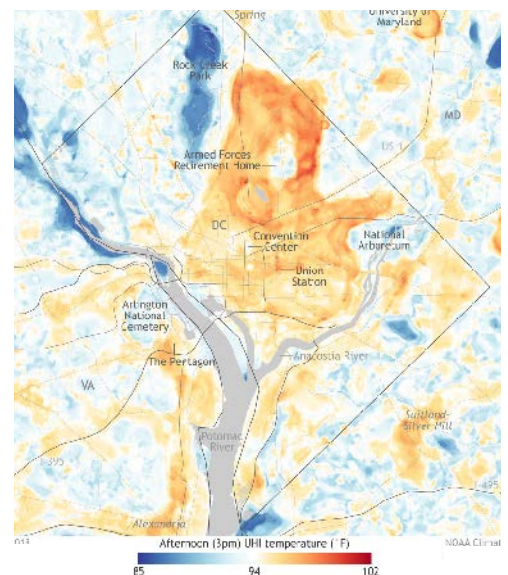
These maps don't just show temperature; they can also be roadmaps for change. The information allows city planners, nonprofits, and community organizations to prioritize the heat islands for public health intervention, green infrastructure projects, and environmental monitoring. Government officials from both Washington and Baltimore expressed interest in using these maps in their long-term climate resilience planning. Project participants were eager to take the next step by reaching out to vulnerable neighborhoods to help residents develop tailored adaptation plans.

NOAA and its partners plan to develop an off-the-shelf, ready-made template to help other cities to affordably conduct their own urban heat island mapping campaigns. This collaboration demonstrates that diverse teams can quickly generate valuable and low-cost urban heat island maps by engaging community and education partners to build climate resilience.



Vivek Shandas, professor of urban studies and planning at Portland State University, demonstrates how to install a temperature sensor on a car for the urban heat island mapping campaign. (Frank Niepold/NOAA)

In Washington, D.C., the warmest and coolest places differed by 16.5 degrees Fahrenheit. Urban heat islands are visible in red. (NOAA, Portland State University, Science Museum of Virginia)



FEATURED STORY //

Texas educators shadow meteorologists to help their students take on weather preparedness

On a hot day in June, four Texas teachers arrived at [Midland's National Weather Service Forecast Office](#) (WFO), ready to be students for the next three days. These educators — representing a K-10 charter school called the University of Texas Permian Basin STEM Academy — were preparing to carry out a promising new STEM curriculum centered around a three-week-long project. In search of ways to better guide students through their projects, they had come to the National Weather Service to see meteorology in action.

Texas Teacher Externships (TEX2), a grant-funded program out of the University of Texas in Austin, was designed to prepare teachers to guide their students through a three-week project. This in-depth, interdisciplinary project would require students to assume the roles of STEM professionals, and their teachers needed to get ready to guide them along the way. In just a few days, teachers from the academy learned about every aspect of WFO operations to help with the meteorology component of the students' projects. WFO Midland staff and the teachers discussed the mission of the National Weather Service with particular emphasis on the types of interdisciplinary questions that the students would address. These topics included severe weather operations, local fire weather, and the social science of weather safety and preparedness.

After three days, the teachers were informed and energized to put their newfound knowledge to work. "I had no idea what all your job entails," said Alisha Pierce, one of the TEX2 teachers. Fellow TEX2 educator Crystal Mineo added, "We had a blast with you guys and learned great information to bring back to our students."

The TEX2 teachers decided to develop projects for their students that centered on the question, "What could you do to help your community prepare for a natural disaster?" Students would study natural disasters, including tornadoes, hurricanes, floods, and wildfires. Working in groups of four, they would take on the roles of historian, meteorologist, geographer, and sociologist to investigate their particular hazard. Students would interview a natural disaster survivor, and finally, develop safety preparedness brochures for their community.

Amber Hluchan, meteorologist at WFO Midland, was enthusiastic about their approach. "I was such a weather nerd in high school, still am! I would have loved to do a project like this," she said. Hluchan could see the value of this project and its connection to her own work. "From a NWS employee perspective, I have such a passion for our mission to save lives, and a big part of that is to educate about weather threats and safety," she explained. "I think it's really great that these teachers took this very important role that we play and incorporated it in the project by having the students create a safety preparedness brochure."

With the assistance of WFO Midland staff, the teachers left their externship prepared to bring meteorology into the curriculum. This effort will continue on an annual basis, maintaining the connection between teachers, students, and weather forecasters.



During a workshop, electronics systems analyst Charles Yaws and electronics technicians Kris Harrison and Danny Reed at the Weather Forecast Office in Midland, Texas, show teachers around a local automated surface observing station. (NOAA)

FEATURED STORY //

Maine's coastal communities use NOAA data to prepare for sea level rise

In July, over 60 residents of Cumberland County, Maine, packed into a room in the local Cliff Island Post Office. There, the Gulf of Maine Research Institute (GMRI) led them through an exploration of Maine's climate past, using it as an entry point to help the residents better understand their state's climate present and future.

Most people in Maine, including the attendees of this event, live along the Gulf of Maine, where [coastal waters have warmed](#) more than anywhere else in the United States. This warming water and the ensuing sea level rise contribute to severe storms and [king tides](#) (the highest high tides of the year) that hurt the community's residents, industries, and ecosystems.

To help Maine residents understand and prepare for these threats, GMRI sought out assistance from NOAA's [Environmental Literacy Program](#) (ELP), which supports the use of education as a tool to help people and their communities become more resilient to extreme weather and climate events. Through an ELP grant, GMRI created an interactive learning experience called "Preparing coastal communities for sea level rise." This program integrated NOAA data into story maps — interactive digital tools that combine geographic data and narrative — to engage people in understanding sea level rise, its causes, its future projections, and its impacts on local communities.

In the Cliff Island Post Office, residents used this information to investigate how past weather events had impacted their community. They pulled up data on a Nor'easter known as the Patriots Day Storm of 2007, which caused a 2.7-foot storm surge and 13.3-foot storm tide that flooded their coastline. They then looked at current sea level rise data to identify areas of local risk and prepare to be more resilient against similar threats moving forward. By encouraging residents to evaluate the resiliency of their own communities, GMRI empowered individuals to take an active approach to creating an informed and prepared community.

Over the course of the project, GMRI worked with more than 1,200 Mainers to improve their awareness, knowledge, and understanding of sea level rise and its implications for Maine's coastal communities. In addition, both of GMRI's municipal partners — Portland and South Portland — decided to use GMRI's mapping tools to develop resilience plans that would [reduce greenhouse gas emissions](#) by 80% by 2050. The new plans will lead local departments to reduce their carbon footprints in residential, commercial, and industrial sectors.

"We all need to be involved, in every sector of [our communities]," said Troy Moon, Portland's sustainability coordinator. "We need everyone at the table to figure out how [to make our cities more resilient as the climate changes]." Thanks to GMRI and NOAA's Environmental Literacy Program, more Maine residents now have a seat at the resiliency planning table.



With funding from the Environmental Literacy Program, the Gulf of Maine Research Institute created an interactive learning experience called "Preparing coastal communities for sea level rise." This program integrated NOAA data into interactive story maps to engage people in understanding sea level rise. (Gulf of Maine Research Institute)

FEATURED STORY //

Neighborhoods of the future: Students design solutions for communities prone to flooding

In the Hampton Roads region of Virginia, which deals with the highest rate of sea level rise along the East Coast, residents worry constantly about recurrent flooding — especially after heavy storms or during high tide.

Ashley Montgomery is working to change that. An architecture student at Hampton University and the inaugural Future Resilience Leader with [Virginia Sea Grant](#), Montgomery is a student leader in the Coastal Community Design Collaborative (CCDC). Virginia Sea Grant's Future Resilience Leader Award goes to a graduate student at Hampton University in a resilience-related field — in Montgomery's case, a concentration in adaptation to sea level rise.

The Future Resilience Leader Award allowed Montgomery to work with the program's faculty leaders to further develop the CCDC program. This group of student architects, engineers, and marine biologists works across disciplines to develop innovative designs that help Hampton Roads neighborhoods deal with flooding. During the 2017-2018 school year, the CCDC partnered with the neighborhood of Huntersville to brainstorm new solutions for recurrent flooding.

The residents involved in the project provided the collaborative with information about where flooding typically happens within their neighborhood — information not usually available at that fine of a scale — and brought up other planning-related concerns. The interdisciplinary CCDC team members then used their complementary skill sets to develop ways to address these issues.

"We believe firmly that no one has all the answers, so we spend a lot of time relying on our friends with knowledge in one area or another," says Mason Andrews, an associate professor of architecture at Hampton University and faculty co-leader of the CCDC. "The more voices [that] get heard, the better the results."

For Huntersville, the result was a suite of proposed solutions, each one tailored to a specific location and its needs. "We developed different innovations for handling water storage within each and every block," says Montgomery.

In one area, the team created a plan to convert vacant lots into greenways that could absorb floodwater. In another, they developed the blueprints for an urban farm building that collects rainwater to irrigate the crops it houses, which in turn provide the neighborhood with fresh produce. In an area where residents expressed concern about high-speed traffic, the CCDC worked that problem into their flood adaptation design.

"We developed a really nifty idea of an inverse speed bump," Montgomery explains. "Instead of going over, it goes under, so it can store water at the same time that it helps to slow down traffic."

Huntersville is the fifth neighborhood the CCDC has worked with since the collaborative's inception in 2012. Even though not all proposed designs have been constructed, the collaborative sparks out-of-the-box ideas that might not otherwise come up in discussions with city officials. With support from Virginia Sea Grant, CCDC students and professionals work alongside coastal communities to increase resilience to flooding.



Ashley Montgomery is an architecture student and a Virginia Sea Grant Future Resilience Leader. She is one of the leaders of the Coastal Community Design Collaborative, a group of student architects, engineers, and marine biologists that develop innovative designs to help Virginia's Hampton Roads neighborhoods deal with flooding. (Aileen Devlin/Virginia Sea Grant)

GOAL 4

Future Workforce

A diverse and highly skilled future workforce pursues careers in disciplines that support NOAA's mission.



Carina Fish, Dr. Nancy Foster Scholar

OVERVIEW //

When NOAA's workforce mirrors the composition of the communities we serve, we can better carry out our mission. NOAA Education inspires the marine biologists, meteorologists, and educators of tomorrow, introducing young students to NOAA careers and preparing emerging professionals for the workforce.

OBJECTIVES

- 4.1. Students, particularly from underrepresented groups, consider education and career pathways in disciplines that support NOAA's mission.
- 4.2. NOAA and partner institutions leverage federally funded assets to provide students, particularly those from underrepresented groups, with experiential learning, research, and scholarship opportunities.
- 4.3. Postsecondary students, particularly from underrepresented groups, pursue and complete degrees in disciplines critical to NOAA's mission.
- 4.4. Graduates completing NOAA-supported student opportunities continue education, enter the workforce, and advance in careers that support NOAA's mission.

GOAL HIGHLIGHTS //

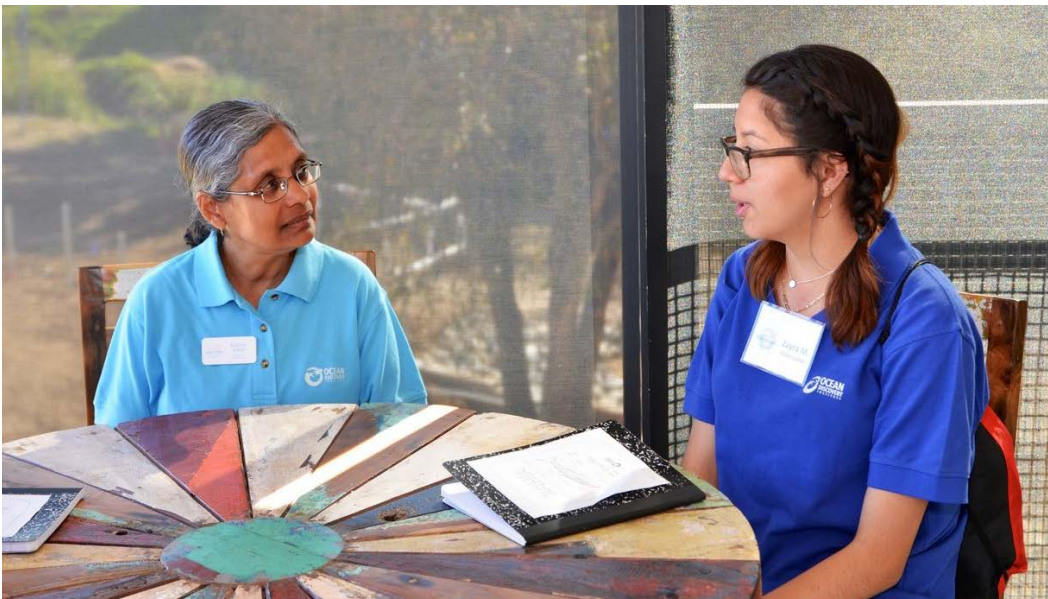
NOAA scientists serve as role models to engage students in STEM

Our experts range from fisheries biologists to satellite technicians, and we need the next generation interested and prepared to join our workforce. NOAA scientists and educators help students explore careers while breaking down misconceptions about who can be — and become — a scientist.

- ▶ Outreach and research staff from [NOAA offices in Boulder, Colorado](#), supported the annual Women in STEM Conference at the University of Wyoming in Laramie. Over 600 young women in grades seven through 12 attended from across the state. NOAA scientists presented three sessions on air pollution and another three on remote sensing. Participants went home with new information about STEM careers and the knowledge and inspiration that women like them are doing those jobs.
- ▶ NOAA's partnership with the [Ocean Discovery Institute](#) (ODI) continued with the completion of ODI's Living Lab. This state-of-the-art facility allows the institute to expand its successful programming and establish the nonprofit as a permanent fixture in San Diego's low-income City Heights neighborhood. Dr. Jasmin John, a scientist at NOAA's [Geophysical Fluid Dynamics Lab](#), became the first scientist-in-residence in the new facility. John shared her experiences as a scientist with students and connected with them over personal and professional experiences. With one successful scientist-in-residence under their belts, ODI plans to continue working with more NOAA scientists in the Living Lab.

OBJECTIVE 4.1

Students, particularly from underrepresented groups, consider education and career pathways in disciplines that support NOAA's mission.



Jasmin John, a physical scientist with NOAA's Geophysical Fluid Dynamics Laboratory, became the first scientist-in-residence at the Ocean Discovery Institute in City Heights, San Diego. "After a presentation I gave to the students, one of the young ladies came up to me," John recalls. "The young lady said, 'To see a woman of color like you giving a talk, being a mentor, and being a scientist is so inspiring.' Those are the moments where you know you're doing good just by doing what you're doing and being who you are." (Ocean Discovery Institute)

- ▶ The [Center for Satellite Applications and Research](#) (STAR) participated at the 2018 Cooperative Research Program Symposium at the University of Wisconsin–Madison, where the theme was, "Turning NOAA science into information for societal benefit." Students, researchers, and professors from the STAR cooperative institutes listened to talks and reviewed posters presented by students and recent graduates. The symposium also included a panel presentation on career paths from current and former

GOAL HIGHLIGHTS //

students, a session on communicating more effectively with peers and the general public, and training on using satellite data.

- ▶ **NOAA Pacific Region Outreach Group**, a team of employees from across five NOAA line offices, developed an outreach booth to bring to events throughout the Pacific. With a focus on careers, the new activities and props allow youth to see themselves working at NOAA. Staff highlight jobs that emphasize NOAA's diverse workforce and the issues they are tackling, including protecting the ocean, studying weather, and building resiliency across the Pacific Islands. At the booth, staff use artifacts to spark conversations about problem solving, working in extreme environments, and collaborating with a wide variety of people and organizations.
- ▶ **Teacher at Sea** alumni bring more than science back to the classroom; teachers also use their experiences at sea to illustrate STEM careers for their students. Trevor Hance, who sailed on the [R/V Hugh R. Sharp](#) in 2015, invited NOAA scientist Lisa Jones to his school in Texas to talk to students about sharks. Iowa teacher Chris Murdock sailed on the [NOAA Ship Oregon II](#) in 2017 and brought NOAA Fisheries scientist Andre DeBose to his school to talk to students about his career as a fisheries biologist.
- ▶ The **Southwest Fisheries Science Center** (SWFSC) and other NOAA offices hosted science and career development symposia, judged research presentations and posters, and mentored the next generation of scientists at the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) Conference in October 2017 in Salt Lake City, Utah. The sessions were attended by about 100 students. SWFSC developed marine science symposia to create a pipeline for SACNAS students. Over the 12-year period that they have been attending SACNAS conferences, NOAA staff have reached over 1,000 students, many of whom have gone on to internships or graduate student positions affiliated with NOAA.

NOAA Southeast Fisheries Science Center fisheries biologist Andre DeBose (front right) met with Teacher at Sea alum Chris Murdock's (front left) high school biology students. (Chris Murdock/NOAA Teacher at Sea)



- ▶ NOAA's **Diversity and Professional Advancement Working Group** (DPAWG) coordinated four STEM outreach events with Parkland Magnet Middle School for Aerospace Technology in Montgomery County, Maryland. The events included hands-on science exercises, career exploration, and a field trip to a NOAA site where students launched a weather balloon. DPAWG members reached 350 middle school students and connected Parkland's STEM faculty to NOAA's education tools and data to support their curriculum.

GOAL HIGHLIGHTS //

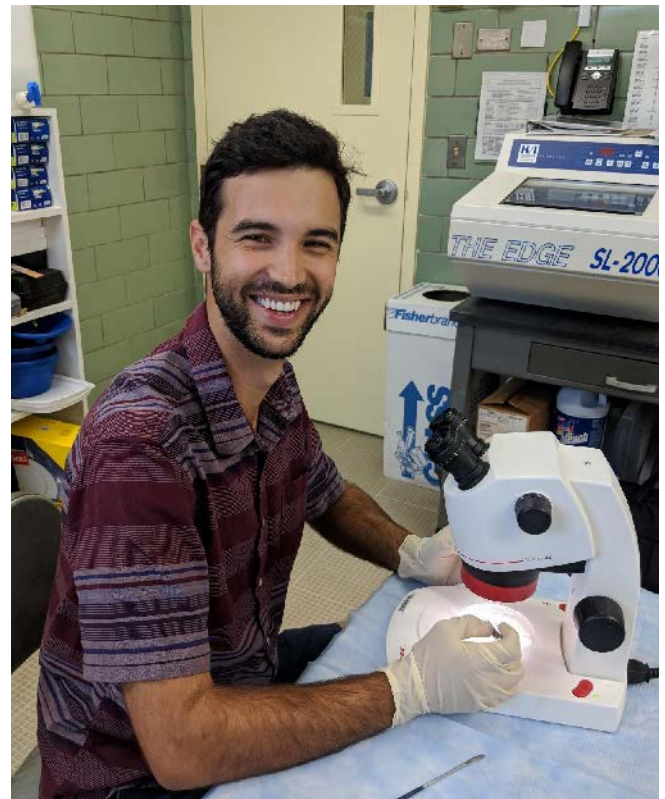
Partners and programs advance early-career learning and research

NOAA and its partners prepare students to compete in tomorrow's job market. By spending a week in coding camp or a summer in a NOAA lab, students gain real-world skills while being immersed in cutting-edge science.

- ▶ [NOAA Educational Partnership Program with Minority Serving Institutions \(EPP/MSI\) Cooperative Science Centers](#) created a new requirement for all graduate students to complete a [NOAA Experiential Research and Training Opportunities](#) internship. In its inaugural year, 46 students completed a 12-week internship at a NOAA office or laboratory. When students are engaged early through hands-on opportunities like internships, they become more competitive applicants when entering the workforce.
- ▶ To succeed in the scientific community, students need to learn to network with professionals, present research, and write scientifically. The [EPP/MSI](#) and [Ernest F. Hollings Scholarship](#) programs supported 103 undergraduate scholar presentations at conferences.
- ▶ The [National Water Center](#) works with the National Science Foundation to host a summer institute where scientists of different ages and backgrounds collaborate to improve water-related products and decision-support services. In 2018, a student from the [EPP/MSI Center for Coastal and Marine Ecosystems](#) was selected to participate in a unique internship program at the summer institute in Tuscaloosa, Alabama. Elizabeth Del Rosario, a Ph.D. student at Texas A&M, used her research to explore how citizen science data might be able to feed into the National Water Model to more accurately predict flooding.
- ▶ The Vice Admiral Conrad C. Lautenbacher Public Service Graduate Scholarship, funded by the [NOAA Center for Earth System Sciences and Remote Sensing Technologies \(CESSRST\)](#), provides financial support for an EPP/MSI [Cooperative Science Center](#) master's or doctoral student in NOAA-related fields at CESSRST. In FY 2018, the scholarship was awarded to doctoral student Stephen Escarzaga, who has spent the last three summers in northern Alaska engaged in research on arctic coastal erosion while also conducting outreach and education activities with indigenous Alaskan communities in the coastal village of Utqiagvik (formerly Barrow), Alaska.
- ▶ [EPP/MSI](#) supported the Scott B. Gudes Public Service Scholarship, funded by the [NOAA Living Marine Resources Cooperative Science Center](#). This scholarship was awarded in 2017 to Stephanie Martinez-Rivera, a Ph.D. student studying fisheries management, ecology, and population dynamics of crustaceans. The scholarship enabled her to conduct outreach with fishing communities on the Eastern Shore of Maryland and distribute educational materials in English and Spanish. "It was very gratifying to see the excitement and interest of the students, particularly young girls, to science concepts and to learn about professional career opportunities in marine sciences," she said.

OBJECTIVE 4.2

NOAA and partner institutions leverage federally funded assets to provide students, particularly those from underrepresented groups, with experiential learning, research, and scholarship opportunities.



Brian Galvez, a NOAA Living Marine Resources Cooperative Science Center graduate intern, completed his NOAA Experiential Research and Training Opportunity with Dr. Howard Townsend at the Cooperative Oxford Laboratory in Maryland. (NOAA)

GOAL HIGHLIGHTS //

- ▶ NOAA's [National Centers for Environmental Information](#) (NCEI) participated in the Google Summer of Code, a three-month experiential learning program for open-source software development. Students advanced their programming skills while developing a mentor-mentee relationship with a scientist. NCEI worked remotely with a student at the Indian Institute of Technology in Mumbai, India, and sponsored a project through the Earth Science Information Partnership to develop a scalable, accessible hydrological toolset library in Python, a high-level programming language.
- ▶ [NCEI](#) developed a climate science mentorship program with Tesla STEM High School in Redmond, Washington. One of the students, Aashna Sheth, developed a virtual mentor-mentee relationship with Dr. Jim Kossin and gained a firm understanding of hurricane intensity and scientific methods. Her project, "The application of microwave satellite data to statistical hurricane intensity prediction scheme," won accolades and acknowledgments from the American Meteorological Society, U.S. Office of Naval Research, the Association of American Geoscientists, Sigma Chi, and Alpha Mu.
- ▶ The [National Weather Service](#) (NWS) worked with the University of Kansas to create the [Student Career On-Site Training](#) (SCOuT) program. This unique university partnership program brings students to weather forecast offices to experience diverse meteorological careers and learn about basic operations, computer systems, and other everyday activities. Students work with a mentor to explore options and select which offices they would like to better understand. Students may visit up to six offices and receive a certificate after completing the SCOuT program.
- ▶ As the ocean absorbs the increasing levels of carbon dioxide in the atmosphere, its water becomes more acidic. This change in pH threatens marine life, including economically important species like oysters and blue crabs. The mid-Atlantic [Sea Grant Programs](#) partnered with NOAA's [Ocean Acidification Program](#) to offer a new [Ocean Acidification Graduate Research Fellowship](#) program for the 2018 and 2019 academic years for students in Delaware, Maryland, New Jersey, New York, and Virginia. The goal of the program is to develop researchers who are ready to help the region to respond to ocean acidification. Fellows focus on science, policy, and outreach.
- ▶ Student volunteers at [NWS](#) forecast offices can learn directly from meteorologists and observe forecast operations first-hand. In FY 2018, NWS hosted nearly 200 student volunteers across 70 different offices around the country. Volunteers included 16 high school students, 119 undergraduate students including eight [Hollings](#) undergraduate scholars, 28 graduate students including nine [Pathways](#) students, and 16 others.
- ▶ [EPP/MSI Cooperative Science Center](#) students were accepted for competitive internships to participate in research on board the [NOAA Ship Okeanos Explorer](#) and the Ocean Exploration Trust Exploration Vessel (E/V) *Nautilus*. Undergraduate Harrison Watson from Jackson State University was selected for an onshore experience in the *Okeanos Explorers-in-Training Program* where he honed his mapping and GIS skills using data collected from seafloor mapping expeditions. Ph.D. fellow Stephen Escarza was selected as a *E/V Nautilus* seafloor mapping intern where he participated on a mission to map the Clarion-Clipperton Fracture Zone from San Francisco to Honolulu.



Hollings scholar Caitlin Ford analyzed the Short Range Ensemble Forecast Dry Thunderstorm Probabilistic Model Guidance during her internship with the National Weather Service (NWS) at the National Weather Center in Norman, Oklahoma. (NOAA)

GOAL HIGHLIGHTS //

NOAA scholarships recruit more diverse applicants

NOAA scholarship programs work to further diversify applicant pools through targeted outreach and improvements to the application process.

- ▶ The Deepwater Horizon oil spill damaged habitats in the Gulf of Mexico, impacting fisheries and economies. The [GulfCorps Program](#) was created to establish a new cohort of environmental professionals with the skills to address these challenges. Florida A&M University (FAMU) and [NOAA Fisheries Office of Habitat Conservation](#), with support from [NOAA Office of Education](#), are helping GulfCorps alumni take the next step in the workforce pipeline. This partnership will provide two scholarships each year to GulfCorps graduates who pursue STEM undergraduate and graduate degrees.
- ▶ In an informal analysis in 2016, [NOAA Office of Education](#) found that a disproportionate number of eligible underrepresented minority (URM) students began but did not submit scholarship applications. Compared to majority applicants, 30% more URM students were not able to obtain two letters of reference. In response, the [Hollings Scholarship](#) program made the requirements for letters of recommendation more flexible and took a strategic approach to targeted recruitment. These revisions resulted in significant changes in the 2018 applicant pool. The number of black students increased from 40 to 54, the number of Hispanic students jumped from 54 to 80, and the number of American Indian/Alaska Native students increased from two to five.
- ▶ In FY 2018, 47% of applicants heard about [NOAA undergraduate scholarships](#) through their professors or mentors. But faculty at many minority serving institutions (MSIs) were not aware of these opportunities. The [Office of Education](#) offered a seminar for mentors, advisors, and professionals that outlined information about NOAA's opportunities and how to encourage sophomores to apply. The scholarship team invited colleges and universities from around the country, with an emphasis on MSIs. Twenty-six participants joined from 21 academic institutions. Half of the respondents reported working at MSIs, and all plan to encourage their students to apply.
- ▶ The [Dr. Nancy Foster Scholarship Program](#) builds connections between underrepresented students and the ocean by recognizing outstanding scholarship and encouraging research, particularly by female and minority students. The program recruited new applicants by targeting 52 minority serving institutions and top schools for black and Hispanic undergraduate and graduate students in fisheries and marine science. More students at 18 of these institutions submitted applications during FY 2018 than did the year before. Five of the 12 current scholars are minorities (42%), compared to 17% of the 42 former scholars. This change suggests that efforts to diversify the applicant pool are working.
- ▶ The [Dr. Nancy Foster Scholarship Program](#) changed its application review process to allow underrepresented graduate students with the greatest financial need to have a better chance of ranking higher. The new process keeps the financial need reviews separate from the general reviews. For the second year in a row, the applicant with the highest financial need was selected as one of the three new scholars.

OBJECTIVE 4.3

Postsecondary students, particularly from underrepresented groups, pursue and complete degrees in disciplines critical to NOAA's mission.



During the summer, Nancy Foster scholar Jessica Hale spent her time observing sea otters feeding in Olympic Coast National Marine Sanctuary. (Kate Thompson/NOAA)

GOAL HIGHLIGHTS //

What's next? NOAA-supported students enter the workforce

A single experience may spark a lifelong interest in STEM, but it takes more than that to keep students in the STEM workforce pipeline. NOAA works with postsecondary students, especially those from underrepresented groups, as they transition into careers.

- ▶ The **Diversity and Professional Advancement Working Group** (DPAWG) piloted a process for creating diverse hiring panels at NOAA. Hiring starts with an interview, and diverse hiring panels not only send the message that applicants from all backgrounds are welcome at the agency but also bring broader perspectives to the hiring process. The [National Ocean Service](#) piloted this idea, and DPAWG developed a database of NOAA staff from diverse backgrounds who are interested in participating on hiring panels in the future. Sixty-five NOAA employees from across the agency signed up to participate.
- ▶ The [Hollings](#) and [Educational Partnership Program with Minority Serving Institutions](#) undergraduate scholarship programs provided students with undergraduate research experiences that set them on a path toward successful graduate opportunities. To date, 128 scholarship alumni have received the National Science Foundation Graduate Research Fellowship. The fellowship provides three years of funding for graduate work and additional support for professional development and research.
- ▶ Getting a job as a young adult can be difficult, but [NOAA Hollings scholars](#) have a strong track record of employment at NOAA and in related fields. In a survey of 580 alumni, 12% joined the NOAA workforce as either a NOAA employee (9%) or contractor (3%). After graduating, 55% of Hollings alumni held jobs in the private sector, 18% joined academia, and 15% worked in the federal, local, or state government.
- ▶ **DPAWG** established a partnership between NOAA and the Society for the Advancement of Chicanos and Native Americans in STEM (SACNAS). DPAWG coordinated a recruitment initiative through SACNAS with support from the offices of [Civil Rights](#), [Human Capital Services](#), and [Education](#), as well as diverse representation from [NOAA Corps](#) and the NOAA line offices. In addition, the working group facilitated a discussion between the SACNAS executive board and NOAA leaders on how both organizations can work together to provide more opportunities for students, especially those from minority groups, in support of NOAA's Diversity and Inclusion Strategic Plan. NOAA staff interacted with several hundred SACNAS members; exit surveys revealed that the NOAA team had a significant impact on increasing awareness of NOAA's mission, student programs, and entryways into the NOAA workforce.
- ▶ In 2017, [Ohio Sea Grant](#) offered 19 college-credit courses and six workshops at Stone Laboratory for high school, college, and graduate students; K-12 teachers; and professionals. A survey of the 1,516 students who have taken courses and workshops at Stone Lab since 2012 highlights the success of the program: of the 299 individuals who responded, 79 were pursuing graduate education or were employed in a career related to their degree within two years of graduation.

OBJECTIVE 4.4

Graduates completing NOAA-supported student opportunities continue education, enter the workforce, and advance in careers that support NOAA's mission.



Darren Clabo, a 2005 NOAA Hollings scholar, is now the State Fire Meteorologist for South Dakota and a research scientist within the Department of Civil and Environmental Engineering at South Dakota School of Mines and Technology. Darren reflects, "Looking back, the Hollings Scholarship allowed me to pursue my academic goals, and I can guarantee that I would not be where I am today without the opportunities afforded by the scholarship." (Ray Bubb, South Dakota Division of Wildland Fire)

FEATURED STORY //

Aspiring ocean explorers get hands-on experience through the Explorers-in-Training program

Hundreds of miles east of Florida, on a ship in the middle of the North Atlantic Ocean, Ryan Marr squinted at his computer as sonar data streamed in. A master's student in maritime history at East Carolina University, Marr typically used sonar as a tool to locate shipwrecks and other underwater areas of potential ethnographic interest. This time, though, he was learning how to use sonar to map a key deepwater area southeast of Bermuda.

Marr was one of the 10 budding ocean explorers who participated in the [Explorers-in-Training](#) (EiT) program this year. This program — run through the [NOAA Office of Ocean Exploration and Research](#) in partnership with the University Corporation for Atmospheric Research — provides undergraduate and graduate students with the rare opportunity to get hands-on training in ocean mapping from shore and aboard the [NOAA Ship *Okeanos Explorer*](#).

While students learn science most effectively when given the opportunity to practice it hands-on, few aspiring ocean explorers have access to the large, expensive equipment needed to practice ocean mapping. Marr cited this as one of his main motivations for joining the EiT program.

“The EiT program not only provided training on equipment normally [not accessible in] graduate programs but also gave me the chance to begin to start the conversation with others who work within the oceanic realm,” Marr explained.

Marr and his fellow 2018 Explorers-in-Training got the unique opportunity to use this equipment as full members of a NOAA ocean exploration team, learning how to collect and analyze complex sonar data.

All students in the EiT program participated in 20- to 30-day mapping cruises — either virtually, in person, or both. Those participating virtually each stood their own eight hour watches via telepresence technology, processing sonar data live from the *Okeanos Explorer* at their home base at the University of New Hampshire's Center for Coastal and Ocean Mapping/Joint Hydrographic Center.

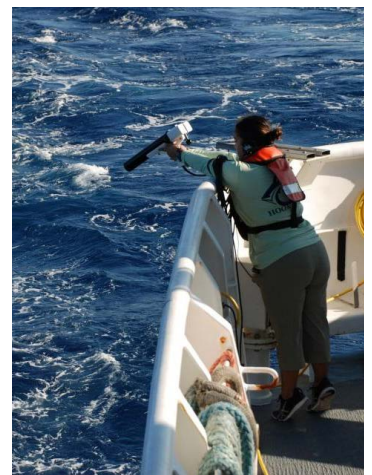
Ship-bound EiTs like Marr had the chance to join the expedition team aboard the *Okeanos Explorer*. While at sea, these students gained the full experience of an ocean exploration expedition, from learning how to live aboard a ship to navigating the challenges of at-sea data collection. Each trainee also completed a project of their own interest, with support from experienced mapping professionals on board.

Whether at sea or on shore, the EiT program helps to lay down the first stepping stone to a career path in marine exploration for undergraduate and graduate students. Over the years, many of the 122 past EiTs have converted their mapping skills into careers as hydrographers, marine archaeologists, and marine resource managers both at NOAA and in the private sector. Others have used their new skills to pursue or enhance their graduate school research in marine science, geography, and ocean engineering.

As for Marr, his experience as an EiT this year solidified his aspiration to return to NOAA. “After completing my master's degree at East Carolina University, I hope to join the [NOAA Corps](#) and continue my service in uniform by assisting those carrying out the research critical to our survivability,” he said. NOAA hopes to see Marr and many more exceptional young explorers join our ranks in the future.



Ryan Marr attributes his current passion for historical preservation to growing up near Revolutionary War sites in New Jersey. He hopes to further develop his skills for maritime history research and eventually return to NOAA as a NOAA Corps officer. (Courtesy of Ryan Marr)



Rebekah Hernandez, a 2018 Explorers-in-Training, deploys an expendable bathythermograph off the stern of the NOAA Ship *Okeanos Explorer* to measure ocean temperature at various depths. (NOAA)

FEATURED STORY //

Teacher at Sea alum connects students in Alaska to NOAA science

In the tundras of western coastal Alaska sits a remote Yup'ik village called Scammon Bay. A town of fewer than 500, its people travel on 4-wheelers or snowmobiles, and there are no roads connecting it elsewhere. Coming or going requires multiple planes and cooperative weather.

It's a beautiful place to live, but science teacher Mary Cook knows that the isolation can be a hurdle for her and her students. Cook works to find ways to inspire them to dream big and tackle challenging subjects.

To directly connect her students to scientific discovery, Cook joined NOAA scientists as a [Teacher at Sea](#) aboard [R/V Norseman II](#) in 2016 for some first-hand research experience. At sea in Glacier Bay, Alaska, Cook and scientists collected underwater images and biological samples to document the geographic range of a deep-sea coral. Every day, her school projected images from her blog in the cafeteria so the whole student body could follow along.

"Being a Teacher at Sea gives me more credibility when I go back to the classroom," Cook explains. "My students know I was on a ship working with real scientists doing real research." Inspired by her voyage, Cook and her students built model ships, studied water pressure and robotics, and researched corals and Glacier Bay National Park.

Glacier Bay is in Alaska, but it is still 1,000 miles away from Scammon Bay. So Cook sought ways to build on her students' enthusiasm and engage them in science closer to home. In such a rural location, Cook's students "don't have a lot of personal interaction with highly-degreed people in the science world." She wanted to introduce her students to researchers whose work would be relevant to them.

In November 2017, NOAA Teacher at Sea Program and the National Marine Sanctuary Foundation Teacher at Sea Alumni Association provided support to send Dr. Diane Stanitski, from NOAA's [Earth Systems Research Laboratory](#), and Dr. John Adler, from the National Ecological Observatory Network, to visit Scammon Bay School for two days.

During their visit, Stanitski and Adler taught students about the climate zones in Alaska and guided them in taking their own surface temperature measurements. Stanitski presented her research tracking environmental responses to changes in snow cover. Each class joined Adler outside to fly a drone over Scammon Bay. Afterward, they built a 3D map of the school from the images they collected.

Cook knows this type of relationship building is formative for her students. "I just think if you know somebody personally, just like my students now know an engineer and a climatologist... that just goes deep. It's a deep impact on a young person."

In her teaching, Cook tries to engage her remote community in emerging STEM fields. By connecting her students to the latest scientific research, Cook believes these experiences prepare her students to succeed when they travel out of Scammon Bay, to Anchorage, Fairbanks, or beyond. "NOAA and the Teacher at Sea Program have been the best way to help me reach that goal," she says.



During a visit from two scientists, Mary Cook's students in Scammon Bay, Alaska, participated in a drone demonstration and several other science activities. (NOAA Teacher at Sea)



Mary Cook, left, was a Teacher at Sea in 2016. She continues to make an impact by connecting her students with NOAA science and scientists. (NOAA Teacher at Sea)

FEATURED STORY //

NOAA scientists engage students at Destination SPACE Satellite Week

In July, 25 high school students arrived at the tree-lined campus of the University of North Carolina Asheville. They were younger than the typical students on a university campus, but their task was taller: in just five days, they would build and launch their own miniature satellites on weather balloons.

These ambitious satellite developers had arrived at [Destination SPACE](#) (Satellite Program for Aerospace-Centered Education) Satellite Week, a program supported through the Asheville Museum of Science. Destination SPACE cultivates long-term interest in STEM by providing hands-on remote sensing opportunities for public high school students. Throughout the week, NOAA scientists from the [National Centers for Environmental Information](#) (NCEI) joined in to share their knowledge and their stories with this group of future satellite experts.

Each day of Satellite Week incorporated a presentation by mentors in the field of remote sensing and a work period in which the students would complete a mission. Missions included building and launching their own “ThinSats,” small satellites capable of transmitting data from an extreme low earth orbit. This technology brings satellites out of the realm of billion-dollar enterprises and into the classroom, giving students a chance to develop satellite hardware, test sensor components, analyze data, and launch an actual payload. In this case, students launched ThinSats tethered to weather balloons.

The students ranged from eighth to 12th grade, and over 80% of them had qualified for scholarships based on financial need. In addition to building ThinSats, they also built and raced “Jiggy Bots” (homemade robots that use different components to light up, vibrate, and move), toured a solar array, and learned to solder. Students gained hands-on experience operating remote sensing instruments and used data for an applied project, getting a taste of the skills that employers in the remote sensing industry — like NOAA — are looking for.

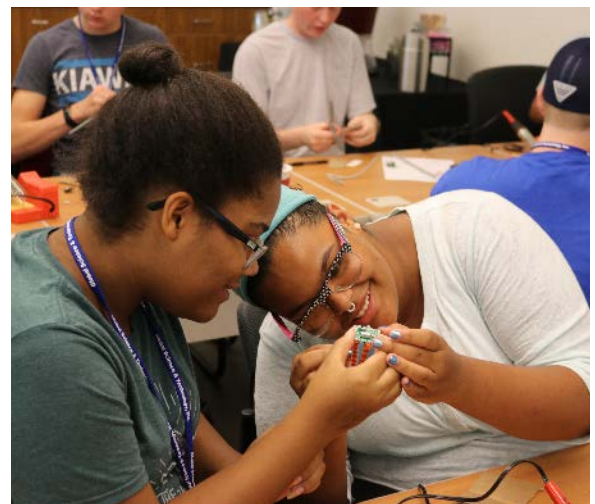
Through a series of presentations and hands-on learning activities, NCEI scientists exposed students to their work. Mary Wohlgemuth, the director of NCEI, and Mike Tanner, director for NCEI’s Center for Weather and Climate, talked about the importance of satellites and STEM as a whole. NOAA scientists joined a lineup of mentors that included retired NASA astronaut Joan Higginbotham, who clocked 308 hours in space and earned NASA’s Exceptional Service Medal.

Over the course of the week, students at Destination SPACE Satellite Camp learned about the value of Earth-monitoring satellites and practiced the same skills used by professional satellite developers. NCEI’s outreach at Satellite Week helped put faces to the field of remote sensing, aiming to inspire and empower students to become the next generation of STEM leaders.



At Destination SPACE Satellite Week, students built their own miniature satellites and launched them on weather balloons. (Annette Hollingshead/NOAA)

Students designed “Jiggy Bot” robots, developing technical skills like soldering. (Annette Hollingshead/NOAA)



FEATURED STORY //

Partnerships with minority serving institutions enhance the NOAA workforce

Mussie Kebede had known he wanted to be a meteorologist since he was in middle school. “My interest [in weather] stemmed from a fascination with geography and winter storms. I would get excited at the prospect of school being canceled due to impending snowstorms,” he recollected. And this was more than the fleeting interest of a kid hoping for a snow day.

“The two interests eventually merged when I discovered the science of weather and its prediction,” he said. “My goal was to work for the [National Weather Service \(NWS\)](#) because it gave me the opportunity to work in public service.” In 2018, Kebede achieved his goal and joined the NWS as a meteorologist at the Hydrometeorological Prediction Center.

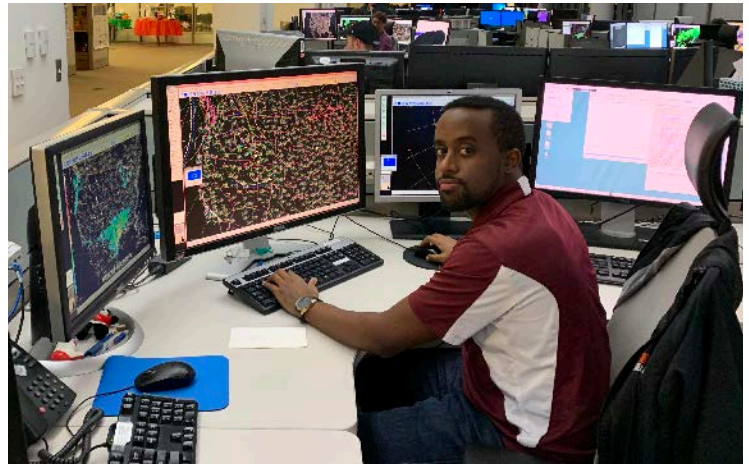
Kebede is among the graduates supported by NOAA’s [Educational Partnership Program with Minority Serving Institutions \(EPP/MSI\)](#) [Cooperative Science Centers \(CSCs\)](#). He earned his master’s degree in atmospheric science from Howard University in Washington, D.C., the lead institution at the [NOAA Center for Atmospheric Sciences and Meteorology \(NCAS-M\)](#).

The CSC awards contribute candidates to a future NOAA workforce that reflects the diversity of the nation. These centers increase participation for all Americans in NOAA-mission STEM disciplines, natural resource management, and policy. Each CSC-supported graduate student has a NOAA mentor who guides their research. These students present their research at conferences and participate in internships at NOAA, developing skills that enhance their competitiveness for entering the workforce in NOAA-related fields. Since 2001, the EPP/MSI CSCs have awarded more than 1,977 postsecondary degrees in fields that are aligned with NOAA’s mission.

CSCs bring new talent from diverse communities, including underrepresented minorities, to the NOAA workforce. In 2018, EPP/MSI CSCs supported 222 students in degree programs (58 doctoral, 68 master’s, and 96 undergraduate). Thirteen CSC graduates entered the STEM workforce, seven of whom joined NOAA in either federal or contractor positions.

Cassandra Shivers-Williams, Ph.D., a graduate of NCAS-M, is the first Peter Lamb Postdoctoral Fellow at the [Cooperative Institute for Mesoscale Meteorological Studies \(CIMMS\)](#), a [NOAA Cooperative Institute](#). She developed an interest in how people make decisions during disasters, which was influenced by her experiences in Louisiana during hurricanes Rita, Katrina, Ike, and Gustav. The CSCs helped Shivers-Williams turn her curiosity into a career. “I would not be at CIMMS without the training, networking, and fellowship opportunities afforded by NCAS-M,” Shivers-Williams noted. “Through my affiliation with NCAS-M, I became immersed in NOAA culture and explored career options.”

These graduates demonstrate that the CSCs contribute a well-trained, diverse candidate pool that supports America’s STEM competitiveness.



Mussie Kebede was one of the students supported by NOAA’s Educational Partnership Program with Minority Serving Institutions Cooperative Science Centers. He now works as a meteorologist for the National Weather Service, stationed in the Forecast Operations Branch of the Hydrometeorological Prediction Center. (Mussie Kebede)



Cassandra Shivers-Williams, Ph.D., is a Peter Lamb Postdoctoral Fellow at the Cooperative Institute for Mesoscale Meteorological Studies. (Cassandra Shivers-Williams)

Organizational Excellence

NOAA functions in a unified manner to support, plan, and deliver effective educational programs and partnerships that advance NOAA's mission.



Rafael de Ameller/NOAA

OVERVIEW //

NOAA Education represents the combined effort of dedicated education professionals across our agency. The strength of our community is built on the relationships between these passionate individuals, their partners, and the audiences they serve. Our community's focus on excellence drives us to enhance and measure performance to provide the best service to the public.

OBJECTIVES

- 5.1. Leaders internal and external to NOAA recognize and support education investments as a way to achieve agency mandates, mission, and goals.
- 5.2. The NOAA Education community develops implementation plans and establishes agency education priorities informed by stakeholder needs and national initiatives.
- 5.3. NOAA educators and partners collaborate at local, regional, and national levels to coordinate efforts, build capacity, and better serve educational audiences.
- 5.4. NOAA and partner organizations use effective evaluation, performance monitoring, and evidence-based approaches in the design and management of educational programs, products, and services.
- 5.5. NOAA develops and supports a coordinated portfolio of products, programs, and partnerships that improves education opportunities in NOAA-related content areas for underserved audiences.

GOAL HIGHLIGHTS //

NOAA educators and partners are recognized for excellence

Hats off to our award-winning educators and partners! These people, programs, and projects have earned awards that speak to the creativity and dedication of our education community.

- ▶ The [Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring](#) recognizes people and organizations that help develop tomorrow's workforce. The Earth Science Women's Network at NOAA's [Cooperative Institute for Research in Environmental Sciences](#) was recognized for this honor in 2018, along with the following faculty from the [Educational Partnership Program with Minority Serving Institutions Cooperative Science Centers](#): Dr. Reginald Blake of the [NOAA Center for Earth System Sciences and Remote Sensing Technologies](#), Dr. Paulinus Chigbu and Dr. Matthew Gilligan of the [NOAA Living Marine Resources Cooperative Science Center](#), and Dr. Paul Tchounwou of the [NOAA Center for Coastal and Marine Ecosystems](#).
- ▶ Two educators received the NOAA Administrator's Award in 2018. Jennifer Hammond was recognized for exemplary leadership of NOAA's [Teacher at Sea Program](#). Dr. Ruth Kelly at the [National Ocean Service](#) developed a cost-effective NOAA-wide program to place undergraduate and graduate interns with mentors in science, policy, and communications. Rear Admiral Timothy Gallaudet, then acting NOAA administrator, described these awardees as "extraordinary public servants."
- ▶ The National Weather Association recognized NOAA's [National Severe Storms Laboratory](#) and the University of Oklahoma [Cooperative Institute for Mesoscale Meteorological Studies](#) for the Meteorological Phenomena Identification Near the Ground — or [mPING](#) — citizen science program with the Larry R. Johnson Special Award for significantly contributing to operational meteorology.
- ▶ The National Technical Association recognized Dr. Vernon Morris, director of the [NOAA Cooperative Science Center in Atmospheric Sciences and Meteorology](#), for pioneering leadership in a technical scientific field. Morris also received the Charles E. Anderson Award from the American Meteorological Society for tireless promotion of programs that provide enhanced research and academic opportunities for minorities in atmospheric science and for enhancing access to science in underserved communities.

OBJECTIVE 5.1

Leaders internal and external to NOAA recognize and support education investments as a way to achieve agency mandates, mission, and goals.



Recipients of the 2018 Presidential Awards for Excellence in Science, Mathematics, and Engineering Mentoring included Dr. Paulinus Chigbu, left, director of the NOAA Living Marine Resources Cooperative Science Center, and Dr. Reginald Blake, right, of the Center for Earth System Sciences and Remote Sensing Technologies. (University of Maryland Eastern Shore, City College of New York)

GOAL HIGHLIGHTS //

Evaluation makes our programs effective and accountable

NOAA collects data on the ocean and atmosphere to understand and predict conditions on our planet. Likewise, NOAA Education programs rely on data to meet the needs of the people we serve.

- ▶ NOAA Climate Stewards became **NOAA Planet Stewards** in response to educator needs, expanding the program's scope to include topics such as marine debris, natural resource management, and weather-related hazards. In FY 2018, the Planet Stewards education community grew by 60%, and applications to the stewardship community increased by 130%.
- ▶ **NOAA Planet Stewards** enhanced the reporting requirements and guidance for its educators about how they should track and present stewardship measures in project reports. Under the new requirements, educators track numbers of students and their stewardship engagement hours. Now, the program can share collective results, such as the total number of acres restored or pounds of carbon sequestered across multiple projects.
- ▶ **Teacher at Sea** collected information from teachers to find out how alumni use NOAA resources after they return from sea. Of the 24 teachers who sailed, 13 responded to the questionnaire. All respondents have integrated NOAA materials into their classrooms, and 11 educators have shared their experiences with their communities.

OBJECTIVE 5.2.

The NOAA Education community develops implementation plans and establishes agency education priorities informed by stakeholder needs and national initiatives.

OBJECTIVE 5.4.

NOAA and partner organizations use effective evaluation, performance monitoring, and evidence-based approaches in the design and management of educational programs, products, and services.

Programs work together to strengthen the NOAA Education community

Networks provide opportunities for NOAA educators from across the country to work on shared activities. We strengthened our networks by bringing people together to build relationships and spark collaboration.

- ▶ **NOAA Fisheries** educators came together for a two-day workshop in May. Twenty-five participants, representing 18 offices from eight regions, gave overviews of their programs and discussed diversity, best practices, and more. The workshop strengthened connections and communication between offices, catalyzing efforts for offices to coordinate endeavors toward education goals.
- ▶ NOAA's **Teacher at Sea** program continued to foster regional alumni networks. Thirty-two teachers from Arizona, California, Colorado, Hawaii, New Mexico, Nevada, and Utah attended a workshop in La Jolla, California. Another workshop in Charleston, South Carolina, brought together 14 teachers from Florida, Georgia, North Carolina, and South Carolina. Five teachers from other regions (Alabama, Delaware, Kentucky, Mississippi, and Virginia) also participated. Teachers strengthened oceanographic content knowledge, built partnerships with NOAA scientists, learned about NOAA resources, and expanded regional alumni networks.

OBJECTIVE 5.3.

NOAA educators and partners collaborate at local, regional, and national levels to coordinate efforts, build capacity, and better serve educational audiences.

Teacher at Sea alumni row a long boat in the San Diego Bay during a 2018 workshop. (NOAA)



GOAL HIGHLIGHTS //

- ▶ **NOAA Bay Watershed Education and Training (B-WET)** program developed a communication toolkit for their network of grantees. The toolkit helps grantees communicate about their funded projects with other educators, leaders, and community members to elevate local awareness and demonstrate the value of their project to the field of environmental education.
- ▶ **NOAA Office of Ocean Exploration and Research (OER)** works with a network of institutions to provide professional development opportunities across the country, helping to bring the science and excitement of ocean exploration into the classroom. In 2018 OER updated and refreshed current professional development materials to ensure that teachers are receiving the most recent information on ocean exploration science and discoveries.
- ▶ **NOAA Satellite and Information Service (NESDIS)** engaged the NOAA Education community and other staff in NOAA DataFest, which took place in August 2018. NESDIS led two sessions to train staff to present on NOAA Science On a Sphere®. Drawing inspiration from a “hackathon,” NESDIS also created NOAA Datathon, an in-person workshop and group challenge to make interactive web applications using NOAA data. Twenty-six NOAA staff participated in the in-person session. Based on survey responses, 89% of participants would recommend or highly recommend this training to others. Datathon is now available as an online, self-directed course.

Expanding our reach to underserved audiences

All Americans deserve access to NOAA science. Throughout this report, we’ve highlighted over a dozen examples of programs reaching traditionally underserved audiences. Themes from 2018 include:

- ▶ **Language:** NOAA and partners coined American Sign Language terms to make it easier for people who are deaf and hard-of-hearing to communicate about estuaries (p. 11). NOAA Fisheries involved Seattle residents in creating a bilingual mural (p. 24).
- ▶ **Geography:** The Ocean Guardian program expanded to reach schools in Texas (p. 20). The Office of Ocean Exploration and Research partnered with science centers to bring ocean science to inland educators (p. 9). The National Weather Service presented to schools by video chat, reaching many more students than they could through in-person visits alone (p. 30). Likewise, the National Marine Sanctuaries Webinar Series immersed educators across the country in our underwater parks (p. 9).
- ▶ **Reach:** The National Weather Service partnered to design weather safety materials for people with intellectual disabilities (p. 29). NOAA Fisheries expanded a sturgeon education program to reach people of all ages and abilities (p. 9). A NOAA Planet Steward worked with diverse community groups to help people restore a local estuary (p. 18). The Ocean Discovery Institute, a NOAA partner, built a lab in a low-income San Diego community (p. 38). The Glasgow Weather Forecast Office partnered with the local Tribal Elders Program (p. 32).
- ▶ **Recruitment:** The Hollings and Nancy Foster scholarship programs conducted outreach to encourage students from underrepresented minorities to apply and made changes to the application or review process (p. 42). NOAA also partnered with the Society for the Advancement of Chicanos and Native Americans in Science to boost recruitment (p. 43).
- ▶ **Representation:** The Diversity and Professional Advancement Working Group has recruited over 40 members since its inception in 2014, providing coordinated support and professional guidance for underrepresented groups at NOAA.

OBJECTIVE 5.5

NOAA develops and supports a coordinated portfolio of products, programs, and partnerships that improves education opportunities in NOAA-related content areas for underserved audiences.

INDEX

A

ACE Basin National Estuarine Research Reserve 53
Alabama 19, 40, 50
Alaska 16, 18, 40, 42, 45
Alaska Fisheries Science Center 16
American Samoa 17
Apalachicola National Estuarine Research Reserve 16
Arizona 8, 30, 50
Atlantic Oceanographic and Meteorological Laboratory 6

B

Bay Watershed Education and Training (B-WET) 5, 8, 13, 21, 22, 28, 51
Chesapeake B-WET 21
Great Lakes B-WET 13
Gulf of Mexico B-WET 22
Hawaii B-WET 5

C

California 8, 10, 16, 17, 18, 22, 23, 25, 38, 41, 50, 51
Center for Satellite Applications and Research 38
Channel Islands National Marine Sanctuary 16
citizen science 22, 23, 49
Climate Program Office (CPO) 31, 33
Coastal Ecosystem Learning Center (CELC) Network 10
Colorado 12, 24, 38, 50
Cooperative Institute for Mesoscale Meteorological Studies 47, 49
Cooperative Institute for Research in Environmental Sciences 24, 49
Cooperative Institutes 24, 47, 49
Cooperative Science Centers 40, 41, 49
Cordell Bank National Marine Sanctuary 8

D

Delaware 16, 41, 50
Delaware National Estuarine Research Reserve 16
District of Columbia 6, 33, 47
Diversity and Advancement Working Group (DPAWG) 39, 43
Dr. Nancy Foster Scholarship 37, 42, 51
Earth Systems Research Laboratory 45
Educational Partnership Program with Minority-Serving Institutions (EPP/MSI) 40, 41, 43, 47, 49
Cooperative Science Centers 40, 41, 49
NOAA Center for Earth System Sciences and Remote Sensing Technologies 40, 49
NOAA Cooperative Science Center in Atmospheric Sciences and Meteorology 47, 49
NOAA Living Marine Resources Cooperative Science Center 40, 49
Environmental Literacy Program 31, 33, 35
Explorers-in-Training (EIT) 41, 44

F

Flagstaff Weather Forecast Office 30
Florida 6, 16, 22, 27, 28, 42, 44, 50
Flower Garden Banks National Marine Sanctuary 30
Fort Peck Indian Reservation 32

G

Geophysical Fluid Dynamics Laboratory 38
Georgia 6, 14, 50
Glasgow Weather Forecast Office 32, 51
Gray's Reef National Marine Sanctuary 14
Great Lakes 13, 17, 19, 21
Gulf of Mexico 6, 22, 42
Hawaii 5, 27, 41, 50, 53
Hollings Scholarship 18, 40, 41, 42, 43, 51

Honolulu Weather Forecast Office 53
Hudson River Estuarine Research Reserve 22, 53

I

Idaho 29
Illinois 5, 17, 30
Illinois-Indiana Sea Grant 5, 17
Indiana 5, 17
Iowa 39

J

Joint Institute for the Study of Atmosphere and Ocean 20
Joint Polar Satellite System (JPSS) 29

K

Kansas 41
Kentucky 50

L

Lake Superior National Estuarine Research Reserve 13
Louisiana 47

M

Maine 11, 35
Marine Debris Program 6, 23, 53
Maryland 29, 33, 40, 41
Massachusetts 11, 28
Michigan 9, 21, 24, 28
Minnesota 13
Mississippi 6, 41, 50
Mokupāpapa Discovery Center 27
Monitor National Marine Sanctuary 20
Montana 32, 51

N

Narragansett Bay National Estuarine Research Reserve 11, 16
National Centers for Environmental Information (NCEI) 6, 7, 9, 41, 46
National Estuarine Research Reserve System (NERRS) 11, 13, 15, 16, 19, 22, 27, 28, 51, 53
ACE Basin NERR 53
Apalachicola NERR 16
Delaware NERR 16
Hudson River NERR 22, 53
Lake Superior NERR 13
Narragansett Bay NERR 11, 16
Rookery Bay NERR 27
Teachers on the Estuary 11
Tijuana River NERR 22
Waquoit Bay NERR 11, 28
Weeks Bay NERR 19
Wells NERR 11
National Marine Sanctuary of American Samoa 17

National Ocean Service (NOS) 8, 9, 12, 19, 30, 43, 44, 49, 50, 51
Marine Debris Program 6, 23, 53
NOAA Planet Stewards 8, 12, 19, 30, 50, 51
Ocean Acidification Program 9, 41
Office for Coastal Management (OCM) 11, 13, 15, 16, 19, 22, 27, 28
National Estuarine Research Reserve System (NERRS) 11, 13, 15, 16, 19, 22, 27, 28
Office of National Marine Sanctuaries (ONMS) 8, 9, 14, 16, 17, 18, 19, 20, 22, 23, 28, 30, 42, 45, 51
Office of Ocean Exploration and Research (OER) 9, 41, 44, 51
National Satellite and Information Service (NESDIS) 29, 38, 46, 51
Center for Satellite Applications and Research 38
Joint Polar Satellite System 29
National Centers for Environmental Information (NCEI) 6, 7, 9, 41, 46
National Severe Storms Laboratory 49
National Water Center 40
National Weather Service (NWS) 29, 30, 32, 34, 41, 47, 51, 53

Flagstaff Weather Forecast Office 30
Glasgow Weather Forecast Office 51
Honolulu Weather Forecast Office 53
Midland Weather Forecast Office 34
Pocatello Weather Forecast Office 29
National Water Center 40
Student Career On-Site Training (SCOUT) 41
Weather-Ready Nation Ambassador 29
Nevada 50
New Hampshire 44
New Jersey 27, 41, 44
New Jersey Sea Grant 27
New Mexico 24, 50
New York 22, 31, 41
NOAA Education Council 2, 3, 53
NOAA Fisheries 6, 9, 16, 18, 25, 39, 42, 50, 51, 53
Alaska Fisheries Science Center 16
West Coast Region 25
Northwest Fisheries Science Center 9
Office of Habitat Conservation 42
Southeast Fisheries Science Center 39
Southwest Fisheries Science Center 18, 39
NOAA Fisheries West Coast Region 25
NOAA Planet Stewards 8, 12, 19, 30, 50, 51
NOAA Research 2, 5, 6, 7, 13, 17, 19, 20, 24, 26, 27, 31, 33, 36, 38, 41, 43, 45, 47, 49, 53
Atlantic Oceanographic and Meteorological Laboratory 6
Climate Program Office (CPO) 31, 33, 53
Cooperative Institute for Mesoscale Meteorological Studies 47, 49
Cooperative Institute for Research in Environmental Sciences 24, 49
Cooperative Institutes 24, 47, 49
Earth Systems Research Laboratory 45
Geophysical Fluid Dynamics Laboratory 38
Joint Institute for the Study of Atmosphere and Ocean 20
National Severe Storms Laboratory 49
Pacific Marine Environmental Lab (PMEL) 5, 7, 20
Sea Grant 2, 5, 7, 17, 19, 26, 27, 36, 41, 43, 53
NOAA Science Camp 5
NOAA Ship *Fairweather* 20
NOAA Ship *Oregon II* 9, 20, 39
NOAA Ship *Rainier* 20
NOAA Ship *Reuben Lasker* 10
North Carolina 7, 9, 46, 50
Northwest Fisheries Science Center 9

Ocean Acidification Program 9, 41
Ocean Guardian Schools 17, 22, 51
Office for Coastal Management (OCM)
National Estuarine Research Reserve System (NERRS) 11, 13, 15, 16, 19, 22, 27, 28, 51, 53
Office of Education 7, 10, 18, 31, 33, 35, 40, 41, 42, 43, 47, 49, 51
Coastal Ecosystem Learning Center (CELC) Network 10
Educational Partnership Program with Minority-Serving Institutions (EPP/MSI) 40, 41, 47, 49
Environmental Literacy Program 31, 33, 35
Hollings Scholarship 18, 40, 41, 42, 43, 51
Office of Habitat Conservation 42
Office of National Marine Sanctuaries (ONMS) ii, 8, 9, 14, 16, 17, 18, 19, 20, 22, 23, 28, 30, 42, 45, 51
Channel Islands NMS 16
Cordell Bank NMS 8, 9
Dr. Nancy Foster Scholarship 37, 42, 51
Flower Garden Banks NMS 30
Gray's Reef NMS 14

Mokupāpapa Discovery Center 27
Monitor NMS 20
National Marine Sanctuary of American Samoa 17
Ocean Guardian School 17, 22, 51
Olympic Coast National Marine Sanctuary 19, 42
Papahānaumokuākea Marine National Monument 27
Office of Ocean Exploration and Research (OER) 9, 44, 51
Explorers-in-Training (EIT) 41, 44
NOAA Ship *Okeanos Explorer* 41, 44
Ohio 19, 43
Ohio Sea Grant 19, 43
Oklahoma 20, 41, 49
Olympic Coast National Marine Sanctuary 19, 42
Oregon 2, 7, 9, 20, 25, 33
Oregon Sea Grant 2, 7
Pacific Marine Environmental Lab (PMEL) 5, 7, 20
Papahānaumokuākea Marine National Monument 27
Pathways Program 41
Pocatello Weather Forecast Office 29
Puerto Rico 24
Rhode Island 11, 16
Rookery Bay National Estuarine Research Reserve 27
R/V *Fulmar* 8
R/V *Hugh R. Sharp* 39
Sea Grant 2, 5, 7, 17, 19, 26, 27, 36, 41, 43
Illinois-Indiana Sea Grant 5, 17
New Jersey Sea Grant 27
Ohio Sea Grant 19, 43
Oregon Sea Grant 2, 7
Virginia Sea Grant 26, 36
South Carolina 50, 53
South Dakota 43
Southeast Fisheries Science Center 39
Southwest Fisheries Science Center 18, 39
Student Career On-Site Training (SCOUT) 41
Teacher at Sea (TAS) 9, 20, 39, 45, 49, 50
Teachers on the Estuary 11
Texas 17, 22, 34, 39, 40, 51
Tijuana River National Estuarine Research Reserve 22
Utah 39, 50
Virginia 6, 26, 33, 36, 41, 50
Virginia Sea Grant 26, 36
Waquoit Bay National Estuarine Research Reserve 11, 28
Washington 5, 6, 17, 19, 20, 25, 33, 41, 47, 51
Weather-Ready Nation Ambassador 29
Weeks Bay National Estuarine Research Reserve 19
Wells National Estuarine Research Reserve 11
Wisconsin 13, 38
Wyoming 38
zoos, aquariums, museums, science centers 9, 10

ACKNOWLEDGMENTS

NOAA Education Council

The NOAA Education Council represents and coordinates education efforts across the agency. The following member programs provided materials for this report to highlight breadth of NOAA Education.

Council Chair

Louisa Koch

Council Vice Chair

Christos Michalopoulos

Bay Watershed Education and Training Program (B-WET)

Bronwen Rice, Jim Foley

Climate Program Office

Frank Niepold

Marine Debris Program

MaryLee Haughwout, Alexis Thorbecke

National Marine Fisheries Service

Kate Naughten, Lisa Hiruki-Raring

National Ocean Service

Bruce Moravchik

National Sea Grant College Program

Jonathan Lilley, Lisa Lawrence

National Weather Service (NWS)

Mary Fairbanks

NOAA Satellite and Information Service

Kat Hawley, Rafael de Ameller

NOAA Teacher at Sea Program

Jennifer Hammond

NWS Warning Coordination Meteorologists

Faith Borden, Kerry Jones

Office for Coastal Management

Atziri Ibanez, Nancy Cofer-Shabica

Office of Education – Higher Education

Marlene Kaplan

Office of Education – K-12 and Informal Education

Christos Michalopoulos, Sarah Schoedinger

Office of National Marine Sanctuaries

Tracy Hajduk, Seaberry Nachbar

Office of Oceanic and Atmospheric Research

Mike Walker, Eric Hackathorn

Office of Ocean Exploration and Research

David McKinnie, Susan Haynes, Debi Blaney

Special thanks

The NOAA Education community would like to thank the NOAA offices, programs, employees, partners, and grantees for their work. Accomplishments were submitted on behalf of NOAA education programs by members of the NOAA Education Council. We are especially grateful to Dayna Rignanese and Matt McIntosh with the Office of National Marine Sanctuaries who designed the graphics on page 3. Thank you also to the many people who contributed images for this report.

In addition, many members of the education community contributed to writing these stories. We would like to extend a special thank you to the following people: Laurita Alomassor, Genie Bey, Ayeisha Brinson, Ellen Brody, Vankita Brown, Jessica Cooper, Victoria Dancy, Claire Fackler, Jaime Frungillo, Patrick Gilchrist, Ben Graves, Gregory Hammer, Molly Harrison, Amber Hluchan, Annette Hollingshead, Madeleine Jepsen, Alicia Keefe, Paulo Maurin, Joan Muller, Christopher Nelson, Michelle Riley, Jacqueline Rousseau, Sandy Sarvis, Emily Susko, Audrey Trotman, Tiffany Upshaw, and all of the other NOAA staff and partners who worked to make these efforts happen. The document was designed and edited by Maggie Allen, John Baek, Kayla do Couto, Lauren Gibson, Marissa Jones, Bekkah Lampe, and Andrea Sassard.

On the cover

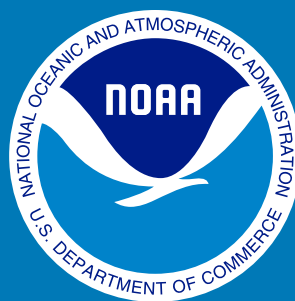
Top left: A sixth-grader from Sacred Hearts Academy removes invasive algae from Maunalua Bay in Hawaii with Mālama Maunalua and NOAA Fisheries. (Mālama Maunalua)

Top center: Meteorologist Jennifer Strahl launches a weather balloon at the Honolulu NWS Forecast Office. (NWS)

Top right: Students observe the animals caught aboard the E/V *Discovery* in the ACE Basin National Estuarine Research Reserve. (Erin Weeks/South Carolina Department of Natural Resources)

Bottom left: Russ Lewis, a volunteer who supports NOAA's Marine Debris Program, has logged 957 trips to his local Oregon beach to pick up litter, removing 6-9 tons of debris each year. (Courtesy of Russ Lewis)

Bottom right: Ashawna Abbott, Aidan Mabey, and Martice Smith (left to right) worked with the Hudson River National Estuarine Research Reserve as high school students. They later returned as mentors and teachers through the Student Conservation Association. (Chris Bowser/Hudson River NERR)



WWW.NOAA.GOV/EDUCATION