

2023 RUCOOL

CENTER FOR OCEAN OBSERVING LEADERSHIP
ANNUAL REPORT



RUTGERS

School of Environmental
and Biological Sciences
CENTER FOR OCEAN
OBSERVING LEADERSHIP



THE NEW BLUE ECONOMY

The new blue economy growth is accelerating as humanity becomes increasingly reliant on the ocean for food, energy, and natural resources. As the diversity of the stakeholders grows, the data needs are increasing exponentially. RUCOOL is working to fill this need with its research efforts expanding to support aquaculture, food security, environmental management and green energy. To meet these challenges, many communities, agencies and countries are coming forward to support RUCOOL programs that continue to grow in number and diversity. Successfully meeting the many needs of these programs, RUCOOL is only possible with our dedicated, highly skilled staff and undergraduate/graduate students. Success is only possible with a motivated and passionate team.

The importance of these efforts will only increase given evidence that the global ocean is experiencing significant change. The coming year will provide many adventures and challenges but our team will meet the need, given the importance to society today and in the future.



Scott Glenn
Board of Governors
Professor



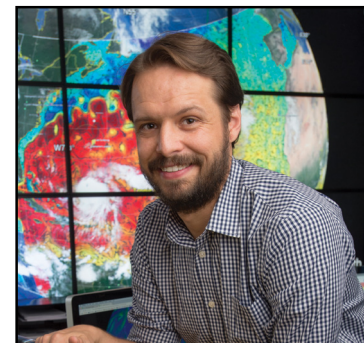
Oscar Schofield
Distinguished Professor



Josh Kohut
Professor



Janice McDonnell
Associate Professor



Travis Miles
Assistant Professor



Grace Saba
Associate Professor



Alex Lopez
Assistant Teaching Professor



Daphne Munroe
Associate Professor



Thomas Grothues
Associate Research Professor

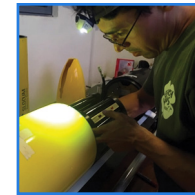
Diverse career pathways with STEM and Marine Science degrees

RUCOOL thrives because of the talented people that keep it running, from the faculty, to students, and the research staff. The RUCOOL group represents 46 individuals. The amazing staff work hard at all times of the day/night 24:7 365 days a year. Their passion is unmatched, but what is often under appreciated is the amazing skills they bring together as a team to help society. We want to THANK the staff for their fantastic contributions and celebrate their too often selfless efforts to push the innovations, operations, education, and overall excellence. The full team of the current RUCOOL staff is shown here. As a group, they illustrate the diverse skills needed to lead and excel. The team has Bachelors, Masters and PhD degrees in biology, education, physics, psychology, engineering, computer science, geography, management, human resources, meteorology, math, ecology, natural resource management, and all aspects of oceanography. There is no question that the diversity of backgrounds and personalities has played a major role in our success here at Rutgers and around the world.

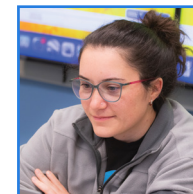
The RUCOOL team manages millions of dollars representing 50+ research programs on the cutting edge and using a wide range of skills. People often ask what skills are needed to thrive in a research environment. Among the skill sets represented by RUCOOL, are program management for large complex projects, complicated budgeting and economic forecasting, advanced computing and management of big data, advanced data quality control/assurance, robotics, sensor technology, ecology, environmental science, shipboard operations, machine learning, satellite remote sensing, software, acoustic sound processing, advanced analytical chemistry, radar technology, signal processing, marketing, communication, K-12 education, entrepreneurial skills and, of course, oceanography.



Samantha Alaimo
Graduate Student



David Aragon
Glider Operations
Director



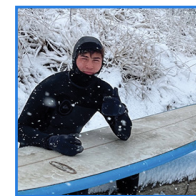
Julia Engdahl
Laboratory
Researcher



Sal Fricano
Graduate Student



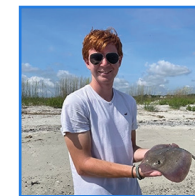
Lori Garzio
Research Analyst



James Kim
Research Project
Assistant



Josh Kohut
Professor



Jake Kuenzli
Graduate Student



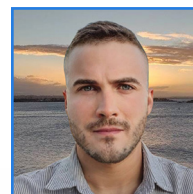
Jessica Leonard
Research Project
Assistant



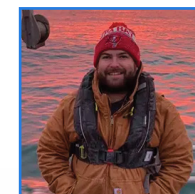
Jesse Noble
Graduate Student



Nicholas Occhiogrosso
Graduate Student



Fernando Pareja
Research Associate



Scott Pescatore
Graduate Student



Hugh Roarty
Director of
HF-Radar



Teemer Barry
Graduate Student



Charlotte Bramich
Graduate Student



Brian Buckingham
Glider Technician



Michael Chen
Graduate Student



Kaycee Coleman
Project
Management
and Analyst



Lauren Cook
Graduate Student



Mike Crowley
Technical Director:
RUCOOL and
MARACOOS



Quintin Diou-Cass
Graduate Student



Scott Glenn
Distinguished
Professor



Joseph Gradone
Graduate Student



Thomas Grothues
Research Associate
Professor



Chip Haldeman
Boat Captain,
Marine hardware



Ethan Handel
HF-Radar
Technician



Leah Hopson
Graduate Student



Becca Horwitz
Graduate Student



John Kerfoot
Lead Software
Developer



Steve Levenson
Financial Manager



Sage Lichtenwalner
Education
Web Design,
Programmer



Alex Lopez
Assistant
Teaching Professor



Janice McDonnell
Outreach and
Education
Associate Professor



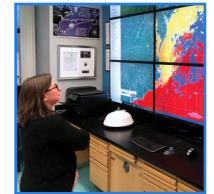
Travis Miles
Assistant Professor



Delphine Mossman
Research Program
Coordinator



Daphne Munroe
Associate Professor



Laura Nazzaro
Research Analyst



Grace Saba
Associate Professor



Oscar Schofield
Distinguished
Professor and
Department Chair



Sophie Scopazzi
Graduate Student



Mya Sharpe
Graduate Student



Michael Smith
Research Analyst



Timothy Stolarz
Marine Technician



Jackie Veatch
Graduate Student



Nicole Waite
Glider Operations
Assistant Director

Innovative Research

OFFSHORE WIND

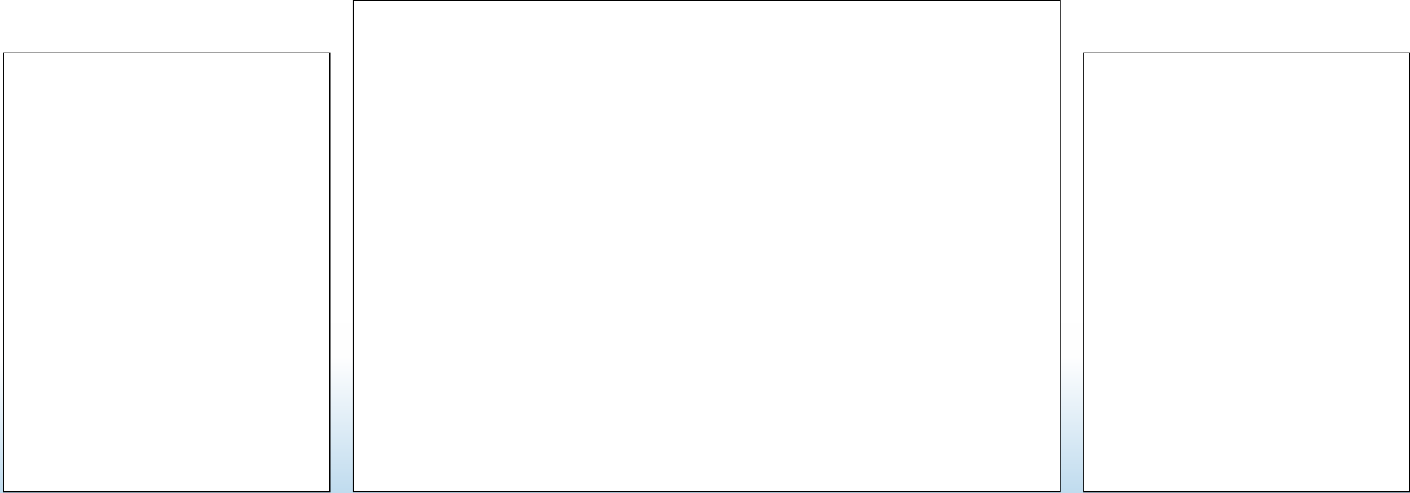
RUCOOL is leading research to inform resource managers and the offshore wind industry in the Northeast US. To learn more, visit rucool.marine.rutgers.edu/research/offshore-wind for wind observations and modeling, rowlrs.marine.rutgers.edu for living resource studies conducted in lease areas, or osw.rutgers.edu for university wide collaboration in educating the future offshore wind workforce. Here are some of the projects we are working on.

i. Monitoring Fisheries Resources Offshore of Atlantic City

In order to evaluate the impacts of offshore wind construction on fisheries resources in New Jersey, we are executing a Fisheries Monitoring Plan of Ørsted’s Ocean Wind 01 offshore wind farm. Multiple coordinated and complementary surveys are being conducted before (2022, 2023), during (2024, 2025), and after (2026, 2027) wind farm construction. These include a bottom trawl survey, environmental DNA sampling, structured habitat survey, Atlantic surf clam dredge survey, pelagic fish survey, acoustic telemetry measures, and collecting oceanographic data. Since 2020, RUCOOL has also been performing underwater glider deployments that listen for whale calls and identify when, and what types of whales frequent these locations.

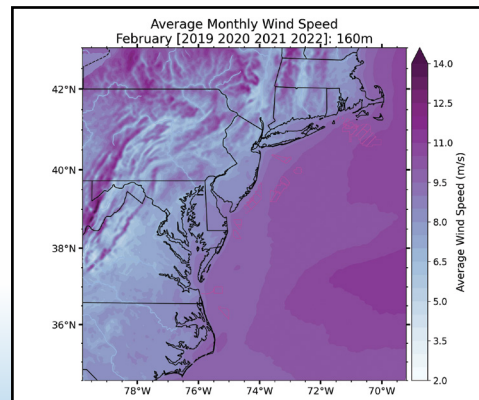
ii. Assessing Clam Resources in Offshore Wind Lease Areas

If you have ever indulged in a plate of clam strips, or savored a hearty bowl of clam chowder, you may just have been eating a clam landed at fishing docks in New Jersey. Many people are surprised to learn that one of the biggest fisheries in the Garden State is the commercial clam fishery. As we begin to develop the ocean for low carbon energy production, it is important to evaluate how much New Jersey’s commercial fisheries rely on these areas for the clams they catch. To do that, Rutgers researchers, led by Dr. Daphne Munroe, have been working with commercial clam fishermen and offshore wind developers to conduct in-depth surveys of the ocean bottom where offshore wind farms will soon be built. The first thing that was needed was a highly specialized piece of clam fishing gear that would allow precise collection of both young and old clams from the bottom. This specialized clam dredge was conceived by collaborating fishermen and its fabrication was funded through the New Jersey Research and Monitoring Initiative. The dredge has been and will continue to be an essential tool for evaluating the clams in the offshore lease sites. In concert with co-located oceanographic and benthic data streams, the dredge is being used to evaluate the clams that are living in and supporting commercial fishing in the offshore wind lease areas today, and over the next 20 years.



iii. Something is Fishy off New Jersey

Despite the attraction of wrecks and artificial reefs to sport fishers, it is unconsolidated sediments (sand, silt, and mud) that make up bottom habitat for the majority of fish species on the New Jersey continental shelf. To the human observer, it may appear unstructured and unstable so that fish move widely along it in search of scattered food. However, shoreface sand ridges form stable underwater hills that sort sediment, direct currents, and rise through temperature layers to structure habitat for invertebrates and likely for the fish that eat them. Ridges are also important sources of sand for beach nourishment and are being eyed as sources for construction material as well. Our team, led by Dr. Thomas “Motz” Grothues, wants to learn about the response of fishes to dredging a sand ridge off Atlantic City by the US Army Corps of Engineers. Sponsored by the Bureau of Ocean Energy Management’s Mineral Management Service, this project performs seasonal fish surveys in collaboration with a commercial fishing trawler. We are looking to see fish distributions before and after the dredges, as well as impacts of the dredging on the sand ridge. We leverage a combination of technologies including video, side scan sonar, acoustic telemetry, AUVs, gliders and satellite data to study these impacts. Early results show tight groupings of Atlantic sturgeon, horseshoe crabs, and winter skate within a sea of dogfish sharks and windowpane flounder. Occasional big rays, such as the uncommon spiny butterfly ray, also add excitement.



iv. It's Windy Offshore

The development of offshore wind energy along the NJ coast has accelerated rapidly over the last four years. As wind turbine lease areas are established and projects enter pre-construction phases it is critical to understand the baseline wind resource, its variability, and what controls that variability. The coastal ocean can have a profound impact on the overlying atmosphere, including across the full swept areas of planned turbines. An understanding of that variability is critical to effective and efficient development of offshore wind farms, as well as grid management and price forecasting, which benefit NJ ratepayers.

Through funding by the NJ Board of Public Utilities, RUCOOL has been studying, evaluating, and simulating the coastal ocean’s influence on wind power production for more than a decade. Over the past four years we have developed and operated a state-of-the-art numerical modeling system that outperforms federal models across all wind lease areas with the potential to serve New Jersey. We have additionally carried out numerous process-focused case studies as well as wind turbine wake interaction investigations, which provide unique insight into some of the potential causes of wind variability. In the coming year, we will use our atmospheric model data archive to develop and deliver a suite of products and analyses to offshore wind stakeholders. Through this effort we seek to enhance stakeholder understanding of the role of the ocean and enhance their ability to plan and respond to ocean impacts on the NJ wind resource.



A WARMING OCEAN PLANET

The RUCOOL team continues its research in the Southern Ocean as part of the National Science Foundation's Long Term Ecosystem Research program and the Global Biogeochemical Argo network. This work is critical as the Southern Ocean plays a disproportionately large role in Earth's carbon cycle and it is undergoing shocking change. Last year (2022) was the lowest sea ice year ever recorded until unfortunately this year which has experienced almost no sea ice growth. The observed declines in sea ice will alter food webs, the amount of atmospheric CO₂ being drawn into the ocean, and will fundamentally alter the Southern Ocean. RUCOOL will be documenting the chemical and biological shifts in response to these sea ice changes. These changes, seemingly far away from us, will have global ramifications for humanity.

[wired.com/story/antarctic-sea-ice-is-at-record-lows-is-it-an-alarming-shift](https://www.wired.com/story/antarctic-sea-ice-is-at-record-lows-is-it-an-alarming-shift)

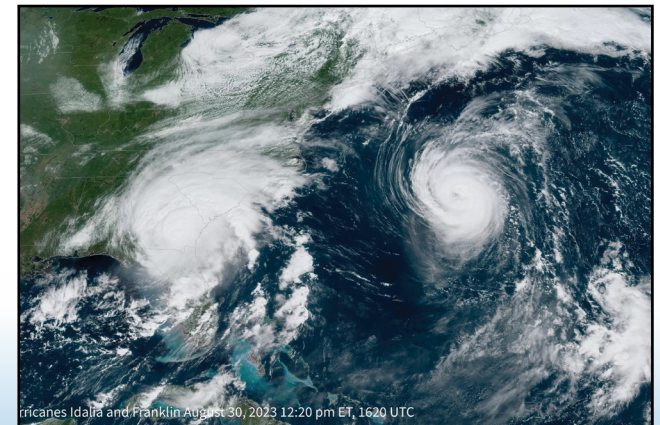
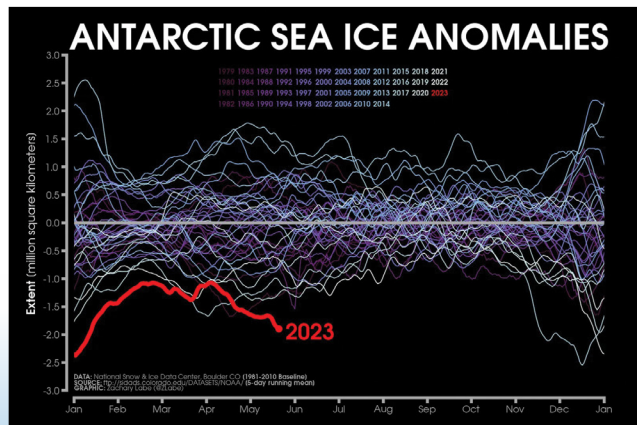
IMPROVING TROPICAL CYCLONE FORECASTING WORLDWIDE

With marine heat waves and extreme weather events a frequent news story, the RUCOOL Hurricane Research Team is increasingly called upon at the national and international level to help organize and provide the ocean observations needed to improve hurricane forecasts. RUCOOL contributes to the national Hurricane Glider Fleet by operating underwater gliders in both the Caribbean, where hurricanes can originate, and in the Mid Atlantic, where hurricanes like Irene and Sandy can make landfall. The glider's ocean data is aggregated in the national Glider Data Assembly Center that is co-led by Rutgers, and sent via the Global Telecommunications System to modeling centers worldwide. Rutgers then closes the feedback loop on the data impact, monitoring how it improves the hurricane models, communicating

to the forecasters where the models are doing well, and communicating to the Hurricane Glider operators where more data is needed. Rutgers scientists further lead hurricane glider research efforts in NOAA's Extreme Event Ocean Observing Team to gain new understanding of the impacts of warming seas on hurricane intensity that will improve the hurricane forecasts of the future.

The Rutgers successes have been noted by the United Nation's Ocean Observing Co-Design Programme. Rutgers scientists co-lead their Tropical Cyclone Exemplar, building the international teams to improve tropical cyclone forecasts and warnings globally. Together they have designed four regional pilot studies:

1. the Caribbean to build capacity among small island states to better forecast the world's most damaging hurricanes
2. the Northwest Pacific to coordinate nations to improve knowledge of air-sea interactions along the path of the world's strongest typhoons
3. the Bay of Bengal to rapidly spin up national ocean observing networks where the world's most deadly cyclones make landfall
4. in the Western Indian Ocean where marine heat waves and tropical cyclones disrupt the marine ecosystems of the world's largest concentration of subsistence fisheries.



25 YEARS OF CURRENT MEASUREMENTS OFF NEW JERSEY!

SeaSonde® oceanographic high frequency radars (HFR) have been mapping currents in the U.S. Mid-Atlantic Bight since 1998 when two stations were installed in New Jersey at Brant Beach and Brigantine as part of the Rutgers University Longterm Ecosystem Observatory (LEO-15). Twenty Five years later, that seminal duo has grown into the 41-site MARACOOS HFR network, the largest managed by a single regional association, providing continuous current maps along more than 1000 km of coastline from Cape Cod to Cape Hatteras. The expansive gridded current velocities serve a variety of stakeholders, including federal agencies like the U.S. Coast Guard for search and rescue and spill response and ocean scientists developing both short-term forecasting applications as well as longer term, multi-decadal changes in coastal circulation. Long-term archives are now available with calculated decadal mean, annual and seasonally averaged surface currents:

doi.org/10.1029/2020JC016368.

This network and the scientists standing behind it at academic institutions such as Rutgers University, University of Delaware, Old Dominion University, University of Connecticut, University of Rhode Island, and University of North Carolina, have been on the leading edge of implementing HFR technology and utilizing HFR data products, both inspiring and guiding other U.S. groups and in dozens of other countries. Many HFR firsts have taken place within the MARACOOS network, a few of which include multi-static currents using offshore buoy-mounted transmitters, bistatic vessel detection, meteotsunami detection, storm intensity predictions, and species habitat assessment and modeling. RUCOOL looks forward to the next 25 years of ocean current research in the mid-Atlantic!







Leadership and Student Success

GRACE SABA WINS THE RUTGERS FACULTY SCHOLAR-TEACHER AWARD

In May 2023, Rutgers President Jonathan Holloway presented RUCOOL's Grace K. Saba with the Faculty Scholar-Teacher Award. "Each year these awards honor members of the Rutgers community selected by their colleagues for outstanding contributions to teaching, research, and public service... I hope you share our pride in and congratulations for this year's honorees," Holloway wrote. The award honors tenured faculty members who have made outstanding synergistic contributions in research and teaching. This award recognizes those who make visible the vital link between teaching and scholarship by contributing to the scholarship of teaching and by bringing together scholarly and classroom activities.



GRAND GRAD STUDENTS!

RUCOOL graduate students were no strangers to winning awards for their research this year. Lauren Cook won the Mid Atlantic Chapter of the American Fisheries Society's best student presentation for their talk entitled "Is fish blue carbon actually Brown?" Jackie Veatch, Courtney Dreyfus and Becca Horwitz were finalists in the Marine Technology Society and IEEE Oceanic Engineering Society Oceans meeting poster session, with Jackie taking home the winning prize for best poster, paper and presentation. Samantha Alaimo and Teemer Barry were awarded fellowships from the NJ Wind Institute to support their field research. Congrats to all of our students for continuing a tradition of excellence in scientific research at RUCOOL!



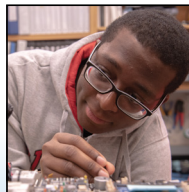
Lauren Cook



Samantha Alaimo



Becca Horwitz



Teemer Barry



Courtney Dreyfus



Jacki Veatch

UNDERGRADS LEADING THE GLOBAL OCEAN GLIDER SENTINEL MISSION

An RUCOOL undergraduate student team, led by Sal Fricano, is now planning the logistics for the first worldwide navigation of a new underwater glider called Sentinel, which will make its maiden voyage at sea by the end of the summer of 2023. The three-year trip around the world will allow the newly designed glider to provide data on the ocean's temperature – a major driver of hurricanes – and depth, measured down to 3,300 feet. The project is a collaboration between RU COOL and Teledyne Marine Webb Research, the company that developed the glider. The longest route the previous model of the glider had been deployed on was from New Jersey to Spain in 2009. "By having a global map of ocean temperatures across the world, you can create incredibly advanced models that predict storm intensities and trajectories," Fricano says. "That can be the life-changing question of, do we evacuate this community that's about to get hit by a hurricane or not?"



MASTERS IN OPERATIONAL OCEANOGRAPHY (MOO)

Our Masters in Operational Oceanography students benefit from individualized attention and small course numbers, career planning assistance, and experience with one of the world's most advanced and longest operating ocean observatories. The program is designed to provide students with a professional degree in a 12-month program for undergraduates with degrees in oceanography, marine science, atmospheric sciences, or ocean engineering. Students deploy and pilot cutting-edge technology ranging from multiple types of AUVs to high-frequency radar, learn to run numerical ocean and atmospheric forecast models, and train in data synthesis/analysis. Students conduct semiannual glider missions along the Endurance Climate Line out of the Rutgers University Marine Field Station. Guided by the faculty and technical staff of RUCOOL, students also complete a research thesis with a climate and/or renewable energy focus. By providing opportunities to learn not just the science, but the technologies used to collect ocean data, and to be part of a real-time ocean observing team, the graduates of our program leave with the skills to be highly competitive in any research or industry career.



THE ONE AND ONLY R/V RUTGERS

The R/V Rutgers continues to be an expansive resource in research and education, extending its reach not only across Rutgers, but to multiple external entities this year as it completed 34 trips with 340 passengers. These include governmental and public outreach groups such as the City of New Brunswick and the Lower Raritan Watershed Partnership, and external research universities such as University of Delaware, Virginia Institute of Marine Science, Rider University, and Middlesex County College (MCC). Additional joint research projects with Monmouth University and Stockton University have also been supported. Forays into the corporate world are not alien to the R/V Rutgers either, as it has supported the development and continued testing of the Naviator - the first drone designed to fly both above and below water, transitioning on the fly. Multiple classes (graduate and undergraduate) have been aboard, along with Marine Technology Society-supported glider camps, deploying a plethora of onboard oceanographic instrumentation and multiple autonomous underwater vehicles. Many of these have become recurrent passengers, with two Rutgers classes (Oceanographic Methods and Data Analysis, Analytical Environmental Chemistry) having requisite trips aboard the R/V Rutgers.

Community Engagement, Beloved Community

RUCOOL TEAMS WINS THE RUTGERS TEAM EXCELLENCE AWARD

In 2022, National 4-H partnered with a cross department team made up of faculty and staff from Rutgers University to develop the national 4-H STEM Challenge Kit. Launched in August 2022 and led by RUCOOL's Janice McDonnell, this 4-H STEM Challenge has the potential of reaching tens of thousands of youth across the country. This was an ambitious undertaking, combining strong leadership across different departments within Rutgers and also working externally with professionals from National 4-H, Teledyne Webb Research, NOAA, and others to develop a 4-H STEM Challenge for youth rooted in hard science addressing marine science issues. Released to a national audience, this kit has increased the visibility of Rutgers and will serve as a model for other land-grant universities to follow.

EDUCATION AND OUTREACH AT RUCOOL

RU COOL faculty continue to seek active partnerships with the community to generate and implement mutually beneficial and socially useful knowledge and practices. Our education and outreach efforts, which include teaching, research, and creative work, have impacted broad audiences of K-12 teachers, students, and New Jersey families, policy makers, and industry.

- K-12 Students and Teachers: Rutgers faculty have worked together to prioritize social, emotional, and academic development to young people across NJ through a range of programs and services.
- 4-H STEM Ambassadors Program: Since 2009, the 4-H STEM Ambassador program engages Rutgers scientists and engineers from all campuses each year to participate in mentorship and educational activities focused on supporting the development of STEM identity in underrepresented youth from NJ. These youth then act as Ambassadors in their communities, teaching and mentoring younger children at local YMCA and Boys and Girls Clubs, reaching thousands of young people over the course of the year. This summer, 52 scientists mentored 59 rising 8th and 9th graders from New Jersey's urban centers.



POLAR ADVENTURES

The RUCOOL education team is wrapping up a \$1.2 million National Science Foundation funded Advancing Informal STEM Learning project, led by Janice McDonnell and Jason Cervenec (Ohio State University), entitled Polar Literacy: A Model for Youth Engagement and Learning. The project was designed to “develop affordable and replicable ways of bringing polar education to informal learning environments, extend our understanding of how polar education initiatives can be delivered to youth with maximum effect, and design a professional development model to improve the capacity for polar region researchers to craft meaningful broader impact activities.”

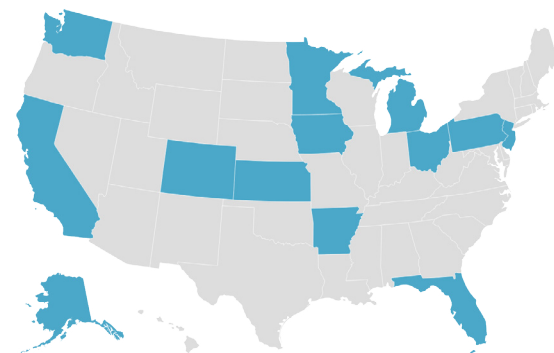
DATA TO THE RESCUE! PENGUINS NEED OUR HELP

This is an out of school time club-based project that leverages the availability of real-world scientific data to strengthen the practices of science, such as visualizing, analyzing, and interpreting data while engaging youth in discussing the impacts of climate change. The project culminates in a creative project called a Data Jam to help youth communicate how the Polar Regions are transforming due to climate change and what that means to them locally. We found that children who participated in Polar Literacy programming reported high levels of engagement in science learning activities and significant increases in both self-reported science identity and confidence in data skills, and significant increases in fascination with polar science!



Polar CAP Program Participants

From Summer 2020 to Spring 2023



Polar CAP Project Programs

Includes virtual and in-person programs from summer 2020 to spring 2023

State	Programs	Participants
Alaska	2	77
Arkansas	1	30
California	1	32
Colorado	1	11
Florida	1	20
Iowa	1	13
Kansas	1	18
Michigan	1	23
Minnesota	1	89
New Jersey	18	856
Ohio	14	281
Pennsylvania	2	75
Washington	2	46
Total	46	1,571

For more information visit <http://polar-ice.org>
Created with Datawrapper



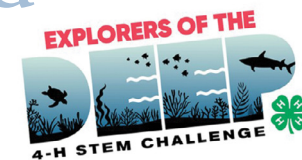
Community Engagement, Beloved Community

OCEAN SCIENCE EDUCATION PROGRAMS AT LOCAL LIBRARIES

RUCOOL staff, graduate and undergraduate students, and faculty have visited more than 22 New Jersey community libraries, bringing ocean science to children and their parents. Starting in 2022 summer under the theme, “Oceans of Possibilities”, we developed three programs focused on physical oceanography (ocean waves activity), biological oceanography (food webs and phytoplankton activity), and geology (sand activity). In 2023, we added a Life on Other Planets activity for the ENIGMA project, led by Dr. Paul Falkowski, and the Explorers of the Deep lessons from the 2022 4-H STEM Challenge.

EXPLORERS OF THE DEEP

This STEM focused kit was developed by a team of educators and oceanographers in the Department of Marine Sciences and the Department of 4-H Youth Development. The kit focuses on the mysteries and adventures of ocean exploration – with ocean robots! Activities were designed to develop observational and critical thinking skills while exploring the interconnected nature between the ocean and humans, regardless of where they live. Kids learn foundational STEM skills while they wrestle with the same questions as today’s top oceanographers and scientists. Activities can be done all at once or individually, making the kit a great resource for classrooms, afterschool programs, clubs, families and more.







50+
ACTIVE AWARDS
(grants, donations,
cooperative agreements)

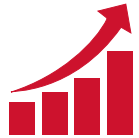


GLIDER

29 Deployments
16,526 kilometers flown
750 days at sea



432
UNDERGRADUATES
taught per year



500
visited RUCOOL
over 20 Countries



R/V RUTGERS

34 Trips
340 people



HFR Surface current coverage
161,000 KM²



\$10.4
MILLION
in funding per year

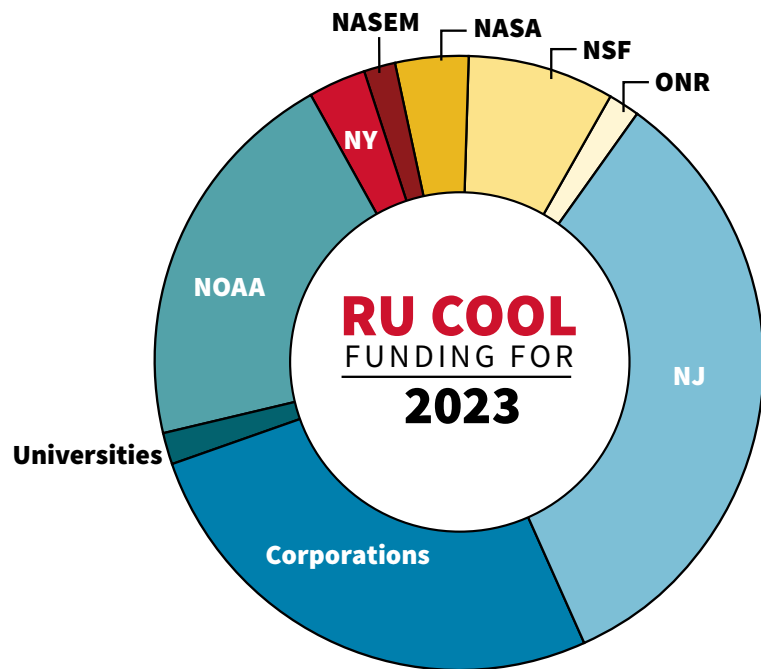






31
Peer Reviewed
Publications



18
GRADUATE STUDENTS
annually





	NJ \$3.5M	State of New Jersey
	\$2.8M	Corporations
	\$163K	Universities
	NOAA \$2.1M	National Oceanic and Atmospheric Administration

	NY \$339K	State of New York
	NASEM \$172K	National Academies of Sciences, Engineering, and Medicine
	NASA \$401K	National Aeronautics and Space Administration
	NSF \$814K	National Science Foundation
	ONR \$150K	Office of Naval Research





Department of Marine and Coastal Sciences
71 DUDLEY ROAD | NEW BRUNSWICK | N.J. | 08901-8520