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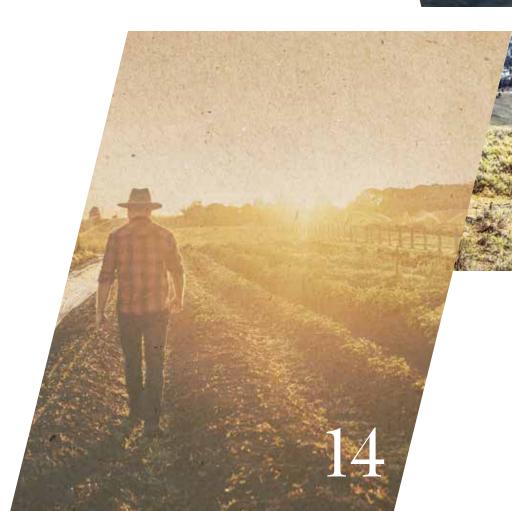
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EARTH DAY
CELEBRATES
50 YEARS

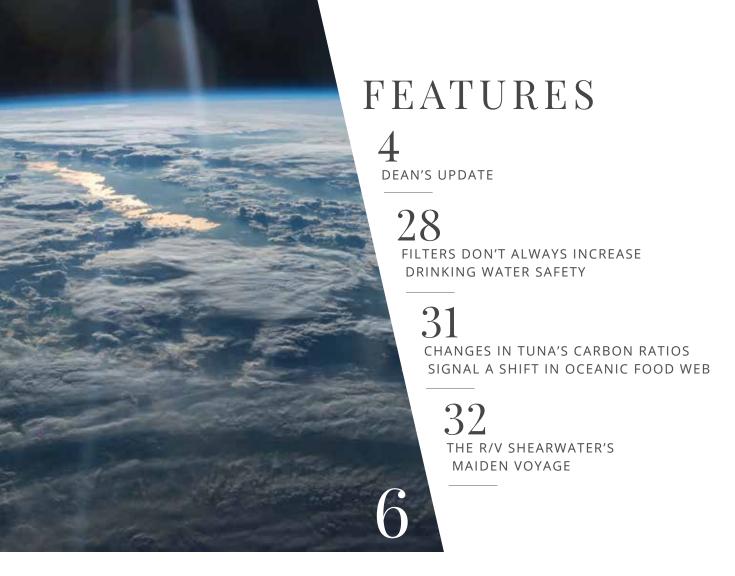
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TODDI STEELMAN STANBACK DEAN, NICHOLAS SCHOOL OF THE ENVIRONMENT

ON APRIL 22, **1970**, the first Earth Day celebrations took place at two thousand colleges and universities, roughly ten thousand primary and secondary schools, and hundreds of communities across the United States. The annual recognition now includes events coordinated globally by the Earth Day Network in more than 193 countries.

While it may seem at times that we are in dire straits with the weather events and predictions of what the state of our natural world will be in the next 50 years, it is important to reflect on the positive aspects of what has changed in the past five decades.

The creation of Earth Day happened at a time when our country and the world were taking a long hard look at how humans were having growing impacts on the environment. In his State of the Union Address in January 1970, President Richard Nixon broke new ground by discussing environmental policy.

"Through our years of past carelessness, we've incurred a debt to nature, and now that debt is being called", Nixon said. "The great question of the Seventies is, shall we surrender to our surroundings, or shall we make our peace with nature and begin to make reparations for the damage we have done to our air, to our land, and to our water?"

That April saw the first Earth Day, the formation of the Environmental Protection Agency was announced that June, and the Clean Air Act was passed later that same year. Precipitated by the publication of Rachel Carson's seminal work, *Silent Spring*, a few years previous, the creation of Greenpeace, and then the passing of the Clean Water Act a year later, these events sparked interest, attention and intention in the public.

The 50th Anniversary of Earth Day should be a time of reflection and commitment for us all. In recognizing this, I have called upon our faculty and staff to focus on three defining areas as we seek to have intentional impact with our science, our teaching and our outreach.

First, climate change is the pre-eminent threat of our time. I want the Nicholas School to further sharpen our identity, increase our visibility, and strategize how we connect across campus to harness the full potential and impact of what Nicholas is doing—and can do—in this arena. We need to amplify how we see climate problems and solutions, because we can, and have, a moral imperative to do so. We need to hone our focus as a whole so we can operate strategically within Nicholas, across campus and in the external world.

Second, every undergraduate student should leave Duke with

some degree of environmental and earth science literacy. Earth and ocean sciences are the foundational educational bedrock for understanding how our planet works. Climate impacts will affect everything from engineering, finance, policy, medicine and countless other fields. We must live up to our responsibility to create greater environmental and earth science literacy as our students graduate and go into the world in which they are poised to effect change.

Finally, I am charging our faculty and staff to focus on narratives of hope and possibility. We are inundated in the media with narratives of hopelessness and impending environmental apocalypse. I am challenging our faculty to emphasize the alternatives we have for dealing with climate change, biodiversity loss and the challenges in our oceans. It is absolutely essential that students understand the foundation of the problems while we also provide them insights into how we can address them.

In the 1970s, we began to recognize the human damage to the earth. This instigated change. Once again, we are witnessing the world change around us. As written by Ernest Hemingway, change "happens gradually and then suddenly." We often talk about ecological tipping points—the point where we shift into a new state of ecological being. I think we are at the cusp of a social tipping point—one that has us finally recognizing the impact we are having on our planet with respect to climate change, leading to the channeling of individual and collective action that can lead us into a new, more fortuitous normal. I intend for the Nicholas School to be visibly present and accounted for as we work toward an Earth Day 50 years from now that has a stable climate, abundant oceans and increasing biodiversity. *



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FIFTY YEARS AGO, when 20 million Americans took part in the first nationwide Earth Day festivities, there was no Endangered Species Act. No National Oceanic and Atmospheric Administration. No Intergovernmental Panel on Climate Change.

Flame retardants were still viewed as a boon for human health. Nearly all cars were gas guzzlers. And terms like "carbon neutral," "environmental justice" and "corporate sustainability" were decades away from entering our everyday vocabulary.

Times change.

This year, nearly one billion people worldwide are expected to observe Earth Day on April 22.

While the list of environmental woes facing our planet doesn't seem to be growing any shorter, and the political will to tackle them seems to have stalled, we think it's important not to lose sight of the progress we've made on many fronts.

To that end, we've compiled a timeline highlighting some of the major environmental milestones of the last half century and the challenges that remain.



SEPTEMBER 27, 1962

Silent Spring is published, an environmental science book by Rachel Carson. The book documented the adverse environmental effects caused by the indiscriminate use of pesticides.

JANUARY 1, 1970

Congress passes the National Environmental Policy Act (NEPA), requiring every federal agency to prepare an Environmental Impact Statement for any legislation.

FIRST EARTH DAY

The National Oceanographic and Atmospheric Administration (NOAA) is created to monitor and improve the conditions of the oceans.



OCTOBER 2, 1970

APRIL 22, 1970

The first Earth Day, a nationwide protest against environmental ignorance. An estimated 20 million people participate across the U.S.

JULY 9, 1970

President Nixon works with Congress to establish the Environmental Protection Agency (EPA), a new federal agency primarily responsible for United States environmental policy.



OCTOBER 18, 1972

The Clean Water Act (CWA) becomes the primary legislation governing water pollution in the country.



DECEMBER 31, 1972

DDT is banned in the United States.



OCTOBER 23, 1972

The Marine Mammal Protection Act (MMPA) protects all marine mammals from importation, exportation, hunting, capture, or any form of harassment, thus encouraging natural resource management in the United States.

DECEMBER 28, 1973

Congress passes the Endangered Species Act in order to prevent the extinction of animals in the United States.

VIEW THE

fws.gov/endangered/species/fag-first-species-listed.html



JUNE 26, 1974

President Nixon signs the Energy Supply and Environmental Coordination Act, the first attempt to balance the nation's energy demands with appropriate environmental regulations.

OCTOBER 21, 1976

The EPA is given complete control over hazardous waste in the Resource Conservation and Recovery Act, which mandates the agency manage all aspects of toxic waste management.

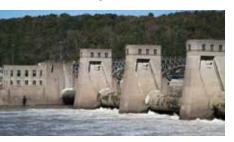




OCTOBER 11, 1976

The Toxic Substances Control Act mandates the EPA to control all new and existing chemical substances being used in the United States. The Act controls polychlorinated biphenyl (PCB) and other toxic products, although the management of existing chemicals are grandfathered and untouched by the act.

cover story



JUNE 15, 1978

The Supreme Court uses the 1973 Endangered Species Act as reason to stop the construction of the Tellico Dam in the Tennessee Valley Authority vs. Hill case. The decision upholds the rights of an endangered species over unrestricted expansion, and reflects growing American opposition to dam construction.

OCTOBER 17, 1986

Emergency Planning and Community Right-to-Know Act (EPCRA), a subset of the Superfund Amendments and Reorganization Act (SARA), requires industries to report toxic releases to the general public.

The federal law creates the new State Emergency Response Commission (SERC) to enforce these new requirements.

1987



NOVEMBER 18, 1988

President Reagan signs the Ocean Dumping Ban Act of 1988, a law that prohibits all waste dumping into the ocean starting in 1992.

APRIL 22, 1990

Earth Day becomes a global event. In a Gallup Poll, 76% of Americans -Democrats and Republicans alike - call themselves "environmentalists."

1977

1986

1988

AUGUST 4, 1977

President Carter establishes the Department of Energy (DOE), charged with carrying out a comprehensive national energy plan that reflects the federal legislation.

OCTOBER 25, 1978

The Nimbus-7 spacecraft is launched as the first satellite with the technology to take comprehensive worldwide measurements of the ozone layer.

SEPTEMBER 16, 1987

The Montreal Protocol is signed by the U.S., Japan, Canada, and 21 other countries, agreeing to phase out ozonedepleting CFCs by the year 2000.



DECEMBER 6, 1988

The World Meteorological Organization and the United Nations Environmental Program establish the Intergovernmental Panel on Climate Change (IPCC).

NOVEMBER

1990

15, 1990 Clean Air Act amendments strengthen restrictions on SO, and NO, emissions, helping reduce acid rain. The Pollution Prevention Act gives corporations new incentives to reduce pollutants.





Ozone Hole Formation Over South Pole Observed by NASA AIRS Visualization of the formation and evolution of the Antarctic Vortex ozone hole over the South Pole from Sept. 1 to Dec. 4, 2014, created using data from NASA Agua spacecraft.



1994

Lead in human blood declines: Study shows that US blood-lead levels declined by 78% from 1978 to 1991 during leaded gasoline phaseout. Meanwhile, American Academy of Pediatrics study shows direct relationship between lead exposure and IQ deficits in children.

1996

EPA air pollution report says sulfur dioxide emissions declined by 40% between 1970 and 1990. The report also claims smog, carbon monoxide and ozone levels are down since passage of the Clean Air Act in 1970.

2002

The U.S. wind energy industry wins passage of an extended production tax credit for electricity generated by wind power.

2002

1995

2005

1993

President Clinton signs order restricting logging in old growth forests.

JANUARY 20, 2001

Bill Clinton leaves the presidency after protecting 58 million acres of national forest from development and creating eight million acres of land as new national monuments. Clinton's conservation record is better than any president since Theodore Roosevelt, whose protection of 230 million acres of land as parks, wilderness, national forests and wildlife preserves remains unequalled.

1991

Sweden is the first nation to impose a carbon tax to curb CO, emissions. By 2010 the tax per ton was 128 euros, and the country's economy had grown 44%.

1995

Wolves reintroduced to Yellowstone National Park.



the Kyoto Protocol officially goes into force without the U.S.

FEBRUARY 16,

majority of the world's

Kyoto - With a

nations ratifying,

2005





G8 PARTICIPANTS

FRANCE GERMANY ITALY

JULY 9, 2008

Group of Eight
(G-8) industrialized
nations agree to cut
greenhouse gas
emissions in half by
2050. This is the first
time that all eight
countries made the
climate commitment.



APRIL 17, 2009

The US EPA rules that emissions of six greenhouse gases, including carbon dioxide, are a danger to public and should be regulated.

JUNE 2005

Former U.S. Vice President Al Gore releases **An**

Inconvenient Truth, a

documentary that describes global warming. The next year, Gore is awarded the Nobel Peace Prize (jointly with the Intergovernmental Panel for Climate Change) for this and related efforts.

APRIL 2, 2007

US Supreme Court rules that states may regulate greenhouse gasses.

JUNE 20, 2007 Renewable energy

investment now tops \$100 billion per year, according to the UN Environmental Program.

2009

2005

2007

MAY 26, 2007

South Pacific deep sea trawling in areas with endangered coral reef systems ended by treaty.

MARCH 30, 2009

President Obama signs the largest wilderness protection bill in 15 years, protecting two million acres in nine states; mostly in California, followed by Idaho, Utah, Colorado, Oregon, Virginia, West Virginia, New Mexico and Michigan.

JULY 6, 2005

The European
Parliament imposes
a permanent ban on
six chemicals known
as "phthalates"
used in
plastic toys and
childcare articles
to soften the
plastic because of
their carcinogenic,
mutagenic and
reprotoxic



JANUARY 25, 2008

US Forest Service opens 3.4 million acres (1.4 million hectares) of Alaska's Tongass National Forest to logging despite protests.



THIS LEGISLATION
GUARANTEES THAT

WE WILL NOT TAKE OUR FORESTS, RIVERS, OCEANS, NATIONAL PARKS, MONUMENTS AND WILDERNESS AREAS FOR GRANTED."

- PRESIDENT OBAMA

effects.

UNITED KINGDOM JAPAN THE UNITED STATES CANADA RUSSIA



SEPTEMBER 30, 2009

The EPA announces **new** Clean Air Act regulations to reduce greenhouse gas emissions from electric power plants.



APRIL 3, 2014

US Dept. of Justice levies largest environmental fine in US history against Andarko Petroleum — \$5.15 billion — for damages suffered by Navajo tribes in the Southeastern US during uranium mining.

2014





the US are announced by the EPA.

SEPT 25, 2015

Chinese premier Xi Jenping and US President Barack Obama announce **new initiatives on containing greenhouse gasses**.



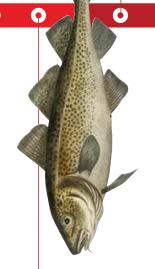
NOV 30-DEC 12, 2015

196 UN member states draft an unprecedented agreement for "an ambitious and balanced" plan to control climate change (aka, the Paris Agreement). Two years later, President Trump announces the US will withdraw from it.



APRIL 22, 2010

The EPA issues rules on automotive fuel efficiency and, for the first time, regulates greenhouse gas emissions. New regulations for coal-fired power plants follow in July.



NOVEMBER 11, 2014

Concerned about depletion of fish stocks, **regulators shut down cod fishing** in the Gulf of Maine.





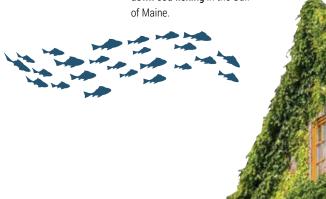
NOVEMBER 6, 2015

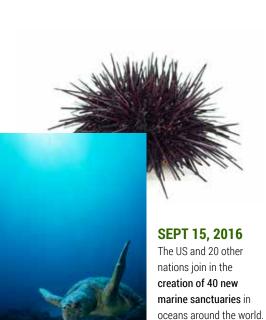
President **Obama stops construction of the Keystone XL oil pipeline** between Canada and the United States.



JULY 25, 2015

Germany generates 78
percent of its electricity from
wind and solar on this day,
setting a new record.







NOV. 2017 EPA found that more than 2,600 counties – roughly 85 percent of the US – met the stringent 2015 NAAQS standards for ground-level ozone.

MARCH 27, 2019

The European Union bans a wide range of single-use plastic items, including straws and cutlery. Local and state laws banning single-use plastic straws and bags begin spreading across the US.



2017

2016

2018

APRIL 22, 2016

A Gallup Poll find that only 42% of Americans and just 27% of Republicans—still consider themselves "environmentalists."



2018

Off the coast of Central America's Belize, a section of the world's second-largest coral reef is removed from UNESCO's endangered list.

2019

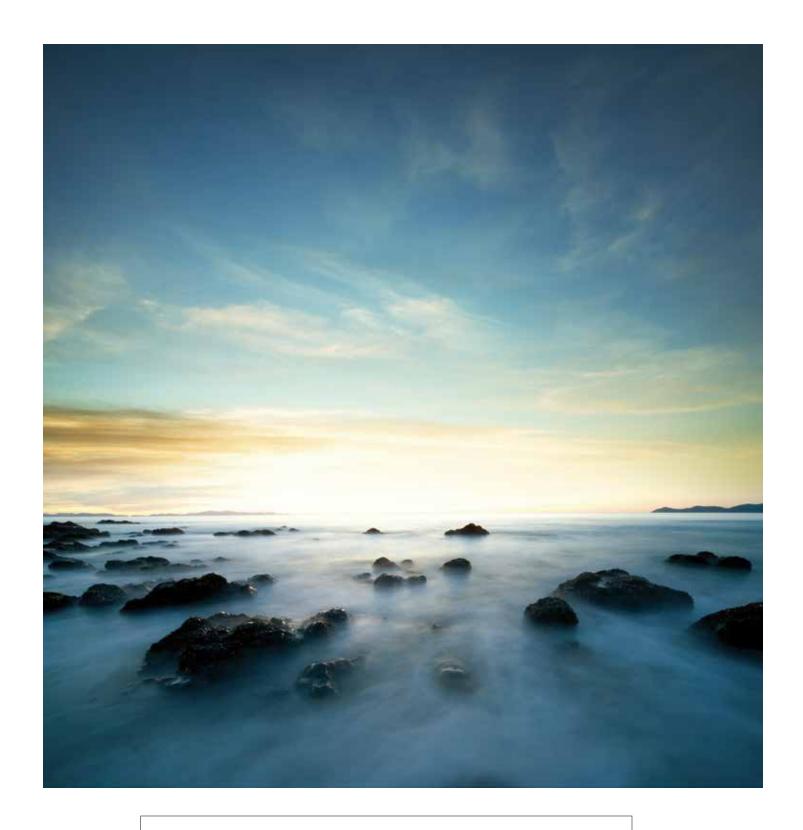


2017

The EPA removed seven Superfund sites, substantially or entirely, from the National Priorities List (NPL), sparking debate about ongoing efforts to clean contaminated sites.



READ FACULTY PERSPECTIVES ON OUR ENVIRONMENTAL FUTURE
NICHOLAS.DUKE.EDU/MAGAZINE



66 YOU CANNOT GET THROUGH A SINGLE DAY WITHOUT HAVING AN IMPACT ON THE WORLD AROUND **YOU**. WHAT **YOU** DO MAKES A DIFFERENCE, AND **YOU** HAVE TO DECIDE WHAT KIND OF DIFFERENCE **YOU** WANT TO MAKE. **99**

THE ROLL DIVIDE



research

"For rural voters, it is not a contradiction to consider yourself pro-environment and yet oppose or have strong reservations about the government's environmental policies," said Robert Bonnie, executive-in-residence at the Nicholas Institute, who led the study.

"In our research, we repeatedly heard rural voters share strong support for conservation and environmental protection in the abstract, but then raise concerns for the impacts or efficacy of government environmental policies," he said.

This concern about government overreach wasn't just a function of political party. Rural Democrats, Republicans and independents all showed less support for federal oversight of the environment and greater preference for policies that are overseen by state or local government that give local residents a greater say in managing their own resources.

"My hope is that this will help us understand how to find common ground with rural constituencies and bridge the urban-rural divide. If rural voters are more comfortable with policies that allow for state and local partnerships and collaboration with rural stakeholders, then this could be an effective approach for enacting nationwide climate measures," said Bonnie, who teaches courses at the Nicholas School and graduated from the school with master's degrees in forestry and environmental management in 1994.

Rural voters aren't rejecting environmental regulation, he added. They understand the need for policies that protect the environment and have a relatively sophisticated understanding of the economic trade-offs. What they are doubtful about is the ability of the federal government to do this well and not increase hardships in rural communities.

To illustrate the point, Bonnie recalled interviewing one farmer from South Dakota who said, "I'm going to sit here and tell you that the climate is very different than it was when my dad was farming the ground. (But farmers) are almost hesitant to say it because they are afraid of the policy consequences once everybody admits it."

The new report comes amid a growing push by scientists, many lawmakers, and a majority of the American public for climate action following years of record-breaking wildfires, floods and other extreme natural disasters. However, major legislation is unlikely to clear Congress without at least some backing from rural industries like agriculture and forestry, which in the past have opposed proposed federal climate policies.

To help find ways to spur new support, Bonnie's team examined who rural voters trust for information on the environment and which messages are most likely to resonate with them.

"We found that messages that appeal to rural Americans' sense of moral responsibility and their interest in acting on behalf of future generations were effective," Bonnie said. "But the messenger may be more important than the message."

Ranchers and farmers emerged as the most trusted sources of information,

followed by university scientists and government experts. Environmental advocacy groups were far less likely to be viewed as trustworthy.

Interestingly, although voters said they trusted university scientists, they also said they rarely received information from them. This, Bonnie said, suggests that developing new pathways to deliver scientific information to rural Americans could be an important focus for policy and outreach.

Bonnie designed the research and wrote the new report with fellow Nicholas School alum Emily Pechar Diamond, now an assistant professor of communication studies and marine affairs at the University of Rhode Island. Diamond earned a PhD in environmental policy from the Nicholas School and Duke's Sanford School of Public Policy in 2019. Her doctoral thesis was "Depolarizing Environmental Policy: Identities and Public Opinion on the Environment."

Elizabeth Rowe, a second-year Master of Environmental Management (MEM) student at the Nicholas School, helped conduct the research and co-wrote the report.

Six other Nicholas School students, including five MEMs and one undergraduate, helped design and conduct focus groups for the project as part of a Democracy Lab course project led by Bonnie and Diamond.

From late 2017 through 2019, the team held focus groups with about 125 rural voters in the West, Midwest and South and polled more than 2,000 additional rural and urban

voters by phone and online. They also interviewed 36 leaders from local government, farming, forestry, business and conservation districts, including leaders in the African-American landowner community and tribal governments.

The polls, focus groups and interviews highlighted some intriguing commonalities and differences between rural and urban Americans' attitudes on the environment.

Clean water is the highest environmental priority among both groups, but rural voters were, at the same time, much more likely to voice concerns about the Clean Water Act's adverse impacts on farmers and other members of their communities.

Many of these voters though, "showed a powerful commitment to protecting the environment, motivated in large part by a strong place identity and desire to maintain local environmental resources for future generations," said Diamond.

These attitudes are reflected in the high importance rural Americans place on issues such as farmland conservation, soil and water conservation, and having clean air for their children to breathe – all of which can yield tangible and sometimes immediate local benefits – in contrast to the much lower priority they place, compared to urban voters, on global issues with deferred benefits, such as climate change.

"If you emphasize win-win solutions and appeal to people's moral responsibility, rural voters are more likely to respond positively. But bridging the urban-rural divide will require more than just new talking points," Bonnie said. "It will require engagement and new partnerships with rural stakeholders and rethinking the design of our environmental policies." *



DOWNLOAD THE FULL REPORT

THE FULL 40-PAGE REPORT,

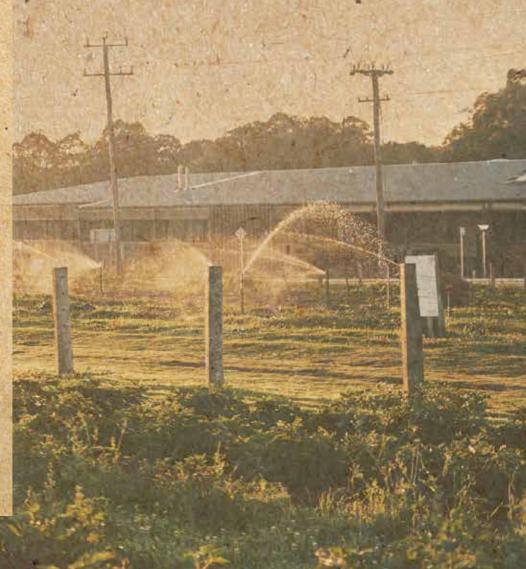
"UNDERSTANDING RURAL

ATTITUDES TOWARD

THE ENVIRONMENT AND

CONSERVATION IN AMERICA," @

HTTP://BIT.LY/RURALATTITUDES







SHOLLY

Cam Sholly, DEL-MEM'10 worked his way up the National Park Service (NPS) ranks to become Yellowstone National Park's superintendent in 2018. Along the way, he decided to search for an opportunity to broaden his environmental experience. The DEL-MEM program caught his attention.

"One of the top-rated schools in the country offering a program conducive to people working full-time was one of the most attractive—if not the most attractive—part of it," Sholly said.

"It's just an outstanding program and I highly recommend it around the country. No matter where you are in life, it can be very enriching. Even if you have a family, and you've got a busy job, it's still something you can fit in and get something real substantive out of."

Sholly said he also benefitted from the real-world experience other members of his cohort brought to the program.

"Classmates were in different lines of work—in the public and private sectors—and most of them were further advanced in life and career, so that was an enhancer," he said.

After graduation, Sholly served as an associate director for the NPS and as the NPS Northwest regional director, overseeing 61 parks in 13 different states.

At Yellowstone, where he began his NPS career in 1990, Sholly is charged with managing the largest national park operation in the world with 800 employees and about 4 million visitors each year.

Sholly credits a combination of experiences and education for his career growth.

"You don't necessarily come across a decision and think, 'Hey, I learned that at Duke,'" he said. "But the experience as a whole exposed me to a lot of different perspectives that I didn't have earlier in my career. All together that continues to help advance sound decision making for me and hopefully anyone else who attends the program."

PROGRAM/HALLMARKS

Our recent ranking as the nation's **most innovative online MEM degree** by the independent ranking service OnlineMasters.com reflects the importance of our program's hallmark features.

RELEVANT CURRICULUM

We incorporate real-life case studies containing problems and solutions directly relatable to your current job and career aspirations into our coursework.

- 2 MULTIDISCIPLINARY APPROACH
 The DEL-MEM program provides insights into many aspects
 of environmental issues by taking advantage of Duke's wide
 range of expertise and resources.
- 3 EXPERIENCED, DIVERSE PARTICIPANTS

We are committed to admitting a diverse student body comprised of high-potential environmental professionals – enabling you to network and exchange ideas with colleagues in your field.

4 ENGAGED FACULTY

You will learn from recognized experts in the field – faculty committed to education, whose work addresses our most important environmental and natural resource challenges.

 $\begin{array}{c|c} & FLEXIBLE, \ INNOVATIVE \\ & FORMAT \end{array}$

We understand that you need to keep learning to advance towards your goals. Through a combination of online and traditional learning, the DEL-MEM allows you to update your education while maintaining your commitment to your job and family.

6 LEADERSHIP DEVELOPMENT

"Leadership in Environmental Management" is a central theme incorporated throughout the DEL-MEM curriculum. You will have the opportunity to assess and enhance your leadership skills within courses and through a workshop in Washington, D.C., that features prominent leaders from the private, public and non profit sectors.

IMMEDIATE RESULTS

Since you will be working while studying, you can immediately apply what you learn to the benefit of your career and your organization or agency.





THREATT -TAYLOR

Dale Threatt-Taylor DEL-MEM'11 had just been promoted to director of the Wake County (N.C.) Soil and Water Conservation District in 2008, when she felt challenged to expand her skills.

"I wanted to see what else was out there beyond what I was focusing on," she said. "When I saw the Duke curriculum, and what I would be exposed to and challenged with, I just said 'I gotta go for this.' It fit me like a glove."

Threatt-Taylor, who earlier this year was named executive director of The Nature Conservacy's South Carolina chapter, said her biggest takeaway from the DEL-MEM program was learning to look at environmental work through a broader perspective.

"When you're in the DEL program, you're exposed to what everybody else has experienced and what they know," she said. "That was a bonus to the education—to listen and talk and create partners and friends across the U.S. and the world."

Threatt-Taylor was also empowered to amplify the word of conservation and the many stakeholders affected by it. Along the way, she earned the nickname "conservation evangelist" and worked to make sure that everyone had a voice at the table.

"There are no unimportant partners, everybody—every partner, landowner, government official—can be an asset and can contribute to the solutions that we're trying to solve in a global or local scale," said Threatt-Taylor.

As the first African American state director for The Nature Conservancy, she serves as the chief executive and conservation strategist for its South Carolina chapter. Threatt-Taylor credits the DEL-MEM program for opening the door to one of the largest environmental organizations in the world.

"I do not think I would have been afforded this opportunity without the experience in program, and that piece of paper that says Duke University on it."

CHERIEWILSON

Cherie Wilson DEL-MEM'15 was still a relatively new mom working fulltime at an environmental consulting firm in Washington, D.C., when she began looking at master's programs.

"I needed to find a program that would allow me to maintain my dayto-day life and have the flexibility to accommodate the pretty demanding schedule that I had," she said.

The Duke Environmental Leadership program fulfilled her need and more.

"I loved the live online platform, which made me feel like I wasn't missing the classroom experience," Wilson said. "And the place-based sessions really allowed for bonding within the cohort.

"The program's unique leadership module was like having amazing therapy sessions, where we all had a chance to unload and talk about challenges in the workplace, and how to get through them while keeping our eyes on the prize."

Wilson, who now serves as director of federal affairs at General Motors, said that those lessons were priceless.

"It was really a value-add to the program because everyone came in with very different backgrounds and perspectives and interests," she said. "You really got to see the diversity of the field. People were able to bring their real-life experiences in the workplace and that really made for rich discussion. That helped strengthen the work in the classroom."

Wilson joined GM soon after graduation in a role primarily responsible for advocating at the federal policy level on behalf of the company's financial services arm, GM Financial.

But, as the leadership training in the DEL-MEM program taught her, she was able to leverage her passion and influence to broaden the scope of her role to include sustainability advocacy.

"My colleagues in the program and I were inspired to find ways to bring about change to challenges, such as climate change, on whatever scale in whatever our sphere of influence may be."





TRANSFERABLE / SKILLS

DEL-MEM students receive in-depth training in:

- 1 LEADERSHIP DEVELOPMENT
- (2) PROGRAM MANAGEMENT
- (3) POLICY ANALYSIS
- (4) ECONOMIC ANALYSIS
- (5) STRATEGIC ANALYSIS
- (6) COMMUNITY-BASED MANAGEMENT

PROGRAM OBJECTIVES

The Duke Environmental Leadership Master of Environmental Management (DEL-MEM) provides mid-career working professionals with the interdisciplinary skills and knowledge needed to accelerate their leadership journey and advance their careers.

Through individual and group coursework and a master's project, students deepen their knowledge of core concepts in environmental management and leadership, and tackle real-life case studies that are directly related to current professions.

PATH: PRIVATE DEGREE: DEL-MEM'15 POSITION:

DIRECTOR OF FEDERAL AFFAIRS AT GENERAL MOTORS

PROGRAM / FORMAT

Our unique program format melds the Nicholas School's multidisciplinary environmental curriculum with the renowned "place and space™" model of Duke's Fuqua School of Business. Students reap the benefits of both online and face-to-face learning models to engage in challenging coursework, develop core leadership skills, and foster lasting relationships with their professors and peers.



Visit us online to view more info on place-based sessions and space-based sessions.

nicholas.duke.edu/del-mem

SONIA BRUBAKER

For more than a decade, Sonia Brubaker, DEL-MEM'14 has worked at the U.S. Environmental Protection Agency (EPA) to ensure that the public has access to sustainable sources of safe drinking water.

Not long into her time at the EPA, she found that an integral part of that mission is communicating the value of water—which would go on to be the focus of her DEL-MEM master's project.

"It's really expensive and people often don't understand what it takes to get water in your faucet," Brubaker said. "Getting people to understand what they're paying for—and why it's important—is a big part of the job.'

Brubaker said that what she learned through the DEL-MEM program led her in 2018 to become the director of the EPA's Water Infrastructure and Resiliency Finance Center, which helps local leaders make informed water infrastructure decisions.

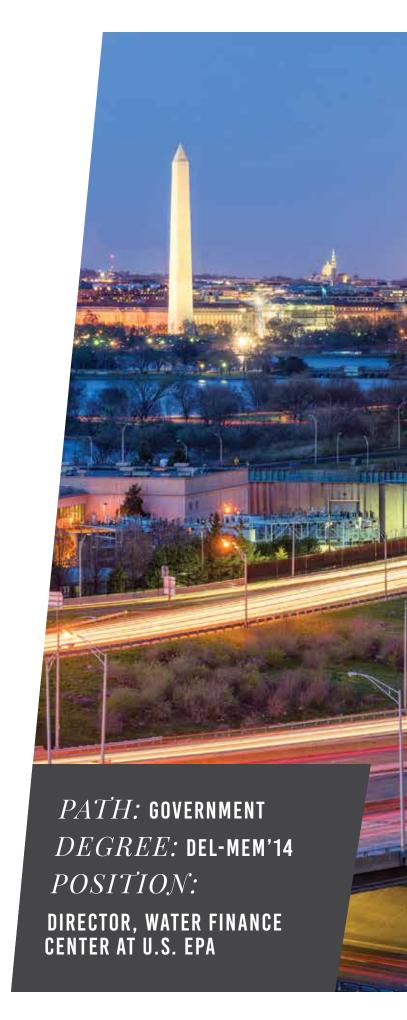
"After I graduated, I used all the research that I had done, and all the ideas I developed, and really put them into action," she said. "I believe it's what helped me get to where I am now."

Brubaker said that the emphasis on leadership in the DEL-MEM program was a strong complement to her Duke education, and something she still relies on.

"It allowed us to discuss how we inspire people, how we get these new ideas out there to make a change in the world," she said.

Brubaker added that an unexpected benefit of the DEL-MEM program was making lasting friendships.

"It was great to go through it with other people who were also working full-time, had a family and had other stuff going on," she said. "I found that it was a great way to meet people who had similar goals—but also brought different perspectives on the world. It was eye-opening to work so closely with them for two years and learn from their experience."





TREVORHUGHES

As Trevor Hughes DEL-MEM'19 started thinking about the end of his U.S. Coast Guard career, he wanted to prepare himself for a future outside the military.

"Retirement can be pretty intimidating and I wanted to take the next step in my development to ensure that not only was the transition smooth, but that it was also an upward trajectory," he said.

Hughes, who was promoted to master chief marine science technician after graduation, chose the DEL-MEM program because it appealed to his continued desire to grow as a leader in the military while also providing access to a world-class Duke education.

Hughes' background primarily focused on environmental response and disaster recovery—having worked on the decontamination of Lower Manhattan after 9/11 and cleanup efforts after the Deepwater Horizon oil spill. The program challenged him to grow outside his comfort zone.

He said that learning from others in the program was greatly valuable. With three kids at home and a demanding career, he also found comfort in seeing his classmates persevere through personal and career changes.

"Life didn't stop for my cohort, like it didn't stop for me," he said. "That kept me from feeling isolated as a working professional and a father."

As one of only 10 master chief marine science technicians in the nation, Hughes is responsible for ensuring regulatory compliance of environmental protection regulations along the Puget Sound region in the Pacific Northwest.

In his 17th year in the Coast Guard, Hughes plans to continue mentoring the next generation to ensure that they understand the systemwide importance of what they do.

"The DEL-MEM program gave me the tools, the education, the network and the confidence necessary to successfully transition from the military into my next career." *



AIR FILTERS HELP ASTHMATIC KIDS BREATHE EASIER

Using a bedroom air filter that traps particles of pollution with diameters smaller than 2.5 micrometers can significantly improve breathing in asthmatic children, a new study co-led by Nicholas School faculty member Junfeng "Jim" Zhang shows.

It's the first study to document that physiological improvements occur in children's airways when air filters are in use, suggesting that with consistent use filters may help prevent, not just alleviate, asthmatic flare-ups.

While using the filters daily for two weeks, children in the study experienced decreased airway resistance and lung inflammation and increased airway elasticity, among other benefits.

"Pharmaceutical companies have spent large amounts to develop drugs that can work on lower airways, but they are very expensive. Our results show that using an air purifier to reduce the exposure of lower airways to pollutants could help asthmatic children breathe easier without those costly drugs," said Zhang, professor of global and environmental health.

"This warrants a clinical trial to confirm findings," he said.

Thirty times smaller in diameter than a human hair, fine particulate matter (PM2.5) is a ubiquitous air pollutant. It originates from fossil fuel emissions, industrial sources and wildfires. The particles penetrate deep into the lower airways where they can trigger or exacerbate asthma symptoms. Inhalers don't help, since they are only designed to open the upper airways.

Zhang and his colleagues published their paper in *JAMA Pediatrics*, a journal of the American Medical Association.

They conducted the study in Shanghai during a period of moderately high PM2.5 pollution in 2017. Forty-three children with mild to moderate asthma were given two

air filters to use in their bedrooms. One was a high-efficiency particulate air filter capable of removing PM2.5; the other was a sham filter. Each filter was used for two weeks with a two-week interval in between. Neither the children nor their families knew which filter was which.

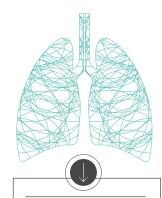
Results showed that PM2.5 concentrations inside the children's bedrooms were up to two-thirds lower when the real air filters were in use than when the sham ones were being used.

This drop coincided with significant improvements in how easily air flowed in and out of the children's small airways and lungs. These improvements included a 24% average reduction in total airway resistance, a 43.5% average reduction in small airway resistance, a 73.1% average increase in airway elasticity, and a 27.6% average reduction in exhaled nitric oxide, a biomarker of lung inflammation.

Although the benefits lasted only as long as the air filters were in use, the filters could serve as a practical preventive measure for asthma management in polluted outdoor or indoor environments worldwide, Zhang said.

They could also be lifesavers in areas near wildfires.

"Look at the high PM2.5 pollution levels that occurred in San Francisco last year as a result of smoke from the California wildfires, and at the air-quality problems happening this year from the bushfires in Australia," he said. "People should really consider using one of these devices during wildfires." Xiaoxing Cui, a 2018 doctoral graduate of Duke, led the study with Zhang. *



THIS DROP COINCIDED
WITH SIGNIFICANT
IMPROVEMENTS
IN HOW EASILY AIR
FLOWED IN AND OUT OF
THE CHILDREN'S SMALL
AIRWAYS AND LUNGS.



AVERAGE REDUCTION
IN TOTAL AIRWAY
RESISTANCE



AVERAGE REDUCTION IN SMALL AIRWAY RESISTANCE



AVERAGE INCREASE IN AIRWAY ELASTICITY



AVERAGE REDUCTION IN EXHALED NITRIC OXIDE, A BIOMARKER OF LUNG INFLAMMATION

The water filter on your refrigerator door, the pitcher-style filter you keep inside the fridge and the whole-house filtration system you installed last year may function differently and have vastly different price tags, but they have one thing in common.

They may not remove all of the drinking water contaminants you're concerned about.

A new study co-led by Nicholas School faculty member Heather Stapleton finds that - while using any filter is better than using none - many household filters are only partially effective at removing toxic perfluoroalkyl substances, commonly known as PFAS, from drinking water.

A few filters, if not properly maintained, can even make the situation worse.

"We tested 76 point-of-use filters and 13 point-of-entry or whole-house systems and found their effectiveness varied widely," said Stapleton, Dan and Bunny Gabel Associate Professor of Environmental Health.

"All of the under-sink reverse osmosis and two-stage filters achieved near-complete removal of the PFAS chemicals we were testing for. In contrast, the effectiveness of activated-carbon filters used in many pitcher, countertop, refrigerator and faucet-mounted styles was inconsistent and unpredictable," she said. "The whole house systems were also widely variable and in some cases actually increased PFAS levels in the water."

"Home filters are really only a stopgap. The real goal should be control of PFAS contaminants at their source," said Detlef Knappe, professor of civil, construction and environmental engineering at North Carolina State University, whose lab teamed with Stapleton's to conduct the study.

Exposure to PFAS, used widely in fire-fighting foams and stain- and waterrepellants, is associated with various cancers, low birth weight in babies, thyroid disease, impaired immune function and other health disorders. Mothers and young children may be most vulnerable to the chemicals, which can affect reproductive and developmental health.

Some scientists call PFAS "forever chemicals" because they persist in the environment indefinitely and accumulate in the human body. They are now nearly ubiquitous in human blood serum samples, Stapleton noted.

The researchers published their peerreviewed findings in the journal *Environmental* Science & Technology Letters. It's the first study to examine the PFAS-removal efficiencies of point-of-use filters in a residential setting.

Samples of filtered water from homes in six North Carolina counties were analyzed for a suite of PFAS contaminants, including GenX, which has been found in high levels in water in the Wilmington, N.C., area.

The analysis showed that reverse osmosis filters and two-stage filters reduced PFAS levels in water by 94% or more, although their high costs might put them out of reach for many of the households most affected by contamination. Activated-carbon filters, which are more affordable, removed 73% of contaminants on average.

The efficiency of whole-house systems using activated carbon filters was more variable. In four of the six systems tested, some contaminant levels actually increased after filtration.

Researchers saw no clear trends between removal efficiency and filter brand, age or source water matrix level. Changing out filters regularly is probably a very good idea, nonetheless, they stressed. Nick Herkert, a postdoctoral associate in Stapleton's lab, was lead author on the study. *

THESE MAY NOT REMOVE ALL OF THE DRINKING WATER CONTAMINANTS YOU'RE CONCERNED ABOUT.



THE PITCHER-STYLE FILTER YOU KEEP INSIDE THE FRIDGE











THE WHOLE-HOUSE FILTRATION SYSTEM

HOME FILTERS ARE REALLY ONLY A STOPGAP. THE REAL GOAL SHOULD BE CONTROL OF PFAS CONTAMINANTS AT THEIR SOURCE 99

—DETLEF KNAPPE

DETLEF KNAPPE IS S. JAMES ELLEN DISTINGUISHED PROFESSOR OF CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING AT NC STATE UNIVERSITY



THE GOOD

"All of the under-sink reverse osmosis and two-stage filters achieved near-complete removal of the PFAS chemicals we were testing for.



+ THE BAD

"The effectiveness of activatedcarbon filters used in many pitcher, countertop, refrigerator and faucet-mounted styles was inconsistent and unpredictable,"

WHAT WORKS BEST FOR YOUR MONEY?

MANY HOUSEHOLD FILTERS
ARE ONLY PARTIALLY
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THE ANALYSIS SHOWED THAT REVERSE OSMOSIS FILTERS AND TWO-STAGE FILTERS REDUCED PFAS LEVELS IN WATER BY 94% OR MORE, ALTHOUGH THEIR HIGH COSTS MIGHT PUT THEM OUT OF REACH FOR MANY OF THE HOUSEHOLDS MOST AFFECTED BY CONTAMINATION. ACTIVATED-CARBON FILTERS, WHICH ARE MORE AFFORDABLE, REMOVED 73% OF CONTAMINANTS ON AVERAGE.



REPLACING COAL WITH NATURAL GAS + RENEWABLES SAVES WATER

The ongoing transition from coal to natural gas and renewables in the U.S. electricity sector is dramatically reducing the industry's water use, new research shows.

"While most attention has been focused on the climate and air quality benefits of switching from coal, this new study shows that the transition to natural gas - and even more so, to renewable energy sources has resulted in saving billions of gallons of water," said Avner Vengosh, professor of geochemistry and water quality.

These savings in both water consumption and water withdrawal have come despite the intensification of water use associated with fracking and shale gas production, the new study shows.

"For every megawatt of electricity produced using natural gas instead of coal, the amount of water withdrawn from local rivers and groundwater is reduced by 10,500 gallons, the equivalent of a 100day water supply for a typical American household," said Andrew Kondash, a postdoctoral researcher at Duke, who led the study as part of his doctoral dissertation under Vengosh.

Water consumption – the amount of water used by a power plant and never returned to the environment - drops by 260 gallons per megawatt, he said.

At these rates of reduction, if the rise

of shale gas as an energy source and the decline of coal continues through the next decade, by 2030 about 483 billion cubic meters of water will be saved each year, the study predicts.

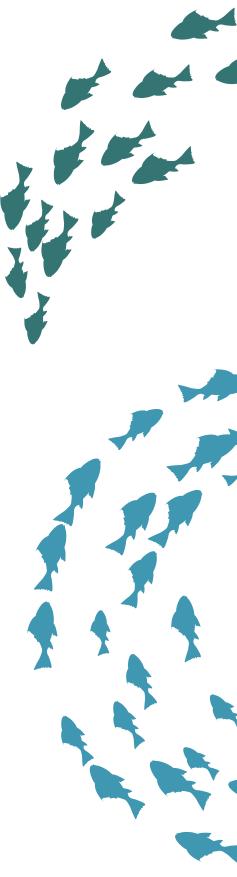
Although the magnitude of water use for coal mining and fracking is similar, cooling systems in natural gas power plants use much less water in general than those in coal plants. That can quickly add up to substantial savings, since 40% of all water use in the United States currently goes to cooling thermoelectric plants, Vengosh noted.

If all coal-fired power plants are converted to natural gas, the annual water savings will reach 12,250 billion gallons that's 260% of current annual U.S. industrial water use.

Further savings could be realized by switching to solar or wind energy. The new study shows that the water intensity of these renewable energy sources, as measured by water use per kilowatt of electricity, is only 1% to 2% of coal or natural gas's water intensity.

Dalia Patiño-Echeverri, Gendell Associate Professor of Energy Systems, co-authored the study with Kondash and Vengosh.

They published their peer-reviewed paper in the journal Environmental Research Letters. *



CHANGES IN TUNA'S CARBON RATIOS SIGNAL A SHIFT IN OCEANIC FOOD WEB

The ratio of carbon isotopes in three common species of tuna has changed substantially since 2000 and this change suggests major shifts are taking place in phytoplankton populations that form the base of the ocean's food web, a new study co-led by the Nicholas School's Nicolas Cassar finds.

"The change we observed in tuna, which are near the top of the marine food web, reflects profound changes in physiology or species composition occurring at the bottom of the food web," said Cassar, professor of biogeochemistry.

By analyzing nearly 4,500 samples of muscle tissue from three common species of tuna caught in the Atlantic, Pacific and Indian oceans between 2000 and 2015, Cassar and his colleagues discovered that the fishes' carbon stable isotope composition values (δ 13C) declined by between 0.08% and .25% during the study period.

About a quarter of the decline in $\delta 13C$ values is attributable to the increased availability of isotopically light fossil fuel-derived carbon in marine ecosystems, Cassar said. This was a change the researchers expected to see.

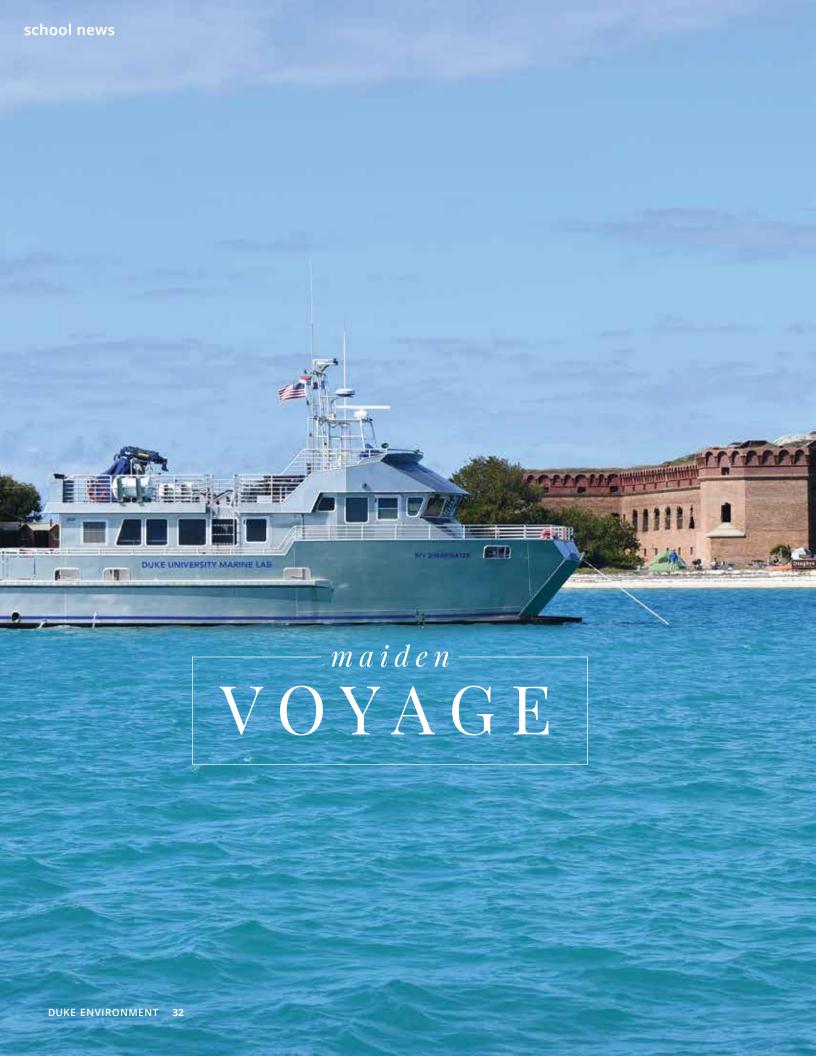
What's driving the rest of the decline isn't yet clear, he said, but one possibility is that much of it may be linked to increased ocean stratification.

Over the last 50 years, 90% of the heat and 30% of the carbon emissions associated with global warming have been absorbed by the oceans. This has promoted conditions in which water masses with different densities, temperatures or levels of saltiness can stratify in layers beneath the surface rather than mix together, creating barriers that inhibit nutrients from rising up from deeper waters to provide fuel for phytoplankton near the surface.

While other contributing factors can't yet be ruled out, analysis conducted as part of the new study supports the hypothesis that as nutrients become more limited at the surface because of stratification, large $\delta 13C$ -rich phytoplankton such as diatoms may be outflanked by smaller phytoplankton cells, which have a natural competitive advantage in lean times.

The magnitude of the decline observed in tuna δ 13C values over such a short time span suggests "this is an issue that merits close scrutiny and additional study," Cassar said. "Because tuna travel long distances, they integrate changes in the food web structure over very large spatial scales."

Scientists from France, the United States, Germany, Australia, New Zealand, Spain, the Seychelles and the French territory of New Caledonia contributed to the research. They published their findings in the journal *Global Change Biology.* *









66

WE CONDUCTED
VALUABLE LAB WORK,
AND THE CREW WAS
INSTRUMENTAL IN
OUR LEARNING—
ALLOWING US TO
TAKE OWNERSHIP OF
THE SCIENCE AND
GIVING US HANDS-ON
OPPORTUNITIES TO
DEPLOY CTDS, STEER
THE SHIP, AND MAP
OUT A ROUTE FOR
OUR FINAL PROJECT.

- STACY CHEN T'22

99



he R/V Shearwater, Duke Marine Lab's new research, education, and outreach vessel, received an enthusiastic welcome after arriving in the port of Miami, at a special event honoring its launch.

The state-of-the-art R/V Shearwater made its

maiden research voyage, which was led by Zackary Johnson, associate professor of molecular biology in marine science. Johnson was joined by six Nicholas School students, and a crew of three that took a ten-day trip around South Florida, the Dry Tortugas and Gulf of Mexico.

The trip included sailing the open sea and visits to a handful of coastal ports. The students experienced a number of marine science learning opportunities like working in teams, data collection and sampling; tracking nutrients and currents; and measuring bacteria and phytoplankton.



PARTICIPATING STUDENTS

Stacy Chen,

Brittany Pashkow, Waverly Reibel, Natalie Rodriguez, Audrey White, and Nicholas School Scholar Cameron Adams. All but Chen, an Environmental

Environmental
Science student, are
studying Coastal
and Environmental
Management.





"LONG MAY SHE SAIL!"

On hand to celebrate the R/V Shearwater, were Duke President Vincent Price, Nicholas School Stanback Dean Toddi Steelman, Marine Lab Director Andy Read, members of the Duke Alumni Association Executive Committee and the Nicholas School Board of Visitors, donors, friends, students, faculty, and staff. Nicholas Board of Visitors members Barbara and Neil Smit were acknowledged for their generous donation to fund the new marine operations dock at the Marine Lab that will berth the Shearwater.

The celebration took place over lunch at American Airlines Arena, with Price, Steelman, and Read speaking about the success of Shearwater's first research trip and how the vessel greatly enhances experiential learning. President Price praised the achievement and offered a toast by exclaiming, "Long may she sail!"

OTHER EVENT HIGHLIGHTS INCLUDED:

- A presentation by Read about Shearwater's advanced features and capabilities, and how the vessel will be used for leading-edge Duke Marine Lab research, hands-on education, and community outreach efforts.
- Tours of the vessel, led by the crew and students who participated in the vessel's first class and research trip.

SUPPORT SHEARWATER'S WORK

Field oceanographic research and education present unique opportunities to understand our environment. Duke alumni who wish to invest in Shearwater's contributions to environmental research, education, and outreach can do so through the "Get on Board" campaign. Ways to give include:

- NAMING GIFTS Opportunities to name parts of Shearwater are still available.
- **SPONSORSHIPS** Fund a student, a research day at sea, or a multiday trip. *







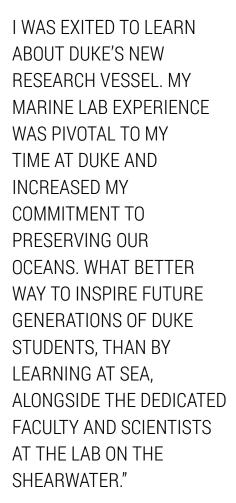
Duke President Vincent Price, Nicholas School Stanback Dean Toddi Steelman, Marine Lab Director Andy Read, members of the Duke Alumni Association Executive Committee and the Nicholas School Board of Visitors, donors, friends, students, faculty, and staff.



SHEARWATER

LEARN MORE ABOUT SUPPORTING
THE R/V SHEARWATER
BY CONTACTING KEVIN MCCARTHY AT
KEVIN.P.MCCARTHY@DUKE.EDU.





JOE VITAGLIANO

KAREN KIRCHOF Karen Kirchof, former associate dean of the Nicholas's School Career and Professional Development Center and a

Development Center and a fierce and vocal champion of our students, passed away in June 2019. To honor her, we have renamed our school's internship fund the Karen Kirchof Internship Fund. Karen's decades-long commitment to student success and her tireless work to create new internships opportunities for them helped launch the careers of more than 3.000 future environmental leaders. She was well-known and widely loved for challenging students to "be bold" in their career choices and "reach higher" to have a positive impact on the world.





pg 34 on the boat: Marine Lab Director Andy Read, R/V Shearwater captain Matthew Dawson, Stanback Dean Toddi Steelman, Duke University President Vincent Price, Kevin McCarthy associate dean, Development + Alumni Relations. pg 35 Joe Vitagliano and Andy Read

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