

THE NATIONAL CONFERENCE ON MARINE ENVIRONMENTAL DNA

November 29-30
2018



The
Rockefeller
University



The Marine Science & Policy Series



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The Marine Science & Policy Series



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About the Monmouth-Rockefeller University Partnership

In 2015, Monmouth University and The Rockefeller University entered into a five-year agreement to pursue a trio of collaborative activities supporting ocean research, education and marine policy. The partnership is the fruit of Monmouth University's successful Marine Science and Policy Initiative Challenge Grant campaign. Collaboration between Monmouth University's Urban Coast Institute (UCI) and The Rockefeller University's Program for the Human Environment (PHE) offers a rare opportunity for timely, flexible support of influential marine science and policy.

The trio of activities in the Monmouth-Rockefeller partnership comprise better observation of ocean noise and its biological effects; smarter, more flexible, and more cohesive development and use of emerging approaches for ocean exploration; and speedy, reliable and affordable use of environmental DNA fragments, or eDNA, to detect the presence and abundance of marine species. To help focus the initiative and amplify its impact, the PHE, led by Jesse Ausubel, and the UCI, led by Tony MacDonald, jointly plan and conduct scientific symposia of regional and national interest. The National Conference on Marine Environmental DNA is the third of four annual conferences in the Marine Science & Policy Series, which are alternating between the campuses of Monmouth in West Long Branch, N.J., and Rockefeller in New York City. The partnership enables access to national and international experts, and engages in complementary programs that reflect the priorities and strengths of each institution.

Advisory Panel: Michael Kubin, RADM Richard Larrabee, USCG (Ret.), Russell Pennoyer, Steven Ramberg, Howard Rosenbaum, Robert Sculthorpe

National Conference on Marine Environmental DNA Sponsors

- Joan and Robert Rechnitz
- Schmidt Ocean Institute
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- Hudson River Foundation

The National Conference on Marine Environmental DNA

Since ever, fishers, children, and scientists have dreamed of sampling the oceans' free-ranging animals without the need to capture or even observe them directly. We stand on the beach or a boat and dream of wearing magic goggles that allow us to know the diversity, distribution, and abundance of marine life. About 20 years ago, researchers glimpsed the realization of the dream, when they appreciated that animals shed DNA in aquatic environments, and that studies of these genetic fragments, known as environmental or eDNA, might provide the evidence from which we could conjure accurate, timely descriptions of marine life.

On behalf of our sponsors, welcome to the first National Conference on Marine Environmental DNA. This conference marks the third of four annual events in a series organized by The Rockefeller University and Monmouth University through a collaboration called the Marine Science & Policy Initiative. The first conference addressed new requirements and styles of ocean exploration and is recounted in the Final Report of the 2016 National Ocean Exploration Forum. In 2017 the second conference, Mid-Atlantic Blue Ocean Economy 2030, assembled leading scientists, policymakers, conservationists, business and community leaders, and communicators to identify opportunities to better align economic growth opportunities and the health of the ocean. This year it is our honor to engage you to see the life of the blue world in a seemingly clear cup of water.

While genetics has become an imperial science, a key for this meeting is to learn its limits and challenges. How fast, accurate, reliable, and affordable are present and foreseeable techniques? How compact and easily operable is the equipment? What are the barriers to greater diffusion and use? How can America make best use of these techniques, for the joy of discovery as well as healthy and wealthy oceans? Crucially, how does eDNA join other tools and techniques in our toolkit to make a powerful, dependable, and efficient system of ocean observation?

Like the arrival of the sextant in the 17th century, eDNA promises safer navigation, in this case for all marine life, because of the potential for wiser human relations with it. May the participants in this conference set the course. Thanks to all.

Jesse Ausubel

Director, Program for the Human Environment, The Rockefeller University

Vice Admiral Paul Gaffney, USN (Ret.)

Ocean Policy Fellow, Urban Coast Institute, Monmouth University



AGENDA

Thursday, November 29, 2018

- 11:00–12:30** *Registration and lunch, Greenberg Building/CRC, outside Carson Family Auditorium*
- 12:30–12:45** *Introductory comments: Jesse Ausubel, The Rockefeller University, Carson Family Auditorium*
- 1:00–1:30** *Plenary I: Francisco Chavez, Monterey Bay Aquarium Research Institute*
Marine eDNA - Opportunities and Challenges for Biological Observing at Regional to Global Scales.
- 1:30–2:00** *Plenary II: Ryan Kelly, University of Washington*
A 10,000-Foot View of eDNA Studies.
- 2:00–2:30** *Coffee, Greenberg Building/CRC, outside Carson Family Auditorium*
- 2:30–3:00** *Plenary III: Elizabeth Andruszkiewicz, Stanford University*
Investigating Environmental DNA Transport in the Coastal Ocean Using a Numerical Ocean Model and Lagrangian Particle Tracking.
- 3:00–3:30** *Plenary IV: Bruce Nash, Cold Spring Harbor Laboratory*
Building and Implementing a Biochemical and Bioinformatic Workflow to Enable Authentic Student eDNA Research.
- 3:30–4:00** *Plenary V: Mark Stoeckle, The Rockefeller University*
Tracking Seasonal Fish and Marine Mammals in a Busy Ocean.
- 4:00–4:30** *Coffee, Greenberg Building/CRC, outside Carson Family Auditorium*
- 4:30–6:00** *Thursday teams meet (Technology development; US applications; Bioinformatics; eDNA biology)*
- 6:00–7:00** *Reception, Greenberg Building/CRC, outside Carson Family Auditorium*
Recognition of prosecutor and novelist Linda Fairstein for incorporation of DNA in the courtroom and fiction on the occasion of publication of *Secrets from the Deep*.
- 7:00–8:30** *Dinner, Greenberg Building/CRC, outside Carson Family Auditorium*

Friday, November 30, 2018

- 7:30–8:30** *Breakfast, Greenberg Building/CRC, outside Carson Family Auditorium*
- 8:30–9:00** *Plenary VI: Barbara Block, Stanford University, Carson Family Auditorium*
Voyage to the White Shark Café: Sequencing at Sea to Locate Top Predators.
- 9:00–9:30** *Plenary VII: David Lodge, Cornell University*
Science, Technology and Application Frontiers of Freshwater and Marine eDNA.
- 9:30–10:00** *Plenary VIII: Kelly Goodwin, Cisco Werner, NOAA*
eDNA: a NOAA Perspective.
- 10:00–11:30** *Friday teams meet (Technology development; US applications; Bioinformatics; eDNA biology)*
- 11:30–11:45** *Coffee, Greenberg Building/CRC, outside Carson Family Auditorium*
- 11:45–12:15** *Closing comments: Paul Gaffney, Monmouth University, Carson Family Auditorium*
- 12:15–2:00** *Monmouth University Urban Coast Institute Champion of the Ocean Award luncheon*
Abby Dining Room, Abby Aldrich Rockefeller Hall
Honoree and Speaker: Dr. Marcia McNutt, President, National Academy of Sciences
Welcome: Grey Dimenna, Esq., President, Monmouth University
Presenter: Tony MacDonald, Director, Monmouth University UCI



Potential Marine eDNA Applications

Monitoring Biodiversity Impacts

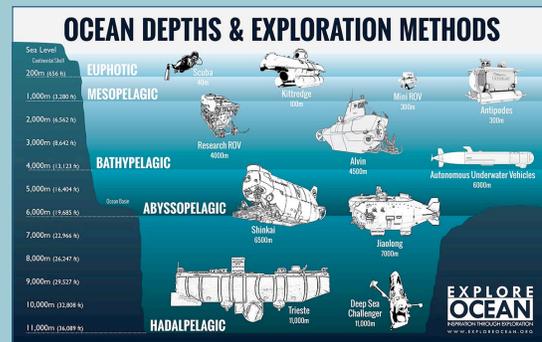
Fishing/Aquaculture/Mining/Energy/Shipping



Weather/Climate/Conservation/Restoration



Research/Exploration



Conveners

JESSE HUNTLEY AUSUBEL

Jesse Huntley Ausubel is Director of the Program for the Human Environment at The Rockefeller University in New York. The program elaborates the technical vision of a large, prosperous society that emits little harmful and spares large amounts of land and sea for nature. Mr. Ausubel both conducts and manages research. Programs he has helped conceive and lead include the Census of Marine Life, to assess and explain the diversity, distribution, and abundance of life in all oceans; the Barcode of Life Initiative, to provide short DNA sequences that identify animal, plant, and fungal species; Encyclopedia of Life to create a webpage for every species; Deep Carbon Observatory, to search for the origin and limits of life and the roots of petroleum and natural gas, and International Quiet Ocean Experiment to survey the ocean soundscape and assess effects of sound added by human activities on marine life. Author or editor of 150 publications, Mr. Ausubel is an adjunct scientist of the Woods Hole Oceanographic Institution. Mr. Ausubel served on President Clinton's Panel on Ocean Exploration in 2000 and co-chaired the 2012 decadal review of the US government program in ocean exploration. In 2010 he received the Blue Frontier/Peter Benchley prize for ocean science and in 2012 was named America's National Ocean Champion. His portrait was included in an exhibit on two dozen leading ocean explorers in 2013.

VICE ADMIRAL PAUL GAFFNEY

Vice Admiral Paul Gaffney, USN (Ret.), is President Emeritus of Monmouth University and an Ocean Policy Fellow in the Urban Coast Institute at Monmouth University. He also served as President of the National Defense University. He is a former Chief of Naval Research and former Commander of Naval Meteorology and Oceanography. He was appointed as a Commissioner, U.S. Commission on Ocean Policy and served during its full term, chaired the Ocean Research Advisory Panel and was the first chair of the Ocean Exploration Advisory Board. Along with Professor Ausubel, he co-chaired the Decadal Review of the National Ocean Exploration Program. The National Academy of Engineering selected him as a Member and he serves on the National Academies Gulf Research Program Advisory Board.



Speakers

ELIZABETH ANDRUSZKIEWICZ

Elizabeth Andruszkiewicz is a Ph.D. candidate in the Civil and Environmental Engineering Department at Stanford University. Her work focuses on studying environmental DNA (eDNA) in oceanic environments to further the advancement of identifying taxa in the water column from DNA in water samples. She is interested in investigating the persistence and transport of eDNA to better understand how to interpret results from both metabarcoding and quantitative PCR assays. She is currently working on developing a modeling framework for eDNA transport in Monterey Bay subject to different forcing scenarios and eDNA properties. Previous work includes investigating the spatial heterogeneity of eDNA in the water column and the role of sunlight in eDNA decay in marine waters. Elizabeth completed her B.S. at the University of Notre Dame in Civil and Environmental Engineering. She started her research on eDNA there by investigating transport of eDNA in freshwater streams using both laboratory experiments and field experiments at the Notre Dame Linked Experimental Ecosystem Facility (LEEF).

BARBARA BLOCK

Barbara Block is the Charles and Elizabeth Prothro Professor in Marine Sciences in Stanford University's Department of Biology. Her lab is based at Stanford's Hopkins Marine Station. Her research focuses on how large pelagic fishes utilize the open ocean environment. Investigations center upon understanding the evolution of heat management strategies in tunas, billfishes, and sharks. Block and her colleagues investigate the cellular mechanisms underlying heat generation and force production in skeletal muscle, the evolution of internal heat production, and the physiological ecology of tunas and billfishes. The research in the lab is interdisciplinary, combining physiology, ecology, and genetics with oceanography and engineering. Block and colleagues at the Monterey Bay Aquarium also established the Tuna Research and Conservation Center, a unique facility that permits physiological research on tunas. They are employing new techniques in remote wildlife tracking and data collection, and molecular genetics to directly examine the short and long-term movement patterns, population structure and behavior of tunas and billfishes. The fish are highly exploited in international fisheries and effective management of existing biodiversity requires an understanding of their biology and population structure. The Block lab actively engages in research at sea to understand the movements and physiological ecology of tunas and billfishes and to gain insight into the selective advantage of heat production in fishes. Block received her PhD from Duke University.

Speakers (continued)

FRANCISCO CHAVEZ

Francisco Chavez is a biological oceanographer interested in how climate variability and change regulate ocean ecosystems on local and basin scales. He was born and raised in Peru, has a B.S. from Humboldt State and a Ph.D. from Duke University. He is a founding member of the Monterey Bay Aquarium Research Institute (MBARI) where he has pioneered time series research and the development of new instruments and systems to make this type of research sustainable. Chavez has authored or co-authored over 250 peer-reviewed papers with 12 in *Nature* and *Science*. He is past member of the US National Science Foundation Geosciences Advisory Committee, has been actively involved in the development of the US Integrated Ocean Observing System (IOOS), is a member of the Governing Board of the Central and Northern California Coastal Ocean Observing System (CeNCOOS) and the Science Advisory Team for the California Ocean Protection Council. Chavez is a Fellow of the American Association for the Advancement of the Sciences; honored for distinguished research on the impact of climate variability on oceanic ecosystems and global carbon cycling. Chavez is also a Fellow of the American Geophysical Union; honored for advancing fundamental knowledge of the physical-biological coupling between Pacific Decadal Oscillations, productivity, and fisheries. The Universidad Pedro Ruiz Gallo in Peru recognized him as Doctor Honoris Causa because of his distinguished scientific career and for contributing to elevate academic and cultural levels of university communities in particular and society in general. Chavez is the 2014 recipient of the Ed Ricketts Memorial award.

KELLY GOODWIN

Kelly Goodwin is part of the Ocean Chemistry and Ecology Division of NOAA's Atlantic Oceanographic and Meteorological Laboratory and is stationed at NOAA's Southwest Fisheries Science Center. Dr. Goodwin primes development, validation, application, and technology transfer of molecular biological tools to address NOAA missions, including improved assessment of ecosystem status. Novel approaches such as high-throughput sequencing of metagenomes and in-situ and automated ocean sampling platforms are used to catalogue biodiversity at multiple levels (bacteria, phytoplankton, zooplankton, fish). Dr. Goodwin's interdisciplinary training supports application of rapid molecular methods to identify sources of microbial and nutrient aquatic contamination with implications for remediation strategies, human safety, and environmental policy. Dr. Goodwin began working for the National Oceanic and Atmospheric Administration (NOAA) in 1999. From 1995-1998, she served as a National Research Council Postdoctoral Associate at the U.S. Geological Survey in Menlo Park, CA, working on the microbial biogeochemistry of halocarbons. She received M.S. (1990) and Ph.D. (1996) degrees in Environmental Engineering Science from the California Institute of Technology (Caltech) in Pasadena. She has a minor in Oceanography (1993) from Caltech through a program in residence at the Scripps Institute of Oceanography. Dr. Goodwin received a B.S. degree in Neurobiological Sciences from the University of Florida in 1988.



Speakers (continued)

RYAN KELLY

Trained as both an ecologist and a lawyer, Ryan Kelly has a broad set of interests, focused both on hard scientific data and policymakers' use of those data. From the science side, he studies the interplay between geography, ecology, and genetics in marine species. His more applied research joins genetic and ecological research with real-world implementation in law and policy, particularly with respect to environmental monitoring, resource management, endangered species, and ocean acidification. In general, he is drawn to projects that have significant elements of both scientific and policy relevance as we work toward more sustainable use of marine resources. Dr. Kelly received his Ph.D. in Ecology, Evolution, and Environmental Biology from Columbia University, and his JD from University of California, Berkeley, School of Law.

DAVID LODGE

David Lodge is Francis J. DiSalvo Director of Cornell University's Atkinson Center for a Sustainable Future, and a professor in the Department of Ecology and Evolutionary Biology. His research focuses on ecological forecasting to better inform environmental risk assessment, natural resource management, and policy development. On numerous occasions he has testified before the U.S. Congress. He served as an expert witness in federal court involving eDNA as evidence of the presence of Asian Carp. He was the first chair of the U.S. government's Invasive Species Advisory Committee in 2000-01, led research on freshwater biodiversity as part of the United Nations' Millennium Ecosystem Assessment in 2000-05, and led an expert subcommittee providing advice to the U.S. Environmental Protection Agency on reducing invasions from the ballast water of ships in 2010-11. He served on the NOAA Scientific Advisory Board, in 2013-2016, as a Jefferson Science Fellow in the US Department of State in 2014-15, and was President of the Ecological Society of America in 2016-2017.

Speakers (continued)

BRUCE NASH

Bruce Nash is Assistant Director for Science at Cold Spring Harbor Laboratory's DNA Learning Center. He holds a doctorate in medical and molecular genetics from the University of Toronto and has research and teaching experience in developmental biology, cell biology, genetics and microscopy. After completing a postdoctoral position at The University of Oregon he joined the DNALC, where he has developed approaches that democratize independent research by students using RNA interference (RNAi), DNA barcoding to identify and study biodiversity, and most recently using high throughput sequencing for metabarcoding of complex mixtures, including using eDNA to study marine fish.

MARK STOECKLE

Mark Stoeckle is Senior Research Associate in the Program for the Human Environment at The Rockefeller University. His research interests include environmental genomics, DNA barcoding, and molecular evolution. Dr. Stoeckle helped organize the early meetings that laid the foundation for the DNA barcoding initiative, including "Taxonomy, DNA, and the Barcode of Life" conference held at the Banbury Center, Cold Spring Harbor Laboratory, New York in September 2003, the inaugural meeting of the Consortium for the Barcode of Life (CBOL), held at the Smithsonian Institution, National Museum of Natural History, Washington, DC, in May 2004, and the inaugural workshop for All Birds Barcoding Initiative (ABBI), "Barcoding Life Takes Flight", held at the Museum of Comparative Zoology, Harvard University, September 2005. His DNA barcoding projects with high school students attracted wide attention, including front-page articles in The New York Times, Washington Post, and Wall Street Journal. Dr. Stoeckle published the first time-series environmental

DNA study of the lower Hudson River estuary in 2017, and presented on eDNA at the United Nations in September 2018. Dr. Stoeckle is a graduate of Harvard University and Harvard Medical School.

CISCO WERNER

Cisco Werner is NOAA's Director of Scientific Programs and Chief Science Advisor. As Director, Dr. Werner is involved in planning, developing, and managing a multidisciplinary scientific enterprise of basic and applied research on living marine resources. Prior to being named Director of Scientific Programs and Chief Science Advisor, he served as the Director of NOAA Fisheries' Southwest Fisheries Science Center (SWFSC). Cisco brings extensive experience leading scientific efforts in the federal government and previously in academia as Director and Professor of Rutgers University's Institute of Marine and Coastal Sciences and Chairman of the University of North Carolina at Chapel Hill's (UNC-CH) Department of Marine Sciences. While at UNC-CH, Dr. Werner was the George & Alice Welsh Distinguished Professor from 2005-2008. From 2007-2017 he was co-Editor in Chief of the journal *Progress in Oceanography*. His research has focused on the oceanic environment through numerical models of ocean circulation and marine ecosystems in the Atlantic and Pacific Oceans. He has studied the effects of physical forcing on lower trophic levels and the subsequent effect on the structure, function and abundance of commercially and ecologically important species, and has authored and co-authored over 100 papers in scientific journals and book chapters. He received his Doctorate in Oceanography in 1984, a Master of Science in Oceanography in 1981, and a Bachelor of Science in Mathematics in 1978, all from the University of Washington.



Ocean Champion Award Luncheon Presenters

GREY J. DIMENNA

Grey J. Dimenna, J.D., is the ninth president of Monmouth University. As president, Dimenna has advanced the goals and objectives set forth in the comprehensive strategic plan endorsed by the Board of Trustees in 2014, and embraced a student-centric approach to his presidency. Dimenna took the helm of Monmouth during a period of tremendous growth, including a new partnership to establish the Bruce Springsteen Archives and Center for American Music, the introduction of new graduate and undergraduate academic programs, and significant progress toward renovation and construction projects including a new Monmouth Stadium and the University's largest capital investment in academic facilities at the School of Science. Prior to his appointment as president by the Board of Trustees, Dimenna previously served as vice president and general counsel at Monmouth University for 20 years, retiring from the position in July 2015. Before joining Monmouth, Dimenna served from 1991 to 1995 as Assistant Section Chief/Senior Deputy Attorney General for the New Jersey Department of Law and Public Safety where he supervised 25 deputy attorneys general, including attorneys representing the state colleges. He was primary counsel for several of the New Jersey State Colleges and Universities and also represented the Department of Higher Education and the New Jersey Higher Education Assistance Authority. Dimenna earned his bachelor's degree in History from the State University of New York at Binghamton and a Juris Doctorate at the Syracuse University College of Law.

TONY MACDONALD

Tony MacDonald is the director of the Urban Coast Institute (UCI) at Monmouth University. Founded in 2005, the UCI serves Monmouth and the public as a forum for research, education, and collaboration in the development and implementation of science-based policies and programs that support stewardship of healthy, productive, and resilient coastal ecosystems and communities. He was previously the Executive Director of the Coastal States Organization (CSO) from 1998-2005. CSO, based in Washington, DC, represents the interests of the Governors of the United States' 35 coastal states and territories on coastal and ocean policy matters. Prior to joining CSO, Tony was the special counsel and director of Environmental Affairs at the American Association of Port Authorities, where he represented the International Association of Ports and Harbors (IAPH) at the International Maritime Organization on negotiations on the London Convention. Tony has also practiced law with a private firm in Washington, DC, working on environmental and legislative issues, and served as the Washington, DC, environmental legislative representative for the Mayor of the City of New York.

Monmouth University Urban Coast Institute Champion of the Ocean Award Luncheon

November 30, 12:30 p.m. | Abby Dining Room | Abby Aldrich Rockefeller Hall
Guests Must Be Registered



MARCIA MCNUTT

Marcia McNutt is a geophysicist and the 22nd president of the National Academy of Sciences. From 2013 to 2016, she was editor-in-chief of the journal *Science*. McNutt was director of the U.S. Geological Survey from 2009 to 2013, during which time USGS responded to a number of major disasters, including the *Deepwater Horizon* oil spill. For her work to help contain that spill, McNutt was awarded the U.S. Coast Guard's Meritorious Service Medal. Before joining the USGS, McNutt served as president and chief executive officer of the Monterey Bay Aquarium Research Institute, which under her guidance became a leader in developing biological and chemical sensors for remote ocean deployment, installed the first deep-sea cabled observatory in U.S. waters, and advanced the integration of artificial intelligence into autonomous underwater vehicles for complex undersea missions. She also chaired the President's Panel on Ocean Exploration, convened by President Clinton in 2000. McNutt is a member of the American Philosophical Society and the American Academy of Arts and Sciences, and a Foreign Member of the Royal Society, UK, and the Russian Academy of Sciences. In 1998, McNutt was awarded the American Geophysical Union's Macelwane Medal for research accomplishments by a young scientist, and she received the Maurice Ewing Medal in 2007 for her contributions to deep-sea exploration.

OCEAN CHAMPION

CAMPUS MAP

EAS



WEISS RESEARCH BUILDING

BIOSCIENCE CENTER

64th STREET GATE DELIVERIES

FRANKLIN D. ROOSEVELT AVENUE

ROCKEFELLER RESEARCH BUILDING

FRICKE HALL

EAST RIVER ESPLANADE

GASSER HALL

BRONK LABORATORY

IT PAVILION

HOSPITAL

GRADUATE STUDENTS RESIDENCE

YORK AVENUE

NURSES RESIDENCE

WELCH HALL (Markus Library)

FOUNDER'S HALL

66th ST GATE MAIN ENTRANCE VISITORS

FUTURE STAVROS NIARCHOS FOUNDATION-DAVID ROCKEFELLER RIVER CAMPUS

FLEXNER HALL

CASPARY HALL

CASPARY AUDITORIUM

ABBY ALDRICH ROCKEFELLER HALL

COLLABORATIVE RESEARCH CENTER

Carson Family Auditorium

Abby Dining Room

GREENBERG BUILDING

Faculty and Students Club

Philosophers Garden

SMITH HALL ANNEX

SMITH HALL

Tennis Court

PRESIDENT'S HOUSE

Additional Resources

Visit phe.rockefeller.edu/eDNAMarine2018 for additional resources from the National Conference on Marine Environmental DNA, including copies of materials shared by presenters.

Other Marine Science & Policy Series Events

2017 The Mid-Atlantic Blue Ocean Economy 2030 Forum, held at Monmouth University

More at: monmouth.edu/uci/symposium2017

2016 The National Ocean Exploration Forum: Beyond the Ships 2020-2025, held at The Rockefeller University

More at: phe.rockefeller.edu/noef

ABOUT LINDA FAIRSTEIN

A graduate of Vassar College and the University of Virginia Law School, Linda Fairstein ran the sex crimes unit of the Office of the New York District Attorney from 1976 to 2002. In 1986 Ms. Fairstein was among the first prosecutors to introduce DNA into the courtroom, and handled many high profile cases, including the Robert Chambers/Jennifer Levin case, known as the Preppy Murder. In 1993, while working full-time, Fairstein published *Sexual Violence: Our War Against Rape*, which the New York Times named a Notable Book. Having successfully written nonfiction, Fairstein, encouraged by an agent friend, decided to try fiction and initiated a series of novels about prosecutor Alexandra Cooper, inspired by crime cases on which she actually worked and New York settings. She is now working on her 20th Cooper novel, many of which have been bestsellers, and has also completed three novels for young readers about Devlin Quick, the Manhattan teenage daughter of the chief of the New York Police Department who is also a sleuth. Although she retired from the DA's office in 2002, Fairstein remains active in *pro bono* legal work and an advocate for strong science in law enforcement and the judiciary.

**National Conference on Marine Environmental DNA
Program Advisory Committee**

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Tony MacDonald, Monmouth University

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Bruce Nash, Cold Spring Harbor Laboratory

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