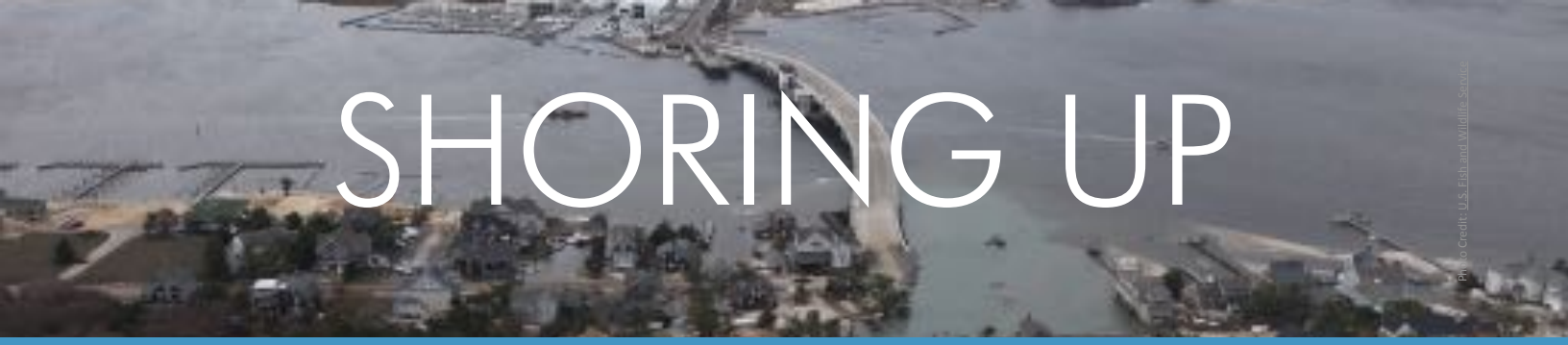


SHORING UP

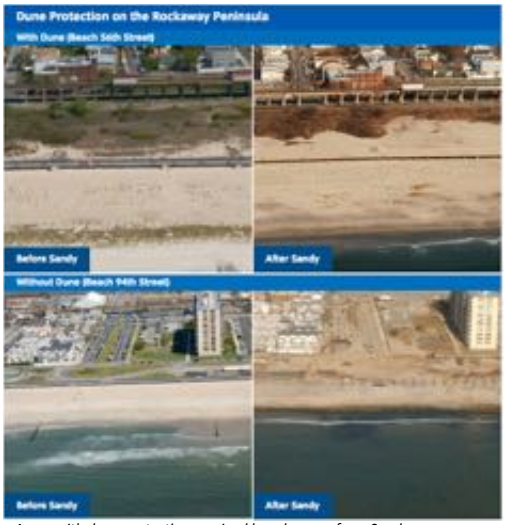
Photo Credit: U.S. Fish and Wildlife Service

A science briefing on the potential of natural infrastructure to enhance the resilience of our nation's coasts

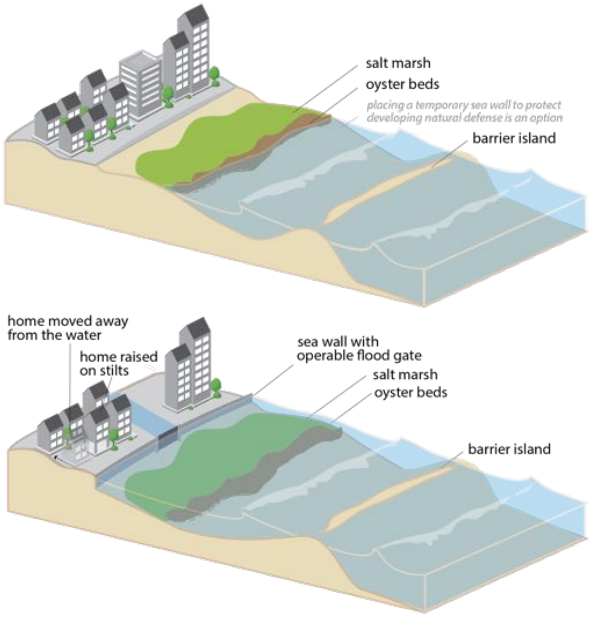
Coastal communities and infrastructure are vulnerable to storms and flooding – a problem made worse by rising sea levels. Natural infrastructure, such as dunes and wetlands, is an important part of the solution to protect our nation's coasts. We are improving our ability to identify opportunities to use natural infrastructure and to measure the multiple benefits provided under a range of conditions.

Natural infrastructure can protect coastal communities

Recent storms such as Hurricane Sandy have dramatically impacted major cities. These storms lead to loss of human lives and homes, disrupted businesses, and damaged infrastructure. Efforts to rebuild after such events, as well as to prepare for future ones, increasingly consider natural infrastructure because it can contribute to the resilience of coastal communities.



Areas with dune protection received less damage from Sandy
Figure Credit: A Stronger, More Resilient New York. 13 June 2013.
http://www.nyc.gov/html/sirr/html/report/report.shtml



Images show examples of natural infrastructure (top) and hybrid infrastructure (bottom).
Figure Credit: Sutton-Grier et al 2015.

Natural infrastructure has been used for decades – but new information is helping us realize its full potential

For years, federal agencies and others have used natural infrastructure to ensure multiple benefits for people. For example, restoring a wetland can reduce floods impacts but also filter water, provide recreation opportunities, and protect wildlife habitat. What's new is our increased ability to identify, measure, and sometimes monetize the long-term benefits and costs of different infrastructure options. There is a growing realization that hybrid approaches — combining layers of natural and built infrastructure — provide many valuable benefits.

Key Considerations

Natural infrastructure can increase cost efficiency: Knowing where natural habitats provide protection now, and where they could offer multiple benefits in the future, can help deliver more cost effective solutions for protecting coastal communities, property, and infrastructure.

Location matters: The value of coastal habitats (dunes, wetlands, coastal forests, reefs) for protection from erosion and flooding varies spatially. Strategic approaches can inform where protecting existing coastal habitat or restoring and/or building natural or hybrid structures can optimize benefits.

Implementation and research can go hand-in-hand: Though much research is still coming online, scientists have developed frameworks to help decision makers assess alternative scenarios for natural infrastructure in terms of cost, protection, and performance — both in the short and long term. Full implementation and integration of these approaches may ultimately require re-examining approaches to permitting, as well as more broadly incorporating ecosystem services assessment into decision making.

Case Study: evaluating options for urban coastal resilience in Howard Beach, NY

Layers of natural, built, and hybrid infrastructure could provide protection and other benefits. Case study from The Nature Conservancy, *Urban Coastal Resilience: Valuing Nature's Role.*

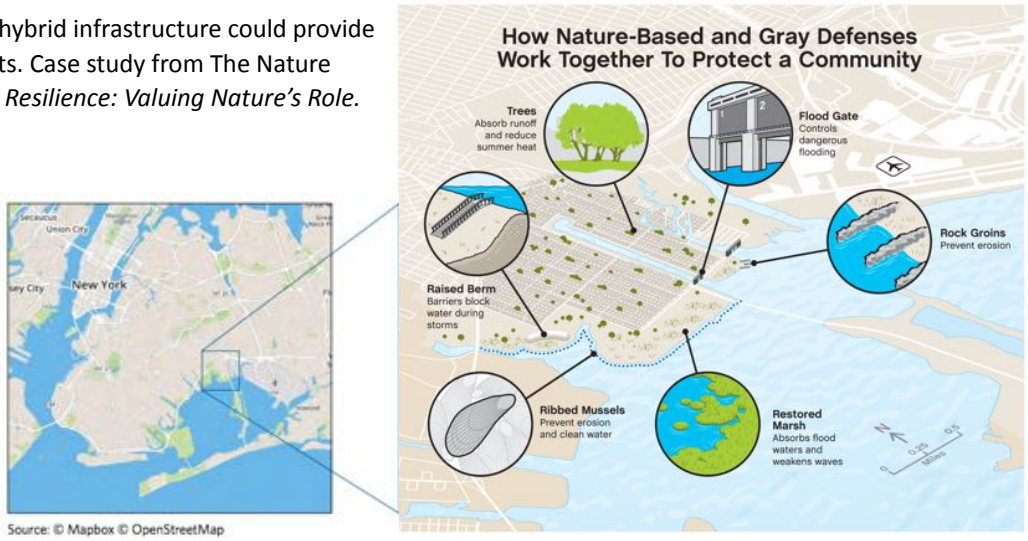


Figure Credit: Urban Coastal Resilience: Valuing Nature's Role Case Study: Howard Beach, Queens, New York, July 2015

For More Information

Dr. Ariana Sutton-Grier, *University of Maryland / National Oceanic and Atmospheric Administration*
Phone: 301-713-3074 ext. 110 | E-mail: ariana.sutton-grier@noaa.gov

Dr. Todd Bridges, *United States Army Corps of Engineers, Engineer Research and Development Center*
Phone: 601-634-3626 | E-mail: todd.s.bridges@usace.army.mil

Dr. Mary Ruckelshaus, *Stanford University / The Natural Capital Project*
Phone: 206-271-6858 | E-mail: mary.ruckelshaus@stanford.edu

Dr. Elizabeth C. Smith, *The Nature Conservancy*
Phone: 646-775-8003 | E-mail: ecodner-smith@tnc.org

SELECTED REFERENCES

Alleman, L., J. Carrera, E.N. Maxwell, E.C. Smith, et al. 2015. Urban Coastal Resilience: Valuing Nature's Role. Case Study of Howard Beach, Queens, New York. Washington, DC: The Nature Conservancy, and CH2M Hill.
Available at: http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/newsroom/the-nature-conservancy-releases-innovative-urban-coastal-resilience-report-o.xml

Evaluates how natural infrastructure (such as mussel beds and restored marsh) can be successfully used in a dense, urban setting in combination with built infrastructure (such as sea walls and flood gates) to provide efficient and cost-effective protection from sea level rise, storm surge, and coastal flooding. This report explicitly estimates the economic value of the contributions of nature, finding that combining natural and built defenses holds the most benefits.

Arkema, K.K., G. Guannel, G. Verutes, S.A. Wood, et al. 2013. Coastal habitats shield people and property from sea-level rise and storms. Nature Climate Change 3: 913-918.
Available at: http://msp.naturalcapitalproject.org/msp_concierge_master/docs/Arkema_etal_2013_NCC.pdf

Presents a national map of risk reduction due to natural habitats for the entire U.S. coastline. By considering the people and property most vulnerable to coastal hazards and storms, this research paper identifies where conservation and natural infrastructure can have the greatest potential to protect coastal communities.

Bridges, T.S., P.W. Wagner, K.A. Burks-Copes, M.E. Bates, et al. 2015. Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience. ERDC SR-15-1. Vicksburg, MS: U.S. Army Engineer Research and Development Center.
Available at: http://el.erdc.usace.army.mil/elpubs/pdf/sr-15-1.pdf

Develops a framework for identifying and evaluating opportunities to integrate natural and built infrastructure, to support coastal risk reduction and resilience. This research report describes how natural infrastructure can reduce risks from coastal storms, and also provide a range of additional ecosystem services that support coastal ecosystems and communities (including benefits related to commercial and recreational fisheries, tourism, clean water, habitat, and support for cultural practices).

Coastal Green Infrastructure and Ecosystem Services Task Force. 2015. Ecosystem-Service Assessment: Research Needs for Coastal Green Infrastructure. Washington, DC: Office of Science and Technology Policy.
Available at: https://www.whitehouse.gov/blog/2015/08/27/using-green-infrastructure-enhance-coastal-resilience

Recommends areas for prioritized Federal research to support the integration of natural infrastructure into risk reduction, resilience planning, and decision making. This report is a useful reference for planners and decisions makers that provides an introduction to major categories of natural infrastructure and associated ecosystem services, as well as factors that should be taken into account when considering if, when, and how to incorporate natural infrastructure into a given setting.

Sutton-Grier, A.E., K. Wowk, H. Bamford. 2015. Future of our coasts: The potential for natural and hybrid infrastructure to enhance the resilience of our coastal communities, economies and ecosystems. Environmental Science & Policy 51: 137-148.
Available at: http://www.resilient-infrastructure-holdingpage.org/wp-content/uploads/2015/05/Future-of-Our-Coasts.pdf

Highlights strengths and weaknesses of the coastal protection benefits provided by built infrastructure, natural ecosystems, and hybrid approaches for coastal protection. Includes case studies where hybrid approaches are being implemented to improve coastal resilience as well as some policy challenges that can make implementation of these approaches more difficult.

PANELIST BIOGRAPHIES

Photo Credit: U.S. Fish and Wildlife Service

Ariana Sutton-Grier

Research Faculty, University of Maryland
Ecosystem Science Adviser, National Oceanic and Atmospheric Administration
Silver Spring, MD

Phone 301-713-3074 ext. 110 | **E-mail** ariana.sutton-grier@noaa.gov

Dr. Ariana Sutton-Grier is an ecosystem ecologist with expertise in wetland ecology and restoration, biodiversity, biogeochemistry, climate change, and ecosystem services. Dr. Sutton-Grier is a research faculty member at the University of Maryland in the Earth System Science Interdisciplinary Center and is also the Ecosystem Science Adviser for the National Ocean Service at NOAA. She holds Bachelor's degrees from Oregon State University in Environmental Science and International Studies and a doctoral degree from Duke University in Ecology. She leads the NOAA Coastal Blue Carbon Team as well as an interagency blue carbon group. She gets especially excited about seeking and discovering innovative opportunities to combine science and policy to solve environmental problems and promote ecosystem conservation. Her research has been published in many environmental and policy journals and featured in several news stories, as well as a children's science TV show.

Todd Bridges

Senior Research Scientist for Environmental Science
Engineer Research and Development Center, United States Army Corps of Engineers
Vicksburg, MS

Phone 601-634-3626 | **E-mail** todd.s.bridges@usace.army.mil

Dr. Todd Bridges is the U.S. Army's Senior Research Scientist for Environmental Science. He became a Senior Professional (ST) within the U.S. Army in 2006, where his responsibilities include leading research, development and environmental initiatives for the U.S. Army and U.S. Army Corps of Engineers (USACE). His primary areas of research activity at the U.S. Army Engineer Research and Development Center concern 1) the science and engineering of sustainable infrastructure development, 2) the development of risk and decision analysis methods applied to water resources infrastructure and environmental systems, and 3) assessment and management of environmental contaminants. Over the last 20 years, Dr. Bridges has published more than 60 journal articles and book chapters and numerous technical reports. He received his B.A. (1985) and M.A. (1988) in Biology/Zoology from California State University, Fresno and his Ph.D. (1992) in Biological Oceanography at North Carolina State University.

Mary Ruckelshaus

Managing Director
Natural Capital Project / Stanford University
Seattle, WA

Phone 206-271-6858| **E-mail** mary.ruckelshaus@stanford.edu

Dr. Mary Ruckelshaus is a consulting professor at the Stanford Woods Institute for the Environment. She is the Director of the Natural Capital Project partnership which develops approaches for valuing nature and the services it provides and to integrate these values into decision-making. Her recent work focuses on developing ecological models including estimates of the flow of environmental services under different management regimes in marine systems worldwide. Dr. Ruckelshaus previously led the Ecosystem Science Program at NOAA's Northwest Fisheries Science Center. She also serves on the Science Council of The Nature Conservancy and is a Trustee on its Washington Board and is a past chair of the Science Advisory Board of the National Center for Ecological Analysis and Synthesis (NCEAS). She was Chief Scientist for the Puget Sound Partnership, a public-private institution charged with achieving recovery of the Puget Sound terrestrial, freshwater and marine ecosystems. Dr. Ruckelshaus has a B.S. in human biology from Stanford University, an M.S. in fisheries from the University of Washington, and a Ph.D. in botany, also from the University of Washington.

Elizabeth C. Smith

Environmental Economist
The Nature Conservancy
New York

Phone 646-775-8003| **E-mail** ecodner-smith@tnc.org

Dr. Elizabeth C. Smith is an environmental economist with The Nature Conservancy in New York. Her overall research focus includes market and non-market valuation for natural resources, experimental market design for ecosystem services and public preferences for environmental management. For the last decade Dr. Smith's research has focused on exploring methodologies for valuation and provision of critical environmental assets, including ecosystem services. Since joining The Nature Conservancy in 2012 Dr. Smith's research has been focused on the valuation of Long Island's market and non-market goods that impact the coastal economy. She now spends the majority of her time working on projects at the intersection of infrastructure, community resilience and policy, specifically, trying to integrate a better understanding of natural assets and trade-offs of decision-making and planning. Dr. Smith received her BA from Villanova University, her MPA from Columbia University in Conservation Policy and her Ph.D. in environmental and resource economics from University of Rhode Island.

David Malakoff

Deputy News Editor
Science Magazine
Washington, DC

Phone 202-326-6446| **E-mail** dmalakof@aaas.org

David Malakoff is a science writer with Science Magazine in Washington, D.C. where he covers the politics of science and writes about research discoveries in a wide range of fields. He previously served as Editor-at-Large of Conservation Magazine. And from 2004 to 2008 he was a correspondent and senior editor on NPR's Science Desk, helping steer the network's coverage of science, technology, and the environment.

Ya'el Seid-Green
American Meteorological Society
Policy Program
202.355.9821
yseidgreen@ametsoc.org

Erica Goldman
COMPASS
Director of Policy Engagement
202.630.7480
erica.goldman@COMPASSonline.org

Heather Mannix
COMPASS
Policy Engagement Specialist
202.681.2106
heather.mannix@COMPASSonline.org