



IMPROVED USE AND UNDERSTANDING OF NNBF IN THE MID-ATLANTIC

March 2017



MARCO
MID-ATLANTIC REGIONAL
COUNCIL ON THE OCEAN

IMPROVED USE AND UNDERSTANDING OF NNBF IN THE MID-ATLANTIC

The Mid-Atlantic Regional Council on the Ocean (MARCO) and the Climate Change Action Team (CCAT) recognize that information on sustaining wetlands, nature-based shoreline management and climate change is rapidly evolving, and continued research is important to understand the systems affected by the environment and management efforts. The information in this report will inform MARCO activities, but nothing in this document should be construed as a MARCO endorsement or MARCO policy. MARCO and CCAT hope that others find the information in this report useful to their climate adaptation efforts.

Suggested citation: Schrass, K. and A.V. Mehta. 2017. Improved Use and Understanding of NNBF in the Mid-Atlantic. Annapolis, MD: National Wildlife Federation.

Cover photo: U.S. Fish and Wildlife Service

ACKNOWLEDGMENTS

Funding for this project was provided by MARCO under an award from the U.S. Department of Interior (DOI) through the North Atlantic Landscape Conservation Cooperative (NALCC), but this material does not represent official DOI or NALCC policy.

The National Wildlife Federation would like to thank all of the stakeholders in New York, New Jersey, Delaware, Maryland and Virginia who contributed their time and knowledge throughout the course of this project. In addition, NWF would like to extend special thanks to the Mid-Atlantic Regional Council on the Ocean Climate Change Action Team and Management Board for their invaluable input, guidance and support.



National Wildlife Federation
20 Ridgley Avenue, Suite 203
Annapolis, MD 21401
www.nwf.org

CONTENTS

LIST OF ABBREVIATIONS	3
EXECUTIVE SUMMARY	4
SECTION 1: INTRODUCTION	5
DEFINING NATURAL AND NATURE-BASED FEATURES	6
PROJECT METHODOLOGY	6
HOW TO READ THIS REPORT	7
 SECTION 2: BUILDING THE CASE FOR NNBF	7
CHALLENGE: DEMONSTRATING THE VALUE OF NNBF VS. GRAY INFRASTRUCTURE	9
CHALLENGE: IDENTIFYING AND HIGHLIGHTING APPROPRIATE CONTRACTORS AND PROJECTS	11
CHALLENGE: BUILDING PUBLIC AWARENESS OF NNBF	13
CHALLENGE: FINANCING NNBF PROJECT IMPLEMENTATION	14
 SECTION 3: SITE ASSESSMENT	16
CHALLENGE: FUNDING FOR SITE ASSESSMENT	17
CHALLENGE: LACK OF A STANDARDIZED ASSESSMENT PROTOCOL	18
 SECTION 4: PROJECT DESIGN	20
CHALLENGE: POTENTIAL FOR INEFFECTIVE PROJECT DESIGN	21
 SECTION 5: PROJECT PERMITTING	23
CHALLENGE: LACK OF COMMUNICATION BETWEEN APPLICANTS AND REGULATORS	24
CHALLENGE: MISALIGNMENT BETWEEN DESIGN GUIDANCE AND STATE-LEVEL POLICIES	25
CHALLENGE: APPLICANT & REGULATOR UNDERSTANDING OF NNBF	26
CHALLENGE: PERMITTING COSTS & TIMELINE	27
 SECTION 6: PROJECT PERFORMANCE MONITORING	29
CHALLENGE: RESOURCES FOR PROJECT MONITORING	30
CHALLENGE: LACK OF BROADLY UTILIZED OR STANDARDIZED METRICS AND METHODS	31
SECTION 7: CONCLUSION	33
APPENDIX A: List of Phone Interview Questions	34
APPENDIX B: Workshop Agendas	35
APPENDIX C: List of Solutions from Workshop Breakout Sessions	37
APPENDIX D: Resources	45

LIST OF ABBREVIATIONS

CAKE	Climate Adaptation Knowledge Exchange
CRRA	New York Community Risk and Resiliency Act
DNREC	Delaware Department of Natural Resources and Environmental Control
HRNERR	Hudson River National Estuarine Research Reserve
I-SEA	Integrative Shoreline Evaluation Assistance Program
MDSG	Maryland Sea Grant
MD DNR	Maryland Department of Natural Resources
MDE	Maryland Department of Environment
NGO	Non-Governmental Organization
NJDEP	New Jersey Department of Environmental Protection
NNBF	Natural and Nature-Based Features
NOAA	National Oceanic and Atmospheric Administration
NWF	National Wildlife Federation
NY DOS	New York Department of State
NYS DEC	New York State Department of Environmental Conservation
SAGE	Systems Approach to Geomorphic Engineering
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
VA DEQ	Virginia Department of Environmental Quality
VIMS-CCRM	Center for Coastal Resource Management at the Virginia Institute of Marine Science

EXECUTIVE SUMMARY

The impacts of climate change are already being felt in the Mid-Atlantic region. Coastal communities and habitats are threatened by sea level rise and an increasing frequency and severity of strong storms. Traditionally, gray infrastructure like seawalls and bulkheads have been used to protect coasts;

however, these approaches disrupt intact ecological systems and exacerbate damage along adjacent shorelines. As a result, Natural and Nature-Based Features (NNBF) are increasingly being explored as a means of adapting to climate change while also providing numerous economic, ecological, and societal co-benefits that are not derived from traditional gray infrastructure. While significant work has been done at the state and local level across the region, coordinated regional approaches to NNBF are still nascent. To move the entire Mid-Atlantic NNBF community forward towards wider and more informed implementation of NNBF, we sought to answer the most pressing questions concerning their use, and to facilitate collaboration amongst practitioners across organizations and geographies.

Feedback collected from interviews conducted with stakeholders from New York, New Jersey, Delaware, Maryland and Virginia demonstrated that the highest priority barriers to implementation were around building the case for NNBF, initial site assessment, project design, permitting, and post-implementation performance monitoring. Diverse groups of stakeholders were invited to brainstorm the best approaches for addressing these barriers. This report is a summary of the key solution-ideas that resulted from these conversations.



USFWS

KEY CONCEPTS

- **Building the case for NNBF:** To increase adoption of NNBF by marine contractors and the general public, stakeholder feedback suggested a need for well-marketed tools and resources that easily convey the costs and benefits of NNBF compared to gray infrastructure.
- **Site assessment:** Initial evaluation of a project site is crucial for project success. However, site assessment is often not prioritized by funders or regulators, and is constrained by the lack of a standardized assessment protocol. Stakeholders suggested the creation of a single platform for sharing site assessment data and techniques, and also recommended that an initial assessment be prioritized by regulatory bodies.
- **Project design:** The lessons learned from previous projects across the region should inform the design of future NNBF projects. Stakeholders recommended the creation of a network of demonstration sites to test a variety of NNBF approaches in diverse locations and encourage regional collaboration on project design.
- **Project permitting:** Stakeholders recommended expanding and improving communication opportunities between applicants and regulators to streamline the permitting process. Recurring training opportunities for both regulatory agencies and contractors on the current best practices in NNBF implementation can also expedite the permit review processes, and may improve the quality of projects being constructed in the Mid-Atlantic.
- **Performance monitoring:** To expand and improve the collection of project performance data, stakeholders suggested a need for a standardized and coordinated approach to monitoring. Emphasizing low-cost citizen science based methods will help overcome the current lack of funding for project monitoring. As this data is collected, the lessons learned and best practices need to be shared across the region and used to drive improved site selection and design of future projects.



baldeaglebluff/Flickr

SECTION 1 INTRODUCTION

The densely populated coastal communities of New York, New Jersey, Delaware, Maryland and Virginia are highly vulnerable to the effects of climate change, especially rising sea levels and an increasing frequency and severity of coastal storms. As Superstorm Sandy demonstrated, coastal communities and infrastructure are at growing risk to destructive extreme weather events. These risks are especially high in the Mid-Atlantic, where, when accounting for the rate of land subsidence, relative sea level rise is higher than in any other region on the Atlantic coast.¹

Gray infrastructure tactics, such as seawalls and bulkheads, have been the primary method for coastal protection for many years, despite the associated negative impacts to the surrounding ecosystems. Federal agencies including the United States Army Corps of Engineers (USACE), the United States Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA), as well as states, counties and municipalities, are exploring the ways in which Natural and Nature-Based Features (NNBF) can be used by coastal communities to adapt to a changing climate, and reduce the risks posed by

¹ Titus, JG., KE Anderson, DR Cahoon, DB Gesch, SK Gill, BT Gutierrez, ER Thieler, SJ Williams. 2009. Coastal Sensitivity to Sea Level Rise: A Focus on the Mid-Atlantic Region. U.S. Climate Change Science Program. Available online: <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100483V.PDF?Dockey=P100483V.PDF>

sea level rise and coastal storms. This move away from gray infrastructure and towards natural forms of coastal protection is grounded in scientific studies which have demonstrated the effectiveness of NNBF in reducing impacts of climate change on coastal areas while also providing economic, ecological and societal co-benefits^{2,3,4}.

DEFINING NATURAL AND NATURE-BASED FEATURES

NNBF have either evolved through natural processes (for example, marshes and dunes), or have been engineered by humans to mimic natural functioning (for example, living shorelines). According to USACE, natural coastal features take a variety of forms, including reefs (e.g., coral and oyster), barrier islands, dunes, beaches, wetlands, and maritime forests. NNBF can also be a hybrid between man-made structures and nature-based solutions, such as living shorelines, drainage improvements, beach and dune restoration, and breakwaters⁵.



Left to right: VIMS/Flickr; Lynnhaven River NOW; Partnership for the Delaware Estuary/Flickr

PROJECT METHODOLOGY

The National Wildlife Federation (NWF) undertook this project in order to identify solutions to the key challenges that prevent wider implementation of NNBF projects in the Mid-Atlantic. In the first phase, NWF conducted phone interviews with 54 stakeholders from local, state and federal governments, NGOs (non-governmental organizations), and private industry who were involved in implementing NNBF in the following Mid-Atlantic states: New York; New Jersey; Delaware; Maryland; and Virginia. These phone interviews were structured to identify the most pressing challenges of implementing NNBF projects in the region⁶. While the details often varied by the interviewee's location (state) and organization, NWF found that the challenges faced by practitioners could be more broadly grouped into the following categories: building the case for NNBF, initial site assessment, project design, permitting, and post-construction performance monitoring.

² Reguero, B., Bresch, D., Beck, M., Calil, J., & Meliane, I. 2014. Coastal Risks, Nature-Based Defenses and the Economics of Adaptation: An Application in the Gulf of Mexico, USA. *Coastal Engineering Proceedings*, 1(34). Available online: [doi:http://dx.doi.org/10.9753/icce.v34.management.25](http://dx.doi.org/10.9753/icce.v34.management.25)

³ Arkema, K.K., Guannel, G., Verutes, G., Wood, S.A., Guerry, A., Ruckelshaus, J., & Silver, J.M. 2013. Coastal habitat shield people and property from sea level rise and storms. *Nature Climate Change*, 3(10). 913-918.

⁴ Sandifer, P. A., Sutton-Grier, A.E. & Ward, B.P. 2015. "Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation." *Ecosystem Services* 12 (2015): 1-15.

⁵ Bridges, T. S., P.W. Wagner, K.A. Burks-Copes, M.E. Bates, Z. Collier, C.J. Fischenich, J.Z. Gailani, L.D. Leuck, C.D. Piercy, J.D. Rosati, E.J. Russo, D.J. Shafer, B.C. Suedel, E.A. Vuxton, and T.V. Wamsley. 2014. *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, 6-8.

⁶ A copy of the interview questions is included in Appendix A

These challenges informed the design of two in-person workshops and webinars that were held during the month of June 2016 in Richmond, Virginia and New York City, New York⁷. After listening to expert stakeholders highlight existing NNBF efforts in the region, attendees were broken into smaller groups to discuss each challenge in depth. The discussions were heavily moderated to encourage solutions-focused collaboration amongst participants. Each breakout session culminated in a ranking exercise to identify the highest-priority solutions that will address each challenge either in the short- or long-term⁸.

HOW TO READ THIS REPORT

This report is structured to mimic the lifecycle of an NNBF project, from awareness to implementation to monitoring. The first section discusses the challenges and solutions associated with building the case for NNBF, followed by site assessment, project design, project permitting, and finally the evaluation of project performance and monitoring. Each section is annotated and referenced by the following iconography:



Within each section, key challenges identified during the stakeholder interviews are detailed, followed by a summary of the solution-ideas that resulted from the workshops' breakout sessions. Many of these solutions are already in existence and, with wider recognition or application, may address some of the challenges identified by the stakeholder group. Many stakeholders recommended existing resources, and we also conducted an extensive search for relevant tools in the region. We have listed citations or links to these within the "Existing Resources" sub-sections, according to the solution-idea they best address⁹. The "Points of Connection" call-out boxes discuss how specific solutions could have cascading benefits across different challenges.

We conclude each challenge-area by summarizing "Future Actions" that can be taken to address the challenges identified by stakeholders, based on the feedback from the phone interviews, the solutions-focused workshop discussions, and the desktop analysis of relevant tools. Examples of the Mid-Atlantic's best practices and successful NNBF projects are included in the "Learning from Others" call-out boxes, which appear throughout the report.

⁷ Agendas for each workshop are included in Appendix B

⁸ All solution-ideas from the workshops are listed in Appendix C, along with the number of votes each received during the ranking exercise.

⁹ All resources mentioned in the report are listed in Appendix D



Damon Noe/TNC



SECTION 2 BUILDING THE CASE FOR NNBF

Regional Successes

Federal, state and local governments as well as NGOs across the Mid-Atlantic are promoting the use of NNBF to increase coastal resilience. In every state, there are multiple outreach and education programs to increase public awareness and understanding of the benefits associated with NNBF. The [Center for Coastal Resource Management at the Virginia Institute of Marine Science](http://ccrm.vims.edu/livingshorelines/faq.html)¹⁰ (VIMS-CCRM) has a robust information portal for interested property owners that answers potential questions and directs them to other resources and demonstration sites. The Maryland Department of Natural Resources (MD DNR) Chesapeake and Coastal Service offers a [Shoreline Conservation Service](http://dnr.maryland.gov/ccs/Pages/restoration.aspx)¹¹ to provide property owners with financial and technical assistance, in order to control shoreline and stream bank erosion problems. The Delaware Living Shoreline Committee, hosted by the [Department of Natural Resources and Environmental Control](http://dnrec.maps.arcgis.com/apps/MapJournal/index.html?appid=371a244682084370a78d0a54c5edb27a)¹² (DNREC) provides a web-based tour of living shoreline projects in Delaware and New Jersey to help citizens visualize what these projects look like and where they are being installed. New Jersey also

¹⁰ <http://ccrm.vims.edu/livingshorelines/faq.html>

¹¹ <http://dnr.maryland.gov/ccs/Pages/restoration.aspx>

¹² <http://dnrec.maps.arcgis.com/apps/MapJournal/index.html?appid=371a244682084370a78d0a54c5edb27a>

provides a web-based tour of [NFWF-funded NNBF projects](#)¹³, as well as a map of the [current living shoreline projects throughout the state](#)¹⁴. The New York Department of State (NY DOS) created a [visual guide for NNBF projects](#)¹⁵ that can be used to educate private landowners about how nature-based solutions can protect their shorelines. Also in New York, [The Nature Conservancy](#)¹⁶ has demonstrated, through their work at Howard Beach, that blending natural and engineered features (hybrid approaches) can be the most cost effective path to increasing coastal community resilience.

CHALLENGE: DEMONSTRATING THE VALUE OF NNBF VS. GRAY INFRASTRUCTURE

Explanation of the Challenge

In addition to coastal protection from wave and storm events, [NNBF can result in a wide range of co-benefits](#)¹⁷, including but not limited to: aesthetic improvement; enhancement of biodiversity; carbon sequestration; clean water provisioning; education and scientific opportunities; facilitation of sediment accretion that enhances shoreline elevation; recreation; reduction of storm surge and related flooding; reduction of peak flood height; and protection of threatened and endangered species.



Mary Conti/USFWS

Feedback from stakeholder interviews suggests that individuals are often unaware of these many co-benefits, which perpetuates the use of more familiar gray infrastructure tactics. NNBF may be implemented more widely if the true scope of benefits and costs were better understood by, and communicated to, contractors, private landowners, and decision-makers.

Solutions

The solutions generated by stakeholders during the workshop primarily focused on **clarifying and quantifying the cost and benefits of NNBF versus gray infrastructure**. For example, **establishing and advertising a cost comparison of NNBF projects versus bulkheads, rip rap and other forms of shoreline armoring** would demonstrate that nature-based approaches are not always more expensive than their gray counterparts. Many stakeholders see value in **creating a website or tool that provides a rapid lifetime cost/benefit analysis for different techniques along the green-gray spectrum**, based on specific site conditions and landowner preferences. Not only is quantifying the costs of construction and maintenance needed, but stakeholders believe that **better communication of the habitat value created by NNBF for both wildlife and human recreation** could help promote these techniques to different

¹³ <http://njdep.maps.arcgis.com/apps/MapJournal/index.html?appid=049f4937cbdd437bb496a7aea94acd35&folderid=f4686d3c9a7048efb7a1dd8d877eb3f6>

¹⁴ <http://www.nj.gov/dep/cmp/docs/statewide-living-shoreline-projects.pdf>

¹⁵ <http://opdgig.dos.ny.gov/#/storyTemplate/11/2/1>

¹⁶ <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/climate-energy/natural-infrastructure-study-at-howard-beach.xml>

¹⁷ Kelly Burks-Copes, et al. Presentation: Developing Ecosystem Goods and Service Performance Metrics for Natural and Nature-based Infrastructure to Support the NACCS. United States Army Corps of Engineers. 2013. Access online: <http://www.nad.usace.army.mil/Portals/40/docs/ComprehensiveStudy/August%202013%20Webinar/8-27-13%20Task%202B%20EGS%20Perf%20Metrics%20-%20Burks-Copes%20V3.pdf>

audiences. Finally, **helping landowners visualize how NNBF can improve and beautify their property by using demonstration sites** can help secure their buy-in.

POINTS OF CONNECTION



Demonstrating the value of NNBF versus gray infrastructure can help drive landowner demand for these types of projects. An increased demand for NNBF implementation will incentivize contractors to increase their knowledge about, and capacity for, designing successful projects.

Existing Resources

Resources that provide a cost comparison of NNBF vs. traditional gray infrastructure:

- [Partnership for the Delaware Estuary's Practitioner's Guide¹⁸](#)
- [VIMS Living Shores and Coasts Summer 2014, Vol. 9, No. 2¹⁹](#)
- [Rella, A. & Miller, J.K. 2012. A Comparative Cost Analysis of Ten Shore Protection Approaches at Three Sites Under Two Sea Level Rise Scenarios²⁰](#)

Resources that demonstrate the habitat value of NNBF:

- [Donna Marie Bilkovic, Molly Mitchell, Pam Mason & Karen Duhring: The Role of Living Shorelines as Estuarine Habitat Conservation Strategies, Coastal Management²¹](#)
- [TNC Gandy's Beach Project in southern New Jersey²²](#)

Tools that highlight the aesthetic value of NNBF:

- [NOAA CanVis Tool²³](#)

Examples of NNBF demonstration sites:

- [Northern Neck Master Gardeners Reedville Teaching Shoreline²⁴](#)
- [VIMS Teaching Marsh²⁵](#)
- [Hudson River National Estuarine Research Reserve \(HRNERR\) Shoreline Demonstration Site Network²⁶](#)

¹⁸ L. Whalen, Kreeger, D., Bushek, D. Moody, J., Padeletti, A. 2011. Practitioner's Guide; Shellfish-Based Living Shorelines for Salt Marsh Erosion Control and Environmental Enhancement in the Mid-Atlantic. PDE Report #11-04.

¹⁹ <http://ccrm.vims.edu/publications/pubs/rivers&coast/RC914.pdf>

²⁰ <https://s3.amazonaws.com/nyclimatescience.org/240186100-A-Comparative-Cost-Analysis-of-Ten-ShoreProtection-Approaches-at-Three-Sites-Under-Two-Sea-Level-Rise-Scenarios.pdf>

²¹ DM Bilkovic, Mitchell, M., Mason, P., Duhring, K. 2016. The Role of Living Shorelines as Estuarine Habitat Conservation Strategies. *Coastal Management*. 44:3. Pages 161-174.

²² <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newjersey/placesweprotect/gandys-beach-living-shoreline-project-1.xml>

²³ <https://coast.noaa.gov/digitalcoast/tools/canvis.html>

²⁴ [http://www.nnmg.org/files/Reedville__Garden_final71009_\(2\)%5b1%5d.pdf](http://www.nnmg.org/files/Reedville__Garden_final71009_(2)%5b1%5d.pdf)

²⁵ http://ccrm.vims.edu/wetlands/teaching_marsh/background/index.html

²⁶ <https://www.hrnerr.org/hudson-river-sustainable-shorelines/demonstration-site-network/>

FUTURE ACTIONS

Develop an interactive cost-benefit analysis tool:

Existing cost-benefit resources are often in the form of simple tables embedded within larger reports. There is a perceived need to transform this existing data into an interactive online tool in which individuals could describe basic data about their site, and receive information about the various NNBF options and associated costs and benefits, both monetary and non-monetary.

Research on the potential for NNBF to increase property value:

Many stakeholders believe that natural approaches to resilience improve property values, but more research is needed to quantify the impact of NNBF projects on property value.

CHALLENGE: IDENTIFYING AND HIGHLIGHTING APPROPRIATE CONTRACTORS AND PROJECTS

Explanation of the Challenge

Natural and nature-based solutions to coastal resilience are a new approach, and still form only a small portion of the overall marine construction and contracting market. As a result, it is difficult for private landowners to identify contractors and companies that have a history of successfully completed projects. Additionally, contractors need to guarantee success for their customers and therefore have little incentive to advocate for, or experiment with, NNBF. Unless there is a demand from private landowners for these approaches, or the contracting community builds their confidence and experience in using NNBF, the spread of NNBF will be limited.

Solutions

The two major areas where stakeholders saw opportunities for improvement were in the dissemination of information to develop a better-informed public, and the use of trainings and certification to build the knowledge and capacity of contractors. Stakeholders expressed interest in an NGO **developing a list of experienced and vetted contractors** in a specific geography, to assure potential customers that they are retaining skilled NNBF practitioners. Participants also highly ranked the use of a **licensing, certification, or continuing education program for marine contractors** that would both teach the latest science around innovative nature-based coastal resilience practices, and inform interested property owners of which contractors have experience designing and installing NNBF. Simpler solution-ideas also included **creating a list serve for current practitioners, and using it to disseminate updates on best practices and research**. Finally, there was significant interest in the **creation of a regional story-map or interactive website that highlights contractors that have designed and installed successful projects across the Mid-Atlantic**.

POINTS OF CONNECTION



A continuing education program for contractors will help build a knowledgeable and experienced workforce that is well-informed regarding best practices in NNBF site assessment, design and construction.

Existing Resources

Resources for licensing or certification for marine contractors:

- Licensing Models: [Chesapeake Bay Landscaping Professional Certification²⁷](#), [National Green Infrastructure Certification Program²⁸](#), [SITES Certification²⁹](#)
- Training Models: [VIMS Training³⁰](#), [CBNERR Coastal Training³¹](#)

Resources that use story maps and interactive websites to highlight projects in the Mid-Atlantic:

- [DNREC Story Map³²](#)
- [Hudson River National Estuarine Research Reserve \(HRNERR\) Shoreline Demonstration Site Network³³](#)
- [NJ Living Shoreline Projects³⁴](#)

FUTURE ACTIONS

Create a single e-mail list-serve of current practitioners:

Many practitioners voiced interest in receiving e-mailed updates about this body of work, while others expressed that information within an e-mail is likely to be overshadowed by the many other e-mails received per day.

Develop an approved contractors list:

While there are significant constraints that often prevent government agencies from recommending specific contractors to landowners, this could be an opportunity for one or more NGOs to highlight recommended or preferred contractors.

Compile project case studies:

A regional overview of NNBF projects that highlights successes and failures of each project, and includes insight from experienced practitioners.



USFWS

²⁷ <http://cblpro.org/>

²⁸ <http://ngicp.org/>

²⁹ <http://www.sustainablesites.org/>

³⁰ http://ccrm.vims.edu/education/ls_design_class/

³¹ http://www.vims.edu/cbnerr/coastal_training/course_catalog/index.php

³² <http://dnrec.maps.arcgis.com/apps/MapJournal/index.html?appid=371a244682084370a78d0a54c5edb27a>

³³ <https://www.hrnerr.org/hudson-river-sustainable-shorelines/demonstration-site-network/>

³⁴ <http://njdep.maps.arcgis.com/apps/MapJournal/index.html?appid=049f4937cbdd437bb496a7aea94acd35&folderid=f4686d3c9a7048efb7a1dd8d877eb3f6>

CHALLENGE: BUILDING PUBLIC AWARENESS OF NNBF

Explanation of the Challenge

Nature-based approaches should be an evaluated option when coastal property owners consider protecting their shorelines. However, this is not standard practice given the tradition of bulkheads, rip rap and other forms of shoreline armoring along the coasts.

Solutions

Overcoming this challenge will involve private landowners having a level of familiarity regarding NNBF that is on par with built (gray) solutions. Stakeholders identified a number of pathways to raising awareness. Many participants felt that a more strategic and unified approach to **marketing the efficacy and co-benefits of nature-based options could increase demand**. Building upon existing networks, **master naturalists and master gardeners could be trained to advise landowners on using natural shoreline features**. Once installed, NNBF will become a permanent feature of the property and landowners will need **easily accessible information and resources on the proper care and maintenance of their sites**.

POINTS OF CONNECTION



Identifying and distributing project maintenance requirements would not only remove uncertainty of upkeep in the long-term, but would also help address some permitting concerns, including clarifying when project maintenance requires additional permits. Synthesizing project maintenance and care requirements into a single, comprehensive resource at a state or regional scale will require additional performance data collection, and would help inform permit requirements in the future.

Existing Resources

Train master naturalists and gardeners to conduct homeowner education and outreach:

- [University of Maryland Bay-Wise Program](https://extension.umd.edu/baywise)³⁵

Educate the public about what NNBF can achieve, and its efficacy:

- [Wetlands Watch Homeowner's Guide](http://wetlandswatch.org/homeowners-guide/?rq=homeowners)³⁶

FUTURE ACTIONS

Easily-accessible resource for project maintenance requirements:

Long-term upkeep of NNBF is a significant hurdle that may result in many landowners choosing traditional gray infrastructure for use on their properties. To reduce the uncertainty around long-term care, an NGO could host a web-service that helps landowners identify their project needs and best practices for maintenance.

³⁵ <https://extension.umd.edu/baywise>

³⁶ <http://wetlandswatch.org/homeowners-guide/?rq=homeowners>

LEARNING FROM OTHERS:

Northern Neck Master Gardeners I-SEA Program

The Integrated Shoreline Evaluation Assistance Program was launched by [Northern Neck Master Gardeners³⁷](#) in 2012, and is a community service initiative focused on helping waterfront property owners address concerns about shoreline stabilization. Through this program, Master Gardener Shoreline Evaluation volunteers participate in advanced training by the Virginia Cooperative Extension to qualify as Water Stewards. The training also includes the use of shoreline management decision tools developed by VIMS-CCRM.

After completing the Water Steward training, Shoreline Evaluation volunteers provide on-site consultations for waterfront property owners, for a fee of \$50. Volunteers follow standardized methods to visually assess and collect data from each site, the results from which inform written recommendations that are provided to the property owner. This expert advice informs landowners about their options for shoreline stabilization based on their site-specific conditions. Landowners also receive a copy of the Master Gardener publication, *Homeowner's Guide to Shoreline Management*.

In addition to working directly with interested waterfront property owners, Shoreline Evaluation Volunteers lead public outreach efforts, such as educational seminars and speaking to community organizations, regarding erosion control methods.



Northern Neck Master Gardeners

CHALLENGE: FINANCING NNBF PROJECT IMPLEMENTATION

Explanation of the Challenge

One of the most common challenges raised by stakeholders from every state was the financing of NNBF projects. The need for increased funding to support NNBF is not limited to the construction phase, but is a consistent challenge throughout the entire project lifecycle. There are some unique solutions to obtaining financial support for implementation, site assessment (Section 3) and project performance monitoring (Section 6).

Solutions

Stakeholders suggested that the creation of statewide programs such as **low interest loans, tax credits, or cost-sharing to encourage the adoption of nature-based approaches to coastal resilience** will reduce the lifetime cost of these projects and incentivize private landowners to adopt NNBF practices. In areas

³⁷ <http://www.nnmg.org/shoreprotect.asp>

that are of high risk to recurrent flooding and storm-related damage, stakeholders recommended increased **financing for purchasing private properties and preserving open space** to protect sensitive habitats and ensure natural coastal infrastructure for communities located further inland.

Stakeholder feedback also suggested a need for **uniform liability and insurance standards for NNBF**. Property owners need clarification regarding who is held financially and legally responsible for the success of these projects, and who is liable for any damages that result in the event of project failure. Stakeholders also proposed that **finances, penalties and mitigation funds obtained by the state be used to finance future projects**.

POINTS OF CONNECTION



As previously mentioned, financing NNBF projects was a common theme across many challenges and solutions. Financial support for project implementation may encourage site assessment and post-construction performance monitoring, and could alleviate concerns regarding permitting costs and timelines.

Existing Resources

Loan or cost-share programs:

- [MD DNR Zero-Interest Loan Program for Living Shorelines³⁸](#)
- [Delaware's Sussex Conservation District Cost-Share Program³⁹](#)
- [Virginia Clean Water Revolving Loan Fund Living Shorelines Loan Program⁴⁰](#)

Buy-out and relocation programs:

- [New Jersey Blue Acres Program⁴¹](#)
- [MD DNR Program Open Space⁴²](#)

FUTURE ACTIONS

Expansion of low-interest loan programs:

Maryland was the first state in the Mid-Atlantic to establish a zero-interest loan program, which served as the model for the Virginia Living Shorelines Loan Program. Adoption of financial support programs in the other Mid-Atlantic states can be a successful tool in expanding the use of NNBF. In discussions, landowners have cited this financial support as a key factor in their decision to implement NNBF rather than a traditional gray approach.

³⁸ <http://dnr.maryland.gov/ccs/Pages/livingshorelines/ftassistance.aspx>

³⁹ <https://www.sussexconservation.org/programs/cost-share-program>

⁴⁰ <http://www.deq.virginia.gov/Portals/0/DEQ/Water/ConstructionAssistanceProgram/Living%20Shorelines%20Loan%20Guidelines-FINAL.pdf>

⁴¹ http://www.nj.gov/dep/greenacres/blue_flood_ac.html

⁴² <http://dnr.maryland.gov/land/Pages/ProgramOpenSpace/home.aspx>



NOAA



SECTION 3 SITE ASSESSMENT

Regional Successes

For NNBF projects to perform successfully, it is crucial that they are designed to function within the biological and geophysical characteristics of the project site. Poor site assessment can result in projects that fail to meet their goals and create uncertainty about the viability of nature-based solutions. In Virginia, the [Northern Neck Master Gardeners' Integrated Shoreline Evaluation Assistance](#)⁴³ program informs waterfront property owners about their options for protecting their shoreline, and provides additional information to help landowners manage their property. Maryland's [Coastal Resiliency Assessment](#)⁴⁴, a partnership between MD DNR and The Nature Conservancy, identified "Priority Shoreline Areas," where protection and restoration of natural habitats has the greatest potential to reduce the coastal hazard risk faced by residential communities. This work was integrated into MD DNR's [Coastal Atlas](#)⁴⁵. In New Jersey, the Nature Conservancy's [Restoration Explorer](#)⁴⁶, available through their [Coastal](#)

⁴³ <http://www.nnmg.org/shoreprotect.asp>

⁴⁴ http://dnr.maryland.gov/ccs/Documents/MARCH-2016_MDCoastalResiliencyAssessment.pdf

⁴⁵ <http://gisapps.dnr.state.md.us/coastalatlus/WAB/index.html>

⁴⁶ <http://maps.coastalresilience.org/newjersey/>

[Resilience](#)⁴⁷ mapping tool, allows users to see what types of NNBF are most effective along a six county stretch of New Jersey's coast.

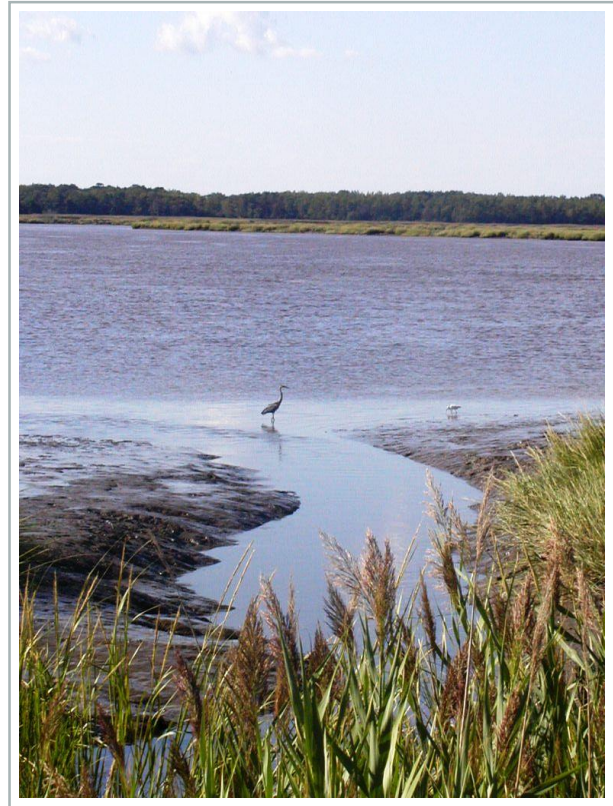
CHALLENGE: FUNDING FOR SITE ASSESSMENT

Explanation of the Challenge

Many NNBF projects are funded through local, state, federal or private grant programs. Due to the relatively short timeframe associated with these funding streams and the time required to complete construction designs and obtain permits, the ability to conduct robust site assessments is often constrained. Furthermore, many funders are more likely to support a project that is well along in the design phase rather than one that still needs an initial site assessment, which is the first step in a lengthy pre-implementation process.

Solutions

To ensure long-term success, NNBF projects require investments at the beginning of the project cycle for detailed pre-design site assessments. This need is not reflected in the current priorities of funding bodies or the regulatory process. The participants felt that **including site assessment in regulatory requirements** may encourage funders of NNBF projects to prioritize site assessment. Another way to overcome the challenge posed by limited funding is to **develop low-cost or no-cost systems for site assessment, such as training volunteer groups to evaluate potential project sites at the request of landowners.**



Lori Jo Jamieson/Flickr

POINTS OF CONNECTION



The upfront availability of funds and/or trained personnel to interact with private landowners for site assessment may encourage choosing an NNBF project over gray infrastructure. Because there are so many variables that impact the success or failure of a project, a more robust, consistent and documented site assessment process will inform future efforts about appropriate design standards per specific site conditions.

⁴⁷ <http://coastalresilience.org/>

Existing Resources

Citizen science assessment:

- [Integrative Shoreline Evaluation Assistance Program \(I-SEA\)](http://www.nnmg.org/shoreprotect.asp)⁴⁸ employed by the Northern Neck Master Gardeners in Virginia.

FUTURE ACTIONS

Encourage the funding community to prioritize site assessment:

Efforts are needed that engage the funding community in discussions around ensuring robust assessments while working within timelines that are acceptable for the grant making organization. Many funders expressed interest in supporting innovative projects that also have the best chance of long-term success. This goal of successful innovation is contingent on robust site assessment to ensure that the project is well matched to local conditions.

CHALLENGE: LACK OF A STANDARDIZED ASSESSMENT PROTOCOL

Explanation of the Challenge

The field of NNBF implementation is characterized by a diverse group of stakeholders, ranging from international non-profit conservation organizations to one-person marine contracting businesses. The diversity and number of practitioners is reflected in the current non-uniform approach to site assessment. Those stakeholders with more expertise and access to greater resources are better equipped to undertake robust site assessments. Developing standardized protocols would help level the playing field and lead to better designed projects.



Tom W. Sulcer/Wikimedia Commons

Solutions

Many stakeholders are already undertaking robust site assessments, and **standardizing these approaches at the state or regional scale** would enable **better sharing of data and site assessment information via a single platform**. A **standardized protocol should be habitat-specific**, and also **take into account regional and/or system-wide connections and processes**.

POINTS OF CONNECTION



A standardized site assessment protocol may also inform the metrics used to evaluate post-installation project monitoring.

⁴⁸ <http://www.nnmg.org/shoreprotect.asp>

Existing Resources

Online data-sharing platforms:

- [Adaptation Clearinghouse](http://www.adaptationclearinghouse.org/sectors/coastal/)⁴⁹
- [Climate Adaptation Knowledge Exchange \(CAKE\)](http://www.cakex.org/case-studies)⁵⁰

Standardized site assessments for coastal NNBF projects:

- [Partnership for the Delaware Estuary's Marsh Futures](http://delawareestuary.s3.amazonaws.com/pdf/Summit15/PDE-Report-15-03_Marsh%20Futures.pdf)⁵¹



USFWS

FUTURE ACTIONS

Use reference conditions to fill the data gap regarding baseline conditions:

In locations where there is a lack of long-term data on biologic, geologic, physical and/or chemical processes these gaps could either be filled by acquiring site specific data or by looking at similar sites across the state and across the region. One approach would be to create a network of reference sites that are intensively monitored and studied, and applying the lessons learned to wider sections of the coast.

Build regional considerations into site assessment:

While an understanding of the dynamics affecting a project at the site scale is critical for project success, these sites exist within larger coastal systems. Therefore, accessible baseline data on regional coastal ecosystem dynamics and services would provide a more comprehensive background for assessment at the site-specific level.

LEARNING FROM OTHERS:

Partnership for the Delaware Estuary's *Marsh Futures*

*Marsh Futures*⁵¹ is a tool that provides site-specific guidance and support to those interested in undertaking projects for the enhancement or protection of salt marshes. This tool helps to ensure that potential projects are appropriately matched to local site conditions and the existing habitat.

Marsh Futures complements existing larger-scale tools, such as the Coastal Resilience Planning Tool, developed by the Nature Conservancy. While the Coastal Resilience Planning tool can help identify options for restoration and protection activities, *Marsh Futures* helps to refine and confirm these options by supporting the collection of site-specific data that can be used to inform the selection of the NNBF approach and project design.



USFWS

⁴⁹ <http://www.adaptationclearinghouse.org/sectors/coastal/>

⁵⁰ <http://www.cakex.org/case-studies>

⁵¹ http://delawareestuary.s3.amazonaws.com/pdf/Summit15/PDE-Report-15-03_Marsh%20Futures.pdf



Partnership for the Delaware Estuary/Flickr



SECTION 4 PROJECT DESIGN

Regional Successes

The Mid-Atlantic region is a center of innovation in the design of NNBFF projects. In the Delaware Bay, the Partnership for the Delaware Estuary is working with partners to determine how [incorporating oysters and ribbed mussels into living shorelines](#)⁵² increases stability. In the Chesapeake, MD DNR and the National Wildlife Federation (NWF) are [integrating sea level rise projections into living shoreline design](#)⁵³.

⁵² Danielle Kreeger, Bushek, D., Walen, L., Moody, J., Padeletti, A. Presentation: Mussel Powered Living Shorelines for Salt Marsh Erosion Control. 2012 Restore America's Estuaries Conference.

⁵³ <http://www.chesapeake-bay.org/index.php/09-2016/29/conquest-preserve-living-shoreline/>

CHALLENGE: POTENTIAL FOR INEFFECTIVE PROJECT DESIGN

Explanation of the Challenge

Many guidance documents have been published to help policy makers, regulators, property owners, and engineering consultants effectively design and construct NNBF projects. Nevertheless, the frequent lack of hard data on site conditions or from past projects results in uncertainty around the physical and environmental processes that influence the effectiveness of NNBF strategies. This gap between high level guidance and site-specific conditions leaves room for project design to be inappropriate for a given location.

Solutions

There is a common understanding that **demonstration projects are needed to further inform design considerations and to demonstrate/test the effectiveness of NNBF project designs**. For project siting, stakeholders identified the need to **provide greater public access to information, available models, and maps illustrating present and future conditions** to be considered in project design. Additional design guidance documents are also needed, including **suggested use of various types of NNBF based on site conditions** and **standards for project adaptability based on feature type, as well as project goals to evaluate design performance over time**. Developing an “assessment cookbook” or **checklist of site condition requirements for different NNBF types** would also help inform effective design considerations. Finally, many stakeholders also see value in **forming state-level committees with diverse expertise** (i.e. regulators, ecologists, engineers, etc.) to review project proposals and innovative strategies, as well as to inform large-scale coordination (similar to [Florida’s Oceans and Coastal Council](#)⁵⁴).

POINTS OF CONNECTION



Demonstration sites that highlight the effectiveness of NNBF projects can be used as an outreach tool for increasing public awareness and understanding of the benefits associated with NNBF.

Existing Resources

State-level committees with diverse expertise to review project proposals, evaluate innovative strategies, and encourage large-scale coordination:

- [Delaware Living Shorelines Committee](#)⁵⁵

“Assessment cookbook”/checklist distinguished by feature type:

- [Stevens Institute Living Shoreline Engineering Guidelines](#)⁵⁶

Guidance for shoreline stabilization techniques based on site conditions:

- [VIMS Living Shoreline Design Guidelines for Shore Protection in Virginia’s Estuarine Environments](#)⁵⁷

⁵⁴ <http://www.dep.state.fl.us/oceanscouncil/>

⁵⁵ <http://www.nj.gov/dep/cmp/docs/20170227-ls-summit/nj-living-shoreline-workgroup-de-committee-2-27-15.pdf>

⁵⁶ <http://www.nj.gov/dep/cmp/docs/living-shorelines-engineering-guidelines-final.pdf>

⁵⁷ http://web.vims.edu/physical/research/shoreline/docs/LS_Design_final_v1.2.pdf

FUTURE ACTIONS

Develop guidebook on suggested ranges of application for each design feature:

Distill the findings of the Stevens Institute's *Living Shoreline Engineering Guidelines*, as well as from other stakeholders across the region, into a quick reference document for what types of NNBF are most effective under different site conditions.

Provide greater public access to information, models, and maps illustrating future conditions to be considered in project siting (for example, sea level rise):

To ensure the long-term success of project sites given the impacts of climate change, the most current models, maps, and tools depicting the impacts of sea level rise and storm surge need to be widely disseminated to engineers and contractors involved in the NNBF field.

LEARNING FROM OTHERS:

Stevens Institute Living Shoreline Engineering Guidelines

The *Living Shoreline Engineering Guidelines ("Guidelines") report*⁵⁸ was developed to inform engineers and regulators on the engineering components of living shorelines design in an effort to prevent project failures, and to align design guidance with the New Jersey Living Shorelines General Permit. The *Guidelines* grouped the approaches to living shoreline design into the following categories: system; hydrodynamic; terrestrial; ecological; and additional considerations. Guidance for selecting between the alternative approaches is also provided in the document.

Not intended to be prescriptive, the *Guidelines* encourage innovation of living shorelines by providing insight regarding how site-specific conditions may influence design. The NNBF approaches covered by this report include sills, breakwaters, joint planted revetment, reef balls, and living reefs.



Harvey Barrison/Flickr

⁵⁸ <http://www.nj.gov/dep/cmp/docs/living-shorelines-engineering-guidelines-final.pdf>



USACE



SECTION 5 PROJECT PERMITTING

Regional Successes

Regulatory requirements for NNBF projects vary widely between the different states in the Mid-Atlantic. Nonetheless, states have made significant progress in adopting policies or processes that ease permitting for NNBF projects. The state of Delaware has adopted a [Statewide Activity Approval](#)⁵⁹ to streamline the permit process for projects under 500 linear feet. [Virginia](#)⁶⁰ and [New Jersey](#)⁶¹ both have general permits, which simplifies permitting requirements for projects that meet specific criteria. In New York, through the [Community Risk and Resiliency Act \(CRRRA\)](#)⁶² of 2014, the NYS DEC (New York State Department of Environmental Conservation) is developing guidance that make natural and/or nature-based features the default approach for resilience projects. In Maryland, [2008 legislation](#)⁶³ made living shorelines the default approach to erosion control projects across the state, and this legislation was formalized in [new regulations](#)⁶⁴ in 2013. At the national level, the USACE is currently in the final stages of creating a [Nationwide Permit](#)⁶⁵, which aims to simplify and standardize the permit process in Army Corps districts across the country.

⁵⁹ http://www.dnrec.delaware.gov/wr/Documents/Shoreline_Stabilization_SAA.pdf

⁶⁰ <http://mrc.virginia.gov/Regulations/fr1300.shtm>

⁶¹ <http://www.nj.gov/dep/landuse/activity/livingshore.html>

⁶² <http://www.dec.ny.gov/energy/102559.html>

⁶³ <http://dnr.maryland.gov/ccs/Pages/livingshorelines/laws.aspx>

⁶⁴ <http://www.mde.state.md.us/programs/Water/WetlandsandWaterways/Pages/LivingShorelines.aspx>

⁶⁵ <https://www.gpo.gov/fdsys/pkg/FR-2016-06-01/pdf/2016-12083.pdf#page=21>

CHALLENGE: LACK OF COMMUNICATION BETWEEN APPLICANTS & REGULATORS

Explanation of the Challenge

Both regulators and applicants voiced concerns on the state of communication during the project permitting phase. From the regulators' perspective, applications are often incorrect or incomplete, and include mistakes that could have been avoided through pre-application conversations or by using available information. The missing and incorrect information slows down the review process. From the applicants' perspective, the permit process is often plagued by slow responses and uncertainty regarding the expectations of each regulatory body responsible for application review. It is also difficult for applicants to know when to expect permit decisions; this uncertainty reduces business-interest in pursuing NNBF.

Solutions

To address the needs on both sides of this problem, stakeholders suggested training **applicants on the best practices in writing and submitting comprehensive permit applications. Applicants also need a better understanding of best practices for submitting conceptual site designs as early as possible in the permitting process.** Especially for those projects that are looking to innovate in the NNBF field, **bringing the regulatory community into the conversation as early as possible in the project timeline can provide clarity as to what potential questions and concerns should be addressed in the application.** MDE and NJDEP both host joint project evaluation meetings attended by USACE and other agencies, and stakeholders **suggested that these regular forums in which potential applicants can ask questions and receive advice from regulatory agencies** provide more nuanced input on specific projects, and establish an understanding between the permitting and construction communities.

POINTS OF CONNECTION



Communication between project applicants and regulators may encourage sound project design. Additionally, stakeholders expressed that private landowners hesitate to pursue NNBF projects because of uncertainty regarding the financing for, and timing of, what is perceived to be a lengthy and involved permitting process.

FUTURE ACTIONS

Advertise and host a free pre-application conference:

Providing a forum for contractors and landowners pursuing NNBF projects where questions about the application process can be identified and resolved prior to application submittal can reduce the time needed to review incomplete and poorly written applications.

LEARNING FROM OTHERS:

New Jersey Coastal General Permit 24

In 2013, the [NJ CZM Rules⁶⁶](#) were revised to encourage “habitat creation, restoration, enhancement, and living shoreline activities,” and to remove some of the regulatory impediments for these projects. In an effort to promote living shorelines projects within the state, a



USFWS

living shorelines working group was created within the NJ DEP to assist potential applicants in navigating the regulatory process. The working group consists of representatives from most programs in NJ DEP, including planning, regulatory, science, engineering and natural resource groups, and is intended to be proactive, and to become involved at the conceptual stage of the project.

The permit is free, but requires that the living shoreline project be designed and/or sponsored by NJ DEP, USFWS, NRCS, USACE, USEPA, NOAA’s Restoration Center, or implemented by a college or university for research purposes. In addition to providing planning assistance at the municipal level to incorporate nature based solutions at the shoreline and inland to address and enhance resilience, the program is developing an external group of stakeholders to further develop and grow the concepts and opportunities.

U.S. Army Corps of Engineers

CHALLENGE: MISALIGNMENT BETWEEN DESIGN GUIDANCE AND STATE-LEVEL POLICIES

Explanation of the Challenge

Specific permit requirements vary from project to project and state to state, however, the most common permit required for NNBF projects is a Regular or Nationwide General Permit from the U.S. Army Corps of Engineers. In NJ, for example, one would also need a Coastal General Permit 24 (N.J.A.C. 7:7-6.24), which was specifically designed to encourage “habitat creation, restoration, enhancement, and living shoreline activities” and to remove some of the regulatory hurdles for these types of projects.

Interview feedback suggests that state and federal agencies, permit-reviewers, practitioners, and other permit applicants often have inconsistent and contradictory interpretations of the potential use and application of NNBF projects. This can lead to implementation that is both disparate and maladaptive at the local and regional scale. Lack of information about design options in existing permit application guidance documents also makes it challenging for applicants to know which types of design options might be approved.

Solutions

To overcome inconsistent and contradictory interpretations of the potential use and application of NNBF projects, stakeholders suggested that **state and federal regulatory language and permitting surrounding NNBF be streamlined**. To provide better guidance on what types of NNBF design options may be

⁶⁶ <http://www.nj.gov/dep/landuse/activity/livingshore.html>

approved, stakeholders advocated that **regulatory agencies provide greater transparency on existing NNBF projects, approved applications (including all permitting documents and supporting documents), and all relevant public notices to better inform design options.**

POINTS OF CONNECTION



Addressing the challenges associated with permitting NNBF will also require the alignment of permit requirements with project design guidance.

Existing Resources

- [USACE recommended Nationwide Permit for Living Shorelines⁶⁷](#)



MD Sea Grant Extension/Flickr

FUTURE ACTIONS

Streamline the permitting process:

While the use of general permits and activity approvals at the state level has improved the permitting process across the region, stakeholders still feel that the multiple, simultaneous reviews of permits are inefficient and overly complex. There was significant support for further exploration into the feasibility of streamlining the permit process across federal, state and local jurisdictions.

CHALLENGE: APPLICANT & REGULATOR UNDERSTANDING OF NNBF

Explanation of the Challenge

Given that the field of NNBF is rapidly evolving, it is difficult for both regulators and applicants to stay up-to-date on the current research findings and best practices for project design. Regulators are often, therefore, unclear on what constitutes a well-designed project, which can slow the permit review process. This is especially true when innovative projects are proposed.

While there are many experienced marine contractors in the region that are doing well-informed, innovative work, the practice of designing and constructing NNBF is still on the rise. For new practitioners, the uncertainty about which techniques are most appropriate reduces the quality of project design and subsequent permit application. As a result, best practices not being taken up as quickly and widely as possible.

⁶⁷ Department of Defense, Department of the Army, Corps of Engineers. Federal Registrar. 81(105). Page 35205. June 1, 2016. Available online: <https://www.gpo.gov/fdsys/pkg/FR-2016-06-01/pdf/2016-12083.pdf>

Solutions

Creating **recurring educational training and events for regulators on the appropriate use of NNBF** can help improve and inform the permit review process. **Critical evaluations of hard infrastructure projects** can also help demonstrate the true costs of shoreline armoring versus NNBF approaches over the lifetime of a project.

POINTS OF CONNECTION



Informing applicants and regulators about the latest science around NNBF will help to clarify the best project design standards based on specific site conditions. Additionally, a more well-informed community of practice within the marine contracting industry may also encourage private landowners to pursue projects that incorporate NNBF.

Existing Resources

Educational information:

- [VIMS Wetland Education Tools⁶⁸](#)
- [VIMS Workshops for Local Wetland Boards⁶⁹](#)
- [HRNERR Regulatory Guidance Report⁷⁰](#)



USACE

FUTURE ACTIONS

Build a community of practice around NNBF in the Mid-Atlantic:

While there were numerous meetings at the state and local level on the use of NNBF for coastal resilience, there were not many opportunities for stakeholders to connect at the regional level. Establishing a regional forum to bring together these stakeholders and share lessons learned would ensure that learning and progress was happening across borders and watersheds.

CHALLENGE: PERMITTING COSTS & TIMELINE

Explanation of the Challenge

Lengthy permitting processes hamper implementation of NNBF projects for both environmental NGOs as well as private industry. In the non-profit community, the short timelines tied to funding for these projects result in the majority of time being spent navigating the permitting process rather than project implementation. This leaves less time and funding available to incentivize innovative design on the front-end, or collection of lessons learned on the back-end of a project. Within the marine contracting industry,

⁶⁸ http://ccrm.vims.edu/education/wetlands_selfeds/index.html

⁶⁹ http://ccrm.vims.edu/education/workshops_events/index.html

⁷⁰ <https://www.hrnerr.org/doc/?doc=240189622>

their incentives are completing a project as quickly as possible and moving on to their next job. The uncertain timeline for permitting these projects ends up costing these businesses money and making them wary of investing in NNBF projects.

Solutions

As described above, it is in the applicants' best interest to complete the permitting process as quickly as possible. Therefore, providing them with as much information as possible on both formal requirements and expectations before submittal can improve the quality of applications that regulatory agencies receive. Stakeholders suggested **example permits that show the style and type of language that regulators would like to see, as well as clearly outlining the required documentation and specifications for the site design.**

POINTS OF CONNECTION



Stakeholder feedback suggests that private landowners are apprehensive of the permitting process for NNBF projects, as it is often time-consuming and costly. Addressing these permitting concerns is likely one of the most effective means to scaling up NNBF installations on private properties.

FUTURE ACTIONS

Example permits:

In order to provide clarity on the requirements that need to be met when submitting permit applications, the dissemination of example permits could provide regulators with a way to demonstrate the components that go into a successful application.



Partnership for the Delaware Estuary/Flickr



NWF



SECTION 6 PROJECT PERFORMANCE MONITORING

Regional Successes

While the number of NNBF projects being designed, permitted and constructed across the Mid-Atlantic is increasing, there is a lack of regular and effective mechanisms for sharing information on the successes, failures and lessons learned from these projects across organizations and geographies. Several organizations have recognized this need for a uniform performance monitoring process and are taking steps to develop metrics and protocols to measure the effectiveness of NNBF projects. For example, the Partnership for the Delaware Estuary has developed a goal-based monitoring approach to help stakeholders in Delaware and New Jersey understand how to measure the success of an individual project. In addition, both New Jersey and New York are taking significant steps to standardize and coordinate NNBF performance monitoring within each state.

CHALLENGE: RESOURCES FOR PROJECT MONITORING

Explanation of the Challenge

The lack of funding that limits pre-project site assessment also poses a serious challenge for post-implementation performance assessment and monitoring. As described earlier, NNBF projects undertaken by the nonprofit community are typically only funded for two to three years, which does not allow for robust or long-term performance monitoring after the project is completed. Few funders are willing to support projects that are just collecting monitoring data. Similarly, the marine contracting industry lacks incentives to commit to any long-term monitoring or maintenance in the interest of pursuing new projects. The lack of financial support to collect data of NNBF project performance limits the collection of this kind of information across the entire region.

Solutions

By **creating monitoring protocols that can be performed by citizen scientists**, the cost of medium- to long-term project monitoring is nearly zero. In order to keep people engaged in the monitoring process the idea of **using smartphone apps to capture and report photo monitoring data** was raised, as well as **focusing monitoring efforts on pre- and post-storm events**.

POINTS OF CONNECTION



Effective future site assessment and project design, efficient project permitting, and building the case for NNBF to the general public are all contingent on project monitoring and the development of scientifically sound performance data.



The development of a scientifically robust, low- or no-cost citizen science program would address concerns about funding for long-term project assessment while engaging the public in understanding the performance and benefits of NNBF. Ultimately, data obtained through a citizen science program may also inform permit requirements and future site design tactics.



Existing Resources

Citizen science photo monitoring:

- [Blue Urchin – MyCoast App](http://mycoast.org/)⁷¹

Pre- and post- storm event monitoring:

- [HRNERR Shorelines Forensic Analysis](https://www.hrnerr.org/shorelinesforensicanalysis/)⁷²

Existing monitoring protocols for coastal NNBF projects:

- [HRNERR Shoreline Assessment](https://www.hrnerr.org/udson-river-sustainable-shorelines/assessing-ecological-physical-performance/)⁷³



NOAA

⁷¹ <http://mycoast.org/>

⁷² <https://www.hrnerr.org/shorelinesforensicanalysis/>

⁷³ <https://www.hrnerr.org/udson-river-sustainable-shorelines/assessing-ecological-physical-performance/>

FUTURE ACTIONS

Development of citizen science monitoring protocols:

Robust monitoring projects through scientific organizations is cost-prohibitive, but in-depth monitoring of specific sites could be complemented and strengthened through citizen science research. Creating monitoring protocols that use standardized metrics and can be performed by landowners or volunteers would greatly lower the cost-barrier to collecting data on the long-term viability of living shoreline projects across the region.

CHALLENGE: LACK OF BROADLY UTILIZED OR STANDARDIZED METRICS AND METHODS

Explanation of the Challenge

Despite ongoing efforts at the federal and state level to develop metrics and monitoring protocols, these efforts have not resulted in a coordinated approach at a regional scale. This lack of standardized data collection is preventing a well-informed and coordinated approach to the sharing of project successes and failures and the associated lessons learned.

Solutions

There are two areas of solutions for standardizing monitoring across the region. The first is **working with regional and national experts to develop standard metrics and protocols for monitoring NNBF**. Following this, these **metrics and standard operating procedures need to be distributed to practitioners** and supplemented with **trainings on how to conduct monitoring**. While long-term monitoring of every site may not be feasible, it would be helpful to select demonstration sites that use a variety of approaches in a variety of locations and could serve to inform decision making around project siting and design.



Partnership for the Delaware Estuary/Flicker

POINTS OF CONNECTION



Consistent performance data collected from a wide-range of project types and scales will build the understanding of how effective NNBF is for increasing coastal resilience throughout the region. Empirical evidence of NNBF performance is essential for all stages of a nature-based project: it will help build the case for NNBF to the public, better-inform permit requirements and processes, and will also contribute to siting and designing the most effective future projects.

Existing Resources

Develop and distribute standardized metrics and standard operating procedures to practitioners:

- [Partnership for the Delaware Estuary's Framework for Standardization Monitoring of Living Shorelines⁷⁴](http://delawareestuary.org/node/229)
- [HRNERR Assessing Ecological and Physical Performance⁷⁵](https://www.hrnerr.org/udson-river-sustainable-shorelines/assessing-ecological-physical-performance/)

FUTURE ACTIONS

Create a regional network of demonstration sites:

This report has highlighted many of the state-level demonstration sites, but by creating a regional demonstration site network special attention could be paid to ensuring that these sites employ a wide range of NNBF approaches across a broad range of habitats. This network could serve as the laboratory for developing the latest science about the effectiveness of NNBF under different scenarios and could serve to test innovative approaches before they are more widely applied.

LEARNING FROM OTHERS:

HRENRR Shoreline Demonstration Site Network

A component of the Hudson River Sustainable Shoreline Project, [HRENRR's Shoreline Demonstration Site Network⁷⁶](https://www.hrnerr.org/udson-river-sustainable-shorelines/demonstration-site-network/) features an array of shoreline stabilization projects implemented and underway throughout the Hudson River Estuary. Identified case studies highlight a variety of techniques that can sustain and enhance valuable ecosystem services, maximize resilience of the system, and be cost-effective compared to traditional approaches. Each case study includes detailed information on the site, planning and design considerations, associated partners, project cost, and other relevant information leading up to implementation of the project. The purpose of this site is to share information, lessons learned, and best management practices regarding sustainable shoreline projects along the Hudson River.



Sarah Lipuma/HRENRR

⁷⁴ <http://delawareestuary.org/node/229>

⁷⁵ <https://www.hrnerr.org/udson-river-sustainable-shorelines/assessing-ecological-physical-performance/>

⁷⁶ <https://www.hrnerr.org/udson-river-sustainable-shorelines/demonstration-site-network/>

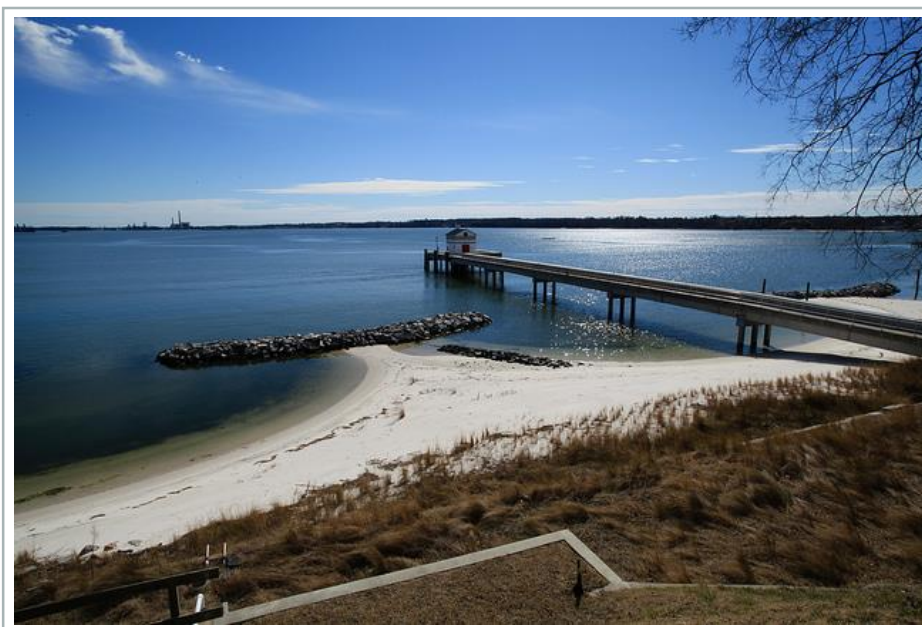
SECTION 7 CONCLUSION

The challenges highlighted above represent significant hurdles to the wider implementation and adoption of NNBF as tools for community resilience across the region. Without dedicated efforts to realize the solutions outlined in this report, the current trend of shoreline armoring will continue to disrupt shoreline ecosystems and decrease the resilience of the Mid-Atlantic coastal communities in the face of climate change.

However, in addition to identifying the most pressing challenges, stakeholders also developed innovative and realistic solutions to these challenges. As this report demonstrates, many of these solutions are not theoretical, but have already been implemented at various scales across the region. Therefore it is not the creation of new solutions that is most needed, but rather the scaling up of best practices and lessons learned to a regional level.

To this end, the National Wildlife Federation feels that there are significant opportunities to move the NNBF community forward in the near term by creating a community of practice in the Mid-Atlantic region. A greater collaboration across states will facilitate sharing and scaling up of lessons learned from practitioners that are leading the development of best practices and innovative projects. The Mid-Atlantic Regional Council on the Ocean and other various regional-focused NGOs are well situated to continue bringing stakeholders together to identify best practices and disseminate them to the wider community.

At the local level, the National Wildlife Federation encourages stakeholders to develop diverse networks both within and outside of their specific geography. A paradigm shift in coastal management away from engineered solutions to natural and hybrid approaches will require diverse organizations working together to support the use of NNBF by: building the case over traditional gray infrastructure; standardizing project design and assessment; streamlining the permitting process; and increasing monitoring efforts for project performance.



VIMS

APPENDIX A: List of Phone Interview Questions

1. What are you doing in relation to NNBF/Green Infrastructure?
2. Who are your primary partners/collaborators in this work?
3. What are the primary challenges associated with your organization and/or region in regards to promoting, planning, or implementing NNBF projects?
4. Are you aware of other programs/offices/organizations (that you are not affiliated with) engaged in these activities within your region?
5. What is needed to best support/address the challenges associated with promoting, planning, or implementing NNBF-related activities?
6. With respect to promoting, planning, or implementing NNBF activities, what is going well in your region?
7. Does your organization collaborate or coordinate on NNBF efforts across state lines/at the regional scale?
8. Do you have data sets/allocated funds for performance monitoring?
9. Do you have a standardized protocol for monitoring and metrics?
10. Are you involved in any Thin Layer Deposition (TLD) projects?
11. Are you open to speaking to other stakeholders at any of our workshops?
12. To what extent is the group engaged in metrics groups relevant to different scales?

APPENDIX B: Workshop Agendas

Workshop A: Nature-based Solutions to Enhance Coastal Resilience

Location: Richmond, VA

Date: June 15, 2016

8:00 – 9:00	Registration & Breakfast (provided)
9:00 – 9:05	Opening Remarks (Karl Schrass, NWF & Laura McKay, Virginia DEQ & MARCO Management Board Chair)
9:05 – 9:15	Project Summary (Avalon Mehta, NWF)
9:15 – 10:00	Presentation: Site Assessment for Design and Monitoring Karl Schrass, NWF, will provide overview of existing site assessment tools for living shorelines and Dr. Danielle Kreeger, of the Partnership for the Delaware Estuary, will discuss their work developing the DELSI Tactic and goal-based project monitoring protocols.
10:00 – 10:45	Presentation: Scaling up NNBF Projects on Private Lands Doug Janiec, of Sovereign Consulting, will speak to the business-side of NNBF. Shereen Hughes, Wetlands Watch, will discuss her work doing outreach and education to landscapers as well as discuss how local governments can integrate green infrastructure into their planning.
10:45 – 11:00	Coffee Break
11:00 – 11:45	Permitting Panel Discussion Representatives of regulatory agencies in VA, DE, MD and USACE will be asked questions regarding NNBF permitting, specifically about what the most significant challenges there are in the current review process.
11:45 – 12:45	Lunch (provided)
12:45 – 1:00	Background for Afternoon Breakout Sessions Afternoon breakout sessions will be focused on summarizing lessons learned and identifying specific solutions to the challenges outlined in the morning presentations. Attendees will participate in three facilitated breakout sessions that will address the challenges/needs/gaps related to: (1) Site assessment and project monitoring, (2) Permitting challenges, and (3) Scaling up NNBF on privately owned lands. Each breakout discussion will be guided by a set of topic-specific questions focused on advancing solutions to identified challenges.
1:00 – 2:00	Breakout Period 1
2:00 – 2:10	<i>Transition</i>
2:10 – 3:10	Breakout Period 2
3:10 – 3:20	<i>Transition</i>
3:20 – 4:20	Breakout Period 3
4:20 – 4:30	Closing Summary & Next Steps Recap of top-tier themes, as captured from the white boards, from each breakout. NWF will identify next steps, highlighting where the project is headed next and how this information is going to be used.

Workshop B: Nature-based Solutions to Enhance Coastal Resilience

Location: New York City, NY

Date: June 28, 2016

8:00 – 8:45	Registration & Breakfast [Concourse Lobby]		
8:45 – 9:00	Opening Remarks. <i>Chris Hilke, National Wildlife Federation</i> [Rm C201-203]		
9:00 – 9:25	NYSDEC: Perspectives on Natural and Nature-based Features. <i>Dawn McReynolds, NYSDEC</i> [Rm C201-203]		
9:25 – 9:50	NJDEP Living Shorelines Program. <i>Steve Jacobus, NJ DEP</i>		
9:50 – 10:05	Break		
10:05 – 10:50	Site Assessment and Project Performance Monitoring: The Importance of Standardization for the Development of the N-NBF Practice. <i>Jackie Jahn, GreenVest</i> [Rm C201-203]		
10:50 – 11:35	Design Guidance for Nature-Based Shorelines: Past Progress and Future Challenges. <i>Dr. Jon K. Miller, Stevens Institute of Technology</i> [Rm C201-203]		
11:45 – 12:45	Lunch [Rm C201-203]		
12:45 – 1:00	Introduction to Breakout Sessions [Rm C201-203]		
1:00 – 2:10	Parallel Breakout Sessions. <i>Choose 1</i>		
	Rm C201	Rm C202	Rm C203
	Site Assessment & Project Monitoring	Permitting Challenges	Project Design Standards
	<i>Facilitator: Dorina Frizzera, NJ DEP & Lisa Auermuller, Rutgers</i>	<i>Facilitator: Betsy Blair, NYSDEC</i>	<i>Facilitator: Kristen Marcell, NYSDEC</i>
2:10 – 2:25	Break		
2:25 – 3:35	Parallel Breakout Sessions. <i>Choose 1</i>		
	Rm C201	Rm C202	Rm C203
	Site Assessment & Project Monitoring	Permitting Challenges	Project Design Standards
	<i>Facilitator: Dorina Frizzera, NJ DEP & Lisa Auermuller, Rutgers</i>	<i>Facilitator: Betsy Blair, NYSDEC</i>	<i>Facilitator: Kristen Marcell, NYSDEC</i>
3:35 – 4:00	Closing Summary & Important Announcements [Rm C201-203]		

APPENDIX C: List of Solutions from Workshop Breakout Sessions

WORKSHOP A: Richmond, VA	
Site Assessment & Project Performance Monitoring	Total Votes
Continue to identify and improve the distribution of standardized metrics and operating procedures	17
An NGO to evaluate and publish a case study report of existing projects. This should detail the "success" and "failures" of each, and should heavily involve input from those that have been working in the field.	17
An NGO or other organization to develop an online list of existing projects, such as a story map/Interactive website of projects in the full region	16
Incorporate photo-monitoring or other follow-up procedures into permit requirements	16
Increase the level of staff training for both contractors and regulators	11
Identify key metrics for pre- and post- implementation	11
Encourage lower-cost monitoring through citizen science	11
Monitoring by property owners - Photo, satisfaction feedback	11
Regional coordination to encourage standardized assessment and monitoring	10
Regional entity to push for a policy shift/reexamination in support of site assessment and monitoring	10
Education/outreach of what made existing projects successful	10
Develop an events-based monitoring program (Pre-and post-storm)	9
Development of an online, rapid cost/benefit analysis tool for entities interested in exploring shoreline protection options	7
Distribute, either through a website or other means, a single list-serve of NNBF practitioners	7
Inventory future projections of project performance	6
Collaborate with universities to develop and facilitate site assessment and/or monitoring	5
Inventory existing monitoring protocols	5
Inventory existing monitoring data	4
Aggregation of studies	4
Extend Funding Timelines	4
Inventory existing standard operating procedures for monitoring	3
Develop an online tool or phone application for project design specifications	3
Enhance the communication network of NNBF practitioners	3
Optimize state-specific datasets/resources	2
Inventory of cost over time of existing projects	2
Credit-incentives for monitoring	2
Host social gatherings for NNBF practitioners	2
Look for and use existing networks	2
Maintenance requirements - web service	2
Improve project design to better deal with site-specific level of energy	1
Utilize existing cross-jurisdictional partnerships	1
Integrate disparate project monitoring datasets	1
Engage business in generating funding for project monitoring	0
Interactive decision-support tool	0
Create a measurement tool for reduction of sediment loss post-project implementation	0

WORKSHOP A: Richmond, VA

Permitting Challenges	Total Votes
Streamline legislation to apply to all levels of regulation (Federal, state, local)	22
Host pre-application meetings with state, federal, and local agencies that are well-advertised to promote high attendance	16
Integrate state and federal agencies with local (county) stakeholders and critical area commission	13
Certification program, with a strong focus on permit applications, as a continuing education requirement	11
Education and outreach focused on broadening private landowner understanding of the permitting process	10
Improve coordination and alignment between the state, USACE, and county	10
Include regulators as early as possible in project design processes	9
Add shoreline management to sub-division process (use the VIMS CCRMP as a model for other comprehensive plans)	9
Promote an integrated view of the property: one that expands beyond just the shoreline	9
Make websites/information portals easy to navigate and use	9
Begin trainings for regulators on the use of living shorelines and other NNBF practices. This should include critical evaluations of gray ("hard") infrastructure.	8
Regulatory agencies need to commit more human resources	8
Work with USACE to understand their authority and how they can better support the goals of state and local regulators	8
Social marketing campaigns	7
Train contractors on best practices in writing and design for application	7
Incentivize attendance at pre-design meeting	7
Standards for acceptable project drawings and scale.	6
Scale up VIMS contractor training and workshops in other states beyond Virginia	5
Create a list of contractors, and the projects they've completed	5
Non-profit, environmental non-governmental organizations to act as project managers to oversee and streamline the project design, permitting, and implementation processes.	4
Example permits from projects at various scales	4
Utilize environmental services	3
Increased availability of regulators to project staff: e.g. office hours.	3
Private sector to review permits	3
Create a workshop series for regulators and permitters to improve their knowledge base about nature-based solutions	2
Use fines and penalties to provide funds or matching funds for non-profit	2
Include a habitat impact table requirement within the permit	2
Non-profits should facilitate building credibility with landowners, providing access to grant dollars, and spreading the word on nature-based solutions	1
Increased public-relations efforts from state agencies (for example, having a booth at boat shows)	1
Train master naturalists to help landowners get started	1
Finalize Phase II General permit in VA	0
Non-profit organizations: prior to receiving grant funds, check-in with regulators to ensure that implementation can begin quickly after receiving award	0
Make necessary datasets publicly available and easy to access	0
Summarize information needed in permit application	0

WORKSHOP A: Richmond, VA

Building the case for NNBF	Total Votes
Demonstrate the value of NNBF - multiple services, and who receives the benefits	11
Increase public outreach and education efforts	10
Communicate the challenges of NNBF contractors/private landowners, such as regulations, forces of nature, future maintenance	9
Certification/licensing program for marine contractors (e.g., continuing education requirements)	8
Increase funding for project implementation	7
Gather evidence of working benefits of living shorelines	7
Improve the amount and availability of project performance data	6
Demonstrate the value of NNBF - multiple services, and who receives the benefits	6
Certification/licensing program for marine contractors (e.g., continuing education requirements)	5
Put on same regulatory footing integrated permitting look at continuum of ecosystem	5
Improve regulatory certainty and standards	4
Market the potential for increased job opportunities	4
Lower the cost of projects through incentives (e.g. a break on mitigation)	4
Receive and publicize buy-in from community leaders	4
Tax breaks for private landowners that install an NNBF project	4
Compile and distribute a list of approved contractors	4
Uniform standards related to liability and insurance	3
Compile a database of projects, and highlight the contractors involved	3
Get TMDL credits for projects on private lands	3
NGO to host one-on-one meetings with community leaders to inform about NNBF	3
State level technical advisory group	3
Peer to peer training for private landowners	3
Demonstrate to business-owners that there is money to be made	3
Examples of projects that demonstrate success	3
Certification/licensing program for marine contractors (e.g., continuing education requirements)	3
Educate private landowners about the price difference between NNBF and gray infrastructure	3
Tours of homes/properties that have living shorelines (or other NNBF)	3
Market to private landowners from the "protect your property" perspective - saving their land, protecting family heritage	3
Compile and distribute a list of approved contractors	3
Demonstrate the success of past projects	3
Expedite the permit review process	2
Non-profit or other organization to facilitate connecting property owners with experienced NNBF contractors	2
Better coordination and alignment between federal, state, and local regulatory agencies	2
Government agencies to provide service that will help with technical design of NNBF	2
Improve the amount and availability of project performance data	2
Guide landowners on how to make green solutions for coastal resilience visually appealing. Maryland's Critical Area Commission has a great resource: "The Green Book for the Buffer"	2
Target NNBF marketing to waterfront property owners specifically	2
Reward/recognize citizens; for example, use the Baystar Homes as a model	2
Compile and distribute a list of approved contractors	2

WORKSHOP A: Richmond, VA

Building the case for NNBF (cont.)	Total Votes
Help guide property owners in how to deal with contractors, including information about what questions to ask	2
Increased understanding of the investment needed for shoreline protection	2
One-on-one meetings with landowners and NNBF experts (either contractors or NGO)	2
Demonstrate the value of NNBF - multiple services, and who receives the benefits	2
Address the overall challenge public-relations	2
Document projects through collecting video content. Both the project construction and impacts to drainage, erosion, etc.	2
Increase funding for project implementation	2
Corporate sponsors to help communities	1
Develop a cost-sharing program for NNBF in a community	1
Public outreach and education focused on NNBF implementation techniques	1
NGO to host a continuing education and certification program for contractors and/or properties with NNBF	1
Collection of performance data to increase confidence of project success	1
Identify what motivates choice for coastal property owners via a social marketing study	1
Build bonds between property owners or contractors with regulatory staff	1
Professional training	1
Tax breaks for private landowners that install an NNBF project	1
NGO to provide technical advice staff that are available for site visits to interested property owners	1
Education regarding the challenges of long-term maintenance	1
Use projects like Elizabeth River as a model: Develop a well-communicated plan that involves big partnerships and that has been built upon lessons-learned and successes from previous projects	1
Build bonds between property owners or contractors with regulatory staff	1
Manage expectations of property owners	1
NGO to provide technical advice staff that are available for site visits to interested property owners	1
Market NNBF through social media	1
Reward/recognize citizens; for example, use the Baystar Homes as a model	1
Tax breaks for private landowners that install an NNBF project	1
Commit to enforcing existing NNBF regulations	1
Demonstrate how/if property values increase with green coastal resilience projects (a hedonic pricing model)	1
Increase funding for project implementation	1
Build partnerships that will promote the use of NNBF to help communities accomplish TMDL goals.	1
Increase funding for project implementation	1
Property owners with NNBF should receive a break on stormwater fees	0
NGO to host a city/community-wide wetlands workshop, with a focus on depicting shorelines before- and after- living shoreline installation	0
Financial assistance for ongoing maintenance	0
Educate property owners about the benefits of NNBF, specifically wave attenuation capabilities	0
Marketing should focus on the co-benefits of NNBF rather than the cost	0
Integrate incentives	0
Develop a cost-incentive program, such as low-interest loans	0
Financial assistance for ongoing maintenance	0
Educate real estate agents about the benefits of NNBF	0

WORKSHOP A: Richmond, VA	
Building the case for NNBF (cont.)	Total Votes
Focus NNBF marketing around "doing the right thing" for the environment	0
Develop easy to understand and succinct fact sheets with the details of previous NNBF projects	0
Identify a "champion" in each community that will promote the use of NNBF locally	0
Property owners with NNBF should receive a break on stormwater fees	0

WORKSHOP B: New York, NY	
Site Assessment & Project Performance Monitoring	Total Votes
Find platform to share data, site assessment information, and project reporting metrics (i.e. clearing house)	23
Site assessment & Project Monitoring to be a required component of permit applications, process, and timeline	23
Educate funders on monitoring timelines & financial needs; Funders to support maintenance and monitoring of projects	18
Standardized site-assessment protocol that is habitat-based and site-specific between NY and NJ	17
Identify partners (i.e. academic, NGO) to reduce the burden of long-term monitoring	16
Project lifespan and projected effectiveness should be detailed in trade-off decisions and be reflected in monitoring metrics, risk assessment, and cost-benefit analyses	16
Require standardized project approaches and monitoring metrics, clear identification of project goals within the context of regulatory priorities	13
Increase flexibility of permit review process to allow for adaptive management/risk management project approaches	12
Adopt short-term monitoring for permit compliance and long-term monitoring for adaptive management	12
Look across all protocols and try to standardize. For example: PDE does a great job now with methods/metrics that are both project specific; DOI metrics report across landscape features (both ecological and social metrics)	12
Ensure the forthcoming NYS DEC LS Guidance Document includes a regional perspective and is habitat oriented	12
Propose hard infrastructure-fees to fund NNBF monitoring	10
Revisit/revise project goals to ensure project adaptive capacity	10
Identify innovative funding streams for project monitoring, including Local fees, taxes, impact fees, etc.	9
Develop consistent and transferable terminology for both site assessment & project monitoring	9
Find standardized format for shared site assessment and project monitoring data	9
Develop site assessment protocols that are mindful of reg/permitting needs & monitoring needs	8
Required monitoring should reflect the priority for adaptive management/risk management and the inherent dynamic nature of the challenges and solutions	6
Long-term monitoring should be a required component and fed/state funding	5
Clearly identify responsible entities for long-term monitoring and maintenance of NNBF projects	5
Develop guidance document on total project valuation for funders and applicants that highlights site assessment, construction, and post-project monitoring costs.	5
Use the NJ/TNC Metrics/Monitoring framework as a foundation for standard assessment protocol	5
Develop a state trust-oriented models for funding monitoring	4
Align distribution platforms and data/monitoring formats across federal/state/regional entities	4

WORKSHOP B: New York, NY	
Site Assessment & Project Performance Monitoring (cont.)	Total Votes
Regional considerations should be included in project assessment (system vs. site-approach)	4
Acquire reference conditions to fill the gap on baseline conditions	4
Duration of required project performance monitoring to vary based on category of metrics being collected	3
Develop more rigorous, upfront site assessments to decrease need for mitigation down the line	3
Require "lessons learned" in project performance analyses	3
Required monitoring should be tied to specific metrics	2
Due to funding limitations for monitoring, establish dedicated funding for a sentinel monitoring program	2
Promote use of maintenance contracts to elicit long-term maintenance of NNBF projects (incentive for contractors)	1
Should be separate source of funding for monitoring of high-priority demonstration projects	1
Due to limited resources, project monitoring should be specific to stated goals of the project	1
Conduct alternatives analysis for monitoring that details different time horizons, associated costs, and priority metrics	0
Establish bond funding mechanisms for large scale projects	0

WORKSHOP B: New York, NY	
Permitting Challenges	Total Votes
Develop checklist of what permitting entities need (similar to the NYC Waterfront Navigator)	20
Develop more demonstration projects that showcase the outcomes and track records of NNBF to support permitting of these types of projects	18
Streamline the permitting process between federal and state requirements (i.e. Resolve discrepancies between federal and state approaches to the permitting process)	16
Develop a "cookbook" of NNBF projects that demonstrate success under various site conditions (i.e. habitat-based, goal specific)	15
Develop standards/certifications/community of practice to demonstrate NNBF concepts (i.e. SAGE)	13
Regulatory agencies to provide greater transparency on what existing, approved applications, including all permitting documents, all relevant public notices from regulatory agencies, and supporting documentation (in electronic form)	13
Applicants need to define project goals upfront & likelihood of success; propose proof-of-concept for NNBF projects/demo projects; applicants are able to demonstrate likelihood of neutral or positive benefit	12
Relieve the high burden of demonstrating degradation of a resource for applicants by developing a checklist that reflects both federal and state regulatory needs/requirements; Agencies develop online "phased checklists" that are proportional to project size (i.e. for smaller projects, select fewer monitoring requirements)	11
Remove regulatory disincentives for private landowners (i.e. in NY, state jurisdiction ends at the bulkhead, whereas it extends further out with a living shoreline - need to revisit NY's Tidal Wetland regulations)	10
Research/data supporting the cost/benefits of habitat conversions to inform permit review (i.e. how might habitat conversion impact water quality)	8

WORKSHOP B: New York, NY	
Permitting Challenges (cont.)	Total Votes
Collaborate with others to secure funding to address research gaps & to do more projects	8
Convene interagency meetings that provide coordinated (multi-jurisdictional) comments on project, and through different phases of the project - provide clear written direction (i.e. MD Joint Evaluation Meetings)	8
Encourage research entities to evaluate best practices AND provide incentives to make NNBF projects easier to permit	7
Train waterfront property owners and design professionals about what they can reasonably expect with SLR & other natural processes	7
Address problem that it's easier to do hard projects than NNBF through requirement to analyze broader spectrum of alternatives (similar to MD model)	6
Explore new mechanisms to address barriers to making habitat trade-offs (i.e. payment in lieu of fee, regulatory changes, policy changes)	5
Regulatory agencies to compile one-stop source for GIS data (including regulatory overlays, review jurisdictions, boundaries, agency purview) & other links (i.e. NYSERDA Clearinghouse)	5
Make funding cycles longer to accommodate permit review process	4
Seek regular feedback from regulatory agencies starting with the conceptual phase of the project	4
Improve understanding of habitat services & vulnerabilities	4
Identify resources for/to educate applicants on approaches to characterize habitat trade-offs	4
Set up funding pool for beneficial projects	3
Long-term monitoring needed to demonstrate proof-of-concept for permitting review	2
Define desirable outcomes sought in permitting applications	2
For small projects (i.e. private owner/single family projects), relieve the applicant of permitting fees	2
Develop consensus on what NNBF is/is not and/or what is legit to certify	2
Include future conditions (i.e. climate change projections) in permit applications; permit to current and future conditions	1
Provide tax incentives for property owners who install an NNBF project	1
Require a project sponsor to vouch for/assist with project (similar to NJ DEP GP 24)	1
Fund design phase 1st, then if feasible, fund construction	0

WORKSHOP B: New York, NY	
Project Design Standards	Total Votes
Develop site assessment guidance on site-specific biological processes and physical forces - Require analysis of physical, ecological, future conditions, and adaptability for all NNBF project designs	46
Develop "assessment cookbook"/checklist (possibly by committee) distinguished by feature type (can be informed by the Stevens Institute Guidance book)	27
Develop standards for project adaptability based on feature type and project goals; evaluate performance over time vs. initial construction	27
Demonstration projects that highlight appropriate project design to inform funding solicitations	23
Develop guidance/guidebook on suggested ranges of application for each design feature - guidance should be flexible and allow for the fact that ranges may vary	20
Form state-level committees with diverse expertise (i.e. regulators, ecologists, engineers, etc.) to review project proposals, innovative strategies, big picture coordination (similar to FL's Open Ocean Coasts)	18

WORKSHOP B: New York, NY

Project Design Standards (cont.)	Total Votes
Provide greater public access to information/models/maps illustrating future conditions to be considered in project siting (i.e. SLR)	18
Develop design guidance by NNBF project-types	13
Develop risk-reduction/hazard mitigation value of NNBF projects by feature type	12
Develop guidance on construction methodology & training BMPs	10
New federal and state guidance on evaluating co-benefits of NNBF projects - scaled to project size and cost	8
Require site-specific modeling of future conditions	8
Opportunities to provide continuing education to engineers on NNBF design	8
Funding solicitations should require an analysis of co-benefits	7
Evaluate/adjust co-benefit requirements based on applicants, project size, and new information	6
Develop a project design plan which accounts for current and future conditions	5
Adopt a minimum standard for project survival (i.e. 30 years) - would need to account for a margin of error in the project design (regarding SLR or future conditions) and could entail different thresholds based on project size	4
Tie state general living shoreline permits to new nationwide living shoreline permit	4
Innovative conditional permit - project to be removed/replaced if intended/desired results are not achieved	4
Sea Grant training to practitioners on project design standards	4
Provide outreach to applicants on project design in pre-application meeting	4

APPENDIX D: Resources

Demonstrating the Value of Green Infrastructure				
Organization/Author	State	Resource Title	Resource Description	Web link
Partnership for the Delaware Estuary	DE/NJ	Practitioner's Guide: Shellfish-Based Living Shorelines for Salt Marsh Erosion Control and Environmental Enhancement in the Mid-Atlantic	Thorough description of costs and benefits of living shorelines, as well as the timing considerations for permitting and installation	http://www.delawareestuary.org/pdf/Living%20Shorelines/Final_DELSI%20Practitioners%20Guide_2012.pdf
Maryland Critical Areas Commission	MD	Coastal Resiliency for Private Landowners	Informational factsheet about coastal resilience, geared toward private landowners	http://dnr.maryland.gov/criticalarea/Documents/Coastal_resilience_for_Landowners_Factsheet.pdf
		The Green Book for the Buffer: An Illustrated Guidebook for Planting at the Shoreline	Shoreline greening guide for private landowners	http://dnr.maryland.gov/criticalarea/Documents/PDF/Home/GreenBook_Buffer.pdf
MD DNR Chesapeake and Coastal Services	MD	Shoreline Conservation Service	Description of MD DNR's restoration and conservation program	http://dnr.maryland.gov/ccs/Pages/restoration.aspx
VIMS Center for Coastal Resources Management	VA	Living Shorelines - Frequently Asked Questions	Answers potential questions from interested property owners, and provides links to many other resources	http://ccrm.vims.edu/livingshorelines/faq.html
VIMS Center for Coastal Resources Management	VA	Living Shoreline Implementation: Challenges and Solutions	VIMS assessed the challenges toward living shoreline implementation in Virginia by hosting a workshop with citizens, state agencies, government staff, environmental groups, and contractors. The results, including potential solution-ideas for the financial and permitting barriers in Virginia, are presented in this document	http://ccrm.vims.edu/publications/pubs/rivers&coast/R_C914.pdf
VIMS Center for Coastal Resources Management	VA	Teaching Marsh	A one-acre site of restored marshland that us used as a demonstration site. The marsh was restored in 1999, and helps reduce stormwater contamination in the York River	http://ccrm.vims.edu/wetlands/teaching_marsh/background/index.html
The Nature Conservancy	NY	Urban Coastal Resilience: Valuing Nature's Role	Evaluation of coastal-protection tactics in New York City - determined that hybrid solutions for coastal resilience have the most benefits	http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newyork/climate-energy/natural-infrastructure-study-at-howard-beach.xml

Demonstrating the Value of Green Infrastructure (cont.)				
Organization/Author	State	Resource Title	Resource Description	Web link
NY DOS	NY	NNBF visual guide	Educational images and descriptions about how different nature-based solutions provide coastal resilience	http://opdgig.dos.ny.gov/#/storyTemplate/11/2/1
The Nature Conservancy	NJ	Places We Protect: The Humble Power of Oysters and Coconuts	Example of using NNBF to reduce flooding impacts and protect coastal communities at Gandy's Beach in southern New Jersey. Also discusses benefits to wildlife like horseshoe crabs and red knots	http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/newjersey/placesweprotect/gandys-beach-living-shoreline-project-1.xml
The Stevens Institute, The Center for Maritime Systems, and HRNERR's Hudson River Sustainable Shorelines	NY	A Comparative Cost Analysis of Ten Shore Protection Approaches at Three Sites Under Two Sea Level Rise Scenarios	The study took place at three diverse shoreline sites along the Hudson River. Costs for varying shoreline protection tactics (including traditional grey infrastructure like bulkheads and rip-rap, and NNBF like joint-planting and vegetated geogribs) are reviewed.	https://s3.amazonaws.com/nyclimatescience.org/240186-100-A-Comparative-Cost-Analysis-of-Ten-ShoreProtection-Approaches-at-Three-Sites-Under-Two-Sea-Level-Rise-Scenarios.pdf
DM Bilkovic, Mitchell, M., Mason, P., Duhring, K.	Not state-specific	The Role of Living Shorelines as Estuarine Habitat Conservation Strategies	Demonstrates the conservation and habitat value of NNBF	http://www.tandfonline.com/doi/figure/10.1080/08920753.2016.1160201?scroll=top&needAccess=true
NOAA	Not state-specific	CanVis	Simulates the impacts of different types of development on a shoreline, and allows users to compare the outcomes of multiple scenarios	https://coast.noaa.gov/digitalcoast/tools/canvis.html
Northern Neck Master Gardeners	VA	The Reedville Living Shoreline	Demonstration living shoreline on Cockrell's Creek in Virginia	http://www.nnmg.org/files/Reedville_Garden_final71009_(2)%5b1%5d.pdf
Identifying and Highlighting Appropriate Contractors and Projects				
Organization/Author	State	Resource Title	Resource Description	Web link
Chesapeake Bay Landscape Professional	Chesapeake Bay Watershed	Chesapeake Bay Landscape Professional	Certification program for landscape professionals that design and install NNBF	http://cblpro.org/about-cblp/
National Green Infrastructure Certification Program	Not state-specific	National Green Infrastructure Certification Program	This certification program is in development, but aims to create a pool of skilled workers that can install and maintain green infrastructure	http://ngicp.org/program/

Identifying and Highlighting Appropriate Contractors and Projects (cont.)				
Organization/Author	State	Resource Title	Resource Description	Web link
The Sustainable SITES Initiative	Not state-specific	SITES Rating System	Framework and certification program for landscape architects and other professional to implement nature-based/sustainable practices to recude stormwater runoff, provide habitat for wildlife, increase outdoor recreation opportunities and other environmental benefits.	http://www.sustainablesites.org/
VIMS Center for Coastal Resources Management	VA	Living Shoreline Design - A class for marine contractors	Training for marine contractors regarding ecosystem services, site suitability, and design criteria for living shorelines	http://ccrm.vims.edu/education/living_shoreline_design_class/
VIMS Chesapeake Bay National Estuarine Research Reserve	VA	CBNERR Coastal Training Program	Training for coastal resources professionals	http://www.vims.edu/cbnerr/coastal_training/course_catalog/index.php
DNREC	DE	A Tour of Living Shorelines in Delaware	Interactive map of all living shorelines in Delaware	http://dnrec.maps.arcgis.com/apps/MapJournal/index.html?appid=371a244682084370a78d0a54c5edb27a
Hudson River Sustainable Shorelines	NY	Shoreline Demonstration Site Network	Interactive website of shoreline stabilization techniques, along the Hudson River, that maintain or enhance the ecological services provided and are cost-competitive with gray approaches.	https://www.hrerr.org/hudson-river-sustainable-shorelines/demonstration-site-network/
NJ DEP	NJ	NJ Living Shorelines Projects	Web-based tour of NFWF funded NNBF projects	http://njdep.maps.arcgis.com/apps/MapJournal/index.html?appid=049f4937cbdd437bb496a7aea94acd35&folderid=f4686d3c9a7048efb7a1dd8d877eb3f6
NJ DEP	NJ	NJ Statewide Living Shorelines Projects	PDF map of living shorelines in NJ	http://www.nj.gov/dep/cmp/docs/statewide-living-shoreline-projects.pdf

Building Public Awareness of NNBF				
Organization/Author	State	Resource Title	Resource Description	Web link
University of Maryland Extension	Chesapeake Bay Watershed	Bay-Wise Landscape Management	Resource to inform property owners about nature-based best practices to apply to their own properties	https://extension.umd.edu/baywise/home-landscape-best-management-practices
Wetlands Watch	VA	Homeowner's Guide to Wetlands	Resource for homeowners in designing, permitting, and maintaining wetlands in their own backyards	http://wetlandswatch.org/homeowners-guide/?rq=homeowners
Financing NNBF Project Implementation				
Organization/Author	State	Resource Title	Resource Description	Web link
MD DNR	MD	Financial and Technical Assistance	Low-interest loan program for those interested in installing a living shoreline in Maryland	http://dnr.maryland.gov/ccs/Pages/livingshorelines/ftassistance.aspx
MD DNR	MD	Land Acquisition and Planning	Land acquisition program for areas to be used for public recreation and open space	http://dnr.maryland.gov/land/Pages/ProgramOpenSpace/home.aspx
Virginia Department of Environmental Quality	VA	Virginia Clean Water Revolving Loan Fund - Living Shorelines Loan Program Guidelines	Low-interest loan program for those interested in installing a living shoreline in Virginia	http://www.deq.virginia.gov/Portals/0/DEQ/Water/ConstructionAssistanceProgram/Living%20Shorelines%20Loan%20Guidelines-FINAL.pdf
NJ DEP	NJ	Green Acres Program	Acquisition program for lands in the floodways of the following rivers (and their tributaries): Delaware, Passaic, or Raritan. Acquired land to be used for recreation and conservation purposes	http://www.nj.gov/dep/greenacres/blue_flood_ac.html
Site Assessment Tools and Protocols				
Organization/Author	State	Resource Title	Resource Description	Web link
Northern Neck Master Gardeners	VA	Shoreline Evaluation Program	Volunteers from Northern Neck Master Gardeners visit waterfront properties and inform owners of their options	http://www.nnmg.org/shoreprotect.asp
MD DNR	MD	Maryland Coastal Resiliency Assessment	Extensive assessment in Maryland of coastal risk, to identify where natural habitats have the greatest risk reduction potential	http://dnr.maryland.gov/ccs/Documents/MARCH-2016_MDCoastalResiliencyAssessment.pdf
MD DNR	MD	Maryland Coastal Atlas	Interactive mapper tool for exploring and analyzing Maryland's ocean and coastal data	http://dnr.maryland.gov/ccs/coastalatlaspages/default.aspx

Site Assessment Tools and Protocols (cont.)				
Organization/Author	State	Resource Title	Resource Description	Web link
The Nature Conservancy	NJ	Restoration Explorer and Coastal Resilience Mapping Tool	Mapping tool that allows users to see what type of NNBF is most effective along a six county stretch of New Jersey's coast	http://maps.coastalresilience.org/newjersey/
NJ DEP	NJ	New Jersey Coastal Atlas Interactive Mapping and Planning Tools	Interactive mapper tool for exploring and analyzing New Jersey's ocean and coastal data	http://www.nj.gov/dep/cmp/czm_mapindex.html
NJ DEP	NJ	Shoreline Change Mapping	Mapping tool to visualize how the shoreline has changed over time in specific NJ localities	http://www.nj.gov/dep/cmp/czm_shoreline_change.html
NJ DEP	NJ	Coastal Vulnerability Index (CVI) Mapping	CVI was mapped for all of coastal NJ over four sea level rise scenarios – present day (2014), 2030, 2050, and 2100. Additionally, a CVI-based map was created for each NJ coastal community	http://www.nj.gov/dep/cmp/czm_cvi.html
Adaptation Clearinghouse	Not state-specific	Coastal Resources	Searchable, broad-use platform for data and resource sharing related to coastal resilience	http://www.adaptationclearinghouse.org/sectors/coastal/
Climate Adaptation and Knowledge Exchange (CAKE)	Not state-specific	Case Studies	Database of climate adaptation-related case studies that is searchable and covers a broad geography. In addition to case studies, the CAKE website also includes published studies and links to online tools	http://www.cakex.org/case-studies
Partnership for the Delaware Estuary	NJ	Marsh Futures	Vulnerability assessment at a local scale in southern New Jersey	http://delawareestuary.s3.amazonaws.com/pdf/Summit15/PDE-Report-15-03_Marsh%20Futures.pdf
Project Design				
Organization/Author	State	Resource Title	Resource Description	Web link
Partnership for the Delaware Estuary	DE/NJ	Mussel Powered Living Shorelines for Salt Marsh Erosion Control	Experiments with using oysters and ribbed mussels in living shoreline design for stability and other co-benefits	https://www.estuaries.org/pdf/2012conference/room21/session7/Kreeger_RAE_2012_pres.pdf
National Wildlife Federation and MD DNR	MD	Conquest Preserve Living Shoreline	Living shoreline that was designed around sea level rise projections	http://www.chesapeakebay.org/index.php/09-2016/29/conquest-preserve-living-shoreline/

Project Design (cont.)				
Organization/Author	State	Resource Title	Resource Description	Web link
Delaware Living Shorelines Committee	DE/NJ	Delaware Living Shorelines Committee	Regional partnership to promote nature-based coastal resilience solutions.	http://www.nj.gov/dep/cmp/docs/20170227-Is-summit/nj-living-shoreline-workgroup-de-committee-2-27-15.pdf
Stevens Institute of Technology	NJ	Living Shorelines Engineering Guidelines	Guidance for engineers and regulators on living shoreline design	http://www.nj.gov/dep/cmp/docs/living-shorelines-engineering-guidelines-final.pdf
VIMS	VA	Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments	Provides site evaluation criteria, design considerations, and case studies regarding living shorelines in Virginia	http://web.vims.edu/physical/research/shoreline/docs/L_S_Design_final_v1.2.pdf
Project Permitting				
Organization/Author	State	Resource Title	Resource Description	Web link
DNREC	DE	Statewide Activity Approval (SAA) for Shoreline Stabilization Projects in Tidal and Non-tidal Waters of the State of Delaware	Streamlines the permitting process in Delaware for living shorelines and other nature-based solutions for projects less than 500 linear feet	http://www.dnrec.delaware.gov/wr/Documents/Shoreline_Stabilization_SAA.pdf
Virginia Marine Resources Commission	VA	Living Shoreline Group 1 General Permit for Certain Living Shoreline Treatments Involving Tidal Wetlands	Streamlines the permitting process in Virginia for living shorelines and other nature-based solutions for projects	http://mrc.virginia.gov/Regulations/fr1300.shtm
NJDEP	NJ	General Permit 24 - Habitat Creation, Restoration, Enhancement and Living Shoreline Activities	Streamlines the permitting process in New Jersey for living shorelines and other nature-based solutions for projects	http://www.nj.gov/dep/landuse/coastal/cp_gp24.html
NYS DEC	NY	Community Risk and Resiliency Act (CRRRA)	Requires NY DEC to consider sea-level rise projections in their regulations, and to develop guidance on using nature-based resources to enhance community resilience	http://www.dec.ny.gov/energy/102559.html
MD DNR	MD	Living Shorelines Laws	Identifies living shorelines as the preferred method for shoreline protection against erosion, expands the Critical Areas buffer from 100 ft to 200 ft, and stipulates that a waiver process will be needed for any proposed project that is not a living shoreline	http://www.mde.state.md.us/programs/Water/WetlandsandWaterways/Pages/LivingShorelines.aspx

Increase Understanding (for Applicants and Regulators) of NNBF Permitting				
Organization/Author	State	Resource Title	Resource Description	Web link
VIMS	VA	Education: Wetlands Self Taught Education Units	Self-paced educational seminars regarding permit processes in VA, coastal defense structures, wetlands ecology, and more.	http://ccrm.vims.edu/education/wetlands_selfeds/index.html
VIMS	VA	Workshops and Events	VIMS hosts two workshops per year (one in spring and one in fall) regarding tidal wetlands and shoreline management in the state	http://ccrm.vims.edu/education/workshops_events/index.html
HRNERR: Hudson River Sustainable Shorelines	NY	Hudson River Sustainable Shorelines Project: Legal Framework Analysis	Summary of the federal, state, and local regulations and polices related to shoreline development in the Hudson River Estuary	https://www.hrnerr.org/doc/?doc=240189622
Project Performance Monitoring				
Blue Urchin	Not state-specific	MyCoast App	User-friendly tool for documenting tides, storm damage and more	https://mycoast.org/
HRNERR	NY	Shorelines Forensic Analysis	Post-storm analysis of shoreline structure performance on the Hudson River	https://www.hrnerr.org/shorelinesforensicanalysis/
HRNERR	NY	Assessing Ecological and Physical Performance	Monitoring protocols for evaluating the performance, both physically and ecologically, of nature-based engineered shoreline stabilization projects	https://www.hrnerr.org/hudson-river-sustainable-shorelines/assessing-ecological-physical-performance/