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Nature-Based Infrastructure: NOAA's Role

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SUMMARY

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Nature-Based Infrastructure: NOAA's Role

The National Oceanic and Atmospheric Administration (NOAA) currently supports natural, nature-based, or green infrastructure and other related types of features (hereinafter referred to as *nature-based infrastructure)* as part of its statutory mandates to support, research, restore, and conserve natural resources. NOAA's nature-based activities primarily fall under three line offices: the National Marine Fisheries Service, National Ocean Service, and Office of Oceanic and Atmospheric Research.

NOAA uses the term *nature-based infrastructure* and other related terms interchangeably to describe natural systems or engineered systems that mimic natural processes built to minimize flooding, erosion, and runoff. Nature-based infrastructure projects may include features that are completely natural, such as open lands and trees (e.g., coastal mangroves), or may incorporate varying degrees of hard or "gray" steel and concrete structures, such as seawalls. Often, multiple types of nature-based infrastructure features are combined within a project. Stakeholder selection of nature-based infrastructure features may depend on a combination of factors, including available funding, space constraints, technical feasibility, hydrologic impact, and community acceptance, among other factors. According to NOAA, nature-based infrastructure can provide several benefits such as flood, erosion, and runoff management, wave buffering, improved water quality, wildlife habitat, opportunity for groundwater recharge, recreation uses, and aesthetic appeal, among others. The extent to which nature-based infrastructure features provide these benefits is partially dependent on the types of features used and the location.

Historically, Congress has directed funding to some federal agencies for the design and construction of hard infrastructure, such as breakwaters, revetments, and bulkheads or seawalls that provide a measurable and expected level of flood, erosion, and runoff management. However, these features also have demonstrated limitations and some unintended consequences. Researchers and practitioners have studied the potential impacts and benefits of hard structures relatively well, whereas similar research on nature-based infrastructure is ongoing.

Practitioners and decisionmakers have been using the term nature-based infrastructure and supporting nature-based infrastructure features since at least the late 2000s (although these types of features have likely been studied and implemented under various terms for several decades). Nature-based infrastructure may continue to be appealing due to (1) stakeholder emphasis on infrastructure features that benefit both humans and the environment in multiple ways and (2) recognition that infrastructure may be longer lasting if it can adjust to changing environmental conditions in the short and long terms. Members of Congress may consider whether and how federal agencies, including NOAA, can support nature-based infrastructure activities by federal agencies.

Congress has neither defined nature-based infrastructure in statutes related to NOAA activities nor directed in statute that the agency support such activities. Congress has provided some statutory direction related to nature-based infrastructure for the U.S. Army Corps of Engineers (USACE) and the Environmental Protection Agency (EPA). Congress may consider whether to define nature-based infrastructure for NOAA or explicitly authorize NOAA to support nature-based infrastructure in specific cases, similar to USACE and EPA, or require NOAA to consider nature-based infrastructure activities across the agency. Congress also may consider requiring federal (and federal with nonfederal) coordination of nature-based infrastructure activities in an existing federal working group (e.g., the System Approach to Geomorphic Engineering community of practice), a new group, or other mechanism. Finally, as NOAA does not identify its nature-based infrastructure activities as separate budget line items, Congress may consider (1) directing NOAA, and other federal agencies, to report its nature-based infrastructure spending and (2) whether to retain existing or establish new mechanisms to fund nature-based infrastructure activities at NOAA.

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The National Oceanic and Atmospheric Administration (NOAA) currently supports natural, nature-based, or green infrastructure and other related types of features (hereinafter referred to as *nature-based infrastructure)* as part of its statutory mandates to support, research, restore, and conserve natural resources. Practitioners and decisionmakers have been using the term *nature-based infrastructure* and supporting nature-based infrastructure features since at least the late 2000s (although these types of features have been assigned various names over time). Nature-based infrastructure may continue to be appealing due to (1) stakeholder emphasis on infrastructure features that benefit both humans and the environment in multiple ways and (2) recognition that infrastructure may be longer lasting if it can adjust to changing environmental conditions in the short and long terms. Members of Congress may consider whether and how to support nature-based infrastructure activities at federal agencies, including NOAA, with these objectives, among others, in mind.

This report describes how NOAA characterizes nature-based infrastructure and the agency's current activities supporting research and implementation of nature-based infrastructure. The report also discusses potential issues for Congress including (1) definitions of nature-based infrastructure in statute, (2) NOAA's authority to support nature-based infrastructure, (3) how NOAA coordinates with other federal agencies and nonfederal entities on nature-based infrastructure activities, and (4) how NOAA funds nature-based infrastructure activities and its total nature-based infrastructure-related expenditures.

Nature-Based Infrastructure as Defined by NOAA

NOAA has defined *natural infrastructure* and *nature-based infrastructure* in NOAA Administrative Order (NAO) 216-117: NOAA National Habitat Policy.[1] NOAA defines natural infrastructure as "healthy ecosystems, including forests, wetlands, floodplains, dune systems, and reefs, which provide multiple benefits to communities, including storm protection through wave attenuation or flood storage capacity and enhanced water services and security."[2]

Similarly, NOAA defines nature-based infrastructure as "engineered systems where natural features are combined with more hard or structural engineering approaches to create a hybrid system."[3]

However, across NOAA's publicly accessible documents and websites, the agency appears to use the terms nature-based infrastructure, natural infrastructure, and green infrastructure interchangeably. **Table 1** lists several types of nature-based infrastructure features as identified by NOAA. According to NOAA, nature-based infrastructure projects may include features that are completely natural, such as open lands and trees, or may incorporate varying degrees of hard or "gray" steel and concrete structures, such as bulkheads (**Figure 1**). Often, multiple types of nature-based infrastructure features are combined within a project. The selection of nature-based

[1] National Oceanic and Atmospheric Administration (NOAA), "NOAA Administrative Order 216-117," at https://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/NAO_216-117.pdf. Hereinafter referred to as NAO 216-117. NAO 216-117 was issued and became effective on June 30, 2015. According to the NOAA Office of the Chief Administrative Officer site, the policy was last reviewed April 8, 2019. NOAA Office of the Chief Administrative Officer, "NOA 216-17: NOAA National Habitat Policy," at https://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/216-117.html. There is a discrepancy between the number of the administrative order noted on NOAA's website (NAO 216-17) and the number of the administrative order as noted on the PDF of the administrative order (NAO 216-117).

[2] NAO 216-117, p. 3.

[3] NAO 216-117., p. 3.

infrastructure features often depends on a combination of available funding, space constraints, land or roof availability, technical feasibility, hydrologic impact, and community acceptance, among other factors.[4]

According to NOAA, nature-based infrastructure can provide several benefits in addition to flood, erosion, and runoff management, such as improved water quality, wildlife habitat, opportunity for groundwater recharge, recreation uses, and aesthetic appeal, among others.[5] The extent to which nature-based infrastructure features provide these benefits is partially dependent on the location and types of features used.[6]

Table 1. NOAA's Examples of Nature-Based Infrastructure Features

Features	Examples
Natural and open lands	Land acquisition; conservation easements; parks and greenways
Forestry practices	Urban forestry; street and yard trees
Green streets	Narrower streets; bio-swales; rain gardens
Bioretention	Rain gardens; bio-swales; stormwater planters
Green or blue roofs	Green roofs; cisterns; roof drainage disconnection
Permeable pavements	Permeable concrete and asphalt; paver blocks; gravel and grass pave systems
Dune or beach creation and protection	Beach nourishment; dune creation; dune vegetation
Mangrove, salt marsh, and tidal wetlands	Mangrove, salt, and tidal marsh restoration and preservation; submerged aquatic vegetation restoration and preservation
Oyster and coral reef	Protection and restoration of existing reefs; establishment of new reefs
Hybrid practices	Coupling hard infrastructure with natural systems (i.e., rock sill or breakwater with marsh grass planting, also referred to as a living shoreline)

Source: CRS adapted from NOAA, *Green Infrastructure Practices*, at https://coast.noaa.gov/data/digitalcoast/pdf/gi-practices-and-benefits.pdf.

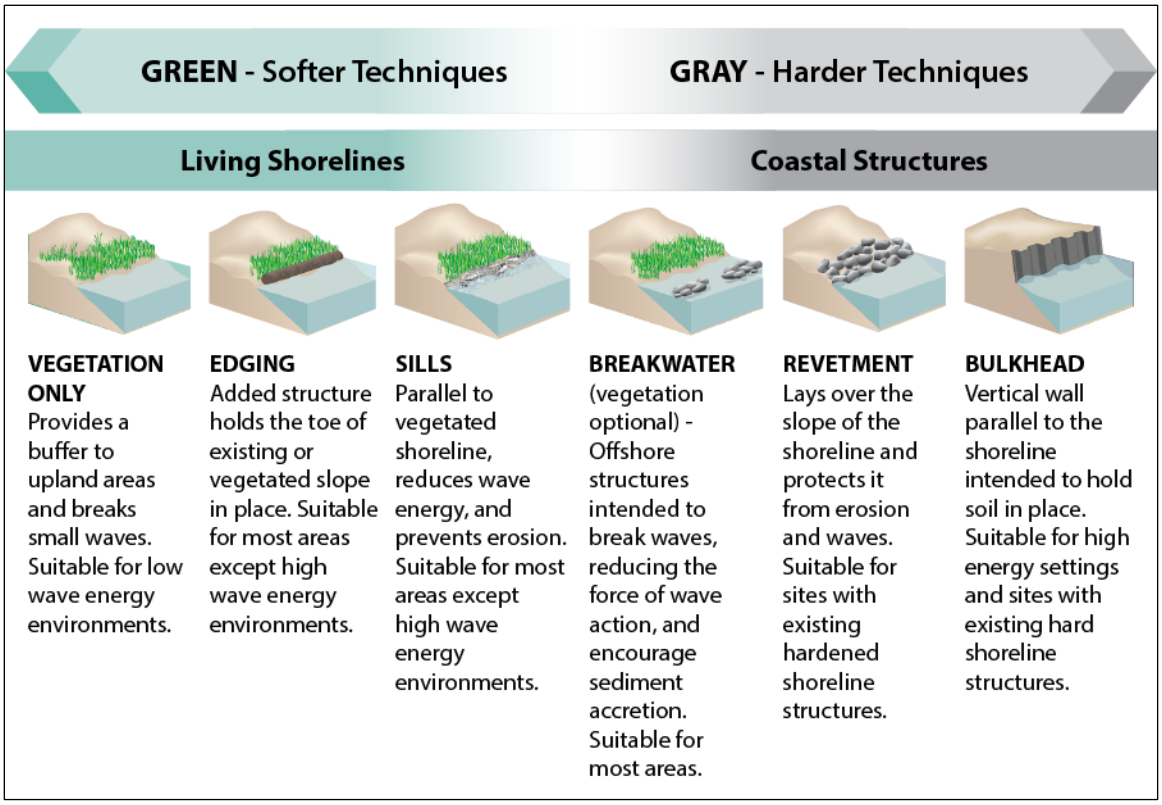
Notes: Features are listed in the order noted in NOAA's *Green Infrastructure Practices.*

[4] NOAA, *A Guide to Assessing Green Infrastructure Costs and Benefits for Flood Reduction*, p. 16, at https://coast.noaa.gov/data/digitalcoast/pdf/gi-cost-benefit.pdf. Hereinafter referred to as NOAA, *GI Guide*.

[5] NOAA, *GI Guide*, p. 15, and NOAA, *Top Ten Things to Know Series: Let Nature be the First Line of Defense – Natural Infrastructure*, at https://coast.noaa.gov/data/nationalfacts/pdf/hand-out-natural-infrastructure.pdf.

[6] U.S. Government Accountability Office (GAO), *Consideration of Project Costs and Benefits in Using Natural Coastal Infrastructure and Associated Challenges*, GAO-19-319, March 2019, p. 8, at https://www.gao.gov/assets/700/698019.pdf. Other factors may include the environmental setting and requirements for maintenance of the feature, among others.

Figure 1. Examples of Potential Coastal Infrastructure Features



Source: CRS, adapted from NOAA, *Guidance for Considering the Use of Living Shorelines*, 2015, p. 8, at https://www.habitatblueprint.noaa.gov/wp-content/uploads/2018/01/NOAA-Guidance-for-Considering-the-Use-of-Living-Shorelines_2015.pdf.

"Hard" Infrastructure vs. Nature-Based Infrastructure

Historically, some federal agencies (e.g., U.S. Army Corps of Engineers [USACE], U.S. Environmental Protection Agency [EPA]) have provided financial and technical assistance and/or constructed hard infrastructure—such as breakwaters, revetments, bulkheads or seawalls, impervious surfaces, and concrete drainage channels—to provide a measurable and expected level of flood, erosion, and runoff management. For example, states have and are still able to use EPA's Clean Water State Revolving Fund to fund the construction of seawalls (to protect centralized wastewater treatment works) and "traditional pipe, storage, and treatment systems" (for stormwater), among other projects. However, these features also have demonstrated limitations and some unintended consequences. For example, some studies have shown that seawalls may disrupt sediment transport, steepen offshore beaches, cause erosion at the bottom or ends of the seawall, or narrow the beach in front of the seawall.

Nature-based infrastructure may be an alternative to hard infrastructure or may be used in combination with hard infrastructure. It may provide flood, erosion, and runoff management without some of the unintended consequences of hard infrastructure. Nature-based infrastructure also may provide other benefits not typically associated with traditional hard infrastructure. For instance, constructing natural salt marshes alongside hard infrastructure may benefit water quality, wildlife habitat, and public access, with the potential for the salt marsh to accrete sediment and grow vertically as sea levels rise. Nature-based features with plant components, such as mangroves and vegetated dunes, may also be able to shift in response to changing shoreline conditions, in contrast to permanently placed hard structures.

The potential benefits as well as limitations of hard structures are relatively well studied, whereas similar research to determine the efficacy and cost-benefits of nature-based infrastructure is ongoing. Developing, testing, and evaluating nature-based infrastructure can be time-consuming and uncertain. As plantings grow, for example, they also may need to adjust to variable conditions and possibly compete with invasive species. It may also be unclear how certain types of nature-based features may respond in the long-term or in extreme climatic events that may occur infrequently. Additionally, in many cases, federal permitting processes have been developed for hard

infrastructure. The federal permitting process for projects that incorporate nature-based infrastructure, however, is developing and may become clearer over time. For example, USACE released its Nationwide Permit 54 – Living Shorelines in 2017 for "the construction and maintenance of living shorelines to stabilize banks and shores in coastal waters."

Sources: EPA, *Overview of Clean Water State Revolving Fund Eligibilities,* May 2016, pp. 8 and 13; Systems Approach to Geomorphic Engineering (SAGE), Natural and Structural Measures for Shoreline Stabilization, 2017, pp. 3, 5-6; National Research Council, *Reducing Coastal Risk on the East and Gulf Coasts*, Washington, DC, 2014, pp. 72, 79; GAO, *Army Corps of Engineers: Consideration of Project Costs and Benefits in Using Natural Coastal Infrastructure and Associated Challenges*, March 2019; U.S. Department of Transportation Federal Highway Administration, *Nature-Based Solutions for Coastal Highway Resilience*, white paper, February 2018; National Science and Technology Council, Committee on Environment, Natural Resources, and Sustainability, *Ecosystem-Service Assessment: Research Needs for Coastal Green Infrastructure,* August 2015; National Oceanic and Atmospheric Administration Coastal Services Center, *Economic Assessment of Green Infrastructure Strategies for Climate Change Adaptation: Pilot Studies in the Great Lakes Region*, May 2014; Tjeerd J. Bouma et al., "Identifying Knowledge Gaps Hampering Application of Intertidal Habitats in Coastal Protection: Opportunities and Steps to Take," *Coastal Engineering*, vol. 87 (May 2014), pp. 147-157; and USACE, *Decision Document Nationwide Permit 54*.

Notes: Recently, Congress has directed both USACE and EPA to consider and support nature-based infrastructure as well (e.g., "tidal wetlands and living shorelines.").

For more information about USACE Nationwide Permits, see CRS Report 97-223, *The Army Corps of Engineers' Nationwide Permits Program: Issues and Regulatory Developments*, by Nicole T. Carter.

NOAA's Nature-Based Infrastructure Activities

NOAA's National Habitat Policy (NAO 216-117) directs the agency to protect, maintain, and restore ocean, coastal, and Great Lakes ecosystems by "applying natural and nature-based infrastructure," among other activities.[7] According to the agency, this work is supported by a variety of statutory mandates and authorities.[8] Congress has not defined in statute *nature-based* or related terms for NOAA, nor has it explicitly directed NOAA to broadly support nature-based features or related activities across the agency.

NOAA's nature-based infrastructure activities fall primarily under three line offices: the National Marine Fisheries Service (NMFS), National Ocean Service (NOS), and Office of Oceanic and Atmospheric Research (OAR). According to NOAA, many of the agency's nature-based infrastructure activities are related to restoration and conservation projects; the projects are typically local or regional in scale and take place within coastal or Great Lakes states.[9]

- NMFS's Restoration Center administers the community-based restoration grant program with congressionally appropriated funds to support nature-based infrastructure activities, among other restoration activities, implemented by institutions of higher education; nonprofit and for-profit organizations; U.S. territories; and state, local, and tribal governments.[10] The NOAA Restoration Atlas, a project-tracking database, lists over 2,000 community-based restoration

[7] NOAA, "NAO 216-17: NOAA National Habitat Policy," at https://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/216-117.html.

[8] NOAA notes statutes such as the Coastal Zone Management Act of 1972 and the Coral Reef Conservation Act of 2000, among others. NOAA, "NAO 216-17: NOAA National Habitat Policy," at https://www.corporateservices.noaa.gov/ames/administrative_orders/chapter_216/216-117.html.

[9] NOAA, "Restoration Atlas," at https://restoration.atlas.noaa.gov/src/html/index.html.

[10] Community-based restoration grants are also known as coastal and marine habitat restoration grants. NOAA, "Coastal and Marine Habitat Restoration Grants," at https://www.fisheries.noaa.gov/grant/coastal-and-marine-habitat-restoration-grants.

projects, many of which include nature-based infrastructure features and multiple benefits.[11] For instance, the Restoration Center provided funds for the planting of marshgrass along the coast of Northumberland County, VA, to reduce shoreline erosion and improve fish habitat (**Figure 2**).[12]

Figure 2. Example of Nature-Based Infrastructure Features Supported by NOAA's National Marine Fisheries Service

(Northumberland, VA, Marshgrass Planting Project)

Source: NOAA, "Restoration Atlas – Northumberland Marshgrass Planting Project," at https://restoration.atlas.noaa.gov/src/html/index.html. Used with permission.

Notes: According to NOAA Restoration Atlas, the picture depicts the "replanted shoreline site in Northumberland County, Virginia. Spartina patens planted in front of coir fiber log at toe of eroding slope." Coir fiber logs are tube-shaped devices filled with coconut fiber material, designed to stabilize the toe of a bank and promote sediment trapping. Virginia Department of Conversation and Recreation, *The Virginia Stream Restoration and Stabilization Best Management Practices Guide,* at https://www.deq.virginia.gov/Portals/0/DEQ/Water/Publications/BMPGuide.pdf.

- Several programs and activities under NOS support research and implementation of nature-based infrastructure. For example, the Coral Reef Conservation Program, National Coastal Zone Management Program, and National Estuarine Research Reserve System provide technical assistance and administer competitive grant programs to a variety of entities, such as institutions of higher education; nonprofit organizations; and local, state, and tribal governments, among others.[13] Coastal scientists with NOAA's National Centers for Coastal Ocean Science have estimated the economic value of nature-based infrastructure to stabilize coastlines along the Pacific Northwest.[14] Additionally, the Damage

[11] NOAA, "Restoration Atlas – About the Data," at https://restoration.atlas.noaa.gov/src/html/index.html.

[12] NOAA, "Restoration Atlas – Northumberland Marshgrass Planting Project," at https://restoration.atlas.noaa.gov/src/html/index.html.

[13] For more information about the National Coastal Zone Management program, see CRS Report R45460, *Coastal Zone Management Act (CZMA): Overview and Issues for Congress*, by Eva Lipiec.

[14] NOAA National Centers for Coastal Ocean Science, "A Multidisciplinary, Integrative Approach to Valuing

Assessment, Remediation, and Restoration Program, a program with components in both NMFS and NOS, supports nature-based infrastructure implementation through funds recovered in settlements or litigation. For example, it has supported the design and implementation of a living shoreline with breakwaters in Pensacola, FL, to (1) create and restore salt marsh and reef habitat and (2) protect and stabilize the shoreline, with funds from the BP Deepwater Horizon spill settlement (**Figure 3**).[15]

Figure 3. Example of Nature-Based Infrastructure Features Supported by NOAA's National Ocean Service

(overview of the Project GreenShores Site II layout)

Source: Deepwater Horizon Trust Council. Used with permission. Correspondence with NOAA Legislative Affairs, December 6, 2019.

Notes: Construction on the project is expected to commence in 2020.

- Under OAR, the Climate Program Office and the National Sea Grant College Program (Sea Grant) both support research and implementation of nature-based infrastructure through competitive grant programs on a variety of topics, including nature-based infrastructure.[16] For example, the Climate Program Office has awarded grants to institutions of higher learning and agencies within state government to support the development and application of methodologies to

Ecosystem Services from Natural Infrastructure," at https://coastalscience.noaa.gov/project/valuing-ecosystem-services-from-natural-infrastructure/.

[15] NOAA, "Restoration Atlas – DWH - Florida Pensacola Bay Living Shoreline Project," at https://restoration.atlas.noaa.gov/src/html/index.html. For more information about this project, see Gulf Spill Restoration, "Florida Pensacola Bay Living Shoreline Project," at https://www.gulfspillrestoration.noaa.gov/florida-pensacola-bay-living-shoreline-projec. For more information about restoration after the Deepwater Horizon spill, see CRS Report R43380, *Gulf Coast Restoration: RESTORE Act and Related Efforts*, by Charles V. Stern, Pervaze A. Sheikh, and Jonathan L. Ramseur.

[16] The National Sea Grant College Program is a "national network of 34 university-based programs and the National Sea Grant Library." NOAA Sea Grant, "Sea Grant Programs," at https://seagrant.noaa.gov/.

value nature-based infrastructure.[17] Sea Grant also may support research or provide technical assistance for nature-based infrastructure projects. For instance, Alaska Sea Grant organized trainings in "Green Infrastructure for Coastal Resilience" for municipal and borough planners, designers, landscape architects, public housing authority planners, academics, and nonprofits.[18] In another case, New York Sea Grant funded the monitoring of nature-based shoreline erosion management measures in various regions of New York.[19]

Additional NOAA programs may have roles related to nature-based infrastructure, such as reviewing projects that may use nature-based infrastructure and providing underlying data for decisionmaking. For example, the NMFS Office of Protected Resources is often involved in reviewing nature-based infrastructure projects that may affect protected species under NOAA's jurisdiction.[20] NOAA may also direct appropriated funding to nonfederal organizations, such as the National Fish and Wildlife Foundation, to support nature-based infrastructure activities.[21] For example, NOAA provides funds and program oversight to the foundation's National Coastal Resilience Fund, which in FY2019 funded grants to "create, expand, and restore natural systems in areas that will both increase protection for communities from coastal storms, sea- and lake-level changes, inundation, and coastal erosion while also improving valuable habitats for fish and wildlife species," among other objectives.[22]

Potential Policy Issues for Congress

Definitions in Statute

Congress has not defined the term *nature-based infrastructure*, or similar terms, in statute for NOAA as it has for USACE and EPA. For example, in P.L. 114-322 Congress defined *natural* and *nature-based* features and directed USACE to consider the features when studying the feasibility of flood risk management, hurricane and storm damage reduction, and ecosystem restoration projects (33 U.S.C. §2289a). In P.L. 115-436, which amended the Clean Water Act, Congress defined *green* infrastructure and directed EPA to promote green infrastructure use, among other activities (33 U.S.C. §1362(27) and 33 U.S.C. §1377a).[23]

[17] NOAA Climate Program Office, "COCA FY2016 – Ecosystem Services for a Resilient Coast in a Changing Climate," October 3, 2016, at https://cpo.noaa.gov/Meet-the-Divisions/Earth-System-Science-and-Modeling/AC4/ArtMID/6339/ArticleID/694.

[18] Alaska Sea Grant, "Introducing Green Infrastructure for Coastal Resilience," at https://alaskaseagrant.org/event/introducing-green-infrastructure-for-coastal-resilience/.

[19] New York Sea Grant, "Measuring Success: Monitoring Natural and Nature-Based Shoreline Features in New York State," at https://seagrant.sunysb.edu/articles/t/new-york-shorelines-new-york-shorelines-news.

[20] Email from NOAA Office of Legislative Affairs, March 28, 2019.

[21] For more information, see CRS Report R44740, *National Fish and Wildlife Foundation (NFWF): History, Function, and Funding*, by R. Eliot Crafton.

[22] National Fish and Wildlife Foundation, "National Coastal Resilience Fund 219 Request for Proposals," at https://www.nfwf.org/coastalresilience/Pages/2019rfp.aspx.

[23] It is unclear if the features considered under these definitions are distinct or overlap. Under 33 U.S.C. §2289a, Congress defines a natural feature as "a feature that is created through the action of physical, geological, biological, and chemical processes over time" and a nature-based feature as "a feature that is created by human design, engineering, and construction to provide risk reduction by acting in concert with natural processes." Under 33 U.S.C. §1362(27), Congress defines green infrastructure as "the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or

Congress may consider whether and how to define the term and the types of nature-based infrastructure for NOAA. Some Members of Congress have proposed definitions within the context of new NOAA programs. For example, H.R. 1317 in the 116th Congress would provide definitions for *natural*, *nature-based*, and *nonstructural* features to be used as criteria for new NOAA financial assistance programs.[24] Two other nearly identical bills in the 116th Congress, H.R. 3115 and S. 1730, define the term *living shoreline* for the use within a new agency-administered grant program.[25]

A NOAA-specific definition of nature-based infrastructure and similar terms in statute may help the agency prioritize and manage its nature-based infrastructure activities. A definition also could potentially limit the types of nature-based infrastructure, by inhibiting the development and adoption of new designs and features that are not captured in a statutory definition. Further, a NOAA-specific definition may conflict with other federal agency definitions for nature-based infrastructure. Congress may consider whether one definition should be used among all federal agencies to minimize the potential for confusion. A single definition across all federal agencies, however, could conflict with the various missions and activities of the different federal agencies.

Authorities for Nature-Based Infrastructure

Congress has directed NOAA to support, research, restore, and conserve natural resources in a variety of statutes. Congress has not enacted authorities specifically for nature-based infrastructure activities; however, NOAA has interpreted some of its authorities to include support for nature-based infrastructure activities. For example, in 2009 Congress directed NOAA to create the Coastal and Estuarine Land Conservation Program (CELCP) under the Coastal Zone Management Act (CZMA; P.L. 111-11, 16 U.S.C. §1456-1 and §1456d). Congress established the CELCP to provide grants to nonfederal entities to protect "important coastal and estuarine areas that have significant conservation, recreation, ecological, historical, or aesthetic values" (16 U.S.C. §1456d), which may include natural or open lands, identified by NOAA as nature-based infrastructure in **Table 1**. Similarly, Congress instructed NOAA to conduct and support "activities to conserve coral reefs and coral reef ecosystems" (16 U.S.C. §§6401-6409). NOAA has identified coral reefs as a type of nature-based infrastructure (**Table 1**); coral reefs have been shown to buffer waves and provide protection from shoreline erosion.[26]

Some stakeholders contend that NOAA is already authorized to support nature-based infrastructure features through its existing statutes.[27] Others in Congress, however, have proposed legislation that would expand the type of nature-based infrastructure activities NOAA currently supports. For example, in the 116th Congress, H.R. 1317 would direct NOAA to "improve the resilience of the built and natural environment to natural disasters and climate change" by using natural, nature-based, and nonstructural features, among other features. Another bill, H.R. 3115, would require NOAA to administer grants for "designing and implementing ... living shorelines; and ... innovative uses of natural materials and systems to protect coastal communities, habitats,

evapotranspirate stormwater and reduce flows to sewer systems or to surface waters."

[24] A similar bill (S. 2783) was introduced in the 115th Congress.

[25] Similar bills (H.R. 4525 and S. 3087) were introduced in the 115th Congress.

[26] NOAA Ocean Service Education, "Importance of Coral Reefs," at https://oceanservice.noaa.gov/education/kits/corals/coral07_importance.html.

[27] U.S. Congress, House Committee on Natural Resources, *Living Shorelines Act of 2019,* Report together with dissenting views to accompany H.R. 3115, 116th Cong., 1st sess., November 26, 2019, H.Rept. 116-316, p. 10. Hereinafter referred to as H.Rept. 116-316.

and natural system functions," among other provisions. Expanding NOAA's authority for nature-based infrastructure activities has been met with some opposition. For example, some in Congress have argued that a new NOAA grant program that H.R. 3115 would authorize "strays from the long-standing Congressional intent of providing eligible coastal states and territories the flexibility to design programs that best address local challenges by inserting federal priorities into a state-run program."[28]

Coordination of Nature-Based Infrastructure Activities

NOAA often supports nature-based infrastructure activities alongside other federal and nonfederal partners. For example, the agency has provided financial and technical support to the aforementioned Pensacola Bay Living Shoreline Project, which also receives support from the Florida Department of Environmental Protection.[29] In addition, NOAA has been a part of several federal interagency and interorganizational efforts to better understand and support nature-based infrastructure. For instance, NOAA was a part of the federal Coastal Green Infrastructure and Ecosystem Services Task Force established in response to *Hurricane Sandy Rebuilding Strategy* recommendations.[30] The task force was co-chaired by NOAA and the U.S. Geological Survey and resulted in the development of a 2015 report.[31] Report recommendations focused on "coastal green infrastructure" metrics, production functions (e.g., how can the United States better track how ecosystem changes may impact infrastructure), ecosystem-service valuation, social factors, and decisionmaking support.[32]

NOAA also has been a member of the interorganizational Systems Approach to Geomorphic Engineering (SAGE) working group. SAGE includes representatives from federal and state agencies, academic and research institutes, nongovernmental organizations, and the private sector.[33] SAGE is a "community of practice" and aims to share advances in the science,

[28] H.Rept. 116-316. The Member was referring to the Coastal Zone Management Act's (CZMA) national program. H.R. 3115, as introduced, would not amend the CZMA, but could be administered in coordination with CZMA provisions.

[29] NOAA, "Restoration Atlas – DWH - Florida Pensacola Bay Living Shoreline Project," at https://restoration.atlas.noaa.gov/src/html/index.html. Other related projects in Pensacola Bay were supported by NOAA, as well as the U.S. Fish and Wildlife Service, the National Fish and Wildlife Foundation, the City of Pensacola, the Gulf Power Company, and the Ecosystem Restoration Support Organization, Inc. NOAA, "Restoration Atlas – Green Shores Oyster Reef and Salt Marsh Creation-Phase II," at https://restoration.atlas.noaa.gov/src/html/index.html.

[30] Hurricane Sandy Rebuilding Task Force, August 2013, *Hurricane Sandy Rebuilding Strategy*, at https://www.hud.gov/sites/documents/HSREBUILDINGSTRATEGY.PDF. For more information about the strategy see CRS Report R43396, *The Hurricane Sandy Rebuilding Strategy: In Brief*, by Jared T. Brown.

[31] National Science and Technology Council (NSTC), Committee on Environment, Natural Resources, and Sustainability, *Ecosystem-Service Assessment: Research Needs for Coastal Green Infrastructure*, August 2015, at http://sagecoast.org/docs/sci_eng/cgies_research_agenda_final_082515.pdf. Hereinafter referred to as NSTC, *Research Needs for CGI*. Members of the task force included representatives from the Bureau of Land Management, Council of Economic Advisers, Council on Environmental Quality, Department of Defense, Department of Housing and Urban Development, EPA, Federal Emergency Management Agency (FEMA), Office of Management and Budget, Office of Science and Technology Policy, National Security Council, USACE, U.S. Department of Agriculture, U.S. Fish and Wildlife Service, U.S. Forest Service, and U.S. Geological Survey. Other federal agencies, such as EPA, have been a part of another interorganizational working group, the Green Infrastructure Collaborative. *Federal Agency Support for the Green Infrastructure Collaborative*, July 16, 2014 (Amended October 8, 2014), at https://www.epa.gov/sites/production/files/2015-10/documents/federal-support-for-green-infrastructure-collaborative_508.pdf.

[32] NSTC, *Research Needs for CGI*, p. 35.

[33] Other federal agencies include FEMA and USACE. SAGE, "Management Team" and "Leadership Team," at http://sagecoast.org/info/organization.html.

engineering, policy, and financing of nature-based infrastructure across organizations.[34] For example, organizations, including NOAA, have been a part of SAGE pilot projects in selected locations working to address issues such as shoreline loss using nature-based infrastructure.[35] SAGE also brings organizations together to discuss technical, policy, and financial issues through periodic meetings and serves as a public resource aggregator by compiling links to technical guidance, conference proceedings, research, and other materials.[36]

Congress may deliberate whether and how to direct NOAA to manage nature-based infrastructure activities within the agency or with non-NOAA organizations in specific ways. For example, Congress may require NOAA to coordinate its nature-based infrastructure within an intra-agency working group or task force. Alternatively, Congress could establish an advisory board or similar group to provide recommendations for better intra-agency, interagency, and interorganizational coordination.[37] For coordination with organizations outside of NOAA, Congress may authorize in statute an already established working group, such as SAGE, or create a new group focused on nature-based infrastructure.

Some stakeholders may argue that a statutory requirement for NOAA to coordinate with federal and nonfederal partners may facilitate information sharing, promote the efficient use of available funding, and streamline permitting across federal agencies. Others may argue that unless Congress specifically authorizes NOAA to support nature-based infrastructure activities, the agency should (1) focus resources solely on meeting current congressional directives and/or (2) coordinate at their own discretion.

Funding for Nature-Based Infrastructure

Congress funds NOAA to support, research, restore, and conserve natural resources primarily through the annual appropriations process.[38] NOAA reports its spending to Congress on a program-by-program basis, but nature-based infrastructure activities are not tracked specifically as line items in either the agency's annual budget request or in congressional appropriations bills and reports. For example, Congress appropriated $68 million to the National Sea Grant College Program in FY2019; however, NOAA does not track what portion of that funding was used to support nature-based infrastructure activities.[39] Similarly, NOAA does not report the proportion of funding supporting nature-based infrastructure activities in other NOAA programs. Congress may consider requiring NOAA to track and/or report its spending on nature-based infrastructure

[34] SAGE, "Community of Practice," at http://sagecoast.org/info/organization.html.

[35] SAGE, "SAGE Workgroups" and "Regional Demonstrations," at http://sagecoast.org/info/activities.html.

[36] SAGE, "SAGE Workgroups" and "Regional Demonstrations," at http://sagecoast.org/info/activities.html and SAGE, "Science and Engineering," at http://sagecoast.org/info/sci-eng.html. Call with NOAA Office for Coastal Management, NOAA, August 14, 2019. The SAGE management team is composed of representatives from the federal agencies, nongovernmental organizations, academia, and the private sector. SAGE, "Management Team" at http://sagecoast.org/info/organization.html.

[37] For example, in P.L. 108-446 (20 U.S.C. 1411) Congress directed the Secretary of the Interior to establish an advisory board to the Bureau of Indian Affairs to "develop and recommend policies concerning effective inter- and intra-agency collaboration."

[38] Some nature-based infrastructure activities also are funded through settlements with responsible parties in cases of injuries to the environment. NOAA Damage Assessment, Remediation, and Restoration Program, "Natural Resources Damage Assessment," at https://www.darrp.noaa.gov/what-we-do/natural-resource-damage-assessment.

[39] U.S. Congress, House Committee on Appropriations, *Making Further Continuing Appropriations for the Department of Homeland Security for Fiscal Year 2019, and for Other Purposes*, committee print, prepared by Conference Report to Accompany H.J.Res. 31, 116th Cong., 1st sess., February 13, 2019, H.Rept. 116-9, p. 616.

activities. Other federal agencies also likely do not track spending related to nature-based infrastructure activities, and Congress may consider requiring all federal agencies to report their nature-based infrastructure expenditures. Congress has sometimes required federal agencies to submit crosscut budgets detailing individual agency expenditures (e.g., USACE water resources research and technology institutes expenditures as required under 42 U.S.C. §10303) as well as some interagency expenditures (e.g., Great Lakes restoration activity expenditures as required under 33 U.S.C. §1268a).

Stakeholders hold different views about whether or how Congress should fund nature-based infrastructure activities. Congress could continue to appropriate funds that support NOAA's core capabilities and mission, without specifying they be used for nature-based infrastructure activities. Alternatively, Congress could, for example, appropriate funds for existing or new NOAA programs that provide grants to nonfederal entities explicitly for research and implementation of nature-based infrastructure.[40] Several bills introduced in the 116th Congress address funding for nature-based infrastructure activities in various ways. For example, H.R. 3115 would create a new grant program to fund the installation of living shorelines, a type of nature-based infrastructure feature. H.R. 1317 would (1) issue a U.S. Postal Service semipostal stamp and use some of its proceeds to fund prize competitions and research catalog development, and (2) authorize appropriations for capitalization funds to establish state community resilience revolving funds for the implementation of nature-based infrastructure, among other projects.[41] S. 2284 would establish the Carbon Dividend Trust Fund with requisite fund transfers to federal agencies. As proposed in S. 2284, NOAA's portion of the fund transfer would support several programs, including a coastal resiliency program that would be required to prioritize the consideration of natural and nature-based infrastructure. However, some Members of Congress have argued that the establishment of new grant programs, such as the living shoreline grant program in H.R. 3115, are "duplicative and wasteful," as Congress already appropriates funding to NOAA that may be used to support nature-based infrastructure.[42]

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[40] The Trump Administration requested to eliminate various NOAA programs that provide grants to external entities in the agency's FY2018, FY2019, and FY2020 NOAA budget requests. During House and Senate appropriations committee hearings focused on the agency of the Department of Commerce, several Members of Congress asked the NOAA officials testifying why the agency requested to eliminate the programs. In response, NOAA officials stated that the agency had focused its budget requests on funding NOAA's core capabilities and mission. U.S. Congress, House Committee on Appropriations, Subcommittee on Commerce, Justice, Science, and Related Agencies, *Hearings before a Subcommittee of the Committee on Appropriations*, Commerce, Justice, Science, and Related Agencies Appropriations for 2020 Part 6, 116th Cong., 1st sess., March 27, 2019 (Washington: GPO, 2019), pp. 63, 70, and 73; and Senate Committee on Appropriations; Subcommittee on Commerce, Justice, and Science, *Review of the FY2020 Budget Request for the U.S. Department of Commerce*, 116th Cong., 1st sess., April 2, 2019, CQ Congressional Transcripts https://plus.cq.com/doc/congressionaltranscripts-5505550?3&searchId=KtKnHfMH (accessed August 2, 2019), pp. 20 and 36.

[41] For more information on U.S. Postal Service semipostal stamps, see CRS Report RS22611, *Common Questions About Postage and Stamps*, by Michelle D. Christensen and CRS Report R44809, *Multinational Species Conservation Fund Semipostal Stamp*, by Pervaze A. Sheikh, Michelle D. Christensen, and Kalyn R. Dorheim.

[42] H.Rept. 116-316, p. 10.