Promoting Coastal Resilience through Partnerships and Planning:

Communities, Sea Grant Programs, SERPPAS, and Military Installations

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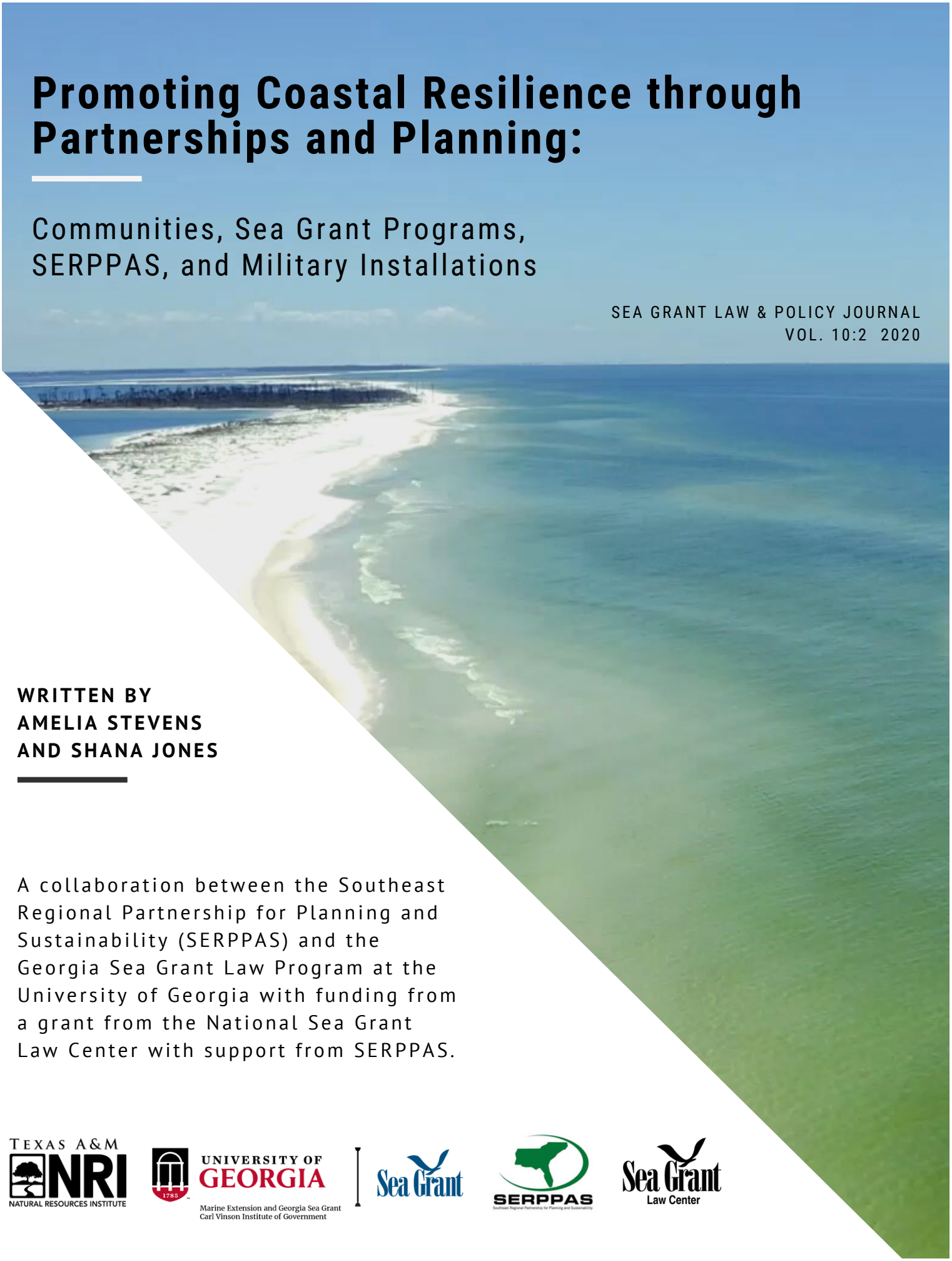

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I. INTRODUCTION

Natural and working landscapes adjacent to military installations are often highly valuable coastal resources and are increasingly at risk from multiple threats, specifically climate-related hazards. As such, it is important to preserve and protect these resources not only to maintain compatibility within the military mission but also to sustain the natural and built infrastructure for the surrounding communities. A tremendous opportunity exists for Sea Grant professionals working on coastal resilience issues to partner with military and civilian personnel also working on these issues at and around coastal installations. The overall goal of this article is to describe existing efforts in the Southeast to further develop such partnerships.

This article first focuses on the climate-related threats to coastal installations, particularly in the Southeast, and the steps taken by the Department of Defense (DoD), state and local governments, and regional partners, specifically the Southeast Regional Partnership for Planning and Sustainability (SERPPAS)[1], to mitigate the risks posed to the missions of the installations and ensure installation resiliency[2].

It then provides an overview of two categories of military programs – land acquisition and community land use planning – that have the strong potential to serve as important adaptation and coastal resilience tools that support broader community resilience beyond military installation boundaries.

The article concludes with an overview of findings from a workshop held in August 2019 among SERPPAS, Sea Grant, state Coastal Zone Management program partners, and others, which focused on understanding challenges and opportunities for collaboration between military installations and communities on coastal resilience efforts as well as identifying pilot projects to enhance resilience for the benefit of military readiness and surrounding communities.

About the Authors

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II. MILITARY READINESS AND COASTAL RESILIENCE IN THE SOUTHEAST

In the recent years, military installations have become increasingly vulnerable to climate-related threats. In January 2019, the Department of Defense (DoD) released a climate report, which detailed the vulnerabilities to **seventy-nine** mission assurance priority installations. Installations all over the country are affected by flooding, wildfire, drought, desertification, and thawing permafrost. Flooding and natural weather events, such as hurricanes, pose the greatest risk to installations on the coast.[3]

A. EXAMPLES OF COASTAL CLIMATE-RELATED ISSUES FACING MILITARY INSTALLATIONS

Flooding concerns for military installations particularly include storm surge from severe weather events, which are magnified over time from sea level change. As sea level rise continues to increase as a threat, permanent inundation could severely and permanently affect installations. For example, at Naval Station Norfolk, Virginia, the largest U.S. naval base, nuisance flooding from high tide events results in increasing coverage of land, contributing to extensive delays in ship repairs at Norfolk Naval Shipyard. In the past eleven years, NS Norfolk has suffered nine major floods that damaged ship-repairing equipment and infrastructure on base.[4] Norfolk is part of the larger Hampton Roads region, which is one of the most vulnerable to flooding installations in the United States. In addition to nuisance flooding, the Hampton Roads area is seeing an increased vulnerability to coastal storms. A Joint Land Use Study[5] identified and implemented eighteen recommendations, including requiring all new development to be raised significantly.[6] The DoD also partnered with NASA to develop a base-specific flood modeling tool.[7]

Also affected by sea level rise is North Carolina's Marine Corps Base Camp Lejeune. The Center for Climate and Security released a report in 2018 that identified Camp Lejeune as a vital Marine base threatened by rising seas. By the end of the 21st century, Camp Lejeune could be exposed to 25% flooding from a Category 1 hurricane, and 40% flooding from a Category 4 storm. Hurricane Florence in 2018 made landfall in North Carolina as a Category 1, but caused over $3 billion in damage due to Camp Lejeune's aging infrastructure, significantly affecting the family housing complexes and preventing the servicemen and women living there from getting to the base. Commandant of the Marine Corps Gen. Robert Neller spoke of this problem saying that the Marines fight from the sea so they need to be located "somewhere where we can get to the sea."[8]

The effects of severe weather events are demonstrated most significantly at Air Force Base Tyndall in the wake of 2018's Hurricane Michael. Following Hurricane Michael, approximately 60% of Tyndall's buildings were destroyed,

resulting in almost $5 billion worth of damage.[9] Additionally, a fifteen-foot storm surge damaged barrier islands and destroyed slash pine forests. The base is now being rebuilt as a "**Base of the Future**," a collaborative effort between DoD, private industry, and federal agencies to rebuild in a resilient and sustainable manner. New infrastructure will be rebuilt fourteen to nineteen feet above sea level and be able to withstand 150-180 mph winds, with mission critical areas able to sustain 230 mph winds. A landscape plan is in place to emphasize resiliency and recover some of the destroyed habitat. A Compatible Use Plan, funded by the DoD's Office of Economic Adjustment, is in the planning stages with local communities.[10]

B. EMERGING MILITARY DIRECTION AND COLLABORATION

The DoD Report on Climate Change issued in January 2019 assessed the vulnerability of seventy-nine mission assurance priority installations. Of the seventy-nine installations studied, **sixty were vulnerable to flooding**, **forty-three to wildfire**, **forty-eight to drought**, and **fifty-seven to more than one climate-related hazard**.[11] In light of these threats, the DoD has placed significant focus on three areas to address climate hazards by issuing new guidance documents. The first DoD guidance focuses on "High Performance and Sustainable Building Requirements."[12] Through this guidance, when building new development, installations should provide building design solutions responsive to any government-provided projections of climate change and determination of acceptable risk. This guidance addresses existing buildings by requiring installations to improve climate resiliency of facilities and operations.[13] The second guidance focuses on "Installation Master Planning," which requires installations to create a plan that addresses changes in climatic conditions, such as temperature, rainfall patterns, storm frequency and intensity, and water levels, using climate projections from reliable sources.[14] The third guidance focuses on "Civil Engineering," which includes minimum design flood elevation and flood mitigation requirements and provides civil engineering criteria and best practices for site development.[15]

An ongoing effort by the DoD is the development of a climate vulnerability assessment tool. This tool will provide DoD guidance on using climate data and establish an agreed-upon and consistent set of climate-related projections. It is specifically tailored for the DoD planning and engineering communities. The use of the assessment tool is being phased in, with estimated completion in summer 2020. Other continuing efforts by the DoD to strengthen climate impact mitigation strategies include implementing a climate adaption handbook for installation natural resource managers, updating the "Landscape Architecture" directive to support installation water management and climate resilience, partnering with the defense communities around bases to holistically address climate-related problems, and continuing work with the mission assurance and intelligence communities.[16]

The most recent defense authorization bill, the John S. McCain National Defense Authorization Act for Fiscal Year 2019, amended 10 U.S.C. § 101 by adding the definition of military installation resilience. The statute now defines "military installation resilience" as follows:

Military Installation Resilience

> The term 'military installation resilience' means the capability of a military installation to avoid, prepare for, minimize the effect of, adapt to, and recover from extreme weather events, or from anticipated or unanticipated changes in environmental conditions, that do, or have the potential to, adversely affect the military installation or essential transportation, logistical, or other necessary resources outside of the military installation that are necessary in order to maintain, improve, or rapidly reestablish installation mission assurance and mission-essential functions.[17]

The reauthorization also authorized the DoD to provide funding to state and local governments for off-base infrastructure projects if the assistance will enhance the military value, resilience, or military family quality of life at an installation. Additionally, the new law authorizes the DoD to offer grants to states and local government for assistance to address threats to military installation resilience that could hinder base operations.[18]

3 FOCUS AREAS TO ADDRESS CLIMATE HAZARDS

High Performance and Sustainable Building Requirements

Installation Master Planning

Civil Engineering

III. MILITARY FUNDING PROGRAMS: OVERVIEW AND CONNECTION TO RESILIENCE

The Department of Defense has acknowledged that climate change is a national security issue that can impact missions, operational plans, and installations. Therefore, the DoD has begun taking a systematic approach to mitigate climate threats and to increase installation resiliency through existing programs designed to address other environmental issues. This article focuses on two important DoD programs that work to preserve and protect natural and working landscapes: the **Readiness and Environmental Protection Integration (REPI) Program** and the **Compatible Use Program**, formerly called the Joint Land Use Study (JLUS) Program.

A. READINESS AND ENVIRONMENTAL PROTECTION INTEGRATION PROGRAM (REPI)

DoD established the Readiness and Environmental Protection Integration (REPI) Program in the early 2000s. The REPI Program is a key tool used by the DoD to enhance military readiness by combating encroachment that limits or restricts military training, testing, and operations through land acquisition.[19] REPI projects are land acquisition efforts and natural resource management activities. In coastal areas, they have strong potential to promote resilience by creating buffers that protect property and infrastructure from flooding and storm surge, corridors for wildlife, and areas for habitat such as coastal marsh to migrate as sea levels rise.

REPI FRAMEWORK

Authorized by 10 U.S.C. § 2684a[20], REPI combats encroachment by removing or avoiding land use conflicts near military installations and by addressing regulatory restrictions inhibiting military activities. Encroachment is any external factor that inhibits military readiness. For example, residential and commercial development surrounding the installation emits large amounts of light, reducing the effectiveness of night-vision training. Further, development may affect the habitats of threatened and endangered species, pushing those species onto the less developed military lands and thereby restricting or potentially restricting the military's ability to train and test on the land. Addressing encroachment is important because military readiness depends on the ability of installations and ranges to provide realistic training and effective weapons systems testing.[21] Within the overall framework of REPI administered by the Office of the Secretary of Defense, each military service has its own approach to utilizing the REPI program that works best for that service.[22]

REPI HISTORY

The REPI program began in the early 2000s as the result of an effort at Fort Bragg, North Carolina, to protect longleaf pine forests that serve as habitat for the endangered red-cockaded woodpecker through a program called the Private Lands Initiative.

In 2011, Fort Carson in Colorado became the first installation to complete a large-scale REPI buffer project, working to safeguard 137,000 acres from incompatible development. As REPI evolved, DoD developed new tools, such as land exchanges, to enhance an installation's ability to protect its mission. For example, in 2008, the Navy exchanged 1.65 acres of excess housing property in California for restrictive easements on 282 acres of buffer land owned by a developer adjacent to NAS Fallon. That buffer protects the runway where an F-5 Tiger II supersonic light fighter takes off.[23]

PARTNERSHIPS

Fostering buffer partnerships among the military services, private conservation groups, and state and local governments is a key element to mitigate encroachment. Since REPI's first partnership in 2003, partners contribute funds along with the DoD in a cost-sharing effort to acquire easements or other interests in land from willing sellers to preserve compatible land uses and natural habitats near installations to help sustain critical, at-risk military mission capabilities. Stakeholders are engaged at the federal, state, and local levels to encourage partnering with the installations. REPI also supports large landscape partnerships that seek solutions linking military readiness, conservation, and communities with federal and state partners. These partnerships include SERPPAS, the Western Regional Partnership, America's Longleaf Restoration Initiative and the Sentinel Landscapes Partnership among DoD and the Departments of Agriculture and Interior.[24]

The six REPI projects in the state of Georgia demonstrate these partnerships in action. The DoD has spent more REPI money in Georgia than any other state, with total expenditures equaling over $300 million as of FY 2019.[25] This figure includes REPI expenditures, military service expenditures, and partner expenditures.[26]

A major partner is SERPPAS, one of the regional partnerships previously mentioned. SERPPAS partners work to prevent encroachment around military lands by partnering with REPI in their efforts. Georgia is a member of SERPPAS, along with Alabama, Florida, Mississippi, North Carolina, and South Carolina. An example of these partnerships at work can be found at Fort Stewart in Liberty County, Georgia, a winner of the 2012 REPI Challenge. The Georgia Land Trust matched the $4.5 million from REPI with $5.5 million to purchase 5,508 acres of forested land from Rayonier Timber Company, creating a permanent natural buffer zone for Fort Stewart and removing the development threat that would limit training capabilities.[27] Rayonier retained the timber rights and continues to responsibly manage the land around Fort Stewart as a working forest, keeping approximately 24 forest-related jobs in the community.[28]

In 2019, Naval Submarine Base Kings Bay in St. Marys, Georgia, received a REPI Challenge award to partner with the Nature Conservancy, the Georgia Department of Natural Resources, the U.S. Fish and Wildlife Service, the U.S. Forest Service, Open Space Institute, and private donors to protect an 11,000-acre coastal property known as Cabin Bluff.[29] This area, which was zoned for 10,000 homes and 1 million square feet of commercial space, will now protect critical gopher tortoise habitat and enhance installation resilience.

REPI FUNDING

To receive general REPI funding, each military service must submit proposals to the Office of the Secretary of Defense (OSD) for the annual buffer project funding process. OSD critically evaluates the proposals and works with the services to take into consideration the value and priority of the missions being protected.

The criteria prioritize programs that provide multiple benefits to the community and environment, increase innovation, and strengthen partner cost-sharing to provide the best value to the taxpayers. REPI projects rely on this cost sharing, combining the funds of the DoD through REPI, military services, and partners.

Installations may also receive additional REPI funds through what is known as the REPI Challenge, initiated in 2012. The once a year Challenge seeks to cultivate projects that conserve land at a greater scale, test promising ways to finance land protection, and harness the creativity of the private sector and market based approaches.[30] For example, the Townsend Bombing Range, operated by the Marine Corps in McIntosh and Long County, Georgia, receives both general REPI funding and REPI challenge funding. The Townsend Bombing Range is a 55,000-acre parcel of land and has been deemed by the installation and the state of Georgia as the largest and most important unprotected tract of critical habitat in the lower Altamaha River Corridor. The Bombing Range was a recipient of the 2016 REPI Challenge Award because the project promised to ensure that the tract will remain undeveloped, effectively achieving the installation's encroachment protection goals while leveraging significant funding from partners.[31]

As of 2016, the Bombing Range had received $2 million in REPI Challenge funds, $3.2 million in traditional REPI funding provided to the Marine Corps through the standard DoD process, and $3.7 million from the Office of the Deputy Assistant Secretary of Defense for Readiness, and planned to receive an additional $2.6 million from the DoD as part of the final phase of the Townsend Bombing Range project. Government funds totaling $11.5 million went to the Bombing Range in addition to $23.5 million in funding from partners. Partners include the State of Georgia, the U.S. Fish and Wildlife Service, the U.S. Forest Service, Altamaha Riverkeeper, the Georgia Department of Natural Resources, The Conservation Fund, and The Knobloch Family Foundation, among many others.

The Bombing Range Project not only improves the Marine Corps' ability to train in that space, but also seeks to improve water quality within the third largest watershed in the Eastern Seaboard and seeks to preserve prime habitats for several threatened and endangered species, including the longleaf pine, eastern indigo snake, and gopher tortoise. This collaborative effort added twelve miles of undeveloped river frontage to a fifty-mile protected stretch of the lower Altamaha River, which has been designated by The Nature Conservancy as one of the seventy-five "Last Great Places" in the world.[32] To date, the Townsend Bombing Range has received $75.2 million in funds from both the DoD and partners.[33]

REPI BENEFITS

REPI provides benefits for both the military and the surrounding communities. By reducing encroachment, the military has a heightened ability to train. REPI efforts preserve live-fire and maneuver training along with the capability for night operations. Additionally, lost training days are reduced, allowing for fewer workarounds necessary to continue training and testing. In light of the rising importance of a clear frequency spectrum, REPI buffer zones protect against electromagnetic interference that comes from areas with significant residential development. These zones also shield the military from civilian complaints of electromagnetic interference with household electronics and noise conflicts that arise from military activities that generate loud noises, such as live-fire training, weapons testing, or aviation training. Finally, the military benefits from the REPI program through mission growth and multi-service missions. The military has increased flexibility to use more of the space already under its control for future or expanded missions, helping to satisfy new and future operational demands.[34]

Communities benefit in equally significant ways from the REPI program. When local communities engage with new partners as part of the REPI framework, they find innovative ways to preserve their quality of life while coexisting with the military installation. Further, land preservation allows for agricultural and forest production, supporting a sustainable local economy.

Unlike residential development, working lands are generally compatible with military training. Agricultural uses produce fewer lights that impact night training and testing, and a lower population density eases safety concerns. Creating buffer zones and encouraging compatible land use also enhance operational safety by conducting training exercises away from large populations.[35]

Communities receive environmental benefits as well when engaging in REPI partnerships. Preserving open spaces provides recreational opportunities such as hunting, fishing, and hiking. REPI projects also help protect water resources and water quality by preventing development or other water-intensive uses, as seen with the Altama Plantation and Altamaha Waterfowl Wildlife Management Areas, pristine preserved lands totaling almost 35,000 acres in Glynn and McIntosh Counties.[36]

Another environmental benefit that has been previously discussed is preservation of threatened and endangered species and their habitats in these local communities. REPI projects that preserve habitat off-installation help mitigate restrictions on installation lands under the Endangered Species Act, preserving the species, the habitat, and the land surrounding the installation.[37] Finally, by protecting key habitats, natural resources, and natural infrastructure, REPI projects may help to improve the climate resiliency of an installation and the surrounding area. As outlined by the 2014 Climate Change Adaptation Roadmap, a national defense priority addressed in REPI is planning for weather events and anticipating future climate stressors, thereby helping the communities adapt to future climate change.[38]

B. OFFICE OF ECONOMIC ADJUSTMENT (OEA): MILITARY INSTALLATION SUSTAINABILITY PROGRAM

Another potential avenue for collaboration among military and community partners that could support broader community resilience relates to compatible land use planning. As early as 1985, local communities, in conjunction with military installations, began conducting Joint Land Use Studies (JLUS) to study land uses that are incompatible with the installation's military mission, such as residential development within accident potential zones around airfields, and seeking ways to reduce the operational impacts on adjacent land.[39] Over time, issues of compatibility arose that went beyond land use to include challenges such as spectrum interference, bird strikes, drones, and energy vulnerability. In light of a growing awareness of the breadth of incompatible use, DoD's Office of Economic Adjustment rebranded Joint Land Use Studies as Compatible Use Plans, administered through the OEA's Compatible Use Program.[40] Completion of a Compatible Use Plan is a collaborative approach a community may undertake in partnership with the military installation to identify incompatible use that may impact military activities. The program is designed to encourage local communities to engage with military installations in the process of land use planning to promote community land use that is compatible with continued military operations.[41] Specifically, relevant participants from local community governments and organizations partner with the installation to identify local incompatible use issues and publish reports with actionable strategies and recommendations to mitigate identified issues.[42]

The *Hampton Roads Region – Norfolk and Virginia Beach Joint Land Use Study* is a first-of-its-kind effort to utilize the JLUS process to identify how current and future flooding exacerbated by sea level rise is creating a type of encroachment affecting military bases.[43] The effort involves the cities of Norfolk and Virginia Beach, the Hampton Roads Planning District Commission, and four Navy installations: Joint Expeditionary Base Little Creek-Fort Story, Naval Air Station Oceana, Naval Station Norfolk, and Naval Support Activity Hampton Roads. Because more frequent flooding has been affecting military operations and access to military facilities, the study focused on identifying specific conditions, including recurrent flooding, coastal storms, and erosion, outside of the military footprint that have the potential to impact Navy operations in Hampton Roads.[44] A 266-page draft JLUS was released in early June 2019.[45] The study noted that the Navy depends upon the Hampton Roads region's local governments for roadways, utilities, and support services, identifying **five core challenges** related to how community flooding vulnerabilities are affecting or could affect military readiness:

5 CORE CHALLENGES

Tidal flooding and sea level rise are affecting and will continue to affect the ability of Navy personnel and civilians to get to work.

Roadway flooding on key corridors and in neighborhoods limits access for military personnel to community facilities such as schools, hospitals, and life-safety services such as police, fire, and emergency response. Twenty community facilities such as schools, hospitals, and waste water treatment plants were identified as vulnerable to sea level rise and minor tidal flooding.

Undersized and/or inadequately maintained stormwater cause or exacerbate flooding on roadways and adjacent properties. As sea levels rise, higher water levels at stormwater outfalls will impede the ability of stormwater systems to collect and discharge stormwater flows.

Utilities such as power, water, and wastewater provided by cities and other sources consist of critical infrastructure for maintaining military base operations, and disruption of these networks by flooding could disrupt military operations significantly.

A lack of formalized, regional collaboration beyond project-specific needs of each local jurisdiction as well as routine leadership changes with the Navy and elected officials creates challenges for continuity. A formalized mechanism for coordination focused on flooding is needed.[46]

After identifying these challenges, the study goes on to identify **twenty-two actions** in targeted areas related to **roadway access**, **critical community facilities**, **stormwater and flood risk management**, and **utility reliability**; twenty-three regional coordination strategies related to coordination and Memorandum of Understanding (MOU) development, advocacy for federal funding and federal, state, and local policy changes, and improved technology and data collection and sharing protocols to support cross-jurisdictional analysis; and seven conversations that "require further discussion and exploration among JLUS stakeholders."[47] Criteria were also created to identify eight priority actions, with developing flood mitigation and stormwater management strategies for four major roadways linking military personnel and civilians to DoD assets as the **top four priorities**.[48]

IV. COLLABORATING TOWARDS COASTAL RESILIENCE: WORKSHOP DISCUSSION AND FINDINGS

In 2018, thanks to National Sea Grant Law Center's Small Grants Program, the Georgia Sea Grant Law Program was funded to develop legal and outreach capacity to engage in regional work in collaboration with SERPPAS, a regional partnership that includes North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi and is chaired by DoD and a rotating state agency. A key project objective included hosting a workshop to bring SERPPAS stakeholders, Sea Grant resilience specialists, state Coastal Zone Management program partners, and others together to focus on understanding challenges and opportunities for collaboration between military installations and communities on coastal resilience efforts. When the proposal was submitted, to the authors' knowledge, no Sea Grant program in the Southeast had addressed the connection between military readiness and coastal resilience. Within the SERPPAS footprint, **more than 20** military installations with associated training areas were identified as having potential to benefit from this collaborative effort. This section provides an overview of the primary stakeholder organizations, an overview of a workshop involving these organizations, and findings from the workshop.

A. SERPPAS AND SEA GRANT: BACKGROUND

SERPPAS is a six-state partnership involving state and federal agencies that promotes collaboration in making resource-use decisions supporting national defense, conservation of natural resources, and sustainable working lands and communities in the Southeast.[49] SERPPAS started in 2005 to address population growth, missions becoming more complex, increased competition for limited resources, and increasing costs. SERPPAS works to prevent encroachment around military lands, encourage compatible resource-use decisions, and improve coordination among regions, states, communities, and military services by serving as a forum for military and natural resource agencies to work together across state and agency boundaries in a collaborative, proactive way. SERPPAS addresses coastal resilience by learning about the challenges faced by coastal installations and local stakeholders regarding resilience, building relationships and connections to enhance coordination between installations and surrounding communities on regional resilience projects, and expanding the SERPPAS partnership to include partners more connected with resilience work and coastal issues.[50]

For more than fifty years, the National Sea Grant College program has enhanced the practical use and conservation of coastal, marine, and Great Lakes resources to create a sustainable economy and environment.[51] Established in 1966, the Sea Grant network currently consists of a partnership between NOAA and thirty-three university-based programs in every coastal and Great Lakes state, Puerto Rico, and Guam.[52]

More than 3,000 scientists, engineers, public outreach experts, educators and students are involved in the Sea Grant network.[53] **Resilient Communities and Economies** is one of four priority areas for Sea Grant, involving researchers and outreach specialists developing and supporting research in the areas such as coastal processes, hazards, climate change, and stormwater management.[54] Sea Grant expertise is often engaged to support community resilience planning.

In 2018, leadership and research professionals from Marine Extension-Georgia Sea Grant at the University of Georgia began engaging in discussions with the SERPPAS Coastal Resilience and Regional Adaptation Work Group to identify opportunities for collaboration, given that many of the organization's goals to ensure coastal resilience and regional adaptation appeared to be aligned.

That same year, the National Sea Grant Law Center offered program capacity development funding for Sea Grant legal programs. As described above, the Georgia Sea Grant Legal Program developed a proposal for this funding opportunity to enhance its legal and outreach capacity to engage in regional work in collaboration with SERPPAS, leading to the development and implementation of a workshop led by the two partners. In August 2019, *Collaborating Towards Coastal Resilience in the Southeast* was held in Savannah, Georgia, with approximately 80 participants. In addition to SERPPAS and Sea Grant, important partners also included the DoD, NOAA,[55] the U.S., Army Corps of Engineers,[56] the U.S. Fish and Wildlife Service, the U.S. Forest Service, the National Fish and Wildlife Foundation,[57] coastal specialists from Coastal Zone Management programs in the Southeast, the Carolina Integrated Sciences & Assessments (CISA), and the Gulf of Mexico Alliance (GOMA).

B. WORKSHOP DISCUSSION AND FINDINGS

In addition to being designed to build a critical link among Sea Grant programs, military installations, and the regional natural resources leaders in the Southeast, the agenda for the meeting sought to increase understanding on **1) SERPPAS goals and needs for military readiness on the coast; 2) State and local laws and policies influencing coastal decision-making; and 3) innovative engineering options that incorporate natural systems**.[58] The meeting also concluded with a brainstorming session designed to identify specific pilot projects to pursue across the Southeast region that enhance resilience for the benefit of military readiness and surrounding communities. Discussion findings from the workshop are described in each of these areas shown on the following page.

3 WORKSHOP GOALS

goals and needs for military readiness on the coast

laws and policies influencing coastal decision-making

innovative engineering options

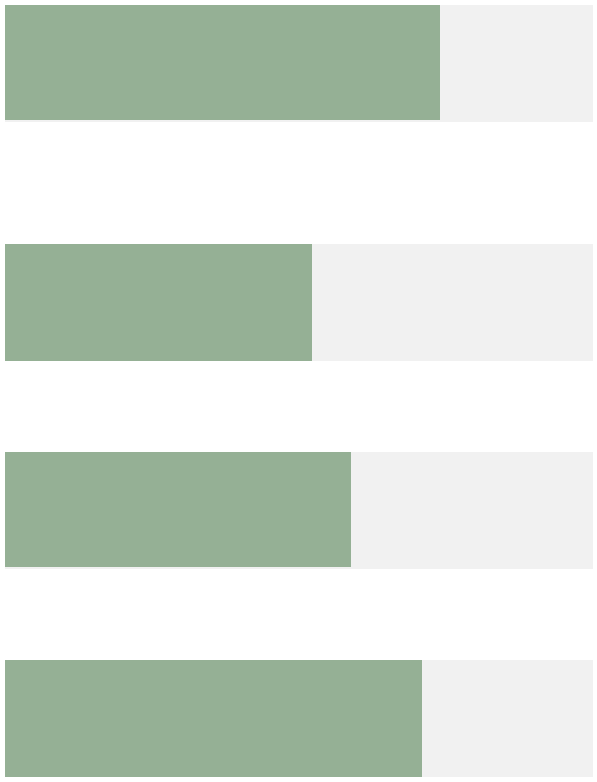
A significant portion of the workshop was dedicated to increasing participants' understanding of military goals and challenges. After an introduction from SERPPAS, Marine Extension-Georgia Sea Grant, NOAA, and the National Fish and Wildlife Foundation[59] about their programs and resilience goals, the workshop turned to an overview of why climate impacts are important to DoD, as the agency must be able to adapt to any threat, including those brought on by climate-related or weather-related events.[60] Wildfires, severe flooding, and storms all significantly impact installations, and a changing climate is a national security issue with potential impacts to DoD missions, operational plans, and installations. It was noted that increasing coverage of land from nuisance flooding during high tides was already affecting many coastal communities surrounding military installations, including Naval Station Norfolk. Specifically, in the Report on Effects of a Changing Climate to the Department of Defense released in January 2019, vulnerability assessments of seventy-nine mission assurance priority installations resulted in the following findings:

Flooding: 60 of the 79 installations have experienced or are vulnerable to flooding, including 16 of the 18 Navy installations.

Wildfires: 43 of the 79 installations are vulnerable to wildfires, including 32 Air Force installations assessed.

Drought: 48 of the 79 installations are vulnerable to drought, including all 18 Navy installations assessed.

Compound Risk: 57 of the 79 are vulnerable to more than one climate-related hazard.[61]



This broad overview was followed by a presentation that provided specific examples of Navy mission impacts, resiliency priorities, and challenges from climate change, including energy, infrastructure, and roads.[62] It was emphasized that Navy Southeast is aviation-based and that the Southeast is also the primary training location for operational units.[63] While the region is aviation-focused, access to "blue water training" is necessary: they must train 300-350 ships, which requires ports, infrastructure, facilities, and ranges, making partnerships with communities a priority. As severe weather events have increased in the Southeast over the last few years, primary concerns include hurricanes, storm surges, erosion, and extreme tides. Actions being taken or considered to address these concerns include: requiring that Inspector General reports evaluate port facility resiliency and sustainability; requiring that Integrated Natural Resource Plans (INRMP's) incorporate resilience/ sustainability concepts in plans and associated projects; and regional and local partnerships to increase resiliency.[64]

U.S. Army soldiers from the 46th Engineer Battalion move tree debris into piles to be pick up Oct. 31, 2018, on Tyndall Air Force Base, Florida. After Hurricane Michael swept the area, multiple major commands have mobilized relief assets in an effort to restore operations after the hurricane caused catastrophic damage to the base. (US Air Force photo by Senior Airman Sean Carnes.

Two biologists from the U.S. Fish and Wildlife Service working as liaisons with Tyndall Air Force Base provided an update on the ongoing recovery actions at the installation following Hurricane Michael, the third most intense hurricane in U.S. history.[65] After the Category 5 hurricane with maximum sustained winds of 160 mph hit the base, approximately 60% of the buildings on base were destroyed, 12,000 acres of mature slash pine sustained catastrophic or severe damage, and a 15-foot storm surge severely eroded the "East End" of the base's beachfront, threatening endangered beach mice and sea turtles. As devastating as the storm was, the base is recovering with a significant coastal resilience focus in several areas. The base is now being rebuilt as a "**Base of the Future**," a collaborative effort between DoD, private industry, and federal agencies to rebuild in a resilient and sustainable manner. New infrastructure will be rebuilt 14-19 feet above sea level and be able to withstand 150-180 mph winds, with mission critical areas built to sustain 230 mph winds. A JLUS was recently funded and is in the planning stages with the surrounding communities.[66] In addition, with the destruction of existing slash pine forests, goals within a current landscape plan to convert to more resilient longleaf pine have been accelerated to four years from 35 years. One unexpected –but happy– outcome of the workshop involved connecting a funding partner with Tyndall's restoration efforts, with the Arbor Day Foundation providing funding for six million longleaf seedlings to reforest nine thousand acres on the base.

A series of potential best practices and resilient outcomes related to coastal habitat impacts also are developing at Tyndall. The base is protected by a series of barrier islands, and damage to these islands from the hurricane was varied. Overall, a year later, dune system and listed species are rebounding. Initial assessments related to the base's recovery are highlighting the importance of maintaining a "second line of defense," namely the dune system area inland between the barrier islands and the mainland, to protect inland built infrastructure and create refugia or "stepping stones" for wildlife and vegetation to migrate as sea levels rise. Other resiliency opportunities also exist including improving natural systems and wetlands through hydrologic restoration. Additionally, a state highway currently runs through the base on route to Mexico Beach. Before the hurricane, plans were already being made to redirect the road; after the hurricane, those plans have accelerated. Creating an alternate route moves the highway inland, reduces prescribed fire constraints and wildlife road mortality, and alleviates base security issues.

After these examples of challenges and priorities from the military perspective were presented, the workshop turned to learning more about funding and partnership opportunities for resilience and discussion of specific resilience-related projects funded by military programs. The REPI program, in particular, has great potential to support resilience efforts, particularly with respect to landscape partnerships, stakeholder engagement, and encroachment management projects that involve purchasing buffer lands and supporting habitat restoration.[67] Since 2004, approximately $857 million in DoD funding and $788 million in partner funding from other federal programs as well as state, local, and nongovernmental organizations have supported REPI projects. Supported by an annual line-item by Congress, REPI funding is based on requirements for funding generated by military departments based on installation-level projects.[68] Fiscal year 2019 represented the highest request to the DoD REPI program from military departments for funding — $216 million – in the history of the program.[69] Congress ultimately approved $85 million in fiscal year 2019, $10 million more than DoD's Presidential Budget Request. REPI funding supports stakeholder engagement, landscape partnerships, and encroachment management projects, which account for 90% of REPI funding and occur at the installation level.[70]

REPI, it was emphasized, works in large part because of DoD and installation partnerships with land trust organizations, federal and state agencies, counties and local communities – "**all dependent on voluntary, private landowner participation**."[71] Through these efforts, more than 586,000 acres at or near 106 installations and ranges in 33 states have been protected.[72]

DoD has had the authority to perform natural resource conservation projects on off-installation lands where it does not have a real property interest.[73] However, the DoD did not have the authority to make long-term financial obligations to an off-site project until the Sikes Act was amended in 2013 in an effort to promote the use of cooperative agreements for land management related to DoD readiness activities.[74] Under the amended Sikes Act, the DoD was given the authority to make long-term financial commitments through cooperative agreements for natural resource conservation projects.[75] The Sikes Act has given REPI authority to expand its resiliency efforts, demonstrated through a case study conducted at Naval Weapons Station Earle in New Jersey.[76]

At the workshop, Naval Weapons Station (NWS) Earle, the Navy base tasked with providing ordnance for all Atlantic Fleet Carrier and Expeditionary Strike Groups, was described of as an

example of how DoD is leveraging expanded §2684(a) authority by protecting lands that improve its resilience against future water shortages and extreme weather events. When Hurricane Sandy hit the New Jersey coastline in 2012, NWS Earle and the surrounding community experienced damages that took three years and $50 million to repair. A current effort by NWS Earle to preserve wetlands and coastal buffer areas is providing space for local governments and non-governmental organizations to plan and execute storm resiliency projects, ultimately sustaining the installation long term by mitigating future costs from storm damage. In addition to preventing future damages from storm surge and stormwater impacts, the base is also using REPI and partner funds to protect lands around their drinking water reservoir and recharge areas for limited groundwater resources, helping ensuring drinking water for 500,000 people. The REPI program points to NWS Earle as a good example of how natural or "green" infrastructure solutions can promote installation resilience as they enhance benefits provided by natural systems, reduce erosion and flooding, attenuate wave energy and storm surge, retain floodwaters, enhance water quality and groundwater recharge, and reduce runoff. They observe, also, that natural infrastructure solutions are often more cost effective than the installation of "gray" or built infrastructure, and can encompass a wide range of possible actions under the REPI program, including:

- Restoring historical hydrology —e.g., wetlands and coastal marshes
- Reestablishing oyster reefs and submerged aquatic vegetation
- Restoring shoreline and dune vegetation
- Removing vegetation that restricts rainwater infiltration
- Enhancing riparian buffers
- Restoring high value habitat[77]

NAVAL WEAPONS STATION (NWS) EARLE

The **Compatible Use Plan** was also highlighted as a tool to promote installation resilience and readiness.[78] DoD's Office of Economic Adjustment (OEA) is available to assist states and communities in responding to major defense actions, including base closures and realignments, base expansions, DoD personnel reductions, industry/ contractor reductions, and operational/ training impacts, as civilian encroachment upon a military installation is likely to impair continued operation utility. Funding opportunities are available for resiliency-related projects. Specifically, the Compatible Use Program Funding is available to assist state and local governments with undertaking a Compatible Use Plan (CUP), formerly called a Joint Land Use Study, in response to encroachment concerns created by a variety of challenges such as population growth, endangered species, water quality and quantity, and climate resilience. There are three ways to receive funding: **installation nomination for CUP by the installation's commander**, **a community proposal under a 2019 Federal Funding Opportunity for Military Installation Resilience**, and **OEA technical and financial assistance** to implement CUP recommendations. For installations that haven't had a JLUS completed in more than five years, OEA emphasized that it is encouraging installations to do a CUP. OEA also previewed an upcoming federal funding opportunity for military installation resilience that was announced near the time of the workshop.

Under DoD's new authority, communities may request funding from OEA for community planning assistance to assist states and communities to work with their local military installations to promote and guide civilian development and activities which are compatible and support the longterm readiness and operability of military installations.[79] To support coastal resilience specifically, OEA is able to fund planning grants and some implementation grants, but not infrastructure. Often the catalyst for broader state and local plans and grant-funded efforts, OEA can establish the framework for conservation buffering, agricultural preservation, potential Sentinel Landscapes, and coastal resilience. For example, the community-driven CUP planning process can support the identification of parcels suitable for conservation partnering and community infrastructure assessments with the changing climate. Resilience projects funded by OEA include Marine Corps Air Station (MCAS) Beaufort/Marine Corps Recruit Depot (MCRD) at Parris Island, SC;[80] Joint Base Langly-Eustis, VA;[81] Naval Weapons Station in Earle, NJ;[82] and Hampton Roads, Virginia.[83]

The Strategic Environmental Research and Development Program (SERDP), one of DoD's environmental research programs, is yet another way DoD is connecting environmental sustainability to support installation resilience and readiness. Established in 1990, SERDP is a partnership among DoD, the Department of Energy (DOE), and the Environmental Protection Agency (EPA) that invests in basic and applied research and advanced development.[84] SERDP focuses on research projects that develop and apply innovative environmental technologies that reduce costs, risks, and time related to solving environmental challenges while also enhancing military readiness.[85]

Dr. Susan Cohen discussed the Defense Coastal/Estuarine Research Program (DCERP) at Marine Corps Base Camp Lejeune, where she served as a researcher and on-site coordinator of a ten-year study (2007-2017) that focused on sustaining the military mission of training and readiness by understanding the function, resilience, and vulnerability of ecosystems in the context of climate change.[86] Located in North Carolina, Camp Lejeune is the U.S. Marine Corp's largest amphibious training base.[87] Home to more than 40,000 Marines and sailors, Camp Lejeune covers approximately 150,000 acres, of which 12% is water.[88]

Structured to be a highly integrated monitoring and research effort, DCERP studied four different ecosystems: **aquatic/estuarine**, **coastal wetlands**, **coastal barrier**, and **terrestrial uplands**. Important results include:

- A new method was developed to determine how the estuary "breathes;"
- Fertilization may help coastal marshes keep pace with sea level rise;
- Climate change over the last 30 years has changed life history traits of red cockaded woodpeckers;
- New findings altering current understandings of barrier island over-wash leading to improvements related to predictions of shoreline position, dune elevation, and resistance to flooding;
- Tidal influence from rising sea level observed further upstream;
- Rise in water temperature in coastal tributary creeks, with higher temperatures – sometimes as much as 8% higher – in more developed watersheds with more impervious surface;
- Climate change to beach landscapes may impact sea turtle selection of a nesting site; and
- Intracoastal Waterway acts to trap sand destined for mainland marshes.[89]

At the workshop, Dr. Cohen also discussed the goal of increasing the resilience of Camp Lejeune's salt marshes from rising sea levels in order to support the military mission and retain the marshes ecosystem service functions.[90]

The project found that:

- When shoreline stabilization is required to protect infrastructure, almost the entire shoreline at Camp Lejuene was suitable for Living Shorelines;[91]
- Shoreline armoring should be avoided to minimize the adverse impacts on ecosystem function;
- Marshes need space to allow for upland migration by, where possible, locating built infrastructure away from estuarine shorelines to facilitate future marsh migration in response to rising sea levels;
- Fragmented and low-lying marshes near the New River Inlet are candidates for thin-layer application of dredged sediment to increase resiliency to sea level rise; and
- Splash Points for amphibious training may be improved by hardening the exit and entry ramps and by adding a Living Shoreline installation adjacent to the ramps.[92]

In addition, **several lessons learned** from the project were also discussed:

Expertise matters. You can't expect natural resource specialists to be climate resilience experts. Natural resources managers are often asked to be climate scientists while climate scientists are often asked to be natural resource managers, even though the expertise is much different.

Climate resilience efforts cannot necessarily be rolled into existing efforts without an influx of funding. People and resources are needed.

Complicated structure of decision-making. Appraising alternatives informally is not ideal; decisions must be justified to the command and resilience priorities set. Installation-level personnel need to be empowered to make resilience decisions.

Monitoring is critical but difficult to emphasize when results aren't seen for many years.

Resilience management is not always a priority, and the benefit from management for resilience is not readily apparent or urgent. Even with uncertainty, managing for overall resilience is never a bad decision.

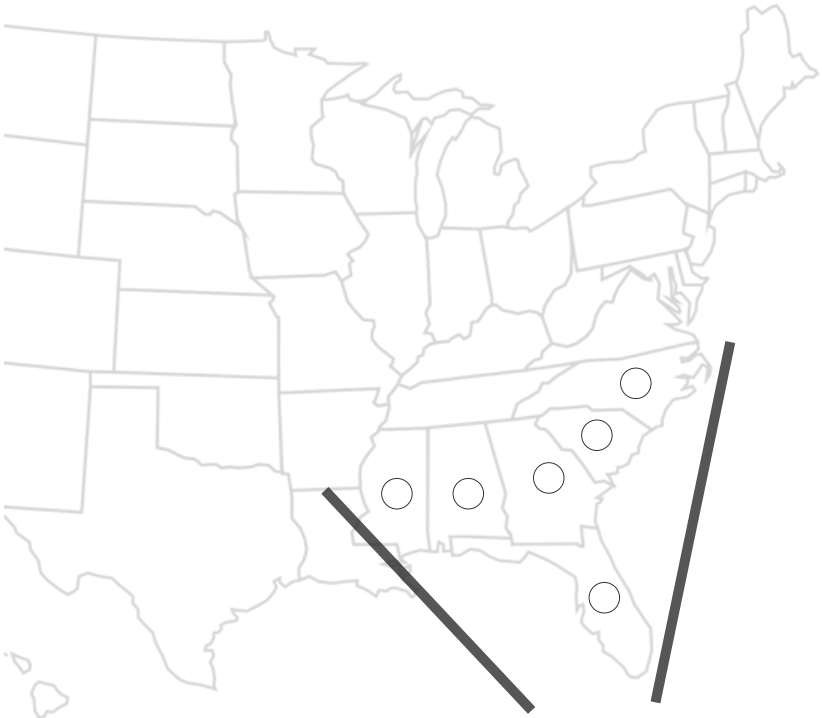
Scale matters. Everything is connected. Scale and connectivity informs who your partners are, and those partners may have different contexts.

Large research programs are not necessary to do resilience. Management for resilience may be occurring now (like managing for longleaf pine and fire), and the question may be whether it is for today's or tomorrow's conditions.

As SERPPAS continues its coastal resilience work, recommendations included designing a letter/ questionnaire to be sent to coastal installation commanders to determine where they think there is risk, and seeking input from military services on baseline conditions and most significant risks to the natural and built environment that threaten mission sustainment at bases and ranges in the SERPPAS region, with emphasis on those in coastal areas. Finally, in regards to expertise, there is a gap between the academic community and end users who can implement the science. Additional tools for the end users can help to bridge that gap.

SALT MARSHES AT MARINE CORPS BASE CAMP LEJEUNE

A shared priority for both SERPPAS and Sea Grant programs is to develop and/or utilize available tools that are designed to inform decision-making as communities plan for coastal resilience. As a lunch discussion, Eric Bush, Chief, Planning and Policy Director of Deep Draft Navigation Planning Center of Expertise U.S. Army Corps of Engineers South Atlantic Division, presented on the status of the USACE South Atlantic Coastal Study (SACS).[93] Modelled on the study conducted in the Northeast after Hurricane Sandy, the SACs is designed to provide a common understanding of vulnerabilities to coastal storms and sea level rise …. along the South Atlantic and Gulf Coast shorelines, including the territories of Puerto Rico and the U.S. Virgin Islands.[94] All six SERPPAS states (North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi) are included within the study, which will occur in tiers. SACS Tier 1 Risk Assessment, which is occurring now, calculates risk in terms of consequence and hazard. The Tier 2 Risk Assessment will add vulnerability into the equation, and also presents an opportunity for local stakeholders, including military installations, to engage with USACE's process at specific locations across the region.[95] The SACS is an opportunity for SERPPAS and Sea Grant programs to leverage and build upon existing resources, data, and tools. Mr. Bush observed that USACE is currently brainstorming ways to include more DoD data into the study. He also noted that more communication was needed related to the kinds of coastal resilience tools being created and DoD's decision-making needs.



SIX SERPPAS STATES INCLUDED IN THE STUDY

Because many of the land use and planning actions that need to be taken to promote resilience will occur at the state and local levels, the workshop also included a session designed to highlight the state and local perspective on resilience issues and their experiences, if any, working with the military. This discussion set the stage for a brief overview of the primary law and policy issues that are arising in the local resilience planning context.

The workshop was designed to provide participants with a better understanding of the state and local experiences dealing with resilience, such as coastal resilience priorities and challenges, examples of working with the military, lessons learned, and further opportunities to partner with the military on resilience. The panel began with Jennifer Kline, Coastal Hazards Specialist with the Coastal and Ocean Management Program at Georgia's Coastal Resources Division.[96] In Georgia, the Georgia Coastal Resources Division's Coastal Zone Management Program oversees eleven coastal counties and acts as a liaison between federal/state agencies and local government. Just a decade ago, no longterm coastal planning was occurring on the coast. With the FEMA Natural Disaster Recovery Framework, which came into effect in 2011, and efforts by Georgia's Coastal Resources Division (CRD), a significant amount of resilience-related work has occurred. For example, CRD currently has a project to prepare to mitigate flooding using green infrastructure, focusing on Tybee Island.More generally, CRD has funded land acquisition, conservation, and LIDAR imagery to assist local communities. In 2018, the agency hosted the first climate conference in Georgia, with the next conference to be held in November 2020. Ms. Kline emphasized that it was a challenge, sometimes, for local governments to acquire funding from agencies or private funders when the emphasis is purely on construction – more funding is needed for planning so that communities are ready to do "shovel ready" projects.

Barbara Neale, Senior Program Analyst with the Office of Ocean and Coastal Resource Management at the South Carolina Department of Health & Environmental Control, observed that coastal resilience work began when South Carolina's CZMA program began in the early 1970s, noting that, while the word "resilience" has only been recently used, much of the work being done to manage the coastal areas, such as maintain waterfronts, directly relates to resilience efforts. As a recent example, Ms. Neale described a project creating a living shoreline at Marine Corps Air Station Beaufort. She noted that a primary challenge when working with other agencies or DoD is making sure that the scale of tools provided applies to local governments.

Michelle Lovejoy, with the North Carolina Foundation for Soil & Water Conservation and the North Carolina Sentinel Landscape Partnership, described the Eastern North Carolina Sentinel Landscape Partnership (ENCSL), which includes several installations within its scope.[97] She explained that, within the 30- plus member partnership, all partners have an equitable seat at the table, small and large, local and state. She emphasized that private landowner engagement is crucial, noting how the ENCSL has engaged private landowners in numerous projects including the Envision EAST-2050 Exercise where participants envisioned future population, jobs, green space, and transportation infrastructure throughout the state; the FloodWise Pilot which looks at conservation through the lens of resilience by bringing in the agricultural community to design watershed-level approaches that would lessen floods; and the Hurricane Florence Agricultural Disaster Program of 2018 that supplied farms with immediate relief. She emphasized the need to include agriculture as part of resiliency, as it is often the leading economic driver in a state and/or local community. Ms. Lovejoy observed that one challenge with working with military installations is the change in installation leadership every two to three years, noting the need to reeducate base leadership because otherwise communication gaps will result.

Rhonda Price, Deputy Director for the Office of Restoration and Resiliency at the Mississippi Department of Marine Resources, noted that the Mississippi CZM Program, which was formed in the 1990s, is a relatively new one. Monitoring and collecting baseline data to measure resilience is a major focus, as well as long term strategy planning and the permitting process. Ms. Price described how the Gulf of Mexico Alliance (GOMA) is very involved in the coastal resilience efforts in Mississippi, using six priority issue teams, including a resilience team, to enhance the environmental and economic health of the Gulf of Mexico.[98] The current campaign, Embrace the Gulf, is a year-long campaign for the region to become more resilient to freshwater inflow.

Policy and legal frameworks obviously influence coastal decision-making. To provide an overview of the region, Dave Blalock, counsel for DoD's Regional Environmental Coordinators (REC), described how he serves as an interface between state policymakers and DoD for the region. In each EPA region, there is a designated REC that functions as a liaison for the region on environmental issues – someone who is able to speak to installations and provide a more direct line to military headquarters when needed. Mr. Blalock noted how DoD recognizes climate change as a threat to national defense, and installations must be prepared to address impacts, including how that relates to aspects outside installation borders. He pointed out how REPI, OEA's enabling statute, and the Sikes Act were all modified with the National Defense Authorization Act of 2019 to include "military installation resilience."

Thomas Ruppert, Coastal Resilience Specialist with Florida Sea Grant, spoke about some of the legal and policy drivers surrounding resilience, particularly at the local level. Infrastructure is extremely important to public works and city managers, and nuisance claims have arisen due to the insufficient maintenance of infrastructure not being able to control flooding. Mr. Ruppert discussed current and potential policy drivers, which included the following:

Current Policy Drivers

- Expense of modifying/ maintaining/ creating infrastructure services (drainage, seawalls, roads, sewer/water treatment, potable, electric, etc.);
- Rising flood insurance rates;
- Rising homeowners' insurance;
- Bond ratings (i.e.—Moody's and other ratings companies downgrading local governments not actively preparing); and
- Equity/social justice/ gentrification/ displacement.

Potential Policy Drivers

- Decreasing property values;
- Increasing limitations on long-term bank mortgages in some areas; and
- Reduced local government income as local government expenses rise (and property taxes fall).

Mr. Ruppert also provided an overview of how constitutional property rights claims ("takings") could occur through perceived insufficient maintenance of infrastructure (i.e.—roads flooded or washed out; excessive flooding due to no longer adequate drainage).[99] He also discussed how local governments could face mandamus actions brought to compel government to act to control flooding; nuisance claims brought for failure to control flooding; and negligence claims brought for failure to control flooding.[100]

Given the high interest among workshop partners in furthering land conservation, habitat preservation, and coastal resilience, the final workshop presentation focused on how innovative engineering options that incorporate natural systems – also known as nature-based engineering – can promote coastal resilience. Dr. Todd Bridges, Army Senior Research Scientist for Environmental Science, U.S. Army Corps of Engineers, discussed Engineering With Nature (EWN), a Corps' initiative that "intentionally aligns natural engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits," which result in "triple win outcomes."[101]

With more than four million miles of roadways, 640,000 of high-voltage transmission lines, more than 90,000 dams, and 4,500 military installations, Dr. Bridges observed that the 20th century could be fairly characterized as the "age of infrastructure." Nature-based engineering, on the other hand, extends our traditional definition of what constitutes infrastructure as it seeks to use natural process to maximum benefit instead of resorting, entirely, to built or "grey" infrastructure. Under this broader conception, Dr. Bridges made the case that land could be understood as the largest category of infrastructure on military installations, with DoD owning 19 million acres, and should be protected and enhanced as such.

Specifically, Dr. Bridges pointed to Horseshoe Bend Island in Louisiana as an example of nature-based engineering where the river was used to engineer the desired future. In the project, dredged sediment was strategically placed in the middle of the river, upriver from an island. Over the course of twelve years, another island was created, producing a shift in the channel, shortening transit distance, and creating a channel that moved sediment more efficiently. This resulted in less annual dredging – saving $1 million annually – and lower carbon emissions. It also created a diverse habitat with abundant plants and wildlife used recreationally by the local community. As another example, Dr. Bridges pointed to the economic value of coastal wetlands following Hurricane Sandy. Using riskindustry based tools, it was estimated that existing wetlands saved more than $625 million in flood damages in the northeast Atlantic region following the storm.[102] In addition to providing numerous examples of EWN techniques and practices being incorporated into USACE infrastructures, Dr. Bridges directed workshop participants to the publicly available *Natural Infrastructure Opportunities Tool*, an online resource where groups can share data in spatial context to identify opportunities for beneficial use.[103]

Finally, Dr. Bridges underscored that EWN is focused on forecasting future need as opposed to restoring past conditions, with major emphasis place on multi-organization collaborations such as SERPPAS.

Dr. Brian Bledsoe, Professor in Resilient Infrastructure at the University of Georgia's College of Engineering and Director of the Institute for Resilient Infrastructure Systems,[104] built upon Dr. Bridges' discussion.[105] He emphasized that nature-based infrastructure can and should work in harmony with conventional gray infrastructure to improve system performance and resilience. He also explained that nature-based infrastructure is a highly interdisciplinary challenge that requires developing rigorous analytical processes, performance standards, and assessment criteria. For example, the "compounding effects" of rain intensity, urbanization, stormwater system capacity and maintenance, channel change, storm surge, heavy inland rain and sea level rise require a systems approach where natural infrastructure works to mitigate several of these effects at once. Dr. Bledsoe then discussed a project related to shoreline armoring,[106] marsh migration, and sea level rise in Georgia. Through literature review, application of local knowledge, application of economic behavioral theory and considerations of vulnerability, he and the principal investigators developed a refined list of eight attributes hypothesized to be associated with the presence or absence of estuarine shoreline hard armoring at the parcel level scale along the Georgia coastline. After analyzing approximately 13,000 estuarine shoreline parcels, 3,000 of which were armored (23%), the most important factor indicating whether a shoreline was likely to be armored was whether a neighbor had an armored shoreline.[107] Elevation and/or distance to the shoreline and the structure's value were the second most important factors. After discussing additional examples and the benefits of natural infrastructure, Dr. Bledsoe concluded with the following key points:

Natural infrastructure is landscape scale. Large scale problems require large scale solutions - go big;

Systems analysis is required at nested scales. Opportunities must be sought for natural infrastructure and conventional infrastructure to work in harmony locally and regionally;

Account for and communicate full co-benefits of natural infrastructure, including environmental, economic, and social; and

Considering compounding effects. Design for robustness across compound events across many future scenarios.

V. CONCLUSIONS

This article sought to document the military's efforts in resilience, specifically coastal resilience in the Southeast, which is fostered by partnerships among the military, state and local governments, and private organizations, namely SERPPAS. The military has strong incentive to prepare and protect its installations from climate-related hazards, an acknowledged threat to national security. These partnerships have made possible many multi-million-dollar projects that promote resilience while also providing great benefit to both military installations and the surrounding communities.

The DoD provides funding through several avenues, specifically via the REPI program. The REPI program is a solution for combating encroachment and supporting the country's long-term military readiness, while delivering mutual, multiple benefits to communities and stakeholders. REPI projects contribute to the longevity of working farms, forests, and ranchlands; increase recreational and open space opportunities for nearby residents and military families; and protect against military relocations that would adversely affect the local economy. REPI has grown and fostered a sea-change in how DoD responds to conservation and military training issues and engages in outside-the-fence land use planning.

Through REPI, the DoD continues to explore policy and regulatory solutions to incompatible development, off installation species habitat, and other mission sustainability issues.

The DoD provides other opportunities for installations and local communities through the Compatible Use Program, which develops Compatible Use Plans, formerly known as Joint Land Use Studies. Identifying incompatible uses allows communities and military installations to develop in a symbiotic manner, benefitting one other while fostering resilient growth and change to current infrastructure and plans. The Office of Economic Adjustment recommends that communities consider the benefits of a CUP if they have not completed one in the past five years. Apart from CUPs, the DoD provides other funding opportunities for communities via the OEA, with new opportunities available in the most recent defense authorization bill.

The workshop held in Savannah, Georgia in August 2019, Collaborating Towards Coastal Resilience in the Southeast, brought together a wide range of stakeholders, including those from SERPPAS, Sea Grant resilience specialists, and state Coastal Zone Management program partners. The meeting sought to increase understanding on SERPPAS goals and needs for military readiness on the coast, state and local laws and policies influencing coastal decision-making, and innovative engineering options that incorporate natural systems. The meeting concluded with a brainstorming session designed to identify specific pilot projects to pursue across the Southeast region that enhance resilience. The meeting has already seen goals come to fruition, with with a private funder connecting with Tyndall's restoration efforts. The workshop has allowed the establishment of enduring collaborative partnerships that will work to increase resiliency for military readiness, coastal communities and economies, and natural resources. A follow-up workshop is anticipated to be held in fall 2020.

1 SERPPAS is a partnership chaired by the DoD and a rotating state agency from North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. SERPPAS works to prevent encroachment around military lands, encourage compatible resource-use decisions, and improve coordination among regions, states, communities and military services.

2 SOUTHEAST REG'L P'SHIP FOR PLANNING AND SUSTAINABILITY & GA. SEA GRANT LAW PROGRAM, COLLABORATING TOWARDS COASTAL RESILIENCE IN THE SOUTHEAST WORKSHOP MEETING SUMMARY (2019) [hereinafter Meeting Summary], *available at* https://serppas.org/media/2935/collaborating-towards-coastal-resilience-in-the-se-meetingsummary_final_102219.pdf (last visited June 24, 2020).

3 DEP'T OF DEF., OFFICE OF THE UNDER SEC'Y OF DEF. FOR ACQUISITION AND SUSTAINMENT, REPORT ON EFFECTS OF A CHANGING CLIMATE TO THE DEPARTMENT OF DEFENSE 4 (2019).

4 Nicholas Kusnetz, *Rising Seas Threaten Norfolk Naval Shipyard, Raising Fears of 'Catastrophic Damage'*, NBC NEWS (Nov. 29, 2018, 4:22 AM), https://www.nbcnews.com/news/us-news/risingseas- threaten-norfolk-naval-shipyard-raising-fears-catastrophic-damage-n937396 last visited June 24, 2020).

5 *See infra* note 41 for further discussion about DoD's Compatible Use Program, which, until 2019, was called the Joint Land Use Program. DoD's Office of Economic Adjustment sponsored Joint Land Use Studies, which are now called Compatible Use Plans, under the program.

6 *See infra* Part IV.

7 Lt. Col. Chad Gemeinhardt, Office of the Assistant Sec'y of Def., Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, Climate Resilience in the Department of Defense (Aug. 27, 2019) [hereinafter Gemeinhardt Presentation].

8 Shawn Snow, *Climate Change Threatens to Block Marines' Access to the Sea*, DEFENSE NEWS (May 6, 2019), https://www.defensenews.com/digital-show-dailies/navyleague/ 2019/05/06/climate-change-threatens-to-block-marines-access-to-the-sea/ (last visited June 24, 2020).

9 Meeting Summary, *supra* note 3; Ari Shapiro, *Tyndall Air Force Base Still Faces Challenges in Recovering from Hurricane Michael*, NPR (May 31, 2019, 5:09 PM), https://www.npr.org/2019/05/31/728754872/tyndall-air-force-base-still-faces-challenges-inrecovering- from-hurricane-micha (last visited June 24, 2020); Bev Banks, *Cities and Bases Start to Feel the Cost of Climate Change*, CLIMATE WIRE (Nov. 5, 2019), https://www.eenews.net/climatewire/stories/1061463745 (last visited June 24, 2020).

10 Meeting Summary, *supra* note 3.

11 *See infra* note 62 for further discussion about DoD priorities as they were presented at the August 2019 workshop.

12 DEP'T OF DEF., UNIFIED FACILITIES CRITERIA 1-200-02 (Oct. 1, 2019).

13 *Id.*

14 DEP'T OF DEF., UNIFIED FACILITIES CRITERIA 2-100-01 (Oct. 25, 2019).

15 DEP'T OF DEF., UNIFIED FACILITIES CRITERIA 3-201-01 (Mar. 19, 2019).

16 Gemeinhardt Presentation, *supra* note 8.

17 John S McCain National Defense Authorization Act for Fiscal Year 2019, Pub. L. No. 115-232, Sec. 2805; 10 U.S.C. § 101.

18 DAN COHEN, ASS 'N OF DEF. CMTY'S, FY 2019 NATIONAL DEFENSE AUTHORIZATION ACT IN REVIEW (2019).

19 Frequently Asked Questions, READINESS AND ENVTL. PROT. INTEGRATION, https://www.repi.mil/About-REPI/Frequently-Asked-Questions/ (last visited June 24, 2020).

20 10 U.S.C. § 2684a.

21 *Frequently Asked Questions*, *supra* note 20.

22 The Department of the Army uses a variety of supporting programs and tools to ensure sustainment of its installations, ranges, and test and training lands, including its implementation of the REPI authority through Army Compatible Use Buffers (ACUBs). ACUBs enable the Army to maintain the capability to support mission requirements through conservation by entering into cooperative agreements with partners who purchase land or interests in land. Under the Department of the Navy, Navy and Marine Corps installations develop an Encroachment Management Program to address compatibility and readiness sustainment. Finally, the Air Force's encroachment management enterprise combines internal real estate acquisition strategies for obtaining easements with external communication and outreach strategies. *Service Program*s, READINESS AND ENVTL PROT. INTEGRATION, https://www.repi.mil/Buffer-Projects/Service-Programs/ (last visited June 24, 2020).

23 *REPI Story Map*: *A History of Major Accomplishments*, READINESS AND ENVTL . PROT. INTEGRATION, https://repimap.org/storymap/ [hereinafter Story Map] (last visited June 24, 2020).

24 *Frequently Asked Questions*, *supra* note 20.

25 READINESS AND ENVTL. PROT. INTEGRATION, GEORGIA FACT SHEET, *available at* https://www.repi.mil/Portals/44/Documents/State_Fact_Sheets/Georgia_StateFacts.pdf (last visited June 24, 2020).

26 Key REPI partners in the Southeast include: Alabama Forest Resource Center, Alabama Land Trust, Altamaha Riverkeeper, Bibb County, Central Georgia Joint Development Authority, Central Savannah River Land Trust, Chatham County, Chattahoochee Fall Line Conservation Partnership, Chattahoochee Valley Land Trust, City of Savannah, Columbus Consolidated Government, Ducks Unlimited, Environmental Resources Network, Georgia Conservancy, Georgia Department of Natural Resources, Georgia Forestry Commission, Georgia Land Trust, Georgia Ornithological Society, Georgia Wetlands Trust Fund, Houston County, Knobloch Family Foundation, Middle Georgia Regional Commission, National Oceanic and Atmospheric Administration, National Wild Turkey Foundation, Peach County, St. Simons Land Trust, State of Alabama, State of Georgia, The Conservation Fund, The Longleaf Alliance, The Nature Conservancy, The Trust for Public Land, U.S. Department of Agriculture – Natural Resources Conservation Center, U.S. Fish and Wildlife Service, and U.S. Forest Service.

27 READINESS AND ENVTL. PROT. INTEGRATION, 2012 REPI CHALLENGE FACT SHEET (2012), *available at* https://www.repi.mil/Portals/44/Documents/REPI_Challenge/2012REPIChallenge_v2.pdf (last visited June 24, 2020).

28 Story Map, *supra* note 24.

29 READINESS AND ENVTL. PROT. INTEGRATION , 2019 REPI CHALLENGE AWARDS (2019), https://www.repi.mil/Portals/44/Documents/REPI_Challenge/2019_REPI_Challenge_Winner_KingsBay_Profile.pdf (last visited June 24, 2020).

30 *Frequently Asked Questions*, *supra* note 20.

31 READINESS AND ENVTL. PROT. INTEGRATION, 2016 REPI CHALLENGE FACT SHEET (2016), *available at*https://www.repi.mil/Portals/44/Documents/REPI_Challenge/2016%20REPI%20Challenge_JUN16_FINAL.pdf [hereinafter 2016 Fact Sheet] (last visited June 24, 2020).

32 *Altamaha River Water Trail*, GEORGIA RIVER NETWORK, https://garivers.org/water-trails-andpaddling/ altamaha-water-trail/ (last visited June 24, 2020).

33 2016 Fact Sheet, *supra* note 34.

34 *Buffer Project Benefits*, READINESS AND ENVTL. PROT. INTEGRATION, https://www.repi.mil/Buffer-Projects/Benefits/ (last visited June 24, 2020).

35 *Id*.

36 *Altamaha*, GEORGIA DEP'T OF NAT. RES., https://georgiawildlife.com/altamaha-wma (last visited June 24, 2020); *Altama Plantation*, GEORGIA DEP'T OF NAT. RES., https://georgiawildlife.com/altama-plantation-wma (last visited June 24, 2020).

37 *Buffer Project Benefits*, *supra* note 35.

38 DEP'T OF DEF., 2014 CLIMATE CHANGE ADAPTATION ROADMAP (2014), https://www.acq.osd.mil/eie/Downloads/CCARprint_wForward_e.pdf (last visited June 24, 2020).
For further information on the REPI program, see Curtis Cranston, Note, *The U.S. Military's Environmental Protection Efforts: Unexpected Eco-Friendly Solutions to Land Management Problems*, 60 B.C.L. REV. 1023 (2019).

39 U.S. GOV'T ACCOUNTABILITY OFF., GAO-17-86, DEFENSE INFRASTRUCTURE: DOD EFFORTS TO PREVENT AND MITIGATE ENCROACHMENT AT ITS INSTALLATIONS 1 (2016) [hereinafter GAO-17-86].

40 *Compatible Use Program*, ALAMO AREA COUNCIL OF GOV 'TS , http://www.aacog.com/620/Compatible-Use-Program (last visited June 24, 2020).

41 GAO-17-86, *supra* note 40, at 14.

42 *Id.* at 16; For further information on the Compatible Use Program, see Announcement of Federal Funding Opportunity, 84 Fed. Reg. 38014 (Aug. 5, 2019).

43 Peter Couto, *Study Details Steps Norfolk, Virginia Beach Should Take to Protect Navy Bases as Sea Levels Rise*, THE VIRGINIAN-PILOT ,(May 29, 2019), https://www.pilotonline.com/government/local/article_3984b93a-8182-11e9-aad6- 5f172ed188a0.html (last visited June 24, 2020).

44 HAMPTON ROADS PLANNING DIST. COMM 'N , NORFOLK AND VIRGINIA BEACH JOINT LAND USE STUDY, EXECUTIVE SUMMARY (2019).

45 HAMPTON ROADS PLANNING DIST. COMM 'N , NORFOLK VIRGINIA BEACH JOINT LAND USE STUDY DRAFT (2019).

46 *Id.* at ES2-ES4.

47 *Id.* at ES6-ES9.

48 *Id.* at ES8.

49 *See* SERPPAS, https://serppas.org/ (last visited June 24, 2020).

50 *Id*.

51 *See* SEA GRANT, https://seagrant.noaa.gov/ (last visited June 24, 2020).

52 *About*, SEA GRANT , https://seagrant.noaa.gov/About (last visited June 24, 2020).

53 *Id.*

54 *Our Work*: *Resilient Communities and Economies*, SEA GRANT, https://seagrant.noaa.gov/Our-Work/RCE (last visited June 24, 2020).

55 Adam Stein, Senior Coastal Hazards Specialist, presented on the National Oceanic and Atmospheric Administration (NOAA), focusing on how the NOAA Office for Coastal Management provides the products, services, and funding that coastal managers need to address coastal resilience across fisheries, research, weather, marine aviation, and operations. The Coastal Zone Management Program consists of 34 states and territories that provides funding from Congress to establish a federal-state partnership. NOAA seeks to support policy and decision makers at all levels by developing information products, in person training, and providing data, tools, and grants related to natural infrastructure. There is opportunity for overlap between NOAA and the state Sea Grant programs, state/local governments, base commands, and the private sectors to assist with coastal resilience efforts.

56 Eric Bush, Chief, Planning and Policy Director, Deep Draft Navigation Planning Center of Expertise, U.S. Army Corps of Eng'rs, South Atlantic Div., presented on the status of the USACE South Atlantic Coastal Study (SACS) and discussed other immediate resilience opportunities through the USACE feasibility studies including incorporating resilience into already existing projects. The SACS is modeled after a similar study conducted along the North Atlantic coast after Hurricane Sandy. It will identify the risks and vulnerabilities of the coastline of the six SERPPAS states (North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi), Puerto Rico and the U.S. Virgin Islands to increased hurricane and storm damage as a result of sea level rise. Currently, the four-year study is in its first year and is an opportunity to leverage and build upon existing resources, data, and tools.

57 Jay Jensen, Director, Southern Regional Office, the National Fish and Wildlife Foundation(NFWF), informed attendees of the type of support NFWF can deliver towards conservation projects. NFWF is focused on building public-private partnerships and supplying funding for projects that are ready to implement, i.e. the "boots on the ground/shovel-ready" type projects. It is the largest conservation fund grant maker in the country, outside of the federal government. NFWF funding is not typically allocated for planning purposes, but the DoD Office of Economic Adjustment (OEA) has funding available to assist with planning if the project is tied to installation communities. Mr. Jessen highlighted the following initiatives:

- The National Coastal Resilience Fund (NCRF), a partnership with NOAA, was formed after Hurricane Sandy, with the next slate of grants to be announced in November 2020. It hits the sweet spot of helping to protect both human communities and wildlife communities, providing communities with

- (57 cont.) protection from impacts of sea-level rise, changing flood patterns, coastal erosion, increased frequency and intensity of storms and protecting and restoring habitat for fish and wildlife.
- The Emergency Coastal Resilience Fund (ECRF) was recently established to assist with the resilience of coastal communities located within federally declared disaster areas impacted by hurricanes Florence and Michael, Typhoon Yutu, and wildfires in 2018, with many eligible areas located within the southeast.
- The recently created Coastal Resilience Evaluation and Siting Tool (CREST) is an online tool meant to identify the intersection between where human community assets and wildlife community assets meet in order to assist with decision making. CREST identifies Resilience Hubs, areas of open space where projects may have the greatest potential to benefit both human community and fish and wildlife resilience.

58 Meeting Summary, *supra* note 3.

59 Jay Jensen, National Fish and Wildlife Foundation, Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, Coastal Resilience NFWF Funding Opportunities (Aug. 27, 2019).

60 Gemeinhardt Presentation, supra note 8. The presentation also identified the following related policies, tools, and reports: DoD Directive 4715.21, Climate Change Adaptation and Resilience; DoD Instruction 6055.17, DoD Emergency Management Program; Climate Adaptation for DoD Natural Resource Managers, May 2019; Report on Effects of a Changing Climate to the Department of Defense, January 2019; Department of Defense Climate-Related Risk to DoD Infrastructure Initial Vulnerability Assessment Survey (SLVAS) Report, January 2018; Climate Change Planning Handbook, Installation Adaptation and Resilience, Naval Facilities Engineering Command, January 2017; Regional Sea Level Scenarios for Coastal Risk Management (CARSWG) Report and Database, April 2016; DoD Climate Change Adaptation Roadmap, October 2014.

61 *Id.*

62 Brock Durig, Navy REC/Fleet Operational Support, Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, U.S. Navy Region Southeast Navy Resiliency Priorities & Challenges (Aug. 27, 2019).

63 For example, all Carrier Strike Groups are certified for deployment in the Southeast operation areas and ranges. *Id.*

64 *Id.*

65 Melanie Kaeser, U.S. Fish & Wildlife Serv., Nat. Res. Liason for Tyndall Air Force Base, and Gianfranco Basili, U.S. Fish & Wildlife Serv., Air Force P'ship Coordinator, Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, Tyndall Air Force Base Update (Aug. 27, 2019).

66 *See* TYNDALL AFB–BAY COUNTY COMPATIBLE USE PLAN, https://www.tyndall jlus.com/ (last visited June 24, 2020).

67 REPI is discussed here in the context of the SERRPAS workshop. For further detail on the REPI program, see discussion *supra* Section III.A. The Sikes Act of 1960 is foundational to DoD's natural resource management efforts. It provides that the Secretary of Defense "shall carry out a program to provide for the conservation and rehabilitation of natural resources on military installations." 16 U.S.C.A. § 670a. DoD works with FWS to develop and implement Integrated Natural Resources Management Plans (INRMPs), which must consider the management of resources and issues such as wetlands, endangered species, invasive species and migratory birds on military installations across the United States. See Major Teresa K. Hollingsworth, *The Sikes Act Improvement Act of 1997: Examining the Changes for the Department of Defense*, 46 A.F. L. REV. 109, 112 (1999).

68 Andrew Porth, REPI Program, Office of the Assistant Sec'y of Def., Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, The REPI Program: Resiliency Projects that Support Military Readiness (Aug. 27, 2019) [hereinafter Porth Presentation].

69 *Id*.

70 In addition to acquiring real estate interests, which provide for the permanent preservation of lands, the 10 U.S.C. § 2684a authority provides for the restoration and management of natural resources and habitat, as well as the ability to provide funding for long-term management via stewardship endowments. Section 2684a also provides for a "funds as match" authority-allowing DoD REPI funds to be considered a non-federal match for USDA and DOI programs. REPI can also fund off-installation natural resources management pursuant to 16 U.S.C § 670c-1 – The Sikes Act.

71 Porth Presentation, *supra* note 69.

72 *Id*.

73 H.R. Rep. No. 113-115, pt. 1, at 3 (2013).

74 *Id*.

75 *Id*.

76 Meeting Summary, *supra* note 3.

77 *Id*.

78 Margit Myers, Dep't of Def., Office of Econ. Adjustment, Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, Compatible Use Plans (Aug. 27, 2019).

79 *See* Announcement of Federal Funding Opportunity, *supra* note 43; 10 U.S.C. § 2391.

80 For this project, the grantee was the Lowcountry Council of Governments in South Carolina. The scope of the project was described as "[h]igh-level evaluation of outside the base infrastructure to develop a funding prioritization list of local infrastructure assets critical to the community and military supporting the USMC F-35B training mission at MCAS Beaufort and recruit training at MCRD Parris Island, which may be jeopardized by recurrent flooding." MARGIT MYERS, OFFICE OF THE ASSISTANT SEC'Y OF DEF., U.S . DEP'T OF DEF., COMPATIBLE USE PLAN: A TOOL TO PROMOTE INSTALLATION READINESS AND RESILIENCY 9, *available at* https://serppas.org/ media/2920/oea-compatible-use-plan.pdf (last visited June 24, 2020). The project resulted in investments made to relocate sewage pumping stations and the City of Beaufort funding a multi-million dollar comprehensive stormwater drainage plan for Mossy Oaks, an area that experiences routine flooding, "is home to many military service members", and "is a thoroughfare to Beaufort Memorial Hospital," all "of which affects the quality of life of service members." *Id*.

81 For this project, the grantee was the City of Newport News. The scope of the project was described as "update[ing] the 2010 Joint Land Use Study to identify land on and off JBLE that are susceptible to flooding and other potential environmental impacts on the installations," with Virginia and the communities "working closely with the Air Force, the Army, and OEA on installation resilience strategies, such as flood mitigation and stormwater management to help protect JBLE." *Id*. at 10. The project resulted in an implementation grant to the City of Hampton from OEA primarily to plan for rerouting traffic and relocating" the main gate "due to flooding and safety concerns." *Id*.

82 *See supra* at Section IV.B.1.d. For this project, the grantee was Monmouth County, NJ. The scope of the project was described as a resilience plan "to include site selection for reshoring efforts" in addition to creating "a network of 40 NGO, state, county and local officials focused on the long-term sustainability of the Navy mission and the storm resilience of the community." Myers, *supra* note 81, at 11. The project resulted in identifying "over twenty nature based adaptation projects that enhance storm resilience in the communities supporting NWS Earle." *Id*.

83 *See supra* Section III.B.

84 *About SERDP*, SERDP, https://www.serdp-estcp.org/About-SERDP-and-ESTCP/About-SERDP last visited June 24, 2020).

85 For information about SERDP's process for proposals, *see id*.

86 Susan Cohen, SERDP, Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, Environmental Sustainability to Support Mission Readiness Defense Coastal/Estuarine Research Program Marine Corps Base Camp Lejeune (Aug. 27, 2019) hereinafter Cohen Presentation]; *See Defense Coastal/Estuarine Research Program*, SERDP, https://www.serdp-estcp.org/Featured-Initiatives/Conservation/Defense-Coastal-Estuarine-Research-Program (last visited June 24, 2020).

87 *Defense Coastal/Estuarine Research Program, supra* note 87.

88 *Id*.

89 *Id*.

90 Cohen Presentation, *supra* note 87.

91 For more information about living shorelines, see *Understanding Living Shorelines*, NOAA FISHERIES, https://www.fisheries.noaa.gov/insight/understanding-living-shorelines (last visited June 24, 2020). Generally, living shorelines use plants or natural elements such as oysters to stabilize coastal and estuarine shorelines in combination with or in lieu of hard structures such as bulkheads. Living shorelines are typically more resilient to storms and improve habitat and water quality.

92 Cohen Presentation, *supra* note 87.

93 Eric Bush, U.S.Army Corps of Eng'rs, Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, The South Atlantic Coastal Study: Creating a Shared Vision to Address Coastal Vulnerability (Aug. 27, 2019) [hereinafter Bush Presentation]; *See South Atlantic Coastal Study-SACS*, U.S. Army Corps of Eng'rs, https://www.sad.usace.army.mil/SACS/ (last visited June 24, 2020).

94 Bush Presentation, *supra* note 94.

95 *Id.*

96 This program is part of the Georgia Coastal Management Program, which was approved by NOAA in 1998 under the Coastal Zone Management Act (CZMA). Administered by NOAA, the CZMA provides for management of the nation's coastal waters and their "adjacent shorelines," which include estuarine areas such as sounds, bays, lagoons, and bayous. 16 U.S.C. §§ 1451-1466 Thirty-four coastal states and territories currently participate in the National Coastal Zone Management Program. Described as a "voluntary partnership between the federal government and coastal and Great Lakes states and territories [that] provides the basis for protecting, restoring, and responsibly developing our nation's diverse coastal communities and resources," the program is designed to encourage states to exercise full authority of the lands and waters in their coastal zone and to provide federal assistance when they do so. 16 U.S.C. § 1451(i). Under the CZMA, states become eligible for federal grants if they develop coastal management plans approved by NOAA. These plans, among other things, must control uses that impact the state's coastal zone. State programs must coordinate with all local, area-wide, and interstate plans applicable to the coastal zone program area as well as have adopted a process for continuing coordination between the state management agency and other governmental agencies having responsibilities with regard to the zone. 16 U.S.C. § 1455(d)(3).

97 U.S. DEP'T OF AGRIC., U.S. DEP'T OF DEF., U.S. DEP'T OF INTERIOR, NORTH CAROLINA SENTINEL LANDSCAPES - THE POWER OF PARTNERSHIPS, *available at* https://serppas.org/media/2925/eastern-north-carolina-sentinel-landscape-outreach.pdf (last visited June 24, 2020).

98 *See* GULF OF MEXICO ALLIANCE, https://gulfofmexicoalliance.org/ (last visited June 24, 2020).

99 *See* Thomas Ruppert, *Castles—and Roads—in the Sand: Do All Roads Lead to a "Taking"?*, 48 ENVTL. L. REP. 10914 (2018) (arguing that extending the ministerial/operational-level duty of maintenance to include inordinately difficult, expensive, or unique or unusual work would undermine the core distinction in tort law between ministerial/operational-level maintenance and discretionary/planning-level work that enjoys sovereign immunity, as such discretionary/planninglevel decisions are the exclusive realm of the legislative branch of government and should not be interfered with by courts). See also Thomas Ruppert & Carly Grimm, *Drowning in Place: Local Government Costs and Liabilities for Flooding Due to Sea-Level Rise*, 87 FLA. B.J. 29 (2013) (arguing that modifications to stormwater systems to provide the same level of drainage despite higher sea-levels causing the system to drain less efficiently constitutes a discretionary decision to upgrade rather than a mere "operational" maintenance decision).

100 *See* Shana C. Jones, et. al., *Roads to Nowhere in Four States: State and Local Governments in the Atlantic Southeast Facing Sea-Level Rise*, 44 COLUM. J. OF ENVTL. L. 67-138 (2019).

101 Todd Bridges, Senior Research Scientist, U.S. Army Corps of Eng'rs, Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, Engineering with Nature for Resilience (Aug. 27, 2019); *See also* ENG 'G WITH NATURE ,www.engineeringwithnature.org (last visited June 24, 2020).

102 *See* UNIV. OF CAL. SANTA CRUZ, COASTAL WETLANDS AND FLOOD DAMAGE REDUCTION: USING RISK INDUSTRY-BASED MODELS TO ASSESS NATURAL DEFENSES IN THE NORTHEAST USA (2016).

103 *Tools*. ENG'G WITH NATURE, https://ewn.el.erdc.dren.mil/tools.html (last visited June 24, 2020).

104 UNIV. OF GA. INST. FOR RESILIENT INFRASTRUCTURE SYS., https://iris.uga.edu/ (last visited June 24, 2020).

105 Brian Bledsoe, Univ. of Ga. Coll. of Eng'g, Presentation at Collaborating Towards Coastal Resilience in the Southeast Workshop, Navigating Four C's of Coastal Resilience (Aug. 27, 2019) [hereinafter Bledsoe Presentation].

106 "Shoreline armoring" is the practice of using physical structures such as bulkheads and sea walls to protect shorelines from coastal erosion. *See What is Shoreline Armoring?*, Nat'l Ocean Serv., https://oceanservice.noaa.gov/facts/shoreline-armoring.html (last visited June 24, 2020).

107 Bledsoe Presentation, *supra* note 106.

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