The Nature Conservancy

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Restoring coastal wetlands for climate resilience:

A CASE STUDY AT NAVAL BASE VENTURA COUNTY POINT MUGU

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Controlled Unclassified Information (CUI)

I Executive Summary

The U.S. Congress and the Department of Defense (DoD) have determined that climate change is a threat to national security and have required military installations to develop plans to improve the climate resilience of both military installations and key supporting civilian infrastructure. A recent Navy report, co-authored by The Nature Conservancy, indicates resilience could be significantly increased at a naval base in southern California by consolidating vulnerable infrastructure on higher ground and restoring wetlands, dunes, and beaches, which buffer the base from storms and absorb floodwaters.

The approach to resilience described in the "Naval Base Ventura County (NBVC) Point Mugu Coastal Adaptation Vision" report (2020)[1] hinges upon the growing awareness within DoD that while flooding and other natural processes can wipe out roads and other built assets, the same natural processes contribute to resilient ecosystems that, in turn, offer long term protection to those same built assets. This alternative of buffering infrastructure with coastal habitats instead of coastal hardening serves as a model for other coastal military installations tasked with improving resilience. If natural infrastructure and coastal restoration strategies are adopted more broadly and supported through substantial DoD investment, it could significantly increase the buffering capacity of a portion of the world's coastal lands, bolster long-term protection for billions of dollars of military and key supporting civilian assets, and reduce the need for costly repairs.

Using natural coastal infrastructure to buffer NBVC Point Mugu from rising sea levels and hazardous storms offers many benefits over traditional approaches. Pre-emptively moving military assets further from the many hazards along the shoreline is a strategic, forward-thinking military readiness tactic. And, when given the space, natural infrastructure such as beaches, dunes, and wetlands are relatively resilient to storms and floods. After a disturbance, natural systems often build themselves back, and can continue to serve as buffers to assets located behind them. Relocating assets away from the shifting coastline also creates a pathway for beaches and wetlands to adjust and migrate with sea level rise. This approach further safeguards all the other benefits provided by natural coastlines—as water purifiers, nurseries for fish, habitat for threatened and imperiled plants and animals, and carbon sinks.

Implications of NBVC's use of natural infrastructure for climate resilience extends far beyond this singular base. Increasing resilience to military installations contributes to regional coastal resilience. The military can also be a powerful partner for communities and conservation organizations in realizing nature-based solutions for resilience. Recent legislation—including updates to the Readiness and Environmental Protection Integration (REPI) statutes that authorizes DoD installations to partner with nearby towns, other agencies, NGOs on conservation – expanded DoD's approach and funding to include nature-based resilience projects.

KEY TAKEAWAYS:

- If no action is taken, a large portion of NBVC Point Mugu's built assets and wetlands would convert to open water by 2060 due to sea level rise and associated erosion and flooding.
- Certain base assets, such as the airfield, need to be defended in place; removing and relocating other assets and infrastructure provides room for the shoreline to naturally maintain and migrate with sea level rise, ensuring the continued existence of beach and wetlands that serve as critical buffers to base assets.
- Wetlands at NBVC Point Mugu are among the largest remaining salt marsh habitats in southern California, supporting a great diversity of species, including imperiled species.
- Removing and relocating assets at the base would create over 700 acres of space to restore to wetlands and natural habitats, bolstering nature's capacity to absorb the impact of storm surges and flooding.
- Relocation with restoration is the only option that meets the military mission and ecological goals – ensuring beaches and coastal habitats will continue to thrive and provide protection in the long-term.


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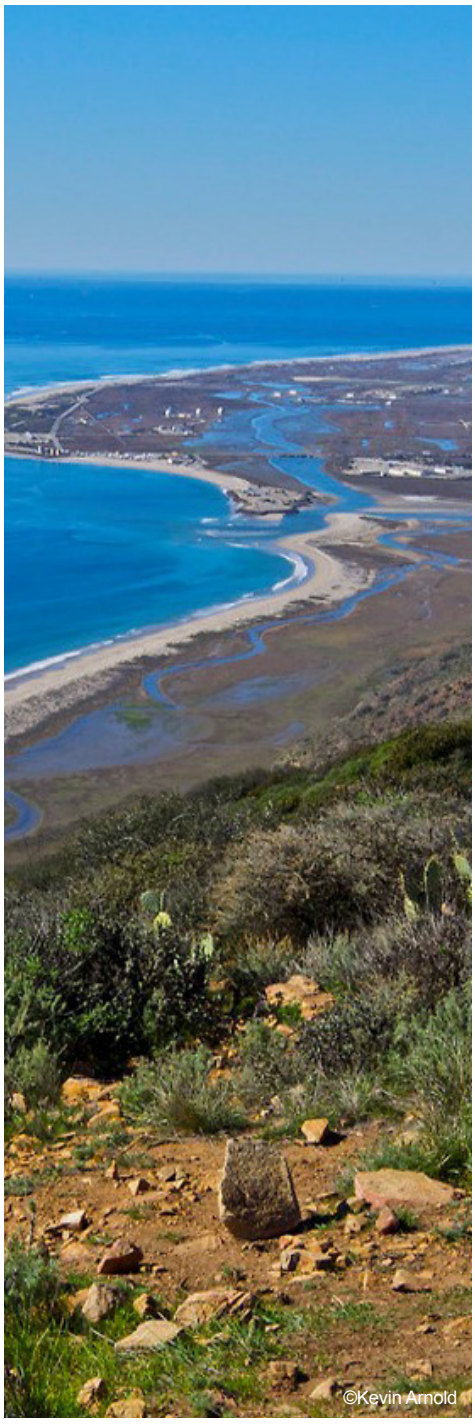
1 Environmental Science Associates. Coastal Adaptation Vision for Naval Base Ventura County Point Mugu. (Prepared for The Nature Conservancy and Naval Base Ventura County, 2020).

Beyond the region, these pioneering efforts at NBVC can also serve as a model for other similarly at-risk coastal installations.[2] While the investment required to relocate infrastructure is significant, doing so creates a pathway for a carefully managed process, versus waiting for disaster to strike before taking protective actions, with the resultant training and opertational interruptions and costly repairs to damages. For example, Hurricane Florence in 2018 damaged hundreds of buildings at Marine Corps Base Camp Lejeune and Marine Corps Air Station New River in North Carolina, with repairs estimated at $3.6 billion,[3] and that same year Tyndall Air Force Base in Florida incurred an estimated $4.7 billion in hurricane damage.[4]

The nature-based approaches and collaborative, science-based planning process represented by the NBVC Adaptation Vision can be replicated locally, regionally, and globally, to ensure that beaches and wetlands continue to thrive and provide protection to coastal communities and critical infrastructure. Making room for natural infrastructure ensures habitats can migrate with sea level rise and continue to act as buffers, providing protection to coastal communities, infrastructure, and ecosystems.

In the absence of widespread adaptation practices that prioritize natural coastal buffers, fear of rising sea levels and storms may trigger governments to build more sea walls and other armaments. This trend poses an existential threat to the planet's already dwindling coastal wetlands and beaches, as hardening facilitates their transition to open water,[5,6,7] and eliminates natural buffering capacity. In the U.S., even with environmental protection laws, more than 100,000 acres of coastal wetland transitioned to open water between 2004-2009, and wetlands disappeared at an average of 60,000 acres per year—a more rapid decline than in the years prior.[8] The global extent of wetlands is estimated to have declined between 64-71% in the 20th century, and degradation continues worldwide.[9] The further loss of coastal habitats will be devastating, especially to communities that depend on the coast for tourism, and the many other ecosystem services provided.

In short, if natural infrastructure and coastal restoration strategies are adopted more broadly and supported through substantial DoD investment, it could significantly increase the buffering capacity of the nation's coastal lands, help secure long-term protection for billions of dollars of military assets, reduce the likelihood of unplanned training and operational disruptions and the need for extremely costly repairs, and set an example for the world.



2 Margaret Tucker and G. James Herrera, Military Installations and Sea Level Rise, (Congressional Research Service, July 2019). https://fas.org/sgp/crs/natsec/IF11275.pdf
3 Jay Price, "After Billions of Dollars in Storm Damage, the Military is Trying to Protect Bases from Climate Change," North Carolina Public Radio WUNC, April 29, 2021. https://www.wunc.org/military/2021-04-28/military-climate-change
4 General Services Administration, "Region 4 FAS personnel lend a helping hand to Tyndall airmen," GSA Newsroom, June 7, 2019. https://www.gsa.gov/about-us/regions/welcome-to-the-southeast-sunbelt-region-4/region-4-newsroom/around-the-region/region-4-fas-personnel-lend-a-helping-hand-to-tyndall-airmen
5 G.B. Griggs, "California's retreating coastline: Where do we go from here?" in California and the World Ocean, Conference '02, Revisiting and Revising California's Ocean Agenda. (Preston: American Society of Civil Engineers, 2005a),121–125.
6 G.B. Griggs, "The impacts of coastal armoring," Shore and Beach, 73,1(2005b), 13-22.
7 R.K. Gittman, F. J. Fodrie, A. M. Popowich, D. A. Keller, J. F. Bruno, C. A. Currin, C. H. Peterson, and M. F. Piehler, "Engineering away our natural defenses: an analysis of shoreline hardening in the US." Frontiers in Ecology and the Environment, 13 (2015): 301 – 307.
8 T.E. Dahl and S.M. Stedman, Status and trends of wetlands in the coastal watersheds of the conterminous United States 2004 to 2009. (U.S. Department of the Interior, Fish and Wildlife Service and National Oceanic and Atmospheric Administration, National Marine Fisheries Service, 2013).
9 Ramsar Convention on Wetlands, State of the World's Wetlands and Their Services to People: A Compilation of Recent Analyses, Briefing Note 7, (12th Meeting of the Conference of the Parties to the Convention on Wetlands, March 2015). https://www.ramsar.org/sites/default/files/documents/library/strp19_4_bn7_e.pdf

II Background

DOD'S COMMITMENT TO RESILIENCE TO ASSURE THE MILITARY MISSION

The United States operates thousands of military installations in the US and worldwide, worth about $1.2 trillion.[10] These facilities are where personnel train, test weaponry, and work to deter foreign adversaries, with the specific aim of ensuring the nation's security.

In recent decades, an unconventional antagonist to military readiness emerged in the form of climate change. Base operations are now persistently disrupted by recurrent drought, heat waves, catastrophic wildfires, and flooding. Additionally, coastal installations are being impacted by rising sea levels, erosion and increasingly powerful storms. In 2018, Hurricane Michael damaged 95 percent of the infrastructure at Tyndall Air Force Base in Florida, with experts projecting a cost of over $3 billion to repair the base.[11]

These threats are likely to increase in severity, duration and frequency in the years to come, and the seriousness of these disruptions prompted the Congress and the Department of Defense (DoD) to declare climate change a major threat to America's national security.[12] The Congress and DoD leadership mandated that the military services incorporate climate considerations into infrastructure and operations planning, and to comprehensively "assess and manage risks associated with the impacts of a changing climate."[13]

The DoD also recently began to emphasize the importance of pursuing climate-adaptive actions that increase base resilience. Resilience has historically been an ecological term, defined as "the amount of disturbance that an ecosystem could withstand without changing self-organized processes and structures."[14] DoD defines resilience similarly, as the "ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions."[15] This definition is associated explicitly with the impacts of climate change and applies to all aspects of DoD, including installations, operations, transportation and more.[16] In 2020, an amendment to U.S. law now requires major bases to, over three years, develop military resilience components in installation master plans to address climate impacts.[17] Other DoD programs, such as the Readiness and Environmental Protection Integration (REPI) statute, were also expanded by Congress to encourage climate resilience.[18]

"The effects of a changing climate are a national security issue with potential impacts to Department of Defense missions, operational plans, and installations."

– US DEPARTMENT OF DEFENSE, 2019

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"Sea level rise, extreme weather, drought, floods, you name it—there is a growing recognition that those are real impacts on national security and the ability of the DoD to operate."

– BOB BARNES, RETIRED BRIGADIER GENERAL, US ARMY

10 U.S. Department of Defense, Report on Effects of a Changing Climate to the Department of Defense, (Office of the Under Secretary of Defense for Acquisition and Sustainment, 2019). https://partner-mco-archive.s3.amazonaws.com/client_files/1547826612.pdf
11 Norm Seip, "Climate Change in Florida is a Threat to National Security," Florida Sun Sentinel, April 9, 2021. https://www.sun-sentinel.com/opinion/commentary/fl-op-com-invading-sea-climate-change-military-20210409-jx4iv2yyobecveam7flu6mwyce-story.html
12 John D. Banusiewicz, "Hagel to Address 'Threat Multiplier' of Climate Change," DoD News, Oct 10, 2014. https://www.defense.gov/Explore/News/Article/Article/603440/hagel-to-address-threat-multiplier-of-climate-change/
13 U.S. Department of Defense, 2019, p. 2
14 L.H. Gunderson, "Ecological Resilience—In Theory and Application." Annual Review of Ecology and Systematics. 31, no. 1 (2000) 425-439.
15 U.S. Department of Defense, DoD Directive 4715.21: Climate Change Adaptation and Resilience. (2000). https://dod.defense.gov/Portals/1/Documents/pubs/471521p.pdf
16 Congressional Research Service, Military Installation Resilience: What Does It Mean? (January 6, 2021). https://www.everycrsreport.com/files/2021-01-06_IN11566_e792abaa4080c20af2d4b0ee49f0a9e05604808d.pdf
17 10 U.S.C. § 2801
18 10 U.S.C. § 2684

REPI PROGRAM (10 USC 2684A)

DoD's Readiness and Environmental Protection Integration program, known as the REPI Program, is based on two key statutes—10 USC 2684a and section 103 of the Sikes Act (16 USC 670c-1)—and is a key tool for combating encroachment or incompatible development (e.g. housing, infrastructure, lights) that can limit or restrict military training, testing, and operations. 10 USC 2684a authorizes partnerships between military branches and private conservation groups and/or state and local governments to address encroachment by working with willing landowners to protect private lands (e.g., farms, forests, ranches) in the vicinity of or ecologically related to military installations or airspace to prevent incompatible development, maintain or improve military installation resilience, and/or protect wildlife habitat, water resources, and natural spaces for the benefit of threatened and endangered species of concern to DoD. 10 USC 2684a also authorizes DoD to contribute to the funding of endowments for the management of natural resources on lands protected pursuant to a REPI partnership agreement. Since the REPI Program was first funded in 2005 at $4.6 million,the program has seen significant boosts in funding from Congress. In total, the REPI program has contributed $2.1 billion dollars[19] to the protection of 750,000 acres around the country, making it one of the major conservation programs of the federal government. Although there is no specified matching funds or cost-share requirement under either 10 USC 2684a or 16 USC 670c-1, 48% of that funding has come from non-DoD sources. This program can be a major tool for increasing coastal resilience nationally. Climate change has recently been recognized by Congress and DoD as yet another form of encroachment,[20] and, accordingly in 2019, the REPI Program statute was amended with the additional goal of maintaining or improving installation resilience, and amended again in 2021 to authorize resilience as a stand-alone statutory purpose for agreements under 10 USC 2864a.[21,22] Congress also amended 10 USC 2864a in 2013 and 2021 to allow authority for funds provided to partners by DoD under 10 USC 2684a or 16 USC 670c-1 to be used to satisfy non-federal cost share or matching funds requirements of any conservation or resilience program of any federal agency.[23,24] This expanded "DoD funds as match" authority will hopefully lead to greater collaboration between DoD and agencies such as FEMA, NOAA, and the Army Corps of Engineers on projects under their respective programs and authorities for the use of nature-based features to strengthen the resilience of DoD installations and communities supporting those installations.

SECTION 103A OF THE SIKES ACT (16 USC 670C-1)

The Sikes Act, first enacted in 1960, recognizes the value of natural resources on U.S. military bases, and aims to promote conservation activities while allowing military lands to continue to meet the needs of military operations. It provides the framework for cooperation between DoD, the U.S. Fish and Wildlife Service, state agencies, universities, Native American tribes, and other non-governmental organizations to manage these resources. The Sikes Act is another powerful tool to address the effects of climate change and reduce the risk of natural disasters through the maintenance and improvement of natural infrastructure both on and off military bases. It requires that conservation goals are cooperatively developed and recorded in a planning document called an Integrated Natural Resource Management Plan (INRMP) and guidance is now provided on how to integrate climate impacts into those plans.[25] Amendments to the Sikes Act over the years, especially amendments to section 103A (16 USC 670c-1), have also given DoD installations greater authority to enter into cooperative agreements with state, local, or tribal governments and NGOs or interagency agreements with federal governments to restore and manage natural resources located "outside the fence line" in order to "relieve or eliminate current or anticipated challenges that could restrict, impede, or otherwise interfere with, whether directly or indirectly, current or anticipated military activities," including the challenges resulting from the impacts of climate change.[26] As with 10 USC 2684a, 16 USC 670c-1 authorizes DoD to contribute funding to an endowment for the management of natural resources that are on lands - including lands owned by local, state, or tribal governments - that are within the scope of a cooperative agreement under the statute.

19 U.S. Department of Defense, 2020 Report on REPI Program Outcomes and Benefits to Military Mission Capabilities, (Office of the Assistant Secretary of Defense for Sustainment, Readiness and Environmental Protection Integration (REPI) Program, 2020).

20 Texas A&M Natural Resources Institute, REPI and Resilience. (Prepared for the Office of the Assistant Secretary of Defense for Sustainment, 2020). https://www.repi.mil/Portals/44/Documents/Resilience/REPIandResilience_TAMU_OCT2020.pdf

21 John S. McCain National Defense Authorization Act for Fiscal Year 2019. H.R.5515. 115th Congress. (2017-2018).

22 U.S. Department of Defense, REPI Resilience Fact Sheet. (March 2021). https://www.repi.mil/Portals/44/Documents/Resilience/REPI_ResilienceFactSheet_MAR21.pdf

23 National Defense Authorization Act for Fiscal Year 2013, H.R.4310. 112th Congress. (2011-2012).

24 William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021. H.R.6396. 116th Congress. (2019-2020).

25 B.A. Stein, D. M. Lawson, P. Glick, C. M. Wolf, and C. Enquist. Climate Adaptation for DoD Natural Resource Managers: A Guide to Incorporating Climate Considerations into Integrated Natural Resource Management Plans. Washington, D.C. (National Wildlife Federation, 2019)

26 U.S. Department of Defense, Using 10 U.S.C. §2684a and the Sikes Act (16 U.S.C. §670c-1) to Maintain or Improve Military Installation Resilience. (Readiness and Environmental Protection Integration Program, 2020). https://www.repi.mil/Portals/44/Documents/Resilience/ResilienceAuthorities_OCT2020.pdf

NATURAL RESOURCE MANAGEMENT FOR RESILIENCE

The military's rising awareness of the need for resilience elevates the potential for natural resource management to play a leading role in climate adaptation efforts. "Sea level rise, extreme weather, drought, floods, you name it—they're happening now and the DoD really needs to do something to protect themselves from the impacts of climate change," said Bob Barnes, retired Brigadier General, U.S. Army and former Assistant Judge Advocate General of the Army, who helped begin the Army's "Private Lands Initiative" that led to the REPI Program, and since his retirement, has worked on many of the amendments to the REPI Program legislation. "One of the best ways to do that is to use natural resource defenses."

Department of Defense installations are not the only stakeholders impacted by sea level rise, flooding, erosion and storms – many coastal landowners in the world are facing similar challenges. How the US military responds to these changes on their land could be hugely impactful to these other places. DoD controls enough total land that its influence is comparable to that of a nation. In California alone, it controls 200,000 acres of coastal land. Coasts are connected, and what one land manager does impacts the function and resilience of adjacent and down coast areas. Additionally, through legislation such as the REPI Program, communities near military lands can partner with the military to fund and implement nature-based resilience programs.

NATURAL SHORE VS ARMORED SHORE

Hard infrastructure like seawalls and revetments will accelerate erosion and negatively impact areas downcoast, whereas, sections of functioning natural coast absorb floodwaters and maintain sediment supply, benefiting adjacent and downcoast areas.


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MILITARY NATURAL RESOURCE MANAGEMENT MISSION

To those unfamiliar with DoD operations, coastal restoration may seem like an odd endeavor for the military to undertake, however, DoD has long viewed environmental conservation across its lands as integral to its mission. Military training and testing require undeveloped and often natural land to simulate wartime conditions.[27] Biodiversity on these lands contributes to its ability to withstand repeated disturbances, and in this way, supports military preparedness. Because the military prioritizes protection from encroaching development and conservation as compatible land use (see "REPI Program" Box), the undeveloped, open space portions of bases, or areas near or ecologically related to bases or airspace, often act as de facto preserves, harboring relatively intact habitats for imperiled species. DoD is required to comply with federal laws such as the Endangered Species Act, Clean Water Act, and many others. As such, DoD lands often serve as a refuge for imperiled species and are recognized as some of the best-preserved natural landscapes in the country.[28]

27 Ya-Wei Li and Timothy Male, Conservation of Defense: Opportunities to Promote Conservation Through Military Readiness, (Washington D.C.: Environmental Policy Innovation Center, 2020).

28 N. Benton, J.D. Ripley, and F. Powledge, Conserving Biodiversity on Military Lands: A Guide for Natural Resources Managers, 2008 edition. (Arlington: NatureServe, 2008). www.dodbiodiversity.org.

NATURE-BASED SOLUTIONS: AN ALTERNATIVE TO ARMORING

Traditionally, when faced with a natural disturbance such as flooding or erosion, one of the most common responses—both inside and outside the military—is to build a sea wall, revetment, or other form of coastal hardening. While hardening is sometimes still deemed necessary for protection of built assets, robust evidence now indicates that natural systems including salt marshes, beaches, dunes, oyster beds, and coral reefs are often more effective and more resilient against storms and flooding than seawalls. Using risk models developed by the insurance industry, scientists have shown that during Superstorm Sandy, the few remaining wetlands along the east coast prevented $625 million of flood damage.[29] In areas that flooded, wetlands lowered flood damage by 11 percent. Properties located behind marshes suffered 16 percent less annual flood damage than properties that had lost their marshes.[30] Scientists have also estimated that a $2 billion investment in wetlands restoration along the Gulf Coast could prevent $18.2 billion of losses.[31]

THE DOWNSIDE OF COASTAL ARMORING

Though coastal armoring is still often deemed necessary for protection of the assets located directly behind the armor, it's now widely understood that armoring ultimately accelerates coastal erosion and beach loss.[32,33,34]


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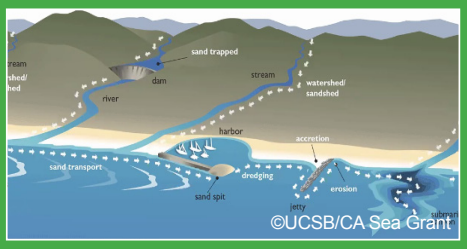
When waves that would normally run up the gradual incline of a beach, instead crash against a hard surface, that force scours away the sand in front of and below that hard surface. As sea levels rise, the wave force on the armoring increases disproportionately to increases in sea level. Coastal armoring also often requires costly maintenance and eventually will not be able to hold back rising waters. When coastal armoring is a primary strategy, it can also create a false sense of security and encourages more development in high-risk areas. If or when the coastal armoring is eventually breached, flood damage and loss of life has the potential to be catastrophic.



©UCSB/CA Sea Grant

Sea walls and other hardening measures also interrupt the ocean's natural process of sand distribution. Sandy beaches are not as stationary as they may seem, and instead act more like rivers, with sand constantly moving on and offshore, carried by gravity down from the land, and by currents from one beach to the next. Once coastal armoring goes up and blocks sand transport, it's only a matter of time before beaches in front of them and downstream disappear.[35]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In contrast, coastal ecosystems have evolved to be adaptable and resilient. Waves don't only erode the coastline, they also build and maintain beaches and dunes. When waves seep into salt marsh habitat—the extra moisture, sediments, and nutrients help plants in the ecosystem thrive and gain elevation, keeping pace with rising seas. Coastal wetlands are not a magic bullet to every threat from climate change—a powerful storm may still cause lasting damage to a wetland and active restoration projects and investments may still be required to facilitate rapid recovery, but when hard infrastructure such as walls are not present, it creates the space and retains restoration as an option.

29 Christine C. Shepard, Caitlin M. Crain, Michael W. Beck, "The Protective Role of Coastal Marshes: A Systematic Review and Meta-analysis" PLOS ONE, November 23, 2011. DOI: 10.1371/journal.pone.0027374

30 Siddharth Narayan, Michael W. Beck, Paul Wilson, Christopher J. Thomas, Alexandra Guerrero, Christine C. Shepard, Borja G. Reguero, Guillermo Franco, Jane Carter Ingram & Dania Trespalacios, "The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA." Scientific Reports. 7 (2017) 9463. DOI:10.1038/s41598-017-09269-z

31 B.G. Reguero, M.W. Beck, D.N. Bresch, J. Calil, I. Meliane, "Comparing the cost effectiveness of nature-based and coastal adaptation: A case study from the Gulf Coast of the United States." PLOS ONE, 13, no. 4 (2018). DOI: 10.1371/journal.pone.0192132

32 G.B. Griggs, 2005a.

33 G. B. Griggs, 2005b.

34 R.K. Gitman, et al., 2015.

35 G. Griggs, and K. Patsch, "The protection/hardening of California's coast: Times are changing." Journal of Coastal Research, 35, no. 5, (2019) 1051–1061.

Several military installations throughout the U.S. are already using coastal restoration projects to combat erosion. After the Earle Naval Weapons Station in New Jersey suffered $50 million in damages from Superstorm Sandy, the installation moved forward with a plan to install a living shoreline of restored oyster reefs. The reefs act like speed bumps, slowing down waves, and oysters also improve water quality by filtering sediment and pollutants, and provide habitat for plants, fish and other sea creatures. At Tyndall Air Force Base, four pilot projects are underway to use natural infrastructure to protect the coast.[36] Similar projects have been installed or are in process at the Marine Corps' air station at Cherry Point, North Carolina, and at Eglin and MacDill Air Force Bases in Florida. The Army Corps of Engineers' Engineering With Nature (EWN) initiative embraces nature-based and/or hybrid solutions for resilience. The Army Corps produced a guidance document and collection of case studies on nature-based resilience solutions at military installations and bases around the country, including NBVC Point Mugu.[37] The NBVC Point Mugu case study featured in this document could not have been done without CNRSW Memorandum of Agreement with The Nature Conservancy (executed in 2016), to assess NBVC Point Mugu's coastal resilience challenges.

Coastal protection projects that aim to maximize the natural abilities of wetlands, beaches, and dunes to slow erosion and absorb floodwaters will often involve removing or relocating infrastructure out of low-lying, flood-prone areas to higher ground. This approach, also referred to as "managed retreat," typically involves a lot of complexity—logistical, ethical, political, financial, and architectural.[38] It's a strategy that has yet to receive much attention within the military, however in April 2021, DoD released a new climate vulnerability assessment tool, which included wetland, beach, and dune restoration and the relocation or removal of buildings in its list of recommended approaches.[39]

Salt marsh bird's beak, an endangered plant found only in coastal wetlands of southern California

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36 U.S. Air Force. Coastal Resilience at Tyndall AFB. Accessed July 2021. http://tyndallcoastalresilience.com/

37 U.S. Army Corps of Engineers, Engineering with Nature: Supporting Mission Resilience and Infrastructure Value at Department of Defense Installations, (2021).

38 John Carey, "Core Concept: Managed retreat increasingly seen as necessary in response to climate change's fury." Proceedings of the National Academy of Sciences, 117 no. 24 (Jun 2020) 13182-13185. DOI: 10.1073/pnas.2008198117

39 A.O. Pinson, K.D. White, E.E. Ritchie, H.M. Conners, and J.R. Arnold, DoD Installation Exposure to Climate Change at Home and Abroad. U.S. (Washington, DC: Army Corps of Engineers: 2021).

III NBVC Point Mugu Adaptation Vision

In California, rising sea levels are predicted to contribute to more severe flooding from El Niño events, higher storm surges, and wave-driven erosion. A recent study by researchers from the U.S. Geological Survey estimated, that by the year 2100, over $150 billion in property in California could be impacted by coastal flooding.[40] A recent study also found that over half of the area of California's natural coastal habitats are vulnerable to loss from sea level rise.[41] Natural infrastructure provides an opportunity to combat impacts from sea level rise to people and nature.

Among DoD's California installations is Naval Base Ventura County (NBVC) Point Mugu, a premier testing and training facility, with a specific mission to "deliver proactive quality support to our tenants and enable their diverse missions through safe and secure base operations."[42] Point Mugu occupies over six miles of coastline about an hour's drive northwest from Los Angeles. NBVC—which also includes Port Hueneme, a few miles north of Point Mugu; and San Nicolas Island, about 50 miles offshore to the west—supports a population of 19,000 personnel, over 80 tenant commands, three warfare centers and two airfields. It's also a major employer in the region, annually contributing about $2 billion to the regional economy. The U.S. Department of the Navy (Navy) has deemed ensuring base resilience mission-critical.

Constructed primarily in and around low-lying coastal wetlands, NBVC Point Mugu experiences flooding, erosion, and storm damage to its facilities. In 2016, shortly after DoD recognized climate change as a threat to national security, the Commander Navy Region Southwest (CNRSW) entered into a partnership with The Nature Conservancy to assess the base's current and future climate change vulnerability. The project team, made up of NBVC personnel, Nature Conservancy scientists, and Environmental Science Associates, was also tasked with developing specific recommended actions that would both improve base resilience and enhance natural resources. One tactic, removing buildings from vulnerable areas of the coast, is not a new approach at NBVC Point Mugu. In 1995, after a storm destroyed assets located along the beach, including an Officer's Club, NBVC opted to remove the structures rather than rebuild.[43]

A HISTORY OF FLOODING

In the past, wind, waves, flooding, erosion and sediment deposition—the predominant forces of nature along the coast—were collectively viewed as threats, with armament as the primary course of action. During a recent storm at NBVC, a key intersection for transporting materials flooded. In response, the revetment was extended 100 feet.

"Not even a week went by when a storm surge event went around the wall and flooded a nearby building. That made it clear: we need to do something that's more than putting up walls."

– VALERIE VARTANIAN, NBVC NATURAL RESOURCE MANAGER

"We knew it was important to start looking at the impacts of climate change on the naval base more closely. What should we expect the impacts to be in the future? How will it affect our mission? We knew we needed to start planning for it."

– KIMBERLY JACOBSEN, NBVC DEPUTY PUBLIC WORKS DIRECTOR

40 P.L. Barnard, L.H. Erikson, A.C. Foxgrover, et al., "Dynamic flood modeling essential to assess the coastal impacts of climate change," Sci Rep 9 (2019) 4309. DOI: 10.1038/s41598-019-40742-z

41 W.N. Heady, B. S. Cohen, M. G. Gleason, J. N. Morris, S. G. Newkirk, K. R. Klausmeyer, H. Walecka, E. Gagneron, M. Small. Conserving California's Coastal Habitats: A Legacy and a Future with Sea Level Rise. (California State Coastal Conservancy and The Nature Conservancy, 2018). https://coastalresilience.org/project/conservation-assessment/

42 Naval Base Ventura County, Mission/Vision & Policies. Accessed July 2021. https://www.cnic.navy.mil/regions/cnrsw/installations/navbase_ventura_county/about/policies.html

43 Kenneth Weiss, "Point Mugu Naval Base Under Attack From Mother Nature" Military: After pounding surf destroys three buildings, officials agree to abandon affected area." Los Angeles Times, March 2, 1995. https://www.latimes.com/archives/la-xpm-1995-03-02-me-37771-story.html

POINT MUGU'S SPECTACULAR NATURAL RESOURCES

In addition to its strategic military significance, NBVC Point Mugu contains 6.5 miles of dune backed beach and one of the largest of the remaining salt marsh habitats in coastal southern California, and as such, harbors spectacular wildlife and biodiversity. Where other coastal areas in the region have succumbed to highways, agriculture, or beach-front homes, Point Mugu has enjoyed the restricted access and protection of the Navy since the early 1940s. The base is home to Mugu Lagoon, a several-mile long pool of brackish water surrounded by fringing salt marsh, fed by fresh water from Calleguas Creek, which drains the surrounding watershed. This complex of beach, dune, estuary, marsh, and uplands supports a diversity of plants and animals including rare and imperiled species.

Groundwork for the CNRSW's partnership with The Nature Conservancy was laid years before when the two partnered (along with other stakeholders), on an ongoing project to protect and restore Ormond Beach. This two-mile strip of sandy beach, dunes and wetland lies directly north of Point Mugu and connects it to Port Hueneme.

ORMOND BEACH

Ormond Beach is a public beach backed by dunes and wetlands located directly north of NBVC Point Mugu. The Nature Conservancy, along with the California State Coastal Conservancy and the City of Oxnard, are working with the Navy to protect and restore what is considered by many experts to be one of the most important coastal wetlands restoration opportunities in southern California. Using REPI funding, the Navy assisted The Nature Conservancy in some of the acquisitions that comprise the 650-acre preserve and established an endowment to support ongoing resource management and maintenance.

Ormond Beach is a clear example of how restoration on one property can enhance resilience elsewhere. In this area, beaches that lie up coast supply sand to NBVC, so its beaches can replenish and build back seasonally and after storms.

Together, Ormond Beach and Mugu Lagoon comprise the largest coastal wetland in southern California, spanning 9 miles from Port Hueneme to Point Mugu. Protecting, restoring, and expanding Ormond Beach provides multiple benefits to the Navy's overall encroachment mitigation strategy, including buffering NBVC mission capabilities, providing alternative habitat for birds away from the airfield, providing habitat for imperiled species, ensuring coastal resilience and flood protection, and integrating preservation of working agricultural lands. Restoring this mosaic of coastal habitats will also benefit the resilience of NBVC by absorbing flood waters and providing natural sediment supply to maintain beaches along NBVC.

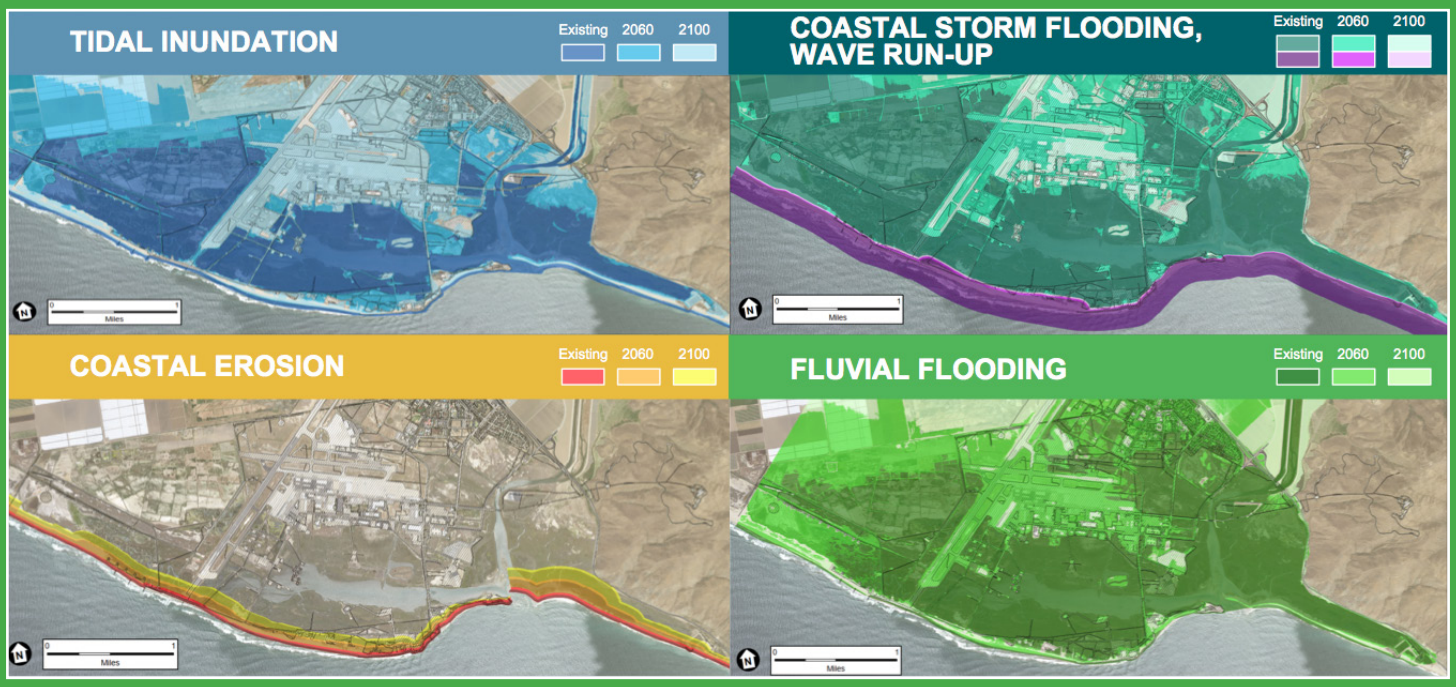
Through this collaboration, the Navy learned of The Nature Conservancy's ongoing work to map current and future sea level rise in the region. The Conservancy's scientists worked for years to amass the best available data, adjusting the models to account for local conditions including topography, oceanography, and river dynamics. Partnership allowed the Navy access to the best science available, and gave The Nature Conservancy a chance to provide expertise on a vision to restore significant wetland habitat.

The approach to resilience described in the Vision hinges upon the growing awareness within the DoD that, while natural processes such as flooding can wipe out roads and other built assets, the same natural processes contribute to resilient ecosystems that in turn offer long term protection to those built assets. Healthy expanses of coastal habitat provide other benefits beyond protective services including cleaning of waters, benefiting marine fishes including commercially important species, recreation and aesthetics, and some of the highest rates of carbon sequestration of any habitats.[44,45] This approach also provides benefits to nature, enhancing the resilience of habitats for a diversity of species. The ecological health of the lagoon and the larger wetlands ecosystem become an essential component of any plan that aims for the long-term protection of the installation.

VULNERABILITY ASSESSMENT

The core research and advisory team included engineers, ecologists, planners, and military and civilian personnel. This team drew upon expertise across NBVC, including base command, public works, facilities and asset management, community planning, and natural resources and environmental management.

The team used state-of-the-art modeling and mapping techniques to quantify hazard risk to each asset throughout the base. Specifically, the team mapped tidal inundation, storm flooding, wave run-up, erosion, and fluvial flooding (from Calleguas Creek), for the entire base, for the years 2010, 2030, 2060 and 2100, down-scaled and fine-tuned to local conditions. The data was cross-walked with medium-to-high sea level rise scenarios (in line with federal and state guidelines). The team measured how hazard exposure will likely impact both built assets and natural habitats over time. Based on exposure to each of the hazards, the team developed risk scores for each individual component of the built environment including buildings, roads, utilities, and other assets.



Source: ESA, 2020

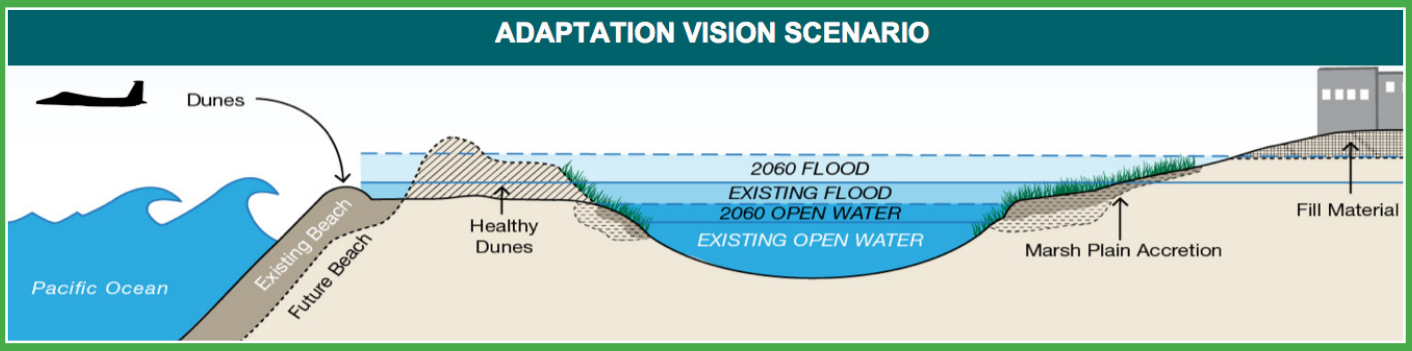
44 E.B. Barbier, S. D. Hacker, C. Kennedy, E. W. Koch, A. C. Stier, and B. R. Silliman, "The value of estuarine and coastal ecosystem services," Ecological Monographs, 81, no. 2 (2011) 169–193. DOI: 10.1890/10-1510.1

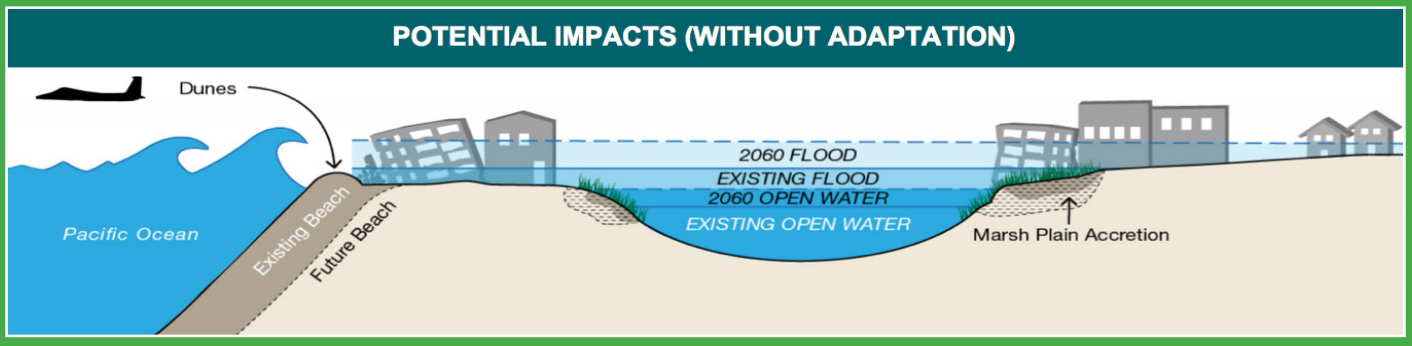
45 E. McLeod, G. L. Chmura, S. Bouillon, R. Salm, M. Björk, C. M. Duarte, C. E. Lovelock, W. H. Schlesinger, and B. R. Silliman. "A Blueprint for Blue Carbon: Toward an Improved Understanding of the Role of Vegetated Coastal Habitats in Sequestering CO2 In a Nutshell," Frontiers in Ecology and the Environment, 9, no. 10 (2011). DOI:10.1890/110004

The analysis shows that if the base stays in its current configuration—with roads, buildings and other infrastructure crisscrossing through low-lying wetlands—the installation's frontline of beaches, dunes, marsh and mudflats would continue to erode or disappear. With sea level rise the vast majority of these habitats and many built assets will be submerged by open water. Losing the mosaic of intertidal habitats to open water and erosion will result in the loss of the protective services provided to the base, as well as critical habitat for species and other ecosystem services, all important to assuring the military mission.

VISION VS IMPACTS

The Vision recommends a suite of adaptation actions and pathways to improve the resilience of built assets, restore natural habitats and their benefits, preserve base functionality, and support the military mission. This includes moving hard infrastructure out of hazard zones into safer grounds where possible, and restoring natural habitats and ecological processes in their place.





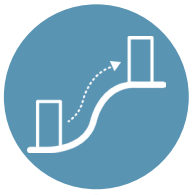
Source: ESA, 2020

RESILIENCE STRATEGIES: DEFEND, REMOVE, RELOCATE, AND RESTORE

The team identified opportunities and constraints for NBVC adaptation strategies by assessing every road, utility, and structure on the 7-square-mile property to determine whether the current location of each asset was critical to mission success. The team evaluated whether the asset must be defended in place, or could be removed or relocated landward. Areas where structures could be removed, would be restored to habitat. This creates opportunity for more hydrological connectivity between wetlands on the base, contributing to their natural resilience capacity and ability to protect the base.

DEFEND

Some assets, such as the airfield and its supporting infrastructure, were deemed critical to defend in place. By enhancing the protective services of surrounding restored coastal habitats, less armoring will be needed to defend those assets which need to remain in place. Some assets determined to be essential in their current location, but vulnerable, may be relocated landward as sea levels rise, shorelines erode, and storm impacts increase.



RELOCATE OR REMOVE

Existing assets whose specific locations are not critical to their function were identified for relocation to a more resilient upland area. The area identified to receive relocated assets, which is further from shore, is a large enough area to accommodate all assets in need of relocation. The designated inland areas where relocated assets will be rebuilt may be regraded and raised above flood levels to provide further resilience. Sediment from Calleguas Creek, which has the third largest sediment yield in California,[46] will be evaluated as an appropriate source for fill material. Built areas, assets, and coastal armoring structures, such as groins and rock revetments, that are no longer needed, will be removed.

RESTORE

Locations where infrastructure is relocated or removed will be restored to coastal habitat. These areas, together with areas already identified under NBVC's Integrated Natural Resource Management Plan (INRMP) and the Restoration Plan for NBVC Point Mugu, comprise over 700 acres for restoration and enhancement of habitat function. The Adaptation Vision also calls for expanding hydraulic conveyance and connectivity throughout the base via expanded culverts and roadway crossings, which will facilitate the maintenance and evolution of marsh systems as sea levels rise. Removal of coastal armoring will also allow coastal processes to rebuild and enhance the dunes and beaches, which will enhance ecological function, protective services, and resilience.

46 U.S. Geological Survey, "Dispersal of River Sediment in the Southern California Bight," in Special Paper of the Geological Society of America (January 2009). DOI:10.1130/2009.2454(2.3).

Source: ESA, 2020

SELECT FINDINGS

- Implementing the measures proposed in the Vision would significantly reduce asset exposure to support the military mission and long-term resilience of the base.
- The measures would shrink the overall footprint of built assets by approximately 30 percent. The reduced footprint would be consolidated within an area of the base projected to be the most resilient to all hazards through 2100, and analyses show there is room to accommodate all required translocated infrastructure.
- Local sediment supply from Calleguas Creek could serve as a potential source of fill to raise relocated assets and to further enhance resilience by providing sediments for the maintenance of coastal habitats as sea levels rise.
- Consolidating assets would free up space for restoration. Together with the surrounding upland areas and areas already targeted for restoration by the base, implementation of this vision would create and enhance over 700 acres of habitat area, providing further wave attenuation and flood management benefits.
- Restored expanses of connected, healthy coastal ecosystems further enhance the resilience of base assets, minimizing the amount of armoring needed.

IV Recommended Next Steps

The project team identified several next steps and recommendations that will further lay the groundwork to achieve the Adaptation Vision for NBVC Point Mugu. These include:

Integration into existing plans, including the Installation Development Plan, the Integrated Natural Resource Management Plan, and NBVC Restoration Plan.

Refined vulnerability assessment to further evaluate the adaptive capacity of base assets, and an economic analysis to quantify the consequences of potential damages from flooding and erosion to the base's built assets.

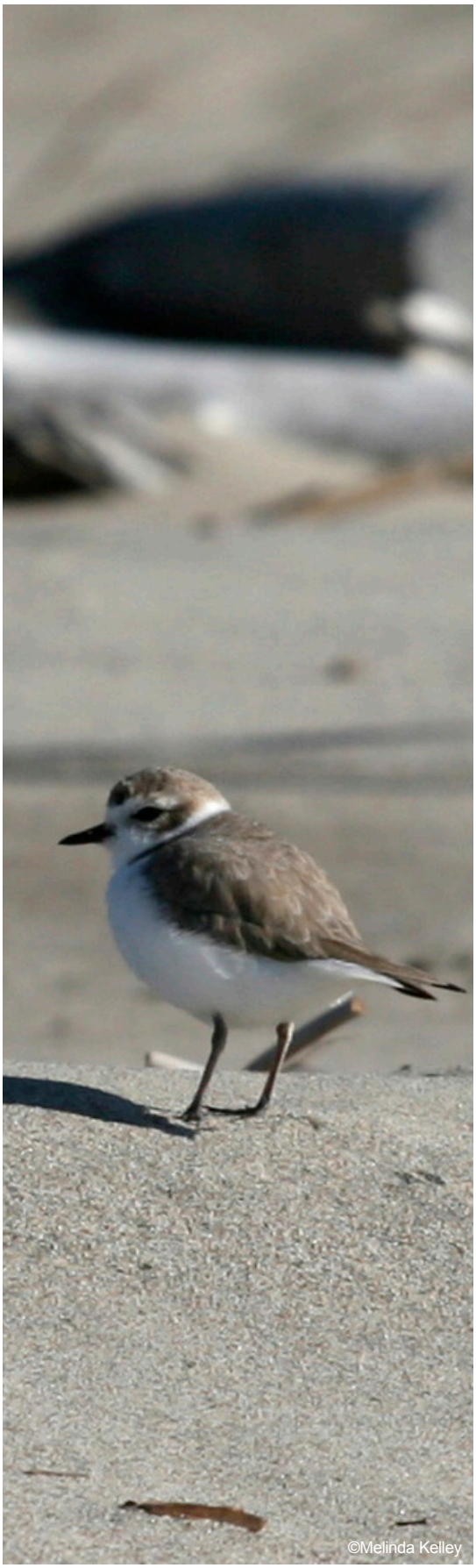
Development of a full adaptation plan and supporting analyses, such as quantifying the hazard risk-reduction provided by natural infrastructure, and the timing and cost of adaptation actions, including interim and near-term actions.

V Implications

THE US MILITARY—A POWERFUL PARTNER ON BUILDING RESILIENCE WITH NATURE

The NBVC Point Mugu Adaptation Vision has the potential to protect billions of dollars of assets from storm and flood damage, helping the military in its objectives to ensure military readiness, and increase long-term resilience of coastal beaches and vital wetland habitat. Increased resilience in one coastal area also increases resilience in nearby areas, so actions taken here enhance coastal resilience regionally. In this case, beaches that lie northwest up the coastline supply sand for beaches down-coast to replenish and build back seasonally and after storms. The reverse is also true—the Navy can take action to improve resilience on its own property, and yet coastal hardening actions at other properties off the base can undermine natural sand replenishment patterns, putting military readiness at risk. DoD programs authorized by Congress are important tools that enable the military to partner with communities and conservation organizations for resilience projects on and off military installations.

Creating space for natural infrastructure and ensuring that beaches and wetlands can continue to act as a buffer long into the future is a strategy that fits with the military's culture of taking the long view and planning decades in advance. The implications of the project reach far beyond this singular installation. These efforts can serve as an example to other installations facing coastal hazards. DoD controls over 200,000 acres of coastal land in California alone, where rising sea levels are predicted to contribute to more severe flooding from El Niño events, higher storm surges, and wave-driven erosion. Worldwide, DoD manages more than 1,700 military installations in coastal areas that may be affected by sea-level rise.[47] DoD also has a long history of performing environmental conservation on the more than 30 million acres under its control, and adopting a natural infrastructure buffering strategy could lead to the restoration of a significant portion of coastal lands. While the investment required to relocate infrastructure is significant, the Government Accountability Office describes climate change and sea-level rise as issues of "fiscal exposure,"[48] and taking action pre-emptively creates a pathway for a carefully managed process. Waiting to act almost guarantees training and operational interruptions and costly damages. Hurricane Florence in 2018 damaged hundreds of buildings at Marine Corp Base Camp LeJeune and Marine Corp Air Station New River in North Carolina, with repairs estimated at $3.6 billion, and that same year Tyndall Air Force Base in Florida incurred an estimated $4.7 billion in hurricane damage.



47 Congressional Research Service, Military Installations and Sea Level Rise, (July 2019). https://fas.org/sgp/crs/natsec/IF11275.pdf

48 Government Accountability Office, Climate Resilience: DOD Needs to Assess Risk and Provide Guidance on Use of Climate Projections in Installation Master Plans and Facilities Designs, GAO-19-453, (June 2019).

Beyond military installations, many coastal areas in the world are potential impacts from sea level rise, and how to protect built assets while also continuing to protect natural coastal habitats and the values they provide. California has already lost more than 90 percent[49] of its coastal wetlands to development, and much of the remaining ten percent is at risk of being subject to hardening measures and transitioning to open water with sea level rise. This would be devastating to shorebirds and many other endangered species that depend on coastal habitat. The loss of coastal habitat would also reduce protection from coastal flooding and impact communities whose economies are coastal dependent. This could impact more than two-thirds of Californians, or the 26.3 million people who live in coastal counties. Worldwide about 40% of the world's population lives within 60 miles of the coast.

Many of these extreme loss scenarios could be avoided if relocation and restoration approaches become more widespread. The collaborative, science-based plan demonstrated by the NBVC Adaptation Vision can be replicated locally, regionally and globally, to help beaches and wetlands continue to thrive and provide benefits to communities, including protection from flooding, food provisioning, cleaning of waters, and aesthetic and recreation opportunities. The military can also be a powerful partner for communities and conservation organizations in realizing nature-based solutions for resilience. Recent changes in legislation, including to the REPI program statutes, among others, serve as opportunities for focus and funding for nature-based resilience projects. If natural infrastructure and coastal restoration strategies are adopted more broadly and supported through substantial DoD investment, it could significantly increase the buffering capacity of a portion of the world's coastal lands, provide long-term protection for billions of dollars of military assets, reduce the need for extremely costly repairs, and set an example for the world.

49 U.S. Geological Survey, National Water Summary on Wetlands Resources: State Summary Highlights. Accessed July 2021. https://water.usgs.gov/nwsum/WSP2425/state_highlights_summary.html

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ESA

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