Opportunities to Accelerate Nature-Based Solutions: A Roadmap for Climate Progress, Thriving Nature, Equity, & Prosperity

A REPORT TO THE
NATIONAL CLIMATE TASK FORCE

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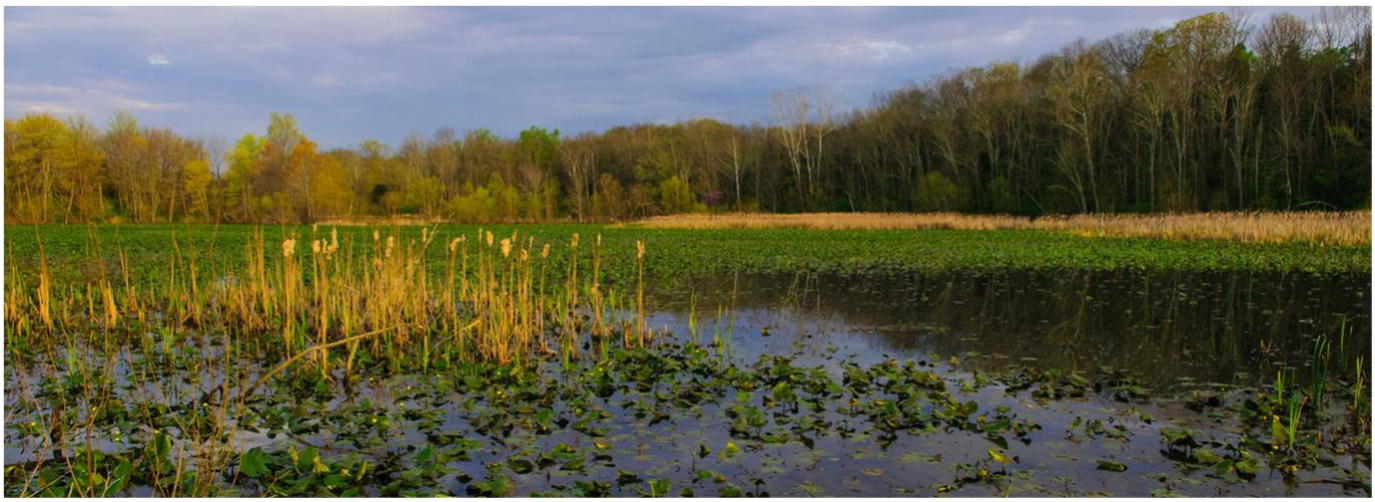

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Table of Contents

Investing in Nature to Solve Today's Challenges

Nature plays an immense role in every aspect of our lives and offers untapped solutions to some of our biggest challenges. President Biden is shining a spotlight on these powerful opportunities. In one of his earliest actions, he set the nation's first ever conservation goal, respecting nature in its own right and recognizing nature's critical role in the economy, national security, human health, equity, and the fight against climate change. On Earth Day, 2022, the President went even further, making protecting and restoring nature and using nature-based solutions a core tenant of our national policy. Executive Order 14072, *Strengthening the Nation's Forests, Communities, and Local Economies*, directed this team to "submit a report to the National Climate Task Force to identify key opportunities for greater deployment of nature-based solutions across the Federal Government, including through potential policy, guidance, and program changes."

The President's policy is direct and clear. It builds on our innate understanding that a healthy and thriving natural world leads to healthy and thriving communities. To build, restore, live and work in concert with nature will lead to significant benefits for both people and the planet. Too often, the power of nature is overlooked and undervalued as a core element of a more just, livable world today and for future generations.

Nature-based solutions, like protecting forests or restoring coastal marshes, are a fundamental pillar of fighting the climate crisis, just like reducing greenhouse gas emissions, deploying renewable energy, and increasing energy efficiency. Natural solutions can reduce emissions, remove carbon from the atmosphere and lock it away, make ecosystems more resilient, and lower climate change risks for people. These solutions are often lower in cost than conventional alternatives, and compatible with existing technology. Nature-based solutions are known to be highly effective and create multiple benefits, including improving human, economic, and ecosystem health. Yet, they are not adopted at the scale and pace that are both possible and urgently needed. Despite notable progress on nature-based solutions, this report finds that significant challenges remain.

There is often an assumption that tackling the climate crisis requires only technological solutions or that "innovation" means "technology". This report presents compelling evidence that nature-based solutions are innovative, and that they are highly complementary to necessary technological solutions. Nature-based solutions and technology can be powerful allies. Indeed, the climate crisis demands that we deploy all available, proven, science- and evidence-based solutions.

The Biden-Harris Administration is committed to maximizing nature-based solutions as critical tools in its toolbox to confront climate change and other major challenges. This report provides a roadmap with five strategic areas of change needed to unleash nature's full potential: Update Polices; Unlock Funding; Lead with Federal Facilities and Assets; Train the Workforce; and Prioritize Research, Innovation, Knowledge, and Adaptive Learning. This is a starting point, an initial framework for action. The steps we collectively take now to drive the integration of nature-based solutions and make them a priority for investments and infrastructure will, in part, determine the success of our fights against climate change, nature loss, and inequity. We call on you to lead with us in advancing these policies and practices to meaningfully improve the lives of Americans and people around the world.

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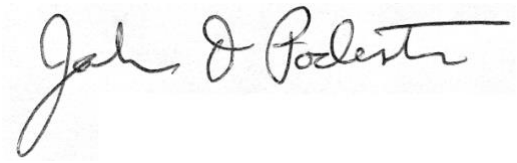

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Executive Summary

Fewer wildfires, more tolerable temperatures, more resilient infrastructure, and safer places to live are all hallmarks of a climate-stable future. Achieving this future is the challenge of our generation, a challenge that requires all of America's strength, knowledge, and ingenuity to confront. But, one powerful source of solutions has been largely overlooked: nature. Deep knowledge, science, and experience have produced a wide variety of nature-based solutions. They can — and must — be critical tools in the fight against climate change.

Nature-based solutions are actions to protect, sustainably manage, or restore natural or modified ecosystems to address societal challenges, simultaneously providing benefits for people and the environment.

On Day One of his Administration, President Biden joined global leaders in committing to limit global warming through the Paris Climate Agreement. Nature-based solutions are key to reaching this goal. America's forests absorb carbon dioxide at a rate equal to 10% of U.S. annual greenhouse gas emissions. Some researchers estimate that nature-based solutions can boost progress towards our climate goal by up to 30%. Despite the potential for nature to be an ally in the fight against climate change, nature is in decline. This loss of nature moves us away from climate goals and the other benefits of a healthy natural environment. If we ignore nature, we are missing big opportunities to stabilize the climate, support good jobs, and build healthy communities. Now is the time to embrace the powerful potential of nature-based solutions. As we aggressively invest in emissions reductions through electric vehicles, clean energy, and industry, we must as aggressively invest in forests, urban parks, coastal wetlands, and other ecosystems.

Meanwhile, the consequences of climate change continue to hit home. Communities across the United States and around the world are facing the impacts of climate change — on land and in the ocean — including intensified storms, flooding, heatwaves, droughts, and wildfires. These impacts intensify inequities, as the same communities that shoulder a disproportionate share of the costs of nature's decline also face the bulk of climate risks. Nature-based solutions are already helping reduce some of these risks. Nature's wetlands saved communities and home owners $625 million in damages during Hurricane Sandy. Urban trees and parks are cooling homes. Forest restoration is reducing wildfire severity. But overall risks continue to mount. For example, the United States has 60,000 miles of coastal roads at risk of flooding. Nature-based solutions can be used alone or in combination with other adaptation solutions, like seawalls or air conditioners, to reduce mounting risks. At this point, nature-based solutions are woefully underused and urgently needed.

Seeing this potential, President Biden and Congress have taken bold action. The Infrastructure Investment and Jobs Act (commonly called the Bipartisan Infrastructure Law) and Inflation Reduction Act made unprecedented investments in nature-based solutions. These laws place forests, agricultural lands and coastal wetlands front and center in the climate fight. For example, $20 billion is directed to farmers, ranchers and private forest owners working to increase carbon

storage and reduce emissions. Another $5 billion is for forest management actions that can reduce wildfire risk, store carbon, and cool communities. These laws also weave nature into infrastructure investments. Over $8.7 billion will support nature-based solutions and other approaches to build climate resilience into transportation systems from the ground up. Another $8.6 billion will restore and conserve coastal habitats. These investments will help buffer communities from storms and boost local economies. With these actions, the federal government is building on expansive Indigenous and scientific knowledge and innovation that have laid the groundwork for accelerated deployment and continued learning.

The Biden-Harris Administration has recognized this once-in-a-generation opportunity to ensure that nature-based solutions reach their full potential. On Earth Day 2022, the President made nature-based solutions a national priority. In Executive Order 14072, the President made a broad call for the accelerated deployment of nature-based solutions to tackle climate change and adapt to impacts already underway. The President also called for a report identifying key opportunities for greater use of nature-based solutions across the federal government. The White House's Council on Environmental Quality, Office of Science and Technology Policy, and Office of Domestic Climate Policy, in consultation with federal agencies, have responded. This report marks the first time in history that the federal government has taken a hard look at what is needed to ambitiously scale up nature-based solutions.

Despite some progress made and good intentions, agencies, Tribal Nations, and stakeholders identified significant challenges to scaling up nature-based solutions. Many people are unaware of nature-based solutions. Few know that nature-based solutions can help address common problems, like coastal flooding or urban heat islands. Far too often, current policies and regulations create unintended hurdles for using these options. Some communities find funds for nature-based solutions insufficient and difficult to navigate. The workforce to design and build nature-based solutions lags in many regions, and is nonexistent in others. Technical challenges can make investors hesitate or delay permitting. These challenges can - and must - be overcome.

This report provides a roadmap with five strategic recommendations for federal agencies to unlock the potential of nature-based solutions and highlights bold Executive Office of the President actions designed to pave the way. Importantly, these recommendations position the United States to prioritize nature-based solutions as go-to options in fighting climate change, nature loss and inequities:

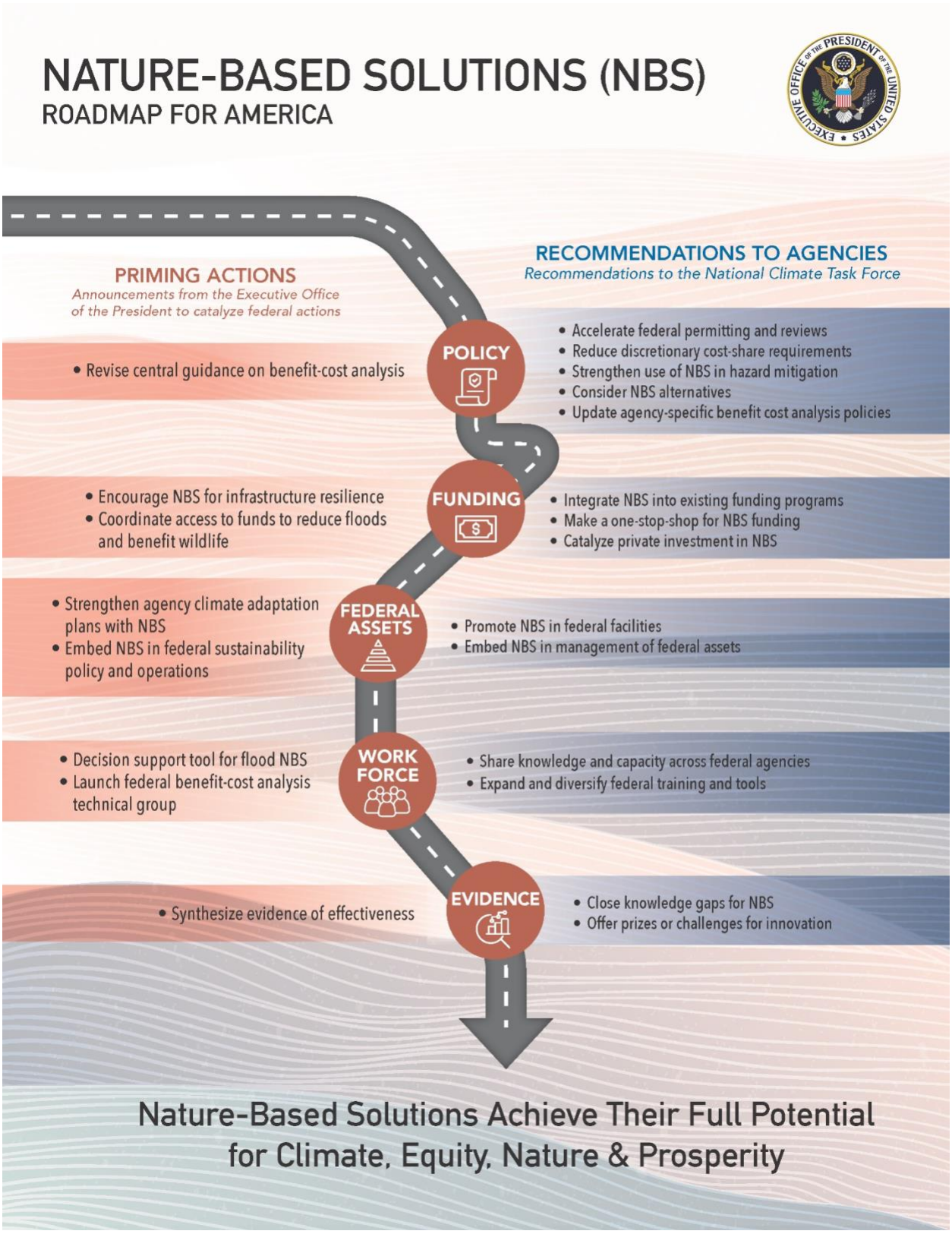
1. **Update Policies:** Agencies should update federal policies and guidance to make it easier to consider and use nature-based solutions. Key opportunities include updating permitting processes or agency review methods. For example, general permits and programmatic reviews have ensured efficient agency review of many types of infrastructure and are ripe for expansion for implementing nature-based solutions. Likewise, updating benefit cost and accounting guidance will make the economic benefits of investing in nature-based solutions more visible on the nation's balance sheets and in regulatory and funding decisions. Natural hazard reduction standards, insurance standards, guidance, and risk management tools should be established or updated to pave the way for nature-based solutions, such as restoring rivers and their floodplains. Discretionary cost-share requirements that unnecessarily constrain the use of nature-based solutions can be reduced or removed, particularly for underserved communities. The Inflation Reduction Act enables some federal departments to change cost-share requirements. Using this

approach to its fullest extent will help address some historic injustices and ensure that climate benefits reach the communities that need them most.

2. **Unlock Funding:** Federal agencies can rapidly reduce emissions and promote community resilience by integrating nature-based solutions into financial assistance and incentive programs. Taking early action, the Biden-Harris Administration is guiding agencies to use infrastructure funding to support nature-based solutions. There are key opportunities in the multibillion-dollar investments in the Bipartisan Infrastructure Law and Inflation Reduction Act for resilient housing, roads, and communities. Agencies can also simplify access to existing funds by increasing coordination and streamlining application processes. Focusing these efforts on historically underserved communities can improve equity and help ensure the communities at greatest risk can access these funds. Coordinated funding could be oriented around geographies or climate risks, like drought, flooding, wildfire, and urban heat. These issues often need to be addressed at larger scales for greatest effect. Private sector investment is also critical and can be catalyzed through innovation challenges and emerging finance models.
3. **Lead with Federal Facilities and Assets:** Federal agencies have begun focused efforts to improve resilience in their facilities, operations, and programs. This is only the start. Agencies can do more by expanding green stormwater infrastructure, green roofs, living shorelines, and other nature-based solutions. Federal facilities standards should require use of nature-based solutions, where appropriate. And standards should be updated as knowledge about nature-based solutions evolves. Agencies with large land holdings can include nature-based solutions in their planning and management, and where appropriate, engage in co-stewardship and co-management with Tribal Nations to right injustices and build resilience. Doing so could store more carbon and shield neighboring communities from climate impacts and natural hazard risks. Federal leadership will help raise private sector confidence in nature-based solutions. It will also expand the workforce and create a successful model for others to follow.
4. **Train the Workforce:** The next wave of good jobs can come from training an equitable, nature-based solutions workforce. Key skills are needed in planning, designing, building, and maintaining nature-based solutions. In particular, more skilled workers are needed in community planning, law, finance, ecology, engineering and maintenance aspects of nature-based solutions. Agency programs can help develop these skills. For example, federal partnerships with labor, academic, and professional organizations can provide technical resources for the current workforce, and support development of nature-based solution job and design standards. The seeds of the future nature-based solutions workforce also need to be planted through science, technology, engineering, art and math (STEAM) education. Federal staff capacities also need strengthening. Agencies can share experiences and build skills for implementing and evaluating nature-based solutions.
5. **Prioritize Research, Innovation, Knowledge, and Adaptive Learning:** As the world changes, we must innovate and fill gaps in our understanding of nature-based solutions and when to use them. Federal agencies can review existing research to identify gaps in understanding the effectiveness of nature-based solutions. Agencies should also develop interagency best practices for monitoring the full suite of benefits from nature-based solutions, including how best to measure and verify climate benefits. Improved adaptive

management and monitoring can generate additional evidence of effectiveness. Agencies should also work alongside and learn from Indigenous Knowledge holders to enhance or restore nature. Agencies should continually explore the potential for nature-based solutions to further their missions and provide multiple benefits. Evidence-building and learning agendas are useful tools to advance these efforts. Agencies can also ask how these solutions can be used to increase equity and environmental justice in climate resilience. Grants, prizes, challenges, and awards can incentivize innovation and expand evidence.

The recommendations in this report are some of the best opportunities we have to meet climate goals and grow climate-ready communities, economies, and sectors. All have a role to play in turning these recommendations into action. President Biden and his National Climate Task Force are in a position to act boldly and lead adoption of these recommendations, advancing nature-based solutions as powerful tools that the nation and the world need now.


NATURE-BASED SOLUTIONS (NBS)
ROADMAP FOR AMERICA
EXECUTIVE OFFICE OF THE PRESIDENT OF THE UNITED STATES
PRIMING ACTIONS
Announcements from the Executive Office of the President to catalyze federal actions
RECOMMENDATIONS TO AGENCIES
Recommendations to the National Climate Task Force
POLICY
• Revise central guidance on benefit-cost analysis
• Accelerate federal permitting and reviews
• Reduce discretionary cost-share requirements
• Strengthen use of NBS in hazard mitigation
• Consider NBS alternatives
• Update agency-specific benefit cost analysis policies
FUNDING
• Encourage NBS for infrastructure resilience
• Coordinate access to funds to reduce floods and benefit wildlife
• Integrate NBS into existing funding programs
• Make a one-stop-shop for NBS funding
• Catalyze private investment in NBS
FEDERAL ASSETS
• Strengthen agency climate adaptation plans with NBS
• Embed NBS in federal sustainability policy and operations
• Promote NBS in federal facilities
• Embed NBS in management of federal assets
WORK FORCE
• Decision support tool for flood NBS
• Launch federal benefit-cost analysis technical group
• Share knowledge and capacity across federal agencies
• Expand and diversify federal training and tools
EVIDENCE
• Synthesize evidence of effectiveness
• Close knowledge gaps for NBS
• Offer prizes or challenges for innovation
Nature-Based Solutions Achieve Their Full Potential for Climate, Equity, Nature & Prosperity

Introduction: Nature-Based Solutions

What are nature-based solutions?

Nature-based solutions are actions to protect, sustainably manage, or restore natural or modified ecosystems to address societal challenges, simultaneously providing benefits for people and the environment.[1] Often, these solutions use long-standing conservation approaches forged in the fight against nature loss. Solutions include protection or conservation of natural areas, reforestation, restoration of marshes or other habitats, or sustainable management of farms, fisheries, forests, or other resources. Opportunities to use nature-based solutions extend across rural forest and farmlands, growing urban centers, coasts and ocean areas, around sensitive infrastructure, and in historically under-represented communities.

The United States has a long history of investing in nature to address pressing problems. Facing the Dust Bowl, President Franklin Roosevelt championed the Prairie States Forestry Project, also known as the "Great Wall of Trees."[2] Under the project, the federal government paid farmers to grow "shelter belts" of trees around farmlands, employing thousands of rural workers. By the time the project ended in 1942, the great wall had over 220 million trees and stretched 140,000 square miles from Texas to North Dakota. The trees reduced erosion, protected livestock from windstorms, provided shade, and created habitat for birds and wildlife. Today, as America's rural landscapes have changed, many of those trees are gone or in decline. It is time to reinvest in nature-based solutions at scales that matter for the climate, people, and the environment.

Nature-based solutions can help to mitigate climate change. Addressing the climate and biodiversity crises requires immediate and sustained action to reach net-zero greenhouse gas emissions by mid-century. The transition to clean energy is necessary, but not sufficient, to achieve national and global climate goals.[3] Transforming our energy system needs to be paired with a drawdown of greenhouse gases already in the atmosphere. Nature-based solutions provide one of the most effective and efficient avenues for achieving this drawdown (Table 1).[4] Researchers estimate that these solutions — when well-designed and managed — can cost-effectively provide over one-third of the climate mitigation needed to stabilize warming to below 2 degrees Celsius by 2030.[5] Realizing the full potential from nature-based solutions to slow climate change requires much more ambitious action by many actors at all scales.

Nature-based solutions can help communities adapt to climate impacts. The Biden-Harris Administration is taking aggressive action to reduce several of the climate-related risks expected to most heavily impact the United States: wildfire, drought, extreme heat (on land and in the ocean), coastal inundation, and inland flooding.[6] Various nature-based solutions can cost-effectively reduce each of these risks[7] (Table 1). For example, urban trees can significantly cool the air, lowering the risk of heat stress on people and infrastructure. This benefit can translate into lower emissions from electricity production, fewer blackouts, and cost-savings for air conditioning by up to 47%.[8] In the United States, these benefits are not distributed equally across all communities. Low-income areas have 15% less tree cover than wealthier ones.[9] Researchers estimate that 62 million trees would have to be planted to close the disparity between these areas, and doing so would benefit 42 million people.[10]

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Used alone or in combination with other infrastructure, some nature-based solutions have proven effective in reducing risks to coasts. Conserving or restoring coastal habitats, like oyster reefs, mangroves, and marshes, can reduce coastal flooding and yield other benefits (Table 1). On average, coastal wetlands reduced flood losses during Hurricane Sandy by 16%.[11] Integration of coastal habitats can make conventional coastal infrastructure more effective and last longer.[12] Studies of living shorelines suggest that they are effective at reducing coastal erosion. They can also be more resilient than conventional gray infrastructure methods like seawalls, requiring little or no repair after storms. Living shorelines also support coastal habitat, recreation, access to nature, and fisheries.[13] Such solutions are critical, as more than 60,000 miles of roads and bridges in the U.S. are at risk from coastal flooding, and this number is expected to grow with continued climate change. Without adaptation, damages to coastal properties in the United States could add up to $3.6 trillion in costs by 2100.[14] Coral reef restoration in Florida and Puerto Rico has the potential to provide $272.9 million annually in direct and indirect flood damage savings—dollars that will compound in value over time. [15]

Box 1. Benefits of Nature-Based Solutions.
This list is not exhaustive.

- Climate mitigation (reduced greenhouse gas emissions and enhanced carbon storage)
- Reduction of major climate risks, such as:
  - Coastal floods and shoreline erosion
  - Inland floods
  - Stormwater and sewer overflow
  - Extreme heat
  - Wildfire
  - Drought
- Job opportunities
- Improved water and air quality
- Fish, timber, and other natural products
- Recreational opportunities and access
- More resilient infrastructure
- Improved physical and mental health
- Cultural benefits
- Wildlife and biodiversity support
- Community development and economic revitalization

Investments in urban trees and coastal habitats are just two examples of nature-based solutions that can be deployed against the crises of climate change, nature loss, and inequity. The examples above, and many others (Table 1), demonstrate that well-designed nature-based solutions often provide multiple benefits (Box 1), even when implemented to address a narrow set of challenges. Restoring forests and grasslands in a mosaic of farms can reduce wind erosion, sequester carbon, bolster crop yields through pollination and pest control, provide recreational opportunities, and recharge rural habitats. Carefully managed prescribed burns, a method developed by Native Americans, can reduce extreme wildfire risk, reduce health impacts and school closures from smoke, and improve forest health to better support cultural uses, endangered species, and recreation. In many cases, using these approaches will help communities address many challenges at once, save money, and build durable solutions.

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Table 1.Examples of nature-based solutions. Each problem and each example of a nature-based solution demonstrates connections to both people and nature. Individual nature-based solutions often provide multiple benefits. The table does not provide an exhaustive list.

Problems	Examples of Nature-based solutions
Greenhouse gas emissions	• **Conserving or restoring coastal habitats, forests, wetlands, and grasslands** - removes carbon dioxide from the atmosphere and stores it, slowing climate change. • **Improved agricultural management**, **including cover crops, no-till, rotational grazing, and sustainable timber management** - reduces erosion, stores more carbon in soils, and vegetation, and requires less fuel through reduced tilling, slowing climate change.
Urban heat island; heat stress; urban air pollution	• **Green roofs** – help to insulate buildings from high temperatures and cool them through evapotranspiration, reducing cooling needs, costs, and emissions. • **Urban trees and forests** – capture air pollutants and cool the air, reducing urban heat island effects and heat stress on people and infrastructure and reducing cooling costs and emissions.
Inland flooding; non-point source pollution (e.g., excess nutrients and sediment); and erosion	• **Floodplain reconnection and restoration** – lowers river height and speed during a flood and reduce erosion, sedimentation, and pollution from excess nutrients. • **Enhanced water storage in wetlands, forests, or farmland** – reduces runoff and flooding, improves groundwater recharge and decreases erosion, sedimentation and pollution • **Protecting or restoring riparian buffers** – slows water, stabilizes banks, and reduces pollution. • **Sustainably managing forests, farms, and grazing lands** – including sustainable forest management, agroforestry, silvopastures, planting cover crops, diversifying crops, and rotational grazing - can reduce erosion and excess nutrients that cause water pollution.
Stormwater and sewer overflow and costs; urban flooding; water pollution from urban settings	• **Green Roofs** – absorb, evaporate, and transpire some water, reducing stormwater runoff and moderating local flooding. • **Rain Gardens** – in shallow basins in yards and along streets or sidewalks, absorb stormwater runoff. • **Bioswales** – long, deep channels of plants and grasses along roads and parking lots - absorb runoff and release water slowly. • **Urban trees and forests** – absorb water, reducing runoff, combined sewer overflow, and urban flooding. • **Constructed wetlands** – capture stormwater runoff, and treat wastewater, reducing costs and pollution.
Shoreline erosion; tidal flooding; storm surge	• **Protecting or restoring coastal habitats** – mangroves, coral reefs, oyster reefs, beaches, rock reefs, coastal dunes, freshwater marshes, and salt marshes all help reduce coastal erosion and, depending on their extent, can reduce flooding from storms and high tides. • **Living shorelines** – native coastal habitats (oyster reefs, salt marsh, mangroves, seagrass beds) alone or in combination with sills and berms, reduce storm surge and coastal erosion and stabilize the shoreline.
Wildfire	• **Forest management** – carefully managed prescribed burns reduce wildfire severity and risk to communities. • **Greenbelts** – forests near communities that are managed to be less flammable or irrigated provide a fire break, reducing fire risks.
Drought	• **Clearing invasive plants** – that use more water than native species increases available water. • **Protecting beavers** - changes hydrology and increases groundwater recharge and dry season flows. • **Water storage on agricultural fields** – converting unproductive crop areas to meadow or wetlands enhances groundwater recharge, while reducing flooding and nutrient pollution.
Crop loss from pests or poor pollination	• **Planting pollinator habitats** – in gardens, along roads, or in other places provides food for pollinators, enhances biodiversity and improves some nearby crop yields. • **Integrated pest management** – restoring or improving habitat for native pest predators (e.g., bats, birds and snakes) reduces the costs of managing pests on agricultural lands.

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Loss of culture or identity; loss of jobs; loss of recreational opportunities	• **Conserving or restoring forests, wetlands, grasslands, and coastal habitats**– provides opportunities for recreation, fishing, hunting, or cultural activities, related jobs, and a sense of place and identity for people. • **Sustainable management of forests, fisheries, and agricultural lands** – managing these and other natural resources provides many Americans with a cultural identity and a way of life.
Obesity, stress and mental health challenges	• **Green space** –provides opportunities for outdoor activities or to receive the health benefits of passively being in nature. • **Neighborhood greening** – vegetation around homes, on school grounds, or around public facilities increases nature exposure, and can provide physical and mental health benefits.

Recent federal investments offer an opportunity to scale up deployment of nature-based solutions

Well-designed nature-based solutions are essential tools in the fight against the climate crisis, but they are far from reaching their full potential. President Biden is making accelerated deployment of nature-based solutions a national priority (Executive Order 14072), and the Biden-Harris Administration is reinforcing this commitment through federal investments, programs, budgets and international agreements.

The President's Bipartisan Infrastructure Law of 2021, and the Inflation Reduction Act of 2022, provide historic investments in infrastructure and climate action. Both make unprecedented moves towards unlocking nature-based solutions to address critical challenges. Embedded in the Bipartisan Infrastructure Law is a recognition that nature-based solutions can act as infrastructure and can help conventional infrastructure perform better and longer. Major investments in this law are directed to nature-based solutions to reduce floods and wildfire risks, increase road safety and durability, provide clean water, and restore habitat. The Inflation Reduction Act provides a massive investment in climate mitigation and adaptation strategies, including in those that nature provides: carbon removal through forest management, forest restoration and conservation, urban tree planting, coastal habitat restoration, and climate-smart agriculture. The Inflation Reduction Act also includes funding that could support nature-based solutions for addressing stormwater, heat islands, and air quality in environmental justice communities. While some of these investments aim to scale up nature-based solutions, the specific use of other fundsare still under development, offering additional opportunities.

The United States has also committed to advancing nature-based solutions through international agreements. For example, the United States recognized this year, with G7 partners, that nature-based solutions are a critical lever for tackling nature loss and the climate crisis.[16] In parallel, the U.S. and the 16 other Ocean Panel countries have pledged to use nature-based solutions as key elements in tackling climate change.[17]

With these historic investments and agreements for the future of our nation comes an unprecedented opportunity to invest billions of dollars into solutions that benefit both people and the environment. Conventional infrastructure planning, siting, and design are likely to create future climate liabilities. Using intentional strategies, like nature-based solutions, can help avoid these risks and bolster resilience. The time is ripe to make an exponential leap in investment for natural infrastructure.

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Taking stock of the state of knowledge and experience with nature-based solutions, and the untapped opportunities at hand, this report identifies critical challenges that stand in the way of greater adoption of nature-based solutions. It provides guiding principles for their effective use, and presents strategic recommendations to unlock the full potential of nature-based solutions to help address the climate crisis, revitalize nature, and create thriving communities.

Challenges to accelerating nature-based solutions

While examples of nature-based solutions abound,[18] many applications have been at smaller scales relative to their potential and the need. Through interagency dialogue, Tribal Consultation, and meaningful public engagement,[19] a diverse set of stakeholders and partners expressed a resounding interest in scaling-up nature-based solutions, and helped to identify challenges that stand in the way of widespread adoption. The challenges are described below as a backdrop for the recommendations for wider implementation of nature-based solutions.

Insufficient awareness of nature-based solutions: Many decision makers, communities, and experts lack awareness of nature-based solutions and the ways they can help address social and economic challenges. As a result, these options are often overlooked. Some people remain unsure of where to apply nature-based solutions, and how to measure and account for their benefits. Relevant forms of knowledge, including Indigenous and local knowledge, often are not considered in design processes and evaluations, leading to missed opportunities and less robust solutions.

Regulatory and policy hurdles: Federal policies and processes can unintentionally promote conventional solutions over nature-based solutions. For example, hazard mitigation tends to focus primarily on conventional solutions (e.g., elevating buildings and utility systems in flood zones and fire-proofing buildings), missing opportunities to integrate nature-based options like floodplain restoration and managing neighboring forests to reduce fire risk. Programs that promote rebuilding damaged structures as they existed before can limit integration of nature-based solutions in recovery. Public engagement for this report revealed that permitting requirements can be difficult to meet even for actions likely to improve the environment (e.g., wetland gains, species protection), and that lack of awareness by regulators may delay agency approval processes. Barriers also exist in some funding policies. For example, the cost-share requirements for some federal funds can create a barrier for underserved communities.

Difficulty accounting for costs and benefits: Public input identified the use of high discount rates in benefit cost analyses to support federal decisions as a challenge. Higher discount rates can favor projects with greater short-term benefits, over those that have longer-term benefits, which is sometimes the case for nature-based solutions. In addition, many of the benefits that nature-based solutions provide fall outside of conventional economic accounting systems and methods. As these benefits are not openly traded in a market, economic systems and tools often miss their significance, biasing decisions in favor of marketed options. Wild pollinators add value to crops, but their contribution cannot easily be seen in the price of a basket of strawberries. The ability of a forest or coral reef to reduce flood damages is obscured in home values or in lower insurance premiums. And some benefits of nature-based solutions, like spiritual experiences, should not be monetized. Many agency guidance documents and accounting tools do not comprehensively capture the range of benefits that nature-based

solutions can provide. For some nature-based solutions, data or modeling gaps remain, especially to identify long-term impacts, and to specify who gains or loses these benefits, making it difficult to track equity implications or design these solutions to overcome past injustices.

Insufficient and uncoordinated funding: Some federal funding programs do not specifically include nature-based solutions as eligible options, and few prioritize them. Programs that do include nature-based solutions are commonly oversubscribed. Most funding covers construction costs, leaving gaps for operation, maintenance, monitoring, and adaptive management. Moreover, many nature-based projects may require funding from multiple federal and non-federal programs to cover costs of the entire project, or to address different aspects of multi-faceted projects. Communities and partners have called for increases in funding and for simplifying the complex federal funding landscape.

Limited federal, community, and workforce knowledge and skills: Implementing nature-based solutions requires different approaches, tools, and skills than conventional options, and

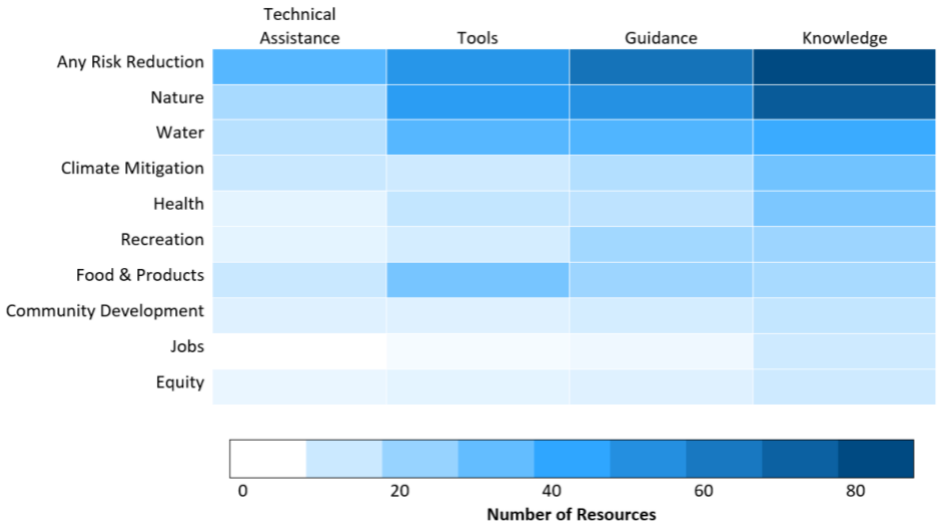

Figure 1. Summary of federal resources available to support use of nature-based solutions for several benefits.

lack of these skills can slow the adoption of nature-based solutions. In a recent federal review,[20] agencies identified 177 resources developed to help build these skills (Fig. 1). Based on this review, most of these existing resources provide general information like case studies and process overviews. Few resources provide the tools, guidance, and technical assistance needed for implementation. Most of the available federal resources, including those jointly developed with non-federal partners, address risk reduction and resilience, with a primary focus on coastal flooding. Gaps remain for other increasingly frequent catastrophic events (e.g., inland flooding, fire, drought, extreme heat). Public input identified a need for additional technical resources and workforce development programs to overcome remaining capacity gaps.

Gaps in evidence of effectiveness: Not all nature-based solutions have received the same level of study.[21] Where evidence is strong, standards have been created and nature-based solutions can be widely used. Where solutions are not yet backed by strong evidence about long-term performance and reliability, their use can be constrained. Evidence that does exist is often

dominated by small-scale tests and examination of only a few of the relevant costs and benefits. Demonstration projects, research, and long-term observations are needed to continue building a robust evidence base for all types of nature-based solutions and their benefits, and to understand how to adapt solutions to future changes.

Addressing these six challenges would help drive a dramatic increase in the use of nature-based solutions. This report identifies strategic opportunities to address these challenges, and cross-cutting principles to guide recommended actions.

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Principles to Guide Design and Implementation of Nature-Based Solutions

Five overarching principles emerged from analysis of past experience, existing knowledge, best practices, and input received through interagency discussion, public roundtables, and Tribal Consultation. These principles can guide agencies as they undertake the actions recommended in this report, and can underpin the effective design, implementation, and maintenance of nature-based solutions.

Start with nature-based solutions

Evidence shows that nature-based solutions can help to address multiple, critical societal challenges simultaneously and often do so in a cost-effective way. Agencies should use their authorities to promote and integrate nature-based solutions wherever possible, unless alternatives are demonstrated to be more beneficial when the full range of benefits are considered.

Benefit people and nature

Nature-based solutions should be deployed to benefit both people and the environment. For example, a carbon mitigation project that uses non-native trees can provide a cost-efficient human benefit, but may not provide net environmental gain. Likewise, nature-based solutions should have a clear benefit to people.

Interweave equity

It is critical to recognize that inequities leave some communities at greater risk from climate change and limit their access to nature's benefits. For example, Native Americans are 48% more likely than others to live in areas at risk from sea level rise.[22] Low-income families and families of color are much more likely to live in areas with little access to nature.[23] Intentional focus on equity and environmental justice can ensure that nature-based solutions do not worsen inequities, and where possible, can reverse inequities. All dimensions of equity (e.g., recognition, procedure, distribution, context)[24] should be considered when adopting nature-based solutions.

Use evidence

Leading with evidence is common sense, often required by law,[25] and is a priority of the Biden-Harris Administration. Nature-based solutions are not one-size-fits all. Their effective design relies on application of evidence from a wide range of disciplines and viewpoints to tailor solutions. Evidence should be used to design and scale nature-based solutions to meet objectives and respond to relevant conditions. Although assessment tools and methods may differ, nature-based solutions should not be subjected to higher standards than conventional solutions.

Continually improve

Ideas, needs, and conditions are constantly changing. As with conventional options, understanding nature-based solutions needs to evolve in response to new evidence and novel challenges. Some nature-based solutions have been proven in a wide range of conditions. Others are just emerging. Many disciplines and ways of knowing, including STEM fields, social sciences, economics, Indigenous and local knowledge, have value to add to the evolution of nature-based solutions. Every solution (conventional, nature-based, or hybrid) should be monitored to assess performance, inform adaptive management, and promote transparency.

Recommendations to Accelerate Nature-Based Solutions for Climate Progress, Thriving Nature, Equity, and Prosperity

Federal agencies and partners have experience applying nature-based solutions, providing a foundation for scaling up their use.[26] This report provides five recommendations for federal agencies to raise awareness of nature-based solutions and strategically accelerate their deployment at the necessary scale and pace. Given the urgency of the triple crises of climate change, nature loss and inequity, the Biden-Harris Administration is also highlighting priming actions – new and recent announcements that use federal authorities to amplify agency leadership and pave the way for rapid adoption of these recommendations. These priming actions are indicated throughout the report in the brown boxes. The National Climate Task Force should respond to the President's call for ambition by setting goals for increased adoption of nature-based solutions and identifying a mechanism to motivate and coordinate development of agency action plans following the recommendations laid out in this report.

Recommendation 1. Update Policies

Federal planning, decision-making, cost-sharing, risk management processes, and benefit-cost analyses should be revised to better facilitate nature-based solutions.

Facilitate and accelerate federal permitting and reviews

The use of nature-based solutions may involve multiple legal processes, from environmental impact reviews and consultations on impacts to species or habitat, to permitting procedures that span across levels of government.[27] Federal agencies should help expedite these processes by advancing action to:

Use general permits for nature-based solutions: The U.S. Army Corp's (USACE) nationwide permits for living shorelines[28] and aquatic habitat management[29] are examples of general permits that can ensure efficient reviews of nature-based solutions. Increased use of these or similar approaches can accelerate project implementation in cases that expect minimal environmental impacts and can benefit local communities. As practical applications of nature-based solutions evolve and mature, agencies can develop new general permits using updated knowledge.

Developing programmatic environmental reviews: Some agencies have developed programmatic reviews that allow for accelerated processes for implementing nature-based solutions**.** Examples include the Federal Highway Administration programmatic agreements and Eco-Logical approach to decision making which coordinate review of numerous species and wetlands impacts associated with large road construction projects,[30] and the National Marine Fisheries Service's programmatic environmental review of coastal habitat restoration activities.[31] As agencies work to scale up and coordinate use of nature-based solutions in specific regions (e.g., a watershed) to address large-scale problems (e.g., regional flooding, or water quality problems) they can develop additional programmatic approaches to accelerate permitting.

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Prioritize permitting for nature-based solutions: Within authorities, federal agencies and interagency permitting teams should aim to accelerate the permitting process for projects that use nature-based solutions. Decreasing the time required to complete environmental reviews and permitting could incentivize their deployment. The Fixing America's Surface Transportation Act, Title 41 (FAST 41)[32] process, created by statute and implemented by the Federal Permitting Improvement Steering Council, already considers large-scale nature-based solutions that meet its criteria. This mechanism should be used to its fullest extent, and new means of prioritizing nature-based solution project permitting can be created within existing authorities.

Build interagency permitting and review teams with expertise in nature-based solutions: Multi-agency permitting or review teams can help advance nature-based solution projects. Federal agencies should create such teams and ensure they include relevant expertise. For example, the San Francisco Bay Restoration Regulatory Integration Team includes staff from the six state and federal regulatory agencies with jurisdiction over habitat restoration projects, and has improved permitting within the region.[33] Increasing expertise in nature-based solutions for the agencies participating in the Unified Federal Review process could facilitate review and permitting of nature-based solutions in disaster recovery actions. In addition, floodplain interagency coordination could be consolidated under one working group. This group could partner with states, Tribal nations and local governments to accelerate permitting of large projects and support implementation of Executive Order 13690's requirement for agencies to consider nature-based solution alternatives in flood management.

Reduce discretionary cost-share and match requirements for nature-based solutions, especially in underserved communities

Recognizing the challenge that cost-sharing can create for underserved communities, the Bipartisan Infrastructure Law and Inflation Reduction Act provided greater flexibility to revise discretionary non-federal cost-share requirements for some nature-based solutions. This will ease access to up to $8.5 billion in funds to the U.S. Department of Agriculture (USDA), the Department of the Interior (DOI), the Department of Transportation (DOT), and the Department of Housing and Urban Development (HUD). Qualifying programs will support forest and other ecosystem restoration, fuel reduction, urban tree planting, water source protection, and more. In addition, the USDA's Forest Service issued Match and Substantial Contribution Policy Changes[34] in July 2022, broadening the values that can be considered in meeting match requirements, removing non-statutory match requirements, and initiating a review of other requirements for forest related nature-based solutions. Other agencies should re-evaluate discretionary cost-share requirements for nature-based solution funding, especially for historically underserved communities.

Strengthen the use of nature-based solutions in hazard mitigation decisions

As climate-driven risks grow, nature-based solutions can bolster and sometimes replace conventional infrastructure systems used to reduce and mitigate hazards (Box 2). For example, elevating homes can reduce flood risks to those structures, while restoring or protecting wetlands and floodplains can reduce flooding of homes, roads, schools, and other nearby assets all at once. Agencies that develop standards (e.g., flood risk standards), guidance, and risk management tools (e.g., National Institute of Standards and Technology (NIST) Community resilience tools[35]) should further integrate nature-based solutions into their risk management resources and protocols, particularly in pre-disaster mitigation programs.

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Consider nature-based solution alternatives

Federal decisions often rely on analyses of different options for a policy or a program (often called an alternatives analysis). For example, these types of analyses are required under the National Environmental Policy Act. Likewise, under Executive Order 12866, regulatory actions that are deemed economically significant require analysis of regulatory alternatives. Agencies should consider whether nature-based solutions, alone or combined with other options, would make appropriate alternatives to particular actions. A prime opportunity is presented through the Federal Flood Risk Management Standard in Executive Order 13690, which directs agencies to consider nature-based solutions when developing alternatives to actions in floodplains. Agencies can also develop materials to facilitate consideration of nature-based alternatives under these and other regulatory, program or funding reviews.

Box 2. Living Breakwaters.

The Staten Island community of Tottenville was once protected by oyster reefs that reduced flood risk and supported a robust oyster farming industry. Siltation, overharvesting, channel dredging, and human pathogens drove the reefs' collapse. To build coastal resilience and revive the oyster reefs, the community used $60 million in HUD Community Development Block Grant – Disaster Recovery funding to construct 2,400 feet of living breakwaters. Partners developed a curriculum for students in 6-8th grade science classes, and the project is serving as a model for community engagement and climate-adaptive green infrastructure. Other kinds of living shorelines (like the marsh below) protect other coasts. Photo credit: NOAA

Update guidance and policies related to benefit-cost analysis

Benefit-cost analysis (BCA) underlies a wide range of federal policy decisions, including regulatory developments and discretionary funding decisions. The Office of Management and Budget's (OMB) circular A-4 provides guidance on benefit-cost methods for all approaches, including nature-based solutions. Even with this guidance, agencies can fail to properly account for the cost savings and other benefits that nature-based solutions create. Agencies should fully follow existing guidance and conduct analyses that will not bias the results to one option or another. Strong analyses pay careful attention to setting an appropriate baseline for comparison, set a timeline for evaluating the project that will capture any lags in accrual of benefits or costs as well as lifetime benefits of nature-based solutions, and, where possible, monetizing benefits. OMB is updating its BCA guidance to reflect method and data advances that will help facilitate full accounting of benefits and costs (see below). Agencies should review their procedures in response to the forthcoming guidance.

Agency and public comments also identified questions and concerns about how best to discount costs and benefits when considering nature-based solutions.[36] Higher discount rates assign less value to future benefits and costs, relative to upfront costs and near-term benefits. As a result, a higher discount rate may reduce the likelihood that solutions that provide greater benefits over time, like some nature-based solutions, will be chosen. Updated guidance may help clarify how

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agencies can compare the benefits and costs of nature-based solutions and alternatives over appropriate time horizons (see below). The Federal Emergency Management Agency (FEMA) is piloting a lower discount rate. To ensure hazard mitigation funding reaches more communities, FEMA announced a lower discount rate (3% instead of 7%) for two of its major financial assistance programs for FY2022.[37] FEMA anticipates that this will increase support of projects accounting for future benefits, such as nature-based solutions.

As federal agencies develop action plans on nature-based solutions, they should review and update, as appropriate, agency-specific policies, guidance and procedures to ensure that nature-based solutions are being substantively considered and incorporated.

Revise Central Guidance on Benefit-Cost Analyses

Federal agencies are required to analyze the costs and benefits of any rule that is significant under Executive Order 12866. President Biden's Day One Presidential Memorandum on Modernizing Regulatory Review called for revisions to the OMB's Circular A-4, which provides agencies guidance on conducting such analysis. The Memorandum specifically identifies the need to improve guidance that advances environmental stewardship. Updates associated with this circular will provide guidance on accounting for benefits and cost reductions resulting from nature-based solutions. Federal agencies also conduct or require a benefit-cost or cost effectiveness analysis for projects and programs, including to inform competitive funding decisions. OMB's Circular A-94 provides guidance on these uses and investments in nature-based solutions. OMB has initiated a review of Circular A-94 to determine whether revisions or clearer guidance is necessary. Revisions could be beneficial because this circular sets the discount rate used to value benefits accruing to nature-based solutions projects.

Recommendation 2. Unlock Funding

Prioritize nature-based solutions in funding decisions for domestic and international projects; increase and ease access to this funding; and catalyze private investment.

Integrate nature-based solutions into existing domestic and international funding programs

Federal funding for domestic and international projects can provide a strong lever to increase the use of nature-based solutions (Box 3). Within their authorities, federal agencies should do more to integrate nature-based solutions into funding programs where they are not yet explicitly considered, and move towards encouraging and prioritizing them. All agencies should review financial assistance programs and remove or revise language that unnecessarily restricts consideration of nature-based solutions. In addition, federal agencies should:

Incentivize nature-based solutions for climate resilience: The White House recently moved to encourage the support of nature-based solutions with infrastructure funds (see below). Federal agencies can follow the recent best-practice guidance for infrastructure projects and apply similar best practices to other relevant programs like disaster response, pre-disaster planning, and community health.

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Encourage Nature-Based Solutions for Infrastructure Resilience

Executive Order 14052 "Implementation of the Infrastructure Investment and Jobs Act" directs agencies to prioritize resilience in infrastructure projects. In support of this goal, the White House is asking agencies to encourage nature-based solutions as an approach to enhance resilience.

Support states and communities in expanding the use of nature-based solutions in formula funding: Much of the domestic funding that could support nature-based solutions is distributed by formula or block grants rather than through competitive grants, thus state and Territorial governments set the priorities for spending. Federal agencies should collaborate with partners to ensure nature-based solutions receive due consideration in their application processes, and identify other means to enable and incentivize them. Opportunities to advance the use of federal formula funds for nature-based solutions include the Environmental Protection Agency's (EPA) State Revolving Fund Programs (SRF), DOT's Federal Formula Grants for Rural Areas, AmeriCorps State and National Grant Program, and HUD's Community Development Block Grants.

Box 3. Current Federal Funding for Nature-Based Solutions.

Several departments and agencies have been promoting nature-based solutions through environmental management for many years. These programs have evolved to support climate adaptation and mitigation through nature-based solutions (e.g., National Oceanic and Atmospheric Administration (NOAA) funding for living shorelines,[38] EPAs Section 319 Nonpoint Source Reduction Program,[39] DOI and USDA programs to reduce wildfire risk[40]). Agencies with development assistance programs, such as the U.S. Agency for International Development's (USAID) sustainable landscapes, reduced emissions from deforestation and degradation, and alternative livelihoods programs, also support nature-based solutions. However, more opportunities to fully leverage nature-based solutions through these and other federal programs exist.

A growing number of infrastructure-focused departments and agencies (e.g., USACE, DOT, and HUD), economic development agencies (e.g., the Economic Development Administration (EDA), Small Business Administration (SBA)), and disaster management agencies (e.g., FEMA) are also integrating nature-based solutions into their programs. FEMA's Building Resilient Communities and Infrastructure program not only allows nature-based solutions but prioritizes them with preference points. USACE began using dredged material for habitat creation and salt marsh restoration decades ago,[41] and in 2020, Congress enacted a national policy for USACE to maximize beneficial use of dredged material.[42] A new funding program through the Bipartisan Infrastructure Law, the PROTECT program, provides $8.7 billion in funding to DOT, for the first time dedicated to resilience of transportation infrastructure, including the use of nature-based solutions.[43] The Inflation Reduction Act will provide at least $1.2 billion in financial assistance to underserved communities through the Neighborhood Access and Equity Grant Program for reduced pollution, heat island effects, and flood damage, and safer and longer lasting roads, all of which can integrate (but do not require) the use of nature-based solutions. The EDA recently included nature-based solutions in its investment priorities for

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Environmentally Sustainable Development.[44] These more recent efforts are the nascent stage of expansion of nature-based solution funding towards the scale of investment that is needed to confront the climate crisis and secure communities and infrastructure.

Support nature-based solutions through international development assistance: Some of the greatest opportunities for nature-based solutions to mitigate climate change and improve resilience to climate risks are in developing countries. Major gaps existing in global funding for humanitarian assistance ($32 billion in 2022)[45] and development assistance ($2.5 trillion annually).[46] Investments in nature-based solutions can help close these gaps efficiently, as they often offer multiple benefits from a single investment. USAID has recognized this possibility by making nature-based solutions one of five foundational pillars for its Climate Strategy 2022-2030.[47] Yet more can be done.

Agencies fostering international development (e.g., the Department of State, USAID, the Department of the Treasury (Treasury), and the Millennium Challenge Corporation) should expand support for nature-based solutions in their core programs (e.g., health, agriculture, nutrition, infrastructure; Box 4). Treasury should work with multilateral development banks and funds to set ambitious goals for nature-based solutions (e.g., establishing funding targets or percentage allocations within mainstream lending) and chart progress towards major integration of nature-based solutions into their core development and infrastructure programming. Treasury could also assess the potential to add poverty-reducing climate resilience to traditional conservation goals in future debt restructuring (e.g. debt for nature swaps). [48]

Box 4. Nature-based Solutions Embedded in Infrastructure and Development Lending.

The InterAmerican Development Bank supports multiple green-grey infrastructure projects that allocate a portion of funds to nature-based solutions. These include a road improvement loan to the Bahamas that incorporates mangrove restoration for road protection, a hydropower plant renovation in Honduras that includes upstream forest restoration to reduce sediment mobilization and delivery, and a community housing development project in Paraguay that embeds nature-based solutions in neighborhoods and adjacent rivers to help manage stormwater and reduce flood risks. Photo credit: IDB

Make access to federal funding for nature-based solutions a one-stop shop

While communities may be interested in the multiple benefits that nature-based solutions provide, current federal funding is often more narrowly focused on specific approaches or outcomes that are being targeted via the funding opportunity. Each funding opportunity is offered by a different agency, with its own mandates, constraints, application processes, and reporting requirements. Under-resourced communities can find it particularly challenging to navigate multiple processes, so achieving equity goals (e.g., Justice40 goals[49]) is especially challenging. Agencies should make it easier to identify and apply for funds to support nature-based solutions by:

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Creating coordinated or common applications: While agencies have varying mandates and statutory requirements, they retain some flexibility. Agencies can work together to help communities identify the best funding sources to meet their needs, and simplify access to those funds. For example, outreach, technical assistance, and application requirements and processes can all be coordinated, where possible. There may also be opportunities to create common application materials that ease the application process. Major opportunities exist for coordination on funds under the American Rescue Plan Act, Bipartisan Infrastructure Law and Inflation Reduction Act, among others. Nature-based solutions funds can also be coordinated around a challenge or geography (e.g., using existing mechanisms like EPA's Geographic and National Estuary Programs). The White House is leading one effort (see below), and agencies should take the initiative to identify and advance other opportunities.

Coordinate Access to Funds that Reduce Floods and Benefit Wildlife

The White House is advancing an effort to simplify access to new Bipartisan Infrastructure Law funds that have a similar purpose - using ecosystem-based approaches to support improvement of fish passage. These funds aim to reduce the risk of flooding, improve habitat connectivity for fish and wildlife, and improve public safety. The U.S. Fish and Wildlife Service, DOT, USDA, and NOAA are coordinating to facilitate access to these opportunities and ensure efficient use of federal funds.

Changing the funding entry point for historically under-represented communities: Instead of expecting communities to navigate multiple funding processes, federal agencies should create multi-agency panels or liaisons that engage with communities, listen, provide technical support, and identify opportunities that fit community needs. For example, EPA and USDA are coordinating to leverage technical assistance resources through their Closing the Wastewater Access Gap Communities Initiative[50] to support communities with chronic lack of access to sanitation services. Federal agencies can drive more community-oriented models to facilitate access to nature-based solutions funds, which in turn can directly support environmental justice objectives.

Coordinating funding to increase scale and benefits: Agencies can coordinate existing programs to incentivize larger scale efforts that can maximize climate resilience and other benefits and provide them where they are needed most. For example, USDA has aligned its voluntary incentive programs around common objectives through its Regional Conservation Partnership Program. Coordinating these and other incentive programs could maximize the scale and impact of nature-based solutions. As another example, USAID could increase and coordinate support for a number of their programs, including Ending Pandemic Threats, PREDICT, Feed the Future, Natural Climate Solutions, Sustainable Landscapes, and Biodiversity programs to increase food security, mitigate climate impacts, and improve adaptation for the communities most vulnerable to climate and natural hazard risks.

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Catalyze private investment in nature-based solutions

Global private sector financing remains small relative to public spending, totaling just 11% of all G20 spending on nature-based solutions, which has reached $14 billion/year.[51] More should be done within authorities to identify and advance federal programs to encourage private investment for nature-based solutions by:

Matching federal funds with private sector investment: Where match requirements remain, federal agencies can help attract non-federal funds to fill match requirements. Several examples of this model exist (Box 5), including the current America the Beautiful Challenge. This fund, administered by the National Fish and Wildlife Foundation, coordinates federal dollars from multiple programs and aims to raise $1 billion in total funding through a 1:1 match of non-federal to federal support. AmeriCorps grants that support restoring parks and public lands, reforestation, and protecting biodiversity, also leverage private and philanthropic dollars to increase community impact. Federal agencies could also explore approaches for allowing credits from private carbon offsets or other offset markets to be used to fund nature-based solution projects.

Box 5. EDA's Economic Integrator Catalyzes Interagency Investments in San Diego.

Maple Canyon is a unique green space that buffers business with nature inside San Diego's sprawling, urban core. When flooding hit the canyon in 2017, the city's commercial enterprises, transportation networks, and natural habitats were impacted. A $6 million EDA grant to the city was matched with $6 million in local investment to support innovative watershed improvements to reduce runoff, recover the city's stormwater infrastructure, mitigate flooding, and enhance outdoor recreation and economic development opportunities. Thanks to the cooperation of federal, state, and local agencies and private sector partners, the restoration project saved nearly 2,000 jobs in the Maple Canyon area. Photo Credit: EDA

Fueling innovation and business growth: The universe of nature-based solutions is expanding rapidly, creating opportunities for federal agencies to promote innovation. Prioritizing and expanding the focus on nature-based solutions in programs that foster innovative business opportunities (e.g., the National Science Foundation's (NSF) Regional Innovation Program, USDA's Conservation Innovation Grants) will speed development of nature-based businesses and build the private workforce. Improvements in monitoring and verification of the benefits of nature-based solutions would also help unlock private sector potential.

Advance and adopt innovative finance models: Private sector insurance can reduce investment risk for public financing of nature-based solutions (e.g., Mexico and Canada have insured a coral reef and wetlands in private insurance markets, as part of flood risk reduction efforts). However, such insurance models are not yet widely used by federal agencies.[52] Federal agencies and programs, including the National Flood Insurance Program, might also be able to use insurance

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to incentivize private sector investment in nature-based solutions. For example, USDA's Risk Management Agency (RMA) offered lower premiums on federal crop insurance to farmers who planted cover crops as part of the Pandemic Cover Crop Program.[53] RMA has committed to continue this type of program should additional resources become available,[54] and could assess other options to encourage investments in nature-based solutions.[55] Treasury, the White House, and other federal entities could explore novel insurance offerings to incentivize nature-based solutions and specify the role for public finance in such products.

Green banks are emerging as mechanisms that can leverage public and private financing to drive nature-based solutions. The Rhode Island Infrastructure Bank demonstrates this potential by financing reforestation with the USDA's Forest Service to reduce local temperatures and energy use in Cumberland, Rhode Island.[56] Through the Inflation Reduction Act's Greenhouse Gas Reduction Fund program, EPA will provide grants to nonprofit financial institutions that will invest in emissions reduction projects that could include nature-based solutions such as forest management to reduce wildfire risk and salt marsh restoration to reduce methane.

Over the next few years, the most innovative financing for nature-based solutions will involve blended finance and include direct subsidies or indirect subsidies through financing conditions. One emerging example is the USACE Corps Water Infrastructure Financing Program, as authorized by the Water Infrastructure Finance and Innovation Act, which offers low-interest rate loans. It focuses on local investments in infrastructure projects that address community water resource needs, promote economic prosperity and improve environmental quality.[57] If the program becomes fully implemented as authorized, it will provide an attractive and important financing model for large-scale nature-based solutions serving water management needs.

To further support the alignment of public and private funds, an interagency task force could be established to identify clear criteria for classifying U.S. subsidies as nature-positive and welfare- or credit-enhancing, and provide criteria to identify when subsidies crowd out rather than crowd in private financing for nature.[58] A public report on task force findings would help guide federal and state decisions in financing nature-based solutions.

Recommendation 3. Lead with Federal Facilities and Assets

Expand use of nature-based solutions in the design, retrofitting, and management of federal facilities and in management of federal natural assets.

Promote nature-based solutions in design, retrofitting and management of federal facilities

The federal government owns and manages over 300,000 buildings in the United States, and many more embassies and facilities around the world. Embedding nature-based features, such as green roofs, can increase facilities' lifespans and lower operating costs. Building with nature-based solutions can also reduce flooding and stormwater runoff, stabilize shorelines, improve pollination for nearby crops, reduce local heat island effects, and increase worker productivity. Around public healthcare facilities, viewing nature through windows or spending time in parks can improve or shorten recovery.[59] As agencies design, update, and manage federal facilities, they should take actions to:

Elevate nature-based solutions in building standards: The design of federal public facilities is governed by the P100 Facilities Standard[60] (public buildings). This standard includes some

guidance on using nature-based solutions. For solutions with a strong evidence base of effectiveness, more can be done to expand guidance and require use through revisions to standards and planning tools. Training for federal facility program managers, planners, engineers, and contractors should include content on nature-based solutions to ensure they are considered and well-implemented when used.

Embed nature-based solutions in facility management: The way facilities are managed affects how much they contribute to climate change and the amount of damage they will incur from climate impacts. Some nature-based solutions can reduce facility maintenance needs, by reducing flood risks, for example. Others can reduce greenhouse gas emissions by moderating temperatures and reducing the need for energy to run air conditioners or heaters. Federal agencies and maintenance partners can make sure that nature-based solutions are considered and used where they can add value. The White House is initiating two efforts to assist federal agencies in identifying these kinds of opportunities (see below).

Strengthen Agency Climate Adaptation and Action Plans with Nature-Based Solutions

As directed by President Biden's January 28, 2021, Executive Order 14008, more than 20 federal agencies have developed adaptation and resilience plans to address their most significant climate risks and vulnerabilities and are now implementing them. The White House will release guidance for updating these plans in Winter 2022. In updating the guidance, the White House will consider additional ways to incorporate nature-based solutions in climate adaptation and action plans and report on how these solutions have been used to enhance resilience and support climate mitigation for federal facilities, lands, and through federal programs.

Embed Nature-Based Solutions in Federal Sustainability Policy and Operations

In coordination with relevant federal agencies, the White House will explore integrating nature-based solutions into policy and operations as part of a suite of efficiency and sustainability solutions to help agencies make progress towards the goals of Executive Order 14057, Catalyzing Clean Energy Industries and Jobs through Federal Sustainability. In particular, in 2023, the White House will investigate adding nature-based solutions to future updates of the Guiding Principles for Sustainable Federal Buildings.

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Embed nature-based solutions in management of federal lands and waters

Federal agencies manage approximately 650 million acres of public land, from national parks to beaches and working forests. Intentionally managing these natural resources to embed nature-based solutions can increase the return on taxpayer dollars[61] (Box 6). Nature-based solutions on Department of Defense (DOD) lands can reduce training interruptions from intense heat, aid military readiness,[62] and reduce risks to surrounding communities from climate hazards. For example, DOD lands can use nature-based solutions to enhance water storage, moderate drought risk, and reduce flood risks from storms and sea level rise. As agencies plan their management of these major resources, they should take the following actions to advance nature-based solutions:

Box 6. Central Sierra Recovery and Restoration Project.

The southern Sierra Nevada in California is famous for iconic places like Yosemite Valley and giant sequoia groves. The region has lost tens of millions of trees to wildfire in recent years. The USDA Joint Chiefs' Landscape Restoration Partnership invested in fuels reduction, hazardous tree removal, and prescribed fire treatments across 3,100 acres, creating defensible space for fire fighters to protect communities during wildfires. Working in partnership, and at this scale, helps reduce wildfire threats, protect water quality and supply, and improve and protect wildlife habitat for at-risk species. Reduced fire hazards also help sustain the local tourism industry. Photo credit: Joint Chief's Landscape Restoration Partnership

Manage federal lands and waters to maximize climate outcomes and other benefits: Agencies manage their lands, waters, and other natural assets for multiple purposes (e.g., sustained natural resource use of timber, minerals, pasture, or other resources; recreation; water supply; education; health care; military readiness; Box 6). In many cases, they can serve these missions and provide additional benefits, including climate resilience, carbon sequestration, and justice.[63] For example, DOI's National Wildlife Refuge System has used public-private partnerships to support refuge management for wildlife and climate mitigation benefits. In another examples, several Executive Orders, Presidential Proclamations,[64] and the USDA and DOI Joint Secretarial Order[65] direct co-stewardship with Tribal Nations of federal lands. Expanding the use of co-management and co-stewardship agreements allows for consideration of Indigenous Knowledge, expanded leadership and economic opportunity for tribes, and greater community connection, which can increase use of nature-based solutions and make lands and waters more resilient. Whether agencies are managing lands for public use, defense, or other purposes, they can consider how their agency guidance, rules, land and natural resource plans, and designations[66] can use these tools to integrate nature-based solutions and better deliver the full suite of benefits their natural assets can provide.

Reclaim legacy mine and well sites using nature-based solutions: The Inflation Reduction Act includes significant funding to close and reclaim abandoned coal mines, oil and gas wells, and pipelines. These funds create a major opportunity to identify and address leakage of methane, a

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powerful greenhouse gas. Agencies using these funds should increase climate benefits even further by reclaiming these sites with nature-based solutions that sequester carbon and provide other benefits – such as native grasslands and forests. Prioritizing these funds for projects near historically underserved communities would also advance the Biden-Harris Administration's commitment to social and environmental justice and provide opportunities for economic redevelopment.

Recommendation 4. Train the Workforce

Improve resources and training for nature-based solutions to support the creation of good jobs in federal agencies and the private sector.

Share knowledge and capacity across federal agencies

Experience with nature-based solutions is stronger in some federal agencies[67] (Box 7) and nascent in others. Sharing knowledge and building new skills could yield rapid advances in adoption of new policies and guidance on nature-based solutions.

To address one critical gap, OMB and the Office of Science and Technology Policy are establishing a federal technical working group to share ideas and expertise on how to account for frequently unmonetized benefits and costs, including those relevant to nature-based solutions (see below).

Box 7. Examples of Online Federal Resources.

EPA web portal on green infrastructure: This web portal has information on building (planning, designing, funding, operations), learning (performance, policy, regulations, BCA), and partners for developing green stormwater infrastructure.

USDA web portal on conservation and agriculture: This web portal has information and access to funding for ways to manage soils, water, plants, animals, energy and air to boost agricultural yields and benefit nature.

NOAA web portal on coastal natural infrastructure: This web portal has information on understanding, communicating, analyzing, prioritizing, and exploring nature-based solutions for coastal hazards and risk reduction.

USACE web portal on engineering with nature: This web portal provides a variety of resources, and information on pilots, podcasts, and research related to integrating engineering and natural systems for sustainable water resource infrastructure.

In addition, many other skill advances are needed, especially for nature-based solution design and permitting. For example, federal staff or applicants may not be aware of whether or how nature-based solutions could meet particular legal requirements, such as how a nature-based solution could help meet water quality standards. Where the effectiveness of nature-based solutions is well understood, agencies can develop clarifying memoranda, permitting case studies, educational materials, and trainings to help staff and applicants match nature-based solutions with particular permitting requirements. For example, EPA has developed materials on how green infrastructure can comply with legal standards, including Clean Water Act pollutant

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Launch Technical Working Group on Frontiers of Benefit-Cost Analysis

The White House will launch a new technical working group on Frontiers of Benefit-Cost Analysis to provide a forum where federal agency staff can collaborate, share lessons, and align methods with the central federal guidance on needed advances in BCA, including for nature-based solutions. This group will provide a venue for executive branch staff to advance this critical aspect of evaluating nature-based solutions.

discharge and stormwater obligations.[68] Other agencies should consider adopting similar models, and sharing them with others. Encouraging federal staff to volunteer during work hours on nature-based solutions projects can also provide exposure to a broad range of skills.

Expand and diversify federal technical assistance, training, resources, and tools

Federal technical assistance and workforce development programs can do more to incorporate nature-based solutions by taking actions to:

Build tools for benefit-cost analysis of nature-based solutions: Accounting for nature-based solutions is unfamiliar to some federal agencies, non-federal partners who apply to federal programs, and the private sector workforce. Agencies can help overcome this challenge by embedding nature-based solutions in user-friendly tools for benefit-cost analysis. For example, FEMA has included relevant nature-based solutions in its benefit-cost tool to allow more flexibility in analyzing these options for their programs.[69] Agencies can make rapid progress by updating or producing similar user-friendly tools oriented to their specific applications. Agencies can also provide technical resources and training opportunities for federal partners and those applying for funding for nature-based solutions.

Fill gaps in training and resource offerings: Common engineering and design standards are needed for a number of nature-based solutions. Additional technical resources are also needed to inform the use of nature-based solutions to mitigate climate change, create jobs, improve health, and increase resilience to wildfire, heat, floods, and other hazards. (Fig. 2). Agencies should identify opportunities to build nature-based solutions into a wider range of existing technical training programs, tools, and resources, and develop new ones to meet emerging needs. For example, the White House is advancing a decision-support tool for flood risk management that will note the potential for nature-based solutions to reduce flood risk (see below). Advancing current or building new technical trainings on nature-based solutions into existing federal programs[70] and portals (e.g., Climate Mapping for Resilience and Adaptation[71], the anticipated conservation.gov) and leveraging partnerships with non-federal organizations can help raise awareness about nature-based solutions and encourage their use. Existing partnerships (e.g., USACE's partnership with University of Georgia on the Network for Engineering With Nature[72]) can also help to build technical and non-technical resources. Gaps in training include those for legal staff accounting and budgeting staff, and construction and maintenance roles.

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Decision Support Tool for Nature-Based Solutions to Reduce Floods

In support of the Federal Flood Risk Management Standard (FFRMS), the White House is working across the Administration to deliver a decision support tool in 2023. The tool will provide necessary information and resources to help agencies and partners successfully implement the FFRMS for actions affecting floodplains, including project siting, design, construction, and repair or rehabilitation. The tool will explicitly support the evidence-based design of nature-based solutions in these contexts.

Build skills through workforce development programs: There is a growing need for an American workforce to deploy nature-based solutions. Along the U.S. Gulf Coast, Deepwater Horizon oil spill settlement funds are being used by NOAA's GulfCorps program to train youth and build the restoration workforce needed to expand natural infrastructure. And across the federal government – at USDA, NOAA, DOI, AmeriCorps, and the Department of Labor (DOL) – nearly 20,000 young people are put to work every year in youth corps programs training the next generation of conservation and climate resilience workers. However, skill sets like engineering, construction and maintenance for emerging types of nature-based solutions still lag. To meet demand, agencies can review existing workforce development programs, add nature-based solutions content, and expand and diversify youth corps programs. Prime opportunities lie within AmeriCorps, DOI, USDA, NOAA, and DOL's youth corps programs, Tribal Conservation Corps, Volunteers.gov, Job Corps, Registered Apprenticeships, pre-apprenticeships, DoD SkillBridge, DOI Maintenance Action Teams, and workforce efforts launched in the National Nutrition Strategy. Agencies can also expand or develop new partnerships with professional associations, standard setting organizations, and universities to expand training capacity and content.

Create and improve best-practice guidance: Several federal agencies have developed robust best-practices guidance to support the use of a subset of nature-based solutions.[73] For example, USACE, NOAA, NIST and partners created international guidelines for the use of nature-based solutions in flood risk reduction.[74] Agencies can review existing best-practice guidance for opportunities to include nature-based solutions, and they can produce new guidance where gaps exist.

Support certifications: Good nature-based solution jobs with strong salaries could be aided by certifications, including pre-apprenticeship and registered apprenticeship curriculums. [75] Federal agencies and partners could evaluate which existing certifications already support nature-based solutions. These certifications could be equitably supported across the workforce, then required in federal contracts. Agencies and partners could also identify gaps in skills not yet certified, and develop new certifications accordingly. Expanded or new certification programs would give employers (e.g., engineering, construction, or landscaping firms; federal agencies) confidence that they have selected qualified contractors.

Embed nature-based solutions in science, technology, engineering, art, and math (STEAM) curriculums and other education programs: A major untapped opportunity to advance

knowledge and strengthen the workforce for nature-based solutions lies along the entire education continuum, from K-12 education, technical institutes, universities, continuing education programs, professional societies, and certifiers. The strategic, technical, financial, and managerial skills needed to sustain nature-based solutions should be embedded at all education levels and throughout all disciplines. A number of agencies (e.g., Department of Education, NOAA, EPA, the U.S. Geological Survey, and USDA[76]) provide educational curriculum, lesson plans, and activities for K-12 education. These can more fully embed nature-based solutions content and learning experiences, where relevant.

Training a strong workforce is a critical step on the road to full adoption of nature-based solutions. Through nature-based solution action plans, federal agencies should review tools, resources, technical assistance, education curriculum, and workforce development offerings. Agencies can identify opportunities to embed information and skill development for nature-based solutions in existing programs, coordinate to streamline access to these programs, and fill remaining gaps.

Recommendation 5. Prioritize Research, Innovation, Knowledge, and Adaptive Learning

Advance research and innovation in all sectors to fully reveal the scale of the opportunity that nature-based solutions provide, and incentivize continual learning about how and where nature-based solutions work best.

Close knowledge gaps for nature-based solutions

Agencies are often required by law[77] to consider evidence in their decision making, so gaps in evidence about nature-based solutions can create challenges for adoption. The White House recognizes the relevance of Indigenous Knowledge and other forms of knowledge in effectively designing nature-based solutions, and has prioritized research and development to fill gaps in evidence with all relevant forms of knowledge.[78] Federal agencies should encourage evidence-building for nature-based solutions[79] by acting to:

Increase evidence on the effectiveness and unintended consequences of nature-based solutions: Nature-based solutions are diverse, and create a wide range of outcomes. Evidence on effectiveness is uneven across nature-based solutions, and scattered across literature from many different disciplines. The U.S. Global Change Research Program (USGCRP) is synthesizing what is known about effectiveness across nature-based solutions and outcomes (see below). Agencies with research mandates (such as NSF, the Centers for Disease Control and Prevention, EPA, USDA, USGS) can fill gaps in available evidence, starting with known gaps related to how nature-based solutions affect mental and physical health and national security. More attention is also needed to identify and avoid unintended consequences that create or worsen inequities. For example, nature-based solutions can increase real estate values near newly-created greenspace, leading to higher rents, out-migration, and gentrification.[80] Understanding negative unintended consequences can help develop ways to avoid them.

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Where possible, research should evaluate multiple impacts and compare nature-based, hybrid, and conventional solutions. For example, continued assessment is needed on approaches to incentivize, validate, and monitor effects of nature-based solutions for climate mitigation and equity outcomes. Federal agencies should also use implementation and adaptive management of nature-based solutions for continual learning about effectiveness, and build these activities into Learning Agendas and Annual Evaluation Plans. Federal agencies can take advantage of opportunities to test large-scale applications of nature-based solutions, for example on military bases and other public lands and waters (e.g., through Sentinel Landscapes Partnership, Forest Inventory and Analysis) and major regional programs (e.g., those focused on Chesapeake Bay, Florida Everglades, Gulf Coast, Puget Sound). Another opportunity is through the Social Impact Partnerships to Pay for Results Act,[81] administered by Treasury, which could support testing and evaluating nature-based solutions.

Synthesize Effectiveness Evidence Across Nature-Based Solutions and Impacts

USGCRP has initiated a synthesis of what is known about the effectiveness of nature-based solutions. USGCRP will make an online evidence library accessible to the nature-based solutions community by 2023. USGCRP here announces that they will analyze this evidence base to determine current confidence in the effectiveness of diverse nature-based solutions for climate mitigation, adaptation, and other benefits, making this analysis available by 2024.

Increase appropriate engagement with Indigenous Knowledge holders: Many nature-based solutions have emerged through millennia of innovation by Tribal Nations and Native communities through engagement and experience with the environment. These solutions continue to be used and improved by them today. Agencies can create pathways for more voluntary engagement of Indigenous Knowledge holders in the development and management of nature-based solutions. Options include developing co-management agreements (e.g., Papahanaumokuakea Marine National Monument, Canyon de Chelly National Monument), self-governance compacts (e.g., for fire management), supporting training centers hosted by Native Americans who wish to share their knowledge with others, and creating liaison positions in federal agencies. The White House will release guidance on Indigenous Knowledge in Federal decisions in 2022. Agencies should update or create their own guidance to align with this forthcoming resource, which can support these critical activities.

Assess the scale of opportunity and need for nature-based solutions: Research efforts have already helped to identify the magnitude, type, and location of opportunities for natural-based solutions to mitigate climate change.[82] Similar assessments are needed to identify the magnitude of the opportunity for each type of nature-based solution to support climate adaptation and other social benefits, and to identify where they are most impactful. Federal agencies could conduct or fund research to identify which regions of the country would most benefit from nature-based solutions to reduce natural hazard and climate change risks for communities, which solutions would be most effective, and how much benefit each could provide. These assessments could then be used to help set goals and prioritize federal investments. As an example, DOI recently launched development of a nature-based solutions roadmap to identify priority strategies relevant to the agency's land management and stewardship responsibilities.

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Advance common measures and increase monitoring to track impacts: Some measures for monitoring and evaluating the benefits of nature-based solutions, like climate mitigation benefits (e.g., carbon dioxide equivalents sequestered each year), are well-established and commonly reported (e.g., through EPA's Greenhouse Gas Inventory[83]). Others, related to measuring resilience benefits (e.g., metrics for reduction in shoreline erosion and resulting change in property value), are still emerging.[84] To improve consistency and transparency, agencies should identify common metrics for understanding the benefits of nature-based solutions and consistently apply them. An opportunity exists to align some metrics through the emerging federal system of environmental-economic statistics.[85] Agencies should fully support this system and its associated natural capital accounts that will provide a critical tool for tracking the economic impacts of investments in nature-based solutions.

Box 8. Engaging Students in Innovation.

EPA's Campus RainWorks Challenge, a green infrastructure design competition, engages students at American colleges and universities by showcasing innovative stormwater management techniques and the benefits of green infrastructure. These stormwater management projects provide co-benefits like climate resilience, greenhouse gas sequestration, water conservation, reduction of heat island effects, and campus beautification. The competition has engaged over 800 multi-disciplinary teams from over 270 colleges and universities to foster collaboration and implement real design changes that improve community access to green space. Photo Credit: EPA

More effort is also needed to monitor these measures once they are agreed. Metrics and methods to quantify and verify carbon mitigation outcomes from the broad suite of nature-based solutions are still needed. For example, there is enthusiasm for agricultural management that enhances soil carbon for climate mitigation, but measuring changes in soil carbon and other changes in the agricultural carbon cycle with current methods can be costly and time consuming. Advances in methods and technologies are needed to support responsible adoption and management of some nature-based solutions.

Develop integrated models to assess nature-based solution alternatives: Quantitative models are often used to estimate how different alternatives for federal decisions will result in changes. Evaluation of nature-based solutions requires models that link changes in the environment to changes in aspects of the economy (e.g. crop prices, fish yields, property damages) or people's lives (e.g. health, time use, education). Most quantitative models do not fully represent these links, making it more difficult to assess nature-based solution alternatives. There is a need for more engineering models that can assess nature-based solutions. Health models can also be advanced in this regard. Federal agencies can develop or fund integrated models and advance development of methods for use in data-limited situations, such as benefit transfer functions. Federal agencies should provide guidance and tools for using such approaches appropriately for nature-based solution analyses. More federal staff with strong skills in these methods are needed.

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Create prizes, challenges, and awards to increase innovation

Prizes and challenges are an effective tool for driving research and innovation, and have been tapped for some nature-based solutions (Box 8).[86] Agencies and partners can leverage challenge and prize platforms (e.g., Challenge.gov) to create new nature-based solutions-oriented competitions. Areas where such approaches could add value include sustainable, climate-smart product development to support forest fuel reduction, or overcoming nursery and seed source supply chain gaps that could limit native coastal habitat and forest restoration. Benefits could arise quickly from tailoring and expanding previous agency efforts towards nature-based innovation, including HUD's National Disaster Resilience Competition.[87]

Federal agencies should include research, innovation and adaptive learning priorities in nature-based solution action plans. They can review evidence-building and learning agendas and embed nature-based solution topics where appropriate. Opportunities to fund others to close critical research and knowledge gaps for nature-based solutions should also be included.

The Road Ahead

The climate crisis, biodiversity loss, and associated environmental injustices demand an all-hands-on-deck effort. Nature-based solutions are a critical component of this work. Members of the public, Tribal nations, non-profit organizations, researchers, and state, local and federal agencies have helped us identify challenges that keep nature-based solutions from reaching their full potential. The roadmap presented here provides a path forward with five synergistic recommendations. Acting on one or two recommendations will not be enough. Investments will stagnate if funded communities lack the skills or workforce to act. Good jobs to build and support nature-based solutions will only last if a strong pipeline of projects is funded and permitted. Near-term progress can be made with today's knowledge. But new challenges will emerge, and continual learning will be needed for nature-based solutions to take us as far as we need to go.

As nations work to meet their commitments under the Paris Climate Agreement, the framework emerging through the Convention on Biological Diversity, and other national commitments, the need for aggressive action on nature-based solutions is clear. With this report, the Biden-Harris Administration charts an ambitious path for action. The federal government, and partners across the country and around the world all have a role to play. Following this path will help create a future where nature-based solutions are a first choice for combating climate change, addressing injustices, creating prosperous communities, and building resilient infrastructure. The National Climate Task Force is in a position to act boldly and lead adoption of these recommendations. Doing so will advance nature-based solutions as powerful tools that the nation — and the world — need now.

Appendix:
Definitions of Nature-Based Solutions

This report defines nature-based solutions as actions to protect, sustainably manage, or restore natural or modified ecosystems to address societal challenges, simultaneously providing benefits for people and the environment. This is a simplified version of the definition agreed to in international negotiations (Table A1, row 1). It is inclusive of the wide variety of nature-based solutions and similar terms used by the federal government, and embeds the critical dual goals of benefitting both nature and people.

Various definitions of nature-based solutions are used across several laws, regulations, and in multilateral agreements. This appendix provides a non-exhaustive compendium of definitions of nature-based solutions, green infrastructure, and other related terminology. It includes definitions that have been agreed to in intergovernmental processes, adopted in federal laws or regulations, or applied by federal agencies. The purpose of this compendium is to provide transparency on the use of these terms across federal agencies, and to the extent possible, encourage alignment toward a common definition, such as the one used in this report. A number of agencies that use nature-based solutions are not listed here, as they do not use specialized terms or definitions.

Table. A1: Terms and definitions related to nature-based solutions used or agreed to by the U.S. government.

Entity	Definition and Context
International Sources	
United Nations Environment Assembly Resolution, 5th session	"Nature-based solutions are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits"[88]
International Union for the Conservation of Nature and Natural Resources	Nature-based solutions are "Actions to protect, sustainably manage and restore natural or modified ecosystems which address societal challenges effectively and adaptively, while simultaneously providing human well-being and biodiversity benefits" [89]
Federal Laws	
Water Infrastructure Improvements for the Nation Act of 2016	"The term ''natural feature'' means a feature that is created through the action of physical, geological, biological, and chemical processes over time. The term ''nature-based feature'' means a feature that is created by human design, engineering, and construction to provide risk reduction in coastal areas by acting in concert with natural processes."[90]
Water Infrastructure Improvement Act of 2019	"The term 'green infrastructure' means the range of measures that use plant or soil systems, permeable pavement or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters." [91]
Infrastructure Investment and Jobs Act of 2021	"The term 'Natural infrastructure' means infrastructure that uses, restores, or emulates natural ecological processes and— (A) is created through the action of natural physical, geological, biological, and chemical processes over time; (B) is created by human design, engineering, and construction to emulate or act in concert with natural processes; or (C) involves the use of plants, soils, and other natural features, including through the creation, restoration, or

	preservation of vegetated areas using materials appropriate to the region to manage stormwater and runoff, to attenuate flooding and storm surges, and for other related purposes. "[92]
Agency Definitions	
Department of Homeland Security: Federal Emergency Management Agency (FEMA)	"Nature-based solutions are sustainable planning, design, environmental management, and engineering practices that weave natural features or processes into the built environment to promote adaptation and resilience" [93]
Department of Transportation: Federal Highway Administration (FHWA)	"[T]he term *nature-based solution* is inclusive of both natural and nature-based features. Natural features are created through the action of physical, geological, biological, and chemical processes over time; nature-based features are created by human design, engineering, and construction to provide risk reduction in coastal areas (WIIN Act 2016, Section 1184) ."[94]
Environmental Protection Agency (EPA)	EPA uses the term green infrastructure as defined in the Water Infrastructure Improvement Act of 2019, above. EPA also uses the term "low impact development," which "refers to systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic habitat"[95].
Department of Commerce: National Oceanic and Atmospheric Administration (NOAA)	"Natural infrastructure, also referred to as green infrastructure, use existing natural areas (and engineered solutions that mimic natural processes) to minimize flooding, erosion, and runoff. Additional benefits can include recreational opportunities, wildlife habitat, as well as cleaner water."[96] NOAA has also recognized low-impact development, conservation, restoration, and implementation of living shorelines as nature-based solutions.
Department of Defense: United States Army Corps of Engineers (USACE)	In a USACE sponsored paper, Natural and nature-based features (NNBF) refer to "the use of landscape features to produce flood-risk management benefits. NNBF projects may also produce other economic, environmental, and social benefits known as NNBF co-benefits. These landscape features may be natural (produced purely by natural processes) or nature based (produced by a combination of natural processes and human engineering) and include such features as beaches, dunes, wetlands, reefs, and islands."[97] Engineering with Nature, refers to "the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaboration."[98]
US Agency for International Development (USAID)	Nature-Based Solutions and Natural Climate Solutions: Actions to conserve, manage, and restore ecosystems (including managed systems such as agricultural lands) that address societal challenges effectively and adaptively are called nature-based solutions when broadly referring to goals like climate adaptation and mitigation or food and water security, and are called natural climate solutions when specifically referring to climate change mitigation.[99]

Abbreviations and Acronyms

BCA	Benefit Cost Analysis
BIL	Bipartisan Infrastructure Law
BLM	Bureau of Land Management
CEQ	Council on Environmental Quality
CPO	White House Office of Domestic Climate Policy
DOD	Department of Defense
DOI	U.S. Department of Interior
DOT	U.S. Department of Transportation
EDA	U.S. Economic Development Administration
EOP	Executive Offices of the President
EPA	U.S. Environmental Protection Agency
FAST 41	Fixing America's Surface Transportation Act, Title 41
DOL	Department of Labor
FEMA	Federal Emergency Management Agency
FFRMS	Federal Flood Risk Management Standard
FPISC	Federal Permitting Improvement Steering Council
GHG	Greenhouse Gases
GSA	General Services Administration
HHS	Health and Human Services
HUD	U.S. Department of Housing and Urban Development
IK	Indigenous Knowledge
IRA	Inflation Reduction Act
IUCN	International Union for the Conservation of Nature
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NOFO	Notice of Funding Opportunity
OMB	Office of Management and Budget
REPI	Readiness and Environmental Protection Integration
SBA	Small Business Administration
SRF	State Revolving Funds
UFC	Unified Facilities Criteria
USACE	U.S. Army Corps of Engineers
USAID	U.S. Agency for International Development
USDA	U.S. Department of Agriculture
USGCRP	U.S. Global Change Research Program
USFWS	U.S. Fish and Wildlife Services

[1] Federal agencies use various terms and recognize various definitions (see Appendix). Other terms include green infrastructure, natural and nature-based features, natural climate solutions, and natural infrastructure. For the purposes of this report, we use the term nature-based solutions as inclusive of all of these terms.
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[9] Carly Ziter et al. 2019. Scale-dependent interactions between tree canopy cover and impervious surfaces reduce daytime urban heat during summer. PNAS 116(15):7575-7580. doi.org/10.1073/pnas.1817561116
[10] Ronald McDonald et al. 2021. The tree cover and temperature disparity in US urbanized areas: Quantifying the association with income across 5.723 communities. PLOS ONE doi.org/10.1371/journal.pone.0249715
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[13] Carter S. Smith, Morgan E. Rudd, Rachel K. Gittman et al. 2022. Coming to Terms with Living Shorelines: A Scoping Review of Novel Restoration Strategies for Shoreline Protection. Frontiers in Marine Science 10, https://doi.org/10.3389/fmars.2020.00434
[14] EPA. 2017. Multi-Model Framework for Quantitative Sectoral Impacts Analysis: A Technical Report for the Fourth National Climate Assessment. U.S. Environmental Protection Agency, EPA 430-R-17-001; https://toolkit.climate.gov/topics/coastal-flood-risk
[15] Storlazzi, C.D., Reguero, B.G., Cumming, K.A., Cole, A.D., Shope, J.A., Gaido L., C., Viehman, T.S., Nickel, B.A., and Beck, M.W., 2021. "Rigorously valuing the coastal hazard risks reduction provided by potential coral reef restoration in Florida and Puerto Rico." U.S. Geological Survey Open-File Report 2021–1054, 35 p., doi: 10.3133/ofr20211054[16] The May 2022 G7 Climate, Energy and Environment Minister's Communique identify Nature-based Solutions (NbS) as "a critical lever for tackling the climate crisis, biodiversity loss, deforestation, desertification, and degradation of ocean and freshwater, and are essential for carbon sequestration and for climate change adaptation" 2022-05-27-1-climate-ministers-communique-data.pdf (bundesregierung.de)
[17] High Level Panel for A Sustainable Ocean Economy 2022. Transformations for a Sustainable Ocean Economy: A vision for Protection, Production and Prosperity. https://oceanpanel.org/wp-content/uploads/2022/06/transformations-sustainable-ocean-economy-eng.pdf
[18] An extensive set of Federal nature-based solutions examples is provided in a companion document: OSTP, CEQ, CPO. 2022. Nature-Based Solutions Resource Guide. Washington DC. https://www.whitehouse.gov/wp-content/uploads/2022/11/Nature-Based-Solutions-Resource-Guide-2022.pdf
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[26] An extensive set of Federal nature-based solutions examples is provided in a companion document: OSTP, CEQ, CPO. 2022. Nature-Based Solutions Resource Guide. Washington DC. https://www.whitehouse.gov/wp-content/uploads/2022/11/Nature-Based-Solutions-Resource-Guide-2022.pdf
[27] Nature-based solutions include actions that may need to go through environmental impact reviews, consultations under the Endangered Species Act or Magnuson-Stevens Fishery Conservation and Management Act, Tribal Consultations, or permitting processes from Federal, state, Tribal, or local governments.
[28] For example, Great lakes application of living shoreline nationwide Permit (1) Aids to Navigation (army.mil); Louisiana application of living shoreline national permit 2017_NWP_54.pdf (army.mil)
[29] USACE national permit for Aquatic Habitat Restoration, Enhancement and Establishment Activities. 2017. NWP27.pdf (army.mil)
[28]Federal Highway Administration | Environmental Review Toolkit | Eco-Logical | Environmental Initiatives (dot.gov); https://www.environment.fhwa.dot.gov/env_initiatives/programmatic_agreements.aspx
[31] National Marine Fisheries Service, https://www.fisheries.noaa.gov/resource/document/restoration-center-programmatic-environmental-impact-statement
[32] Title 41 of the Fixing America's Surface Transportation Act (FAST-41) | Permitting Dashboard (performance.gov)
[33] San Francisco Bay Restoration Regulatory Integration Team (BRRIT) | San Francisco Bay Restoration Authority (sfbayrestore.org)
[34] U.S. Forest Service, Match and Substantial Contribution Policy Changes
[35] National Institute of Standards and Technology Community resilience tools, Community resilience | NIST
[36] https://obamawhitehouse.archives.gov/sites/default/files/page/files/201701_cea_discounting_issue_brief.pdf; Economists generally recommend that public sector investments and regulations (such as those related to nature-based solutions) should be evaluated using a social discount rate, which reflects how society values benefits and costs into the future. The social discount rate is lower than the one often used as the default for Federal projects and policies.
[37]Federal Emergency Management Administration and Office of Management and Budget are trialing an alternative discount rate for FEMA's Building Resilient Infrastructure and Communities program and their Flood Mitigation Assistance Grants program during their FY 2022 offerings. https://www.fema.gov/grants/mitigation/fy2022-nofo
[38] The site says, ""Since 1998, NOAA has supported more than 200 living shoreline projects across the country with funding and technical assistance provided through programs like our Community-based Restoration Program." Living Shorelines Provide Nature-Based Approach to Coastal Protection | NOAA Fisheries
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