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Introduction

Thank you, Chairwoman Castor, Ranking Member Graves, and members of the select committee for holding this hearing. Natural infrastructure is a proven, life-saving, and fiscally responsible solution to sequester carbon and protect communities from the increasingly severe effects of the climate crisis in every state and territory.

Healthy rivers, forests, grasslands, wetlands, shrublands, and shorelines are each essential for resilient communities, carbon sequestration, thriving populations of fish and wildlife, and a vibrant outdoor economy. These natural systems also reduce the need for costly structural flood and storm damage reduction projects and improve the effectiveness and resilience of other critical infrastructure assets. As we confront climate change and anticipate increasingly more frequent and severe storms and weather events, it is essential that we consider all tools at our disposal, including the use of natural systems to help buffer and protect communities.

As we work to confront the immense threats that the changing climate poses to communities today, natural solutions are essential to protecting communities. Climate-fueled hurricanes, heatwaves, fires, floods, and storms are here and their impacts are very real. Last year alone, there were 20 climate-fueled disasters that have each caused at least $1 billion in damages and collectively resulted in $145 billion in damage and the tragic loss of 688 lives. Natural systems—ranging from healthy forests to coastal wetlands and dunes to healthy floodplains—can mean the difference between life and death, homes still standing or a community washed away, life carrying on or lives upended.

Natural solutions that sequester carbon should also be central to any plan to achieve net-zero emissions—and, through the right incentives and investments, can account for more than 30 percent of the emission reductions needed.

Fortunately, over the past several Congresses, natural infrastructure has emerged as a bipartisan solution to the challenges millions of Americans are facing. We've seen supportive policies and increased investment through the Water Resources Development Act, the Farm Bill, Storm Recovery Supplemental Appropriations, reform of Hazard Mitigation Programs, the Land and Water Conservation Fund, America's Conservation Enhancement Act, annual appropriations, and most significantly, the bipartisan Infrastructure Investment and Jobs Act. And there are many more bipartisan opportunities to do even more.

By continuing to leverage the protective value of nature, we can implement approaches that break the destructive and devastating cycle of climate-fueled unnatural disasters. Resilient natural systems can withstand changing conditions and readily recover from extreme floods,

storms, and droughts. They also provide cost-effective and self-sustaining protections and benefits, including reducing flood risks, sustaining fish and wildlife, improving water quality, regulating sediment loading, stabilizing soil, sequestering carbon, and providing recreational opportunities.

Natural infrastructure and nature-based solutions should be a mainstream choice for our infrastructure investments. We know, based on years of evidence, that this approach saves lives and taxpayer dollars. Conserving, restoring, and investing in natural and nature-based features makes communities safer and more resilient by absorbing floodwaters, buffering storm surges, and giving rivers room to spread out without harming homes and businesses. Studies show that restoration can create from around 10 to 40 jobs per $1 million invested. Natural infrastructure reduces the need for new, often expensive structural projects, and provides an important extra line of defense when levees or other structures are required. Natural infrastructure also avoids unintended adverse impacts such as diverting floodwaters onto other communities and inducing development in high risk areas.

For too long, Congress and conservation-focused organizations looked past people when focusing on wildlife, public lands, clean waterways, forests and headwaters, coastal dunes and wetlands, mountain peaks and pristine coasts. This approach has left behind communities of color and treated environmental justice and frontline communities as afterthoughts. We should center the health and safety of people when we prioritize the conservation and restoration of natural systems, while also advancing our goals to recover wildlife, provide clean water and air, reduce erosion, and promote outdoor recreation — all while sequestering large amounts of the excess carbon dioxide currently in the atmosphere.

On behalf of the National Wildlife Federation, our 52 state and territorial affiliates, and our nearly 7 million members and supporters, we are grateful for the leadership of this Committee in laying out thoughtful policy recommendations for natural climate solutions, including conserving and restoring forests, grasslands, floodplains, and ocean and wetland ecosystems; boosting federal spending for new and existing conservation programs to help farmers and ranchers adopt practices that help wildlife and stabilize the climate; helping wildlife adapt to climate change by establishing wildlife corridors and implementing landscape-scale conservation plans; and ensuring equitable access and benefits from natural climate solutions.

A Highly Cost-Effective Solution

For every $1 that we spend on pre-disaster mitigation, we will save $6 to $8 in avoided damages and taxpayer costs. Because of our archaic budget rules, it's easier to spend hundreds of billions of dollars after a disaster through a supplemental appropriation than it is to invest in the ounce of prevention that could have mitigated the damage in the first place. While we score the immediate cost of $1 of mitigation, we fail to account for the long-term cost avoidance on disaster relief and recovery. This just doesn't make sense. As a result, we've spent nearly $300 billion in disaster supplementals over the past decade and that number will only grow. And we urge the committee to consider working with the Senate to amend both rules and statutes like PAY-GO to account for the net-savings that such investments will achieve, while not undercounting the increased expenditures that will accrue without action.

There is a wide and growing body of literature demonstrating how investing in nature before and after natural disasters reduces costs to taxpayers, landowners, and insurers while also saving lives and protecting property.[1] For instance, coastal ecosystems represent a critical buffer against hurricanes and other storms. One acre of wetlands can typically store 1-1.5 million gallons of floodwater.[2] According to a 2008 study, coastal wetlands in the United States provide an estimated $23.2 billion per year in storm protection services, or as much as $5 million per square kilometer of wetland.[3]

Living shorelines, such as marshes enhanced with oyster reef breakwaters, hold up better than bulkheads during major storm events.[4] This protection also comes at lower cost than traditional protective infrastructure. For example, reviving reefs and mangroves can be an order of magnitude more cost-effective than installing seawalls or breakwaters.[5] Moreover, residents with bulkheads in coastal North Carolina report paying double the cost to repair their property and four times the cost for annual shoreline maintenance when compared to residents with more natural shorelines.[6] Living shorelines also protect against coastal erosion on a day-to-day basis, while maintaining connectivity of shoreline habitat.[7]

In coastal Louisiana, investments in wetland restoration generated 28 times as much flood protection, dollar-for-dollar, than a similar investment in six-meter high dikes.[8] In Florida, it has been estimated that comprehensive restoration of the Everglades would yield a four-to-one return on investment.[9] And, wetlands can also help industry meet regulatory requirements at lower cost than by constructing costly water treatment facilities.[10]

Beach restoration and dune nourishment can provide protection from major storm events, boost the local economy through increased recreation, and provide habitat for migratory birds. When Superstorm Sandy hit the East Coast in 2012, Cape May Point, New Jersey, had recently completed a project to widen two miles of the beach, build an 18-foot tall dune, and restore nearby freshwater wetlands. Cape May Point suffered virtually no damage, while surrounding areas sustained $640 million in losses. A host of birds have flocked to the restored wetlands and beach, and ecotourism from birders is estimated to add more than $310 million per year to the county's revenue.[11]

Floodplain acquisition projects have been effective in reducing flood risk, bringing down flood insurance premiums, and creating green spaces for recreation. Along Mingo Creek in Tulsa, Oklahoma, local property owners and businesses have not suffered property losses due to flooding since a voluntary buyout program was implemented in 1984. Additionally, residents have received up to a 35% discount on their flood insurance premiums, which reflects their reduced flood risk.[12]

Inland, reforestation, climate-smart forest management, and watershed restoration all have the potential to bolster natural carbon sequestration, benefit wildlife, and provide economic benefits including job creation. In Oregon, each dollar of public investment in forest and watershed restoration is multiplied in economic activity between 1.7 and 2.6 times as it cycles through Oregon's economy.[13] Similarly, it was estimated that the first year of the Abandoned Mine Land Reclamation Economic Development Pilot Program, alone, would cost less than $30

million but generate more than $140 million in revenue while creating 3,000 jobs and attracting more than 600,000 visitors to the region in Kentucky.[14]

The need to address greater risks from wildfires in many grasslands and forested areas has also grown considerably in recent years due to climate-related increases in extreme heat and drought, combined with higher fuel loads due to nearly a century of over-reliance on fire suppression. Indeed, the cost of wildfire impacts has grown considerably as more people have moved in to the so-called "wildland urban interface." [15] A 2015 study estimated that at least 1.1 million homes are at the highest risk from wildfire in the western United States, with a reconstruction cost of $268 billion dollars.[16] In turn, land management agencies such as the U.S. Forest Service have had to spend significantly larger portions of their budgets on fire suppression, eroding their ability to fund restoration and management activities to improve ecosystem health and resilience.[17]

Ecological forest management has emerged as an important concept for addressing wildfire risks as well as enhancing the health of forest systems. Specifically, ecological forest management may include a combination of strategic thinning, prescribed fire, and managed wildfire to reduce the risk of high-severity wildfire and promote healthier, more-resilient forests. Done thoughtfully, the approach can help balance tradeoffs between short-term costs and impacts of treatment with long-term benefits of reduced risks of large, high-severity fires. For example, a combination of thinning and prescribed fire in eastern and southern California was found to have significantly reduced burn severity in trees during 12 wildfires that occurred between 2005 and 2011.[18]

Further, improved community planning and collaborative risk management efforts, including both targeted codes and ordinances and voluntary, incentive-based approaches, have significantly reduced risks from wildfires. For example, the Firewise USA ® recognition program, a collaborative effort between state and federal agencies and nongovernmental organizations, has been working with communities across the country to reduce wildfire risks by encouraging homeowners to improve defensible space in their neighborhoods. Recent fires have demonstrated the program's success. For example, two consecutive fires in the community of Indian Lakes Estates, Florida, spared numerous homes and structures due to risk reduction preparations that homeowners made under the program.[19] Such programs are likely to be increasingly important as insurance companies continue to assess the risks from worsening wildfires and adjust rates and coverage accordingly.[20]

By updating our scoring rules to account for the net savings we can both increase investment in these life-saving projects, while reducing the long-term national debt projections.

Increasingly Severe Weather Events Are Wreaking Havoc on Communities

Natural climate solutions are essential to our ability to adapt to unavoidable climate impacts, build resilience, and meet net-zero goals. Adaptation is an essential partner to climate mitigation, and nature-based solutions can play a major role for both and provide significant co-benefits for water, air, recreation, hazard reduction, and many other services to society. However, natural

climate solutions must value biodiversity and be ecologically appropriate to ensure no harmful unintended consequences.

The Intergovernmental Panel on Climate Change (IPCC) released a report in February that warned climate change is already severely impacting people and the ecosystems we depend on in every region of the world, with the poorest and most vulnerable at greatest risk, and one million animal and plant species facing the threat of extinction — more than any other time in human history. The IPCC also reported that despite an increase in adaptation activities by governments, businesses, and civil society, far more is needed to help people and wildlife prepare for a changing world.

America is facing increasingly severe storms and floods, extreme droughts, massive wildfires and record high temperatures, fueled by a rapidly changing climate.[21] We have suffered more billion-dollar inland flood disasters in the last decade than in the prior three decades combined. We have endured more billion-dollar hurricane disasters in the last five years than in the decade before.[22] The human suffering caused by these and many smaller disasters is incalculable, with low-income and frontline communities bearing a disproportionate share of the harm.

The ever-mounting toll of human suffering and economic loss from natural disasters shows no sign of abating and every sign that it will continue to grow. Research shows that both the intensity and number of extreme storms will continue to increase appreciably as our climate warms. In some locations, future extreme events could be twice as intense as historical averages.[23] By 2100, previously rare extreme rainstorms could happen every two years.[24] By 2050, high tides could cause "sunny day" flooding in coastal communities 25 to 75 days a year.[25] By the end of the century, homes and commercial properties currently worth more than $1 trillion could be at risk of chronic flood inundation.[26]

Storms and floods in the United States disproportionately harm Black, Latinx, Indigenous, low-income, and frontline communities. For example, the neighborhood that suffered the worst flood damage during Hurricane Harvey was in an area of southwest Houston where 49 percent of the residents are people of color. Similarly, damage from Hurricane Katrina was most extensive in the region's Black neighborhoods. In fact, in four of the seven ZIP codes that suffered the costliest flood damages from Hurricane Katrina, at least 75 percent of residents were Black.[27] Over the next 30 years, the "risk of coastal floods damaging or destroying low-income homes will triple" resulting in the flooding of more than 25,000 affordable housing units each year.[28]

In addition, "while severe storms fall on the rich and poor alike, the capacity to respond to and recover from flooding is much lower in socially vulnerable populations that even in the best of times are struggling to function."[29] Even low levels of flooding can wreak havoc on buildings and the residents who live in them, damaging belongings, disrupting electrical equipment, contaminating water sources and septic systems, and generating mold. These impacts can "cause profound disruptions to families already struggling to make ends meet" and can be particularly challenging to remedy in affordable housing units, which are often in poor repair to begin with.[30]

Nature-based Solutions to Address Community Climate Risks

As the impacts of climate change accelerate, exposing the limitations of relying only on conventional gray infrastructure, the value of nature-based solutions to address community climate risks is becoming increasingly evident. Known by a variety of terms – including natural infrastructure, natural defenses, natural climate solutions, ecosystem-based adaptation, and natural and nature-based features – nature-based solutions can effectively deliver both climate mitigation and climate adaptation outcomes. In 2016, the International Union for the Conservation of Nature (IUCN) published a global standard for the use of these approaches, defining nature-based solutions (NbS) as "actions to protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits."

The use of natural and nature-based systems to address climate risks can encompass a wide range of options, from the protection and conservation of still-intact natural systems, to the restoration of degraded ecosystems, to the use of engineered systems designed to emulate natural system functions. Importantly, nature-based approaches can also be used in concert with structural options to form hybrid or "green-gray" systems for risk reduction. In practice, these approaches can be as simple as planting trees in urban neighborhoods to provide shade and stormwater management benefits or as complex as reengineering riverine systems to restore natural floodplains and lessen flood risks and restore natural ecosystem functioning and biodiversity integrity.

The National Wildlife Federation recently conducted a review and synthesis of nature-based solutions as a contribution to the U.S. Climate Resilience Toolkit's Steps to Resilience planning framework. This review highlighted the following seven key considerations for incorporating nature-based approaches into community-based climate adaptation planning:

- Recognize natural systems and processes as critical infrastructure
- Consider climate impacts on priority natural assets
- Consider equity implications in the design and application of nature-based solutions
- Ensure that nature-based solutions yield net positive biodiversity benefits
- Seek to protect or restore critical natural infrastructure
- Give natural features and processes space to function
- Integrate nature-based solutions into existing planning processes

The Changing Climate and Massive Habitat Losses Have Pushed Wildlife to the Brink

The changing climate, combined with historic and ongoing destruction, fragmentation, and degradation of vast swaths of habitat, have pushed America's wildlife into crisis, helping to drive the planet's ongoing sixth mass extinction of species.[31] As many as one-third of America's plant and wildlife species are vulnerable, with one in five imperiled and at high risk of extinction.[32]

America's freshwater species have been particularly hard hit. Approximately 40 percent of the nation's freshwater fish species are now rare or imperiled.[33] Nearly 60 percent of the nation's

globally significant freshwater mussel species are imperiled or vulnerable, and an additional 10 percent are already extinct.[34]

Our wildlife crisis extends well beyond rare and endangered species, and now affects many widespread and previously abundant creatures, such as the little brown bat, monarch butterfly, and many of our most beloved songbirds. State fish and wildlife agencies have identified more than 12,000 species nationwide in need of conservation action, and fully one-third of North America's bird species require urgent conservation attention.[35] The best way to spur collaborative, proactive recovery efforts to save these thousands of species of greatest conservation need is for Congress to pass the bipartisan Recovering America's Wildlife Act (H.R.2773).

The historic loss and degradation of aquatic wildlife habitat across the country makes each additional acre of wetland lost or natural stream segment channelized even more consequential for the long-term viability of our nation's fish and wildlife. At least ten states have lost more than 70 percent of their wetlands, which provide essential fish and wildlife habitat, while 22 states have lost 50 percent or more of their original wetland acreage.[36] The construction of levees to reduce the frequency and duration of flooding in the lower Mississippi River Valley is the single largest contributor to wetland losses in the country, according to the Department of the Interior.[[37] Fish and wildlife have also been severely harmed through the pervasive alteration of natural stream flows, including from reservoirs and locks and dams, which have occurred in 86 percent of the almost 3,000 streams assessed by the U.S. Geological Survey.[38] It is past time that we turn to the most ingenious engineer on the planet, Mother Nature, to help protect people and wildlife alike with natural infrastructure.

Ecosystem Restoration Provides Multiple Environmental, Health, and Economic Benefits

From the Coastal Louisiana to the Everglades and the Great Lakes to the Puget Sound, many iconic ecosystems across the country have associated restoration plans that, with enough support, could enhance the many co-benefits ecosystem restoration provides for communities and wildlife alike. These watershed-wide ecosystem restoration programs and plans were carefully crafted based upon the best available science and with extensive public input. They enjoy broad, bipartisan support, and their success hinges on the construction and maintenance of shovel-worthy infrastructure projects, including natural infrastructure projects. Implementing these plans creates thousands of good-paying jobs through the on-the-ground work needed to restore our nationally significant lakes, rivers, and estuaries. Many federal and state agencies — including the Army Corps of Engineers, Environmental Protection Agency, Department of Interior, Department of Agriculture, and National Oceanic and Atmospheric Administration — have a critical role to play in supporting a robust restoration economy by developing and implementing these watershed-wide restoration plans and programs.

There are also critical watersheds — such as the Ohio River, the Mississippi River, the Delaware River, and coastal Louisiana — where restoration plans exist or are currently under development at the state or regional level. These working watersheds are also home to many low-income and vulnerable communities, who suffer firsthand as a result from the degradation and pollution of these rivers and surrounding floodplains.

The recently passed bipartisan infrastructure law recognizes the multitude of benefits of investing in watershed-wide approaches that utilize natural infrastructure to restore and protect our aquatic ecosystems across the country. For example, it invested more than $1.7 billion in the Environmental Protection Agency's ecosystem restoration programs, including $1 billion to clean up toxic pollution, restore fish and wildlife habitat, reduce farm and city runoff pollution, and confront invasive species through the federal Great Lakes Restoration Initiative and $238 million for the Chesapeake Bay Program, which coordinates Chesapeake Bay watershed restoration and protection efforts. The law also provided nearly $1 billion for coastal restoration and resilience investments through NOAA and through the National Coastal Resilience Fund, as well as $1.9 billion for Army Corps of Engineers' aquatic ecosystem restoration efforts across the country, including a historic $1 billion for efforts to restore the Everglades. It contains a historic amount of funding for water infrastructure, including over $11.7 billion for the Clean Water State Revolving Fund (CWSRF), of which at least 10 percent of each state's capitalization grants will go toward Green Project Reserve eligible projects, including natural infrastructure projects like wetland restoration and reforestation efforts.

These investments, coupled with annual federal appropriations, will help achieve comprehensive, watershed-wide restoration, enhancing drinking water quality, safeguarding nearby communities from floods and sea level rise, sustaining local and regional economies, protecting wildlife habitat, and creating jobs.

Restored watersheds improve our quality of life, increase property values, provide clean water, support fish and wildlife and enhance outdoor recreation for our families. The on-the-ground work to restore our coasts, lakes, rivers, and estuaries produces jobs and utilizes skills and machinery available in the local workforce, benefiting local economies. These cost-saving, job-creating, and resilience-building investments will also help advance the administration's goals to conserve and restore 30 percent of America's lands and waters.

Continuing to direct federal resources toward these widely-supported and thoughtfully-crafted regional restoration programs are among the smartest and most strategic investments we can make as a nation to create jobs, support regional economies, protect natural resources, enhance fish and wildlife habitat, and make our roads, bridges, water systems, and communities more resilient. These ecologically and culturally-important natural places are nationally-significant hubs of tourism, and many support and protect other critical industries including fisheries, shipping, and energy production. Restoration implementation also supports a $25 billion "restoration economy" that directly employs 126,000 people and supports 95,000 other jobs, mostly in small businesses. Restoring these great watersheds helps sustain our nation's $887 billion outdoor recreation economy. Through federal and state restoration we have an opportunity to stimulate growth and produce jobs in regional economies, and to support the national outdoor economy for years to come. Some specific examples of the benefits of investing in ecosystem restoration, and opportunities to expand ecosystem restoration efforts, include:

- **Coastal Louisiana and the Mississippi River Delta**: Large-scale restoration of coastal Louisiana presents a significant opportunity to protect existing infrastructure and industries of national importance, while growing a restoration economy that can be a model for other coastal communities around the world. Resources should be directed to

implement critical large-scale restoration projects in coastal Louisiana, drawn from the state's Coastal Master Plan. These investments would protect vulnerable communities, sustain critical wildlife habitat, and create jobs. Additionally, lifting the existing cap on shared Gulf of Mexico Energy Security Act (GOMESA) revenues would increase resources available to sustain a restoration economy.

- **Mississippi River Restoration and Resilience Initiative**: Congress should pass H.R. 4202, the Mississippi River Restoration and Resilience Initiative (MRRRI) Act, to establish a non-regulatory EPA geographic program for the Mississippi River mainstem states. The MRRRI Act centers natural infrastructure solutions that have co-benefits for flood risk reduction, water quality improvements, wildlife habitat, recreation, and other services to communities. It would enhance federal coordination with the Army Corps and other agencies around a shared agenda to improve the overall health and resilience of the Mississippi River, through collaboration with states, Tribes, local governments, and other river stakeholders.

- **Chesapeake Bay Restoration**: The Chesapeake Bay watershed is home to more than 18 million people and spans 64,000 square miles across parts of Delaware, Maryland, New York, Pennsylvania, Virginia, and West Virginia and the entire District of Columbia. Over the past decade, the states and the federal government have jointly committed to a massive restoration program in the Bay watershed to restore the Bay and its tributaries by 2025. The COVID-19 pandemic has set back progress — from delayed implementation of conservation practices on farms to the implementation of stormwater practices in urban areas. None of the watershed's restoration goals can be met without the leadership, guidance and accelerated funding support provided by various federal agencies, especially the Environmental Protection Agency.

- **Delaware River Basin Restoration Program**: More than 13 million people rely on clean drinking water from the Delaware River watershed, including residents of New York City, Philadelphia, Trenton, Camden, and Wilmington. The Delaware River Basin Restoration Program, administered by the U.S. Fish and Wildlife Service, develops a coordinated approach to identify and implement restoration and conservation activities across the Delaware River watershed, including natural infrastructure projects that help restore water quality, enhance water management efforts, improve wildlife habitat, and create public access through the entire Delaware River watershed.

- **Everglades**: The bipartisan plan to restore America's Everglades involves constructing a suite of resilience-building water infrastructure projects designed to remove barriers to water flow and to clean, store, and send water south. Completing the restoration milestones outlined in the Army Corps' Integrated Delivery Schedule for Everglades restoration will create over 65,000 jobs, protect drinking water supplies of more than 9 million Floridians, and enhance wildlife habitat. It will also make Florida more resilient in the face of climate change by defending against saltwater intrusion, strengthening shorelines, protecting coastal and inland communities from flooding, and sequestering carbon through restoring seagrass, mangrove, and wetland habitat. Congress should appropriate $725 million to the Army Corps of Engineers in FY 23 to maintain critical

recent momentum to accomplish keystone projects within the Comprehensive Everglades Restoration Plan.

- **Great Lakes Restoration Initiative**: Investing in the Great Lakes Restoration Initiative, which helps protect, restore, and maintain the Great Lakes ecosystem, will protect the drinking water for over 30 million Americans, create jobs, and safeguard public health. Advancing the implementation of such projects in this region creates a 3-to-1 return on investment in local communities, from new real estate and commercial development, to boosting outdoor recreation and tourism, and more housing options and higher home values.

- **National Estuary Programs**: The EPA's National Estuary Programs help protect and restore water quality and habitat in 28 estuaries of national significance in the United States. These estuaries provide important ecosystem services, create wildlife habitat, support economically significant fisheries, and generate billions of dollars in tourism revenues for the country. This program leverages $22 on average in local, state and private sector investment for every $1 of federal funds appropriated to the program.

- **Ohio River Basin**: The Ohio River supplies drinking water to more than 5 million people, and millions more depend on the river for their health, jobs, and quality of life. Unfortunately, the Ohio River basin faces the worst water pollution in the nation that threatens drinking water quality, wildlife habitat, and human health. Resources should be invested in developing and implementing a plan to restore and protect the Ohio River basin ecosystem.

- **Texas Coastal Resiliency Master Plan**: Resources should support ecosystem restoration projects described in the Texas Coastal Resiliency Master Plan, an inclusive stakeholder and community-driven plan that identifies nature-based solutions spanning the entire nearly 400 miles of coastline to help the state shore up its coast and withstand accelerating erosion rates, sea level rise, and increasingly intense Gulf storms.

However, ecosystem restoration and the deployment of natural infrastructure doesn't have to be at the watershed scale to make a meaningful impact. Local and regional restoration efforts around the nation are creating important benefits for people and wildlife. For example, long-term partnerships between the National Wildlife Federation and local communities have led to innovative resilience projects around the country, including in the Great Marsh of Massachusetts, and along the Eastern Shore of Maryland, in the town of Oxford, where a project will incorporate living breakwaters into a design that works with nature to protect coastal communities threatened by increased sunny day flooding and coastal storms.

Additionally, as part of the Resilient Schools Consortium (RiSC) program for middle and high schools in New York City, public school students aged 12 to 20 are planting and caring for native trees on their school grounds to help mitigate urban heat island and absorb stormwater. They're planting thousands of American beach grass plants to stabilize dunes in the frontline community of Coney Island, Brooklyn. Once mature, these vegetated dunes will help to mitigate flooding and property damage from coastal storms, and help to prevent the migration of sand into

shoreline roads. These education efforts are foundational to addressing the multi-generational threat of climate change and the need for adaptation.

An Ounce of Prevention is Worth a Pound of Cure

The value of natural systems for protecting communities has long been recognized. In a 1972 study evaluating options to reduce flooding along the Charles River in Massachusetts, the Army Corps of Engineers concluded:

> "Nature has already provided the least-cost solution to future flooding in the form of extensive [riverine] wetlands which moderate extreme highs and lows in streamflow. Rather than attempt to improve on this natural protection mechanism, it is both prudent and economical to leave the hydrologic regime established over millennia undisturbed."[39]

Wetlands prevented an estimated $625 million in flood damages in the 12 coastal states affected by Hurricane Sandy, and reduced damages by 20 to 30 percent in the four states with the greatest wetland coverage.[40] Coastal wetlands reduced storm surge in some New Orleans neighborhoods by two to three feet during Hurricane Katrina, and levees with wetland buffers had a much greater chance of surviving Katrina's fury than levees without wetland buffers.[41] The forest and other conservation lands that make up the 28,000 acre Meramec Greenway along the Meramec River in southern Missouri contribute about $6,000 per acre in avoided flood damages annually. Wetlands in the Eagle Creek watershed of central Indiana reduce peak flows from rainfall by up to 42 percent, flood area by 55 percent, and maximum stream velocities by 15 percent.

Evidence of the effectiveness of natural climate solutions in reducing flood and storm damages continues to mount, as highlighted in the National Wildlife Federation's report, *The Protective Value of Nature*[42] and in the examples provided as an appendix to this testimony. As aptly noted by the Reinsurance Association of America: "One cannot overstate the value of preserving our natural systems for the protection of people and property from catastrophic events."[43]

Natural infrastructure is also often more cost-effective than structural measures. A recent study documents that using natural infrastructure solutions to reduce coastal flood risks in Texas, Louisiana, Mississippi, and Florida would have a benefit-cost ratio of 3.5 compared to just 0.26 for levees and dikes. Restoring wetlands in this region could prevent $18.2 billion in losses while costing just $2 billion to carry out. Natural infrastructure also has the significant added benefits of being self-sustaining and avoiding the risk of catastrophic structural failures. Importantly, natural infrastructure can work both alone and in combination with more traditional gray infrastructure to reduce flood and storm risks. And while gray infrastructure deteriorates over time, particularly when exposed to climatic conditions that exceed their design parameters, natural infrastructure often has significant adaptive capacity and an ability for self-repair.

A new approach that prioritizes nature-based pre-disaster mitigation and resilience will save taxpayers money and make our communities safer. Far too often, we approach resilience planning through the lens of disaster response and recovery rather than through proactive efforts to increase the resilience of vulnerable communities and water resources before disaster strikes.

One clear example of this is evidenced by the Army Corps' history of supplemental appropriations. From 2005 to 2016, the Corps received $31.4 billion in supplemental funding, which amounts to almost half of the agency's annual discretionary appropriations over that same period. Of those supplemental funds, 87 percent ($27.2 billion) was provided to respond to flooding and other disasters. With ever increasing effects from storms, these emergency supplemental appropriations have also dramatically increased over time, with the Corps receiving "$1.1 billion in the 1990s, $19.2 billion in the 2000s, and $29.0 billion in the 2010s." Many of these expenditures could have been avoided, if we had invested in the necessary resilience projects. Even though we know that for every $1 invested in pre-disaster mitigation, we save $6 in avoided costs, Congressional budgetary rules continue to make it much easier to fund an emergency supplemental appropriation after a disaster than to invest in the ounce of prevention that could have saved money and reduced damage in the first place.

Nature Can Help Mitigate Climate Change

Natural ecosystems also have the ability to sequester and store large amounts of atmospheric carbon, the primary driver of accelerating climate change. Indeed, natural climate solutions have the potential to remove and store more than an additional gigaton of carbon dioxide annually. Such nature-based solutions should be a central component of the nation's climate mitigation strategy.

Forests and other wooded areas represent one of the best opportunities to remove carbon from the atmosphere quickly, reliably, and relatively cheaply. In 2017, the combination of forest land, harvested wood products, and urban trees in the United States accounted for an estimated net uptake of 730.9 million metric tons of carbon dioxide equivalent (MMT CO_2 eq.)[44] — the equivalent of 15 percent of our economy-wide CO_2 emissions (Domke et al., 2020). Forested ecosystems also provide an abundance of ecosystem services and societal benefits: they create habitat for wildlife, produce clean water, provide space for recreation, regulate temperatures, and much more. Between 1990 and 2017, "forest land remaining forest land" was the nation's largest net carbon sink, and conversions of forest land were the largest source of land-based emissions.[45] However, these benefits depend on careful policy and program design and implementation. The combined pressures on forests from development, introduced pests and diseases, aberrant patterns of precipitation, fragmentation, and extreme fire can hamper forest growth and even prevent successful regeneration after disturbance.

It is important, however, to optimize rather than maximize carbon in implementing natural solutions. Strategies that focus strictly on maximizing carbon sequestration — such as converting natural habitat to plantations of rapidly growing tree species — may run counter to important ecological and social values. Avoiding conversion of existing forests, especially carbon-rich old growth, increasing reforestation of historically forested areas, and focusing afforestation on severely degraded lands can all balance ecological and climate needs. Management of the nation's forests should also take account of the changing climate, while also restoring natural patterns of fire and other ecological processes. Urban forestry also deserves significantly more attention for its multiple benefits to air quality, reduction in energy use and the urban heat island effect, absorbing stormwater, and providing wildlife habitat.

Forest and watershed restoration not only increase the climate benefits of forests by increasing their ability to store carbon, but also reduce emissions from fire and decay. A rapidly changing climate, including more severe drought and changing weather patterns, coupled with more than a century of fire exclusion and excessive fuels, has increased the size and intensity of wildfire.

Mitigating the size, severity, and effects of forest fires, and reconnecting forest systems, is essential to ensure watershed health and function, and to optimize the climate benefits forests provide. We can and must better manage our forests, as ecologically appropriate, to increase the capacity for our forests to store carbon and produce clean water. The National Wildlife Federation is grateful that the proposed reconciliation package included $27.5 billion for forest restoration, and we urge the committee to help ensure it remains in any final version that is signed into law.

At the same time, fire is an essential component of many of our forest ecosystems. Prescribed burns can mimic natural processes and reduce fuel loads, unlock nutrients, and reduce the intensity of future wildfires. Furthermore, embracing traditional ecological knowledge and practices and forming authentic partnerships with Indigenous peoples in forest management can be another tool to help to restore the fundamental role fire played in many forested ecosystems, while simultaneously supporting traditional cultural practices and livelihoods (Marks-Block et al., 2021).

Good forest and watershed management is about more than just fire. For example, we need to restore forests at the landscape level and consider their management over longer lengths of time, but also be nimble to account for uncertainty. The U.S. Forest Service estimates that 75-82 million acres of our nation's forests need restoration, including nearly 2 million acres where changes in climate have thwarted nature's ability to reseed and grow forests.

With more than 50 percent of the nation's forestlands under private ownership, it's clear that partnering with landowners will be an essential part of any strategy to increase the climate, wildlife, and community benefits these ecosystems provide. Tax credits for carbon capture accomplished through natural climate solutions could play a key role in halting deforestation, increasing restoration and thereby accelerating greenhouse gas reductions, while providing a host of valuable co-benefits, including increased soil productivity and resilience, water quality and quantity, wildlife habitat and landowner economics. Such a provision could promote additional carbon storage in the soils and vegetation of our nation's private grasslands, wetlands, forests and agricultural lands. Modeling such a tax credit on the 45Q provision for direct air capture could provide parity among natural and technological carbon storage in terms of incentives. In addition, there is a need for incentives to promote responsible, long-term stewardship of forestlands and ensure that the public goods they provide will be enjoyed for years to come. Programs such as those of the Healthy Forests Reserve Program and the collaborative Regional Conservation Partnership Program, which has been used to restore critical longleaf pine (*Pinus palustris*) habitat in the Southeastern United States are critically underfunded.

Since the time of European colonization, we have lost millions of acres of biodiverse bottomland hardwood forests, primarily to conversion for agricultural uses — and when these forests are

lost, so are the invaluable services they provide to adjacent communities, including flood water retention and water quality protection (Allen et al., 2004). Investing in restoration of these ecosystems can reduce burdens on gray infrastructure while simultaneously providing habitat where waterfowl and other wildlife can thrive, especially in regions with imperiled wetland forests, such as the coastal plains of the Southeast.

We also have abundant opportunities to improve the productivity and resilience of agricultural land through targeted forest restoration. In formerly forested areas, restoring tree cover can block wind to reduce erosion, create habitat for pollinators and other beneficial biodiversity, or even help to diversify farmer's income with timber products (USDA, Agroforestry). We should not, however, encourage afforestation and tree planting in native grasslands and other historically non-forested ecosystems, as this can have dire negative consequences on biodiversity and carbon reservoirs (e.g., Tölgyesi et al., 2022).

As extreme climate events increase in frequency, some agricultural lands may begin to flood so frequently that they transform from asset to liability. Restoring riparian forest buffers (30 meters, or about 100 feet) and reforesting floodplains with bottomland hardwoods represents another enormous opportunity to increase climate mitigation while providing a suite of ecosystem benefits, including flood attenuation, erosion prevention, and habitat conservation for aquatic species (Cook-Patton et al., 2020).

Open urban areas have been identified as another high priority area for reforestation and forest restoration (Cook-Patton et al., 2020). And with around 80 percent of the nation's residents inhabiting cities, increasing access to nature and ecosystem service provisioning for urban residents may be one of the most impactful actions at our fingertips.

Urban trees in the United States store an estimated 643 million metric tons of carbon, and sequester an estimated 25.6 million tons annually.[46] Urban forests offer an incredible array of other benefits: they moderate the urban heat island effect, lowering energy bills and providing shade and relief from extreme heat; they intercept rainfall, reducing the intensity of storm impacts on urban gray infrastructure; they can be strategically used to enhance air quality — in other words, they can help us to adapt to many of the challenges of climate change (Pataki et al., 2021). Urban forest patches can provide spaces for recreation, reflection, and wildlife observation not available elsewhere in the urban landscape. Their presence can even provide benefits to physical and mental health (Wolf et al., 2020). The Forest Service estimates these services are valued at more than $18 billion annually (Nowak et al., 2018).

Yet at the present, we know that urban forest canopy cover is often inequitably distributed among racial groups and income levels (Gerrish and Watkins, 2018; Watkins and Gerrish, 2018; Tree Equity, American Forests). This exacerbates disparities in exposure, for example, to the urban heat island effect and in related health risks or financial burdens related to cooling. Historical discriminatory policies such as redlining have shaped these patterns of inequity, with formerly redlined communities often containing less than half the tree canopy (Locke et al., 2021) and experiencing elevated temperatures in compared to their counterparts, by an average 2.6°C and up to 7°C (Hoffman et al., 2020).

We can and should take advantage of the benefits urban forests can provide. But interventions must be community-led. Attempts to "green" communities or increase tree plantings without authentic community engagement, consultation, and involvement at all stages can result in unintended and harmful consequences, including displacement resulting from changes in property values, maintenance costs shouldered by residents, and even negative effects on health (Wolch et al., 2015; Jelks et al., 2021). On the other hand, investment in workforce development to support climate-informed urban forest restoration and reforestation presents yet another opportunity to stimulate local economies and create jobs.

Restoring America's Grasslands for Resilience and Carbon Sequestration

As important as our nation's forests are, its grasslands and sagebrush steppe ecosystems cannot be forgotten. They are as critical to climate success, wildlife habitat, and clean water, as they are iconic. They are working lands, relied upon by ranchers, farmers, energy developers, hikers, campers and hunters. They are also home to hundreds of species of wildlife, from mule deer to snowshoe hare to meadowlark. Yet, investments in their restoration and management are needed to ensure their role as an important tool in combating climate change.

A 2018 University of California at Davis study surmised that grasslands could be a greater and more reliable carbon sink than forests, because they are less "climate-vulnerable." Forests store most of their carbon in the soil, but less than grasslands, so when forests, which are more susceptible to climate conditions, burn they release more carbon into the atmosphere relative to grasslands. Jim Blackburn, professor at Rice University and co-director of its Severe Storm Prediction, Education and Evacuation from Disasters Center estimates that grasslands could potentially capture 1 billion metric tons of carbon each year — more than 14 percent of U.S. annual emissions.

Unfortunately, grasslands are the fastest declining ecosystem in the United States, disappearing at rates exceeding those of the Amazon rainforest.[47] As a result, grassland birds have suffered the steepest losses of all bird species, with populations declining 53 percent since 1970.[48] At least 60 percent of historical grasslands have been converted to cropland and other land uses, with some areas having lost upward of 90 percent over the last two centuries (Brennan and Kuvlesky 2005). The loss and degradation of these habitats have had, and will continue to have, dire consequences for biodiversity and provisioning of ecosystem services, including their ability to store carbon and contribute to climate change resilience.

These losses are also especially troubling for the thousands of species of pollinators who rely on grasslands as habitat. One out of every three bites of food we eat is supported by pollinators, including wild bees and other species — adding more than $15 billion to the nation's crop values.

Grasslands and sagebrush steppe are threatened by invasive grasses that outcompete native grasses and carry fire, and development and cropland conversation. Invasive cheatgrass covers as much as 100 million acres of land in the United States, a serious problem for wildlife and an accelerant for catastrophic fire on both public and private land. On private land, we lose a football field's worth of grasslands every four seconds to development and cropland conversion.

We've lost 40 percent of grassland birds in our lifetimes, and some indicator species, like the Greater Sage-grouse, are teetering on the edge of listing under the Endangered Species Act. We must invest in restoration on our public lands, and find new tools for collaboration to conserve and restore private land.

The highly successful North American Wetlands Conservation Act (NAWCA) provides a model for this type of collaborative work on private lands. It was signed into law in the 1980s when waterfowl numbers were in sharp decline. Because of collaborative action sparked by the act, waterfowl have since increased by 56 percent. Not only do we need to invest in protecting and restoring our federal grasslands, we need to authorize a program for private lands modeled after NAWCA, the North American Grasslands Conservation Act.

To slow continued losses of grasslands to crop production, Congress should make national, the Farm Bill's Sodsaver provision — a common-sense crop insurance reform currently effective in six states (Minnesota, Iowa, North Dakota, South Dakota, Nebraska, and Montana) that reduces crop insurance rates on newly converted agricultural acres for the first three years of production. This reform corrects a policy incentive to convert marginal land to crop production.

Significant investments in grasslands and sagebrush steppe restoration and passage of the North American Grasslands Conservation Act would increase these ecosystems' ability to store and retain carbon, reduce grassland and rangeland wildfire, increase water resources, and improve technology to control cheatgrass and other invasive species.

Making Agricultural Lands More Profitable and Resilient

U.S. farmers and ranchers are uniquely productive compared to the rest of the world. Popular and oversubscribed USDA conservation programs can further enhance and make producers, and their agro-ecosystems, more resilient to extreme weather events exacerbated by climate change. Programs like the Conservation Stewardship Program, Environmental Quality Incentives Program, Conservation Reserve Program, and Regional Conservation Partnerships Program, among others, are examples of public-private partnerships that are in high demand from producers and conservationists but lack the funding to meet that demand. In the past decade nearly 1 million applicants have been rejected by the Environmental Quality Incentives Program, alone (Happ, Michael. 2021. "Closed out: How U.S. Farmers Are Denied Access to Conservation Programs." Institute for Agriculture & Trade Policy. https://www.iatp.org/documents/closed-out-how-us-farmers-are-denied-access-conservation-programs (March 28, 2022)).

Agricultural conservation has many co-benefits for farmers, communities, and the climate (Henneron, L., et al. 2015. "Fourteen Years of Evidence for Positive Effects of Conservation Agriculture and Organic Farming on Soil Life." Agronomy for Sustainable Development 35: 169–81.). Cover crops enhance soil health by reducing erosion and providing natural weed suppression, reducing unintended consequences of overusing increasingly expensive pesticides and herbicides. Diverse crop rotations can also improve a farm's mitigation and adaptation to climate change by naturally cycling nutrients, reducing pests and disease, and while providing a diversified income stream to producers. Reduced or no-till farming rapidly sequesters carbon in

the soil and reduces agricultural runoff and erosion of precious topsoil. Further, producers with livestock and cropping systems can increase soil carbon while reducing costs on feed and fertilizer (Khalil, Mohammad Ibrahim et al. 2019. “Strategic Management of Grazing Grassland Systems to Maintain and Increase Organic Carbon in Soils.” CO2 Sequestration. https://www.intechopen.com/online-first/strategic-management-of-grazing-grassland-systems-to-maintain-and-increase-organic-carbon-in-soils (June 10, 2020). Fully implementing these practices could remove as much as 100- 200 million metric tons of carbon dioxide annually by 2050.[49]

Technical assistance, research, and extension provided by USDA conservation programs are essential for increased adoption of cover crops, diversified crop rotations, decreased tillage, and livestock grazing integration with row crops, among others. The United States’ topsoil is disappearing at twice the rate as it was during the Dust Bowl (DeLonge, Marcia, and Karen Perry Stillerman. 2020. Eroding the Future: How Soil Loss Threatens Farming and Our Food Supply. Union of Concerned Scientists. https://www.jstor.org/stable/resrep28410 (August 9, 2021)). Unfortunately, USDA conservation programs are greatly oversubscribed and unable to meet the demand from producers and need for conservation practices on the land that can address climate and ensure healthy soil, water and wildlife resources into the future. A doubling of conservation funding would begin to address this demand and need.

Reclamation of Degraded Lands

Investments in reclamation of degraded lands such as abandoned mine lands, orphaned oil and gas wells, brownfield sites, and Superfund sites are also an integral part of the climate solution. With proper management, these lands can be turned into forests, grasslands, prairie lands and soils that have the potential to sequester millions of tons of carbon dioxide annually while mitigating other harmful emissions like methane, protecting biodiversity, improving air and water quality, and revitalizing local economies through job creation and increased property value and tax revenues.

Blue Carbon

Oceans and coastal ecosystems also play a valuable role in mitigating climate change, particularly through the ability of wetlands, mangroves, and seagrasses to capture and store carbon, as well as buffer the effects of sea-level rise and increasingly severe storms. These repositories of "blue carbon" sequester more carbon per unit area than forests, and store carbon for a longer period of time.[50] Therefore, maintenance and enhancement of these ecosystems are a critical part of a successful climate strategy — for mitigation, climate adaptation, and community resilience objectives.

Key Bipartisan Opportunities for Congress

LEVEL THE PLAYING FIELD FOR NATURAL CLIMATE SOLUTIONS

- **Replicating the Success of 45Q for Natural Climate Solutions:** The broadly supported and bipartisan 45Q federal tax credit for carbon capture, utilization, and sequestration currently provides a much-needed financial incentive for reducing carbon dioxide emissions from industrial sources, power plants, and through direct air capture technologies. An opportunity exists to replicate this successful model to also spur innovation and deployment of capital into natural climate solutions that sequester additional carbon through restoration of our grasslands, forests, wetlands, waters, and agricultural lands.

  Creating a 45X tax credit for natural climate solutions would catalyze private investment onto private, public, and Tribal lands, while providing greater policy parity for natural solutions with their technological counterparts. It would be a game changer. In addition to accelerating GHG sequestration, such investments would improve the economics of investing in natural carbon sinks, while also increasing soil productivity, boosting resilience (reducing erosion, etc.), improving water quality/quantity, and providing wildlife habitat.

  A 45X tax credit provision could be modeled upon 45Q, providing a per ton credit for additional carbon storage in natural systems at a cost point that's a fraction of the 45Q incentive levels ($20-$30/ton on average natural solutions compared to ~$50-$130/ton for CCUS). While the IRS would implement the tax credit, as it does for 45Q, USDA could manage the measurement/practices side for private lands (this could build upon the carbon accounting protocols envisions by the Growing Climate Solutions Act), DOI could manage protocols for investments in public lands (in conjunction with USDA for National Forests), and NOAA could manage protocols for blue carbon. Tax credits could either be refundable (as proposed by the enhanced 45Q) or transferable for when the value of the tax credit is greater than the taxpayer's tax liability. We believe such an approach would enjoy bipartisan support across the political spectrum.

  Key principals for program integrity:
  - **Predictability/simplicity**: The credit must be easily understandable and accessible for all communities, especially Indigenous communities, people of color, small landowners, veterans, etc. to ensure equitable distribution of the benefits of the program;
  - **Additionality**: Investments must produce new reductions above and beyond the baseline and do not "double pay" for tons already accounted for through carbon offset programs/purchases;
  - **Permanence**: Investments must sequester carbon over the long-term; and,
  - **Ecologically appropriate**: Restoration/reforestation investments must be ecologically consistent for the project's location (e.g. native plants) and should provide co-benefits of resilience, habitat, clean water, etc., as documented through a credible, but simple, management plan.

A 45X tax credit could include multiple options for participation:

- **Practice-based option for small landowners**: Tax credit would be determined by approved practices on the land implements (selected from an approved USDA list of practices with well-documented and predictable results that meet standards of additionality, permanence, and ecologically-appropriateness). This approach would allow smaller landowners to participate and could be easily implemented by USDA.
- **Performance-based option for large landowners**: Tax credit is determined by carbon sequestration performance above a baseline as documented by a carbon registry, approved by USDA. This approach would work better for larger landowners, offers opportunities at scale, and encourages innovation.
- **Natural sequestration on public lands and waters**: Tax credit opportunities should also exist for private investment on public lands (BLM, USFS) and waters (NOAA, etc.) to sequester carbon in ecologically-appropriate ways and provide addition public co-benefits. This would drive significant investment into states with significant public lands, while expanding opportunities for job creation and revenues.

Encourage Conservation of Lands with High Carbon Sequestration, Resilience, and Habitat Values: Just as the Congress came together to create Opportunity Zones to encourage private investment in economically distressed communities, similar opportunities exist to improve the economic incentives for conserving lands that have high carbon sequestration, resilience, or wildlife habitat values. Such an approach would recognize the higher public value of these lands and compensate landowners accordingly with a higher incentive level than the one-size-fits all traditional approach that does not consider ecological value.

Pass the Growing Climate Solutions Act: The bipartisan Growing Climate Solutions Act would direct USDA to standardize protocols for measuring carbon sequestration on agricultural lands. This would create new revenue opportunities for America's farmers through voluntary actions and participation in private and public carbon markets.

ENSURE RESILIENCE INVESTMENTS ACCOUNT FOR NET-SAVINS IN CBO SCORING

- **Modernize CBO scoring rules:** Through the House Rules package and other vehicles, ensure that investments in resilience that would achieve clear and demonstrable net-savings score as debt-reducing. This would free up resources for proactive investments, end the cycle of ever-growing disaster supplemental appropriations, and reduce long-term debt.

PASS BIPARTISAN CONSERVATION INVESTMENTS

- **Bipartisan Recovering America's Wildlife Act:** This landmark piece of bipartisan legislation will restore essential wildlife habitat in all 50 states and territories to recover the more than 12,000 species of greatest conservation need through proactive, collaborative and voluntary actions. This will restore natural systems across the country that will also provide critical resilience services for communities and additional carbon sequestration capacity.

- **North American Grasslands Conservation Act.** Grasslands are the fastest declining ecosystem in the United States, but they are also underappreciated powerhouses of carbon sequestration and storage. Authorizing a program modeled after NAWCA should be a top priority.

- **Wildlife corridors:** Helping wildlife adjust to changing and shifting habitat conditions by facilitating wildlife movements is a critical climate adaptation strategy. Congress took a major step forward by passing a comprehensive wildlife crossings program, including the first funding committed to wildlife crossings, as part of the Infrastructure Investment and Jobs Act. Wildlife corridors must also be maintained away from roads and highways. We appreciate that the House of Representatives passed the full Wildlife Corridors Conservation Act as part of the INVEST in America Act and encourage continued work on wildlife corridors legislation and the Tribal Wildlife Corridors Act.

- **Trillion Trees:** The idea of accelerating the pace of forest restoration is a critical climate solution. We're encouraged by the bipartisan, bicameral negotiations that could result in a consensus bill to achieve essential ecologically-appropriate reforestation, resilience, and carbon sequestration goals.

WATER RESOURCES DEVELOPMENT ACT

There are key opportunities that Congress can pursue to enhance the ability of natural ecosystems to provide climate mitigation, resilience, and other benefits to communities in the context of the Water Resources Development Act of 2022, which is currently under development. More specifically, in the 2022 bill Congress should:

- **Increase Organizational Capacity Through a Resilience Directorate**. Congress should establish a Resilience Directorate within the Office of the Chief of Engineers at the Corps of Engineers to improve the Corps' ability to reduce flood risks, promote coordinated planning across districts and Corps business lines and among Federal agencies, and better leverage the benefits of natural infrastructure. The Directorate should be tasked with ensuring that existing programs, authorities, and operations take full advantage of natural infrastructure and adopt modern, comprehensive planning approaches. Critically, the Directorate should have the resources and budgetary authority needed to work and coordinate across Corps business lines to infuse resilience into every aspect of the Corps' work. Congress should also establish "community and natural systems resilience" as a co-equal project purpose for each water resources project to eliminate a perceived barrier to comprehensive resilience planning. These reforms will help the Army Corps — one of our nation's most influential resilience agencies — take full advantage of its programs and authorities to improve community and water resources resilience and avoid piecemeal planning that can increase flood risks and recovery costs.

- **Utilize Federal and State Expertise.** Congress should ensure that the Corps utilizes the expertise of federal and state fish and wildlife experts when planning projects. Congress

should direct the Corps to utilize recommendations made pursuant to mandatory Fish and Wildlife Coordination Act reviews that derive from the special expertise of federal and state fish and wildlife experts (e.g., methods and metrics for assessing fish and wildlife impacts and mitigation opportunities). The Corps often ignores these critically important recommendations, leading to projects that cause unnecessary harm and to mitigation plans that do not work. Utilizing these carefully developed state and federal expert recommendations is a common sense, cost-effective way to make projects better and improve planning efficiency.

- **Employ Voluntary Easements to Improve Resilience**. Congress should ensure the Corps has the tools it needs to develop and implement resilient solutions. Congress should: (a) direct the Corps to map all flood easements, conservation easements, and permanently protected lands and waters in the project area when assessing the impacts and benefits of a water resources project; (b) direct the Corps to map the many flood easements already purchased by the Corps across the country to facilitate consideration of those easements when planning projects and updating operating plans; and (c) direct consideration of Corps purchased permanent flood easements as an appropriate natural infrastructure solution. Increasing reliance on voluntary flood and other conservation easements will facilitate development of resilient solutions.

FARM BILL

- **Bolster Working Lands Conservation Programs.** Congress should double the funding levels for these popular and successful programs to ensure they can continue to provide benefits to producers, wildlife, and adjacent communities. The historic funding increases proposed in the House-passed reconciliation bill would accomplish this goal.

- **Develop Workforce and Capacity to Meet Reforestation and Restoration Goals.** With additional stocking of our nation's lands, forest ecosystems could uptake nearly 20 percent more CO_2 than they already do (Domke et al., 2020). Whether on public and private forestlands, successful reforestation and active forest restoration depends upon the capacity of nurseries to collect seeds and produce healthy growing stock, as well as the availability of a workforce for nursery production, site preparation, planting, and maintenance (Fargione et al., 2021). And with a rapidly changing climate, we need to ensure that nurseries cultivate and supply robust seedlings, suited for local site conditions and — as much as possible — the conditions of the future. According to a survey of nurseries, labor shortages create the largest bottleneck in the "reforestation pipeline" (Fargione et al., 2021). Investing in a 21st-century Civilian Conservation Corps that puts millions of young Americans to work, in a manner that benefits all communities and provides high-quality workforce development to prepare participants for jobs in the private sector, remains one of our best options to address this bottleneck. Investments in infrastructure, innovation, and research in this space are also badly needed. Expanding both public and private nursery capacity via Farm Bill programs and other targeted funding will provide jobs and stimulate rural economies.

Other Key Opportunities:

- **Increase Green Project Reserve Funding Through the Clean Water State Revolving Fund (CWSRF):** Since its inception in 1987, the CWSRF has provided over $153 billion in low-cost financing to water quality projects across the nation. In 2009, Congress passed the American Recovery and Reinvestment Act, which required that states allocate at least 20 percent of their annual CWSRF capitalization grant for green infrastructure, water efficiency, energy efficiency, and other environmentally innovative projects. It successfully helped shift federal and state wastewater investment toward projects that utilize green and natural infrastructure and promote holistic approaches to wastewater treatment systems. The Green Project Reserve requirement has been extended via appropriations bills every year, but was reduced in Fiscal Year 2012 to 10 percent annually. In order to create additional certainty and incentive for projects that utilize green and natural infrastructure, Congress should permanently require states to use at least 20 percent of their annual CWSRF capitalization grants for the Green Project Reserve. This will help communities finance green infrastructure projects that address climate change, enhance access to green space, protect wildlife habitat, and improve water quality.

- **Ensure Hazard Mitigation Programs Support Natural Solutions:** Hazard mitigation programs at FEMA, HUD, and through the National Flood Insurance Program are significant potential sources of resources for nature-based hazard risk reduction. Although natural infrastructure projects are eligible for many of these programs, challenges exist that impede successful applications for nature-based projects, including in the context of Benefit Cost Analyses and feasibility demonstration requirements. FEMA should continue work to ensure that the Benefit Cost Analysis toolkit is supportive of different nature-based project types, and allows communities to capture the full array of their benefits. The agency should also work to provide communities with additional detailed guidance on designing and successfully applying for funding for nature-based projects. These improvements should be accompanied by additional technical assistance and capacity building support to ensure that all communities benefit from this solution set to improve health and safety. Congress should support expanded consideration of natural solutions for hazard mitigation by requiring at least 15% of funding through the Building Resilient Infrastructure and Communities (BRIC) program to be designated for nature-based projects, and/or by authorizing and directing FEMA to partner with the National Fish and Wildlife Foundation (NFWF) to establish a demonstration grant program designed to fund nature-based projects through FEMA hazard mitigation dollars. By encouraging FEMA to partner with NFWF, Congress can bring NFWF's unique expertise to efforts to promote nature-based mitigation projects, build capacity at all levels of government, and help to further demonstrate the efficacy and multiple benefits delivered by these types of projects. Additionally, NFWF has flexibility to build public private partnerships to support natural infrastructure projects and to leverage private sector funding to support added investment. Finally, Congress can support natural solutions by fully reauthorizing and reforming the National Flood Insurance Program (NFIP) to ensure NFIP premiums communicate accurate levels of risk, with means-tested assistance for those who cannot afford actuarial rates; expanding

pre-disaster mitigation efforts, including through nature-based solutions; and increasing funding available for updated and climate-informed floodplain maps.

- **Increase Funding Available for Gulf Coast Restoration and Resilience:** Congress should increase offshore energy revenues shared with Louisiana and other states under the Gulf of Mexico Energy Security Act (GOMESA), including by lifting the current cap on revenues shared. The State of Louisiana, through a constitutional amendment, has committed these revenues to restoration and resilience efforts, including implementation of the state's Coastal Master Plan. With no time to lose in the battle against sea level rise and coastal land loss, additional GOMESA revenues are vital to continue the essential and urgent work that this funding stream has enabled.

- **Mississippi River Restoration and Resilience Initiative:** Congress should pass H.R. 4202, the Mississippi River Restoration and Resilience (MRRRI) Act, to establish a non-regulatory EPA geographic program for the Mississippi River mainstem states, following the successful model in the Great Lakes. The MRRRI Act centers natural infrastructure solutions that have co-benefits for flood risk reduction, water quality improvements, wildlife habitat, recreation, and other services to communities. It would enhance federal coordination around a shared agenda to improve the overall health and resilience of the Mississippi River, through collaboration with States, Tribes, local governments, and other river stakeholders.

- **Enhance the Capacity of Federal Agencies to Access Needed Climate Adaptation Science:** Over the past decade federal agencies have made important advances in developing their capacity to provide support and climate science to natural resource managers and others charged with the conservation and restoration of the nation's lands, waters, and wildlife. Congress should provide robust budget support to such programs as the U.S. Geological Survey Climate Adaptation Science Center Network, the NOAA Regional Integrated Sciences and Assessments (RISA) Program, and the USDA Climate Hubs. In order to assure the availability of such climate science for natural resource managers, Congress should pass H.R. 6654, the "Climate Adaptation Science Centers Act," which would permanently authorize the U.S. Geological Survey's National and Regional Climate Adaptation Science Centers.

- **Support Ocean-Based Climate Solutions:** Congress should advance solutions that leverage and support the immense climate mitigation and adaptation potential of ocean and coastal ecosystems, which can make coastal communities more resilient and can provide for the conservation and restoration of ocean and coastal habitats, biodiversity, and marine mammal and fish populations. This includes efforts to advance the protection and restoration of blue carbon ecosystems including wetlands, mangroves, kelp, and seagrass, to address challenges with ocean acidification impacts, and to protect and restore coral reef ecosystems that buffer communities.

- **Appropriations and other Spending Packages:** As Congress considers how to fund priorities in Fiscal Year 2023 and beyond, the National Wildlife Federation strongly urges you to ensure that America's lands, waters, and wildlife are not left out of any

future investment package. With hurricane and wildfire seasons fast approaching, communities around the country are bracing for another record-breaking year of extreme weather and natural disasters that devastate local economies, ecosystems, and families. Congress has an opportunity to prevent lost lives and livelihoods with proactive, robust investment in natural infrastructure and natural climate solutions.

During the COVID pandemic, Americans sought refuge outdoors — from neighborhood parks to hiking trails to the most remote wilderness spots in our nation. Families and friends were able to connect safely outside, and millions rediscovered or newly adopted lifelong hobbies like hunting, fishing, and bird watching. However, this increased use — coupled with decades of neglect and underfunding — has strained our forests, wetlands, grasslands, and rivers, as well as the wildlife inhabiting them. It is critical that Congress invest in the restoration and resilience of these shared spaces so that future generations may be able to enjoy them.

Our outdoor heritage is part of the fabric of our society, and it supports an $887 billion outdoor recreation economy. In addition to the economic and societal benefits, these natural landscapes provide a significant opportunity to address the climate crisis, both in adaptation and mitigation. Healthy forests sequester carbon and filter regional water supplies. Resilient shorelines protect communities from storm and flood damage. Removal of invasive species like cheatgrass helps prevent catastrophic fires. Restoration and resilience projects can be tailored to every community in America, improving safety and putting people to work. That's why we're encouraged that the bipartisan IIJA included more than $50 billion for resilience and restoration projects and that the proposed reconciliation package recommends investing an additional $100 billion in on-the-ground work like forest restoration and conservation programs at USDA; public lands, national parks, wildlife habitat, and species recovery through the Department of the Interior; funding for Tribal nations; and coastal resilience initiatives at the Department of Commerce. These resources can flow to communities quickly and make an immediate impact, so long as there is sufficient consultation and permitting staff to efficiently process the project proposals.

Conclusion

Thank you again for the opportunity to testify at this important hearing. Natural infrastructure has the potential to mitigate the threats facing millions of Americans while also conserving and restoring the landscapes and waterways essential to our wildlife heritage and way of life.

The good news is that bipartisan investments in natural infrastructure have already started under your leadership. The bipartisan Infrastructure Investment and Jobs Act made historic investment in natural landscapes essential to our water, wildlife, and way of life — as well as natural infrastructure. The law includes $492 million for the National Coastal Resiliency Fund, a program established in 2018 that invests in restoration and resilience projects that expand natural infrastructure like wetlands and barrier islands. The bill also included $350 million to support the development and construction of wildlife crossings that will improve habitat connectivity and reduce wildlife-vehicle collisions. These investments, from our coasts to our highway system, will save lives.

These investments show Congress has already started to transition toward natural solutions. On behalf of the National Wildlife Federation, our members, supporters, and affiliates, I would urge you to continue down this path. Natural infrastructure is a proven strategy to save lives, protect homes and businesses, conserve and restore our public lands and waters, and practice fiscal responsibility. Thank you and I look forward to your questions.

Endnotes

[1] Glick, P., E. Powell, S. Schlesinger, J. Ritter, B.A. Stein, A. Fuller. 2020. The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction. Washington, DC: National Wildlife Federation: 8-27.
[2] Allen, W., T. Weber, J. Varela, and CMAP Technical Committee. 2014. Green infrastructure vision 2.3: Ecosystem service valuation. Final Report. The Conservation Fund, Chapel Hill, North Carolina, USA.
[3] Costanza, R., O. Pérez-Maqueo, M. Martínez, P. Sutton, S. Anderson, and K. Mulder. 2008. The value of coastal wetlands for hurricane protection. Ambio 37: 241-248.
[4] Gittman, R., A. M. Popowich, J. F. Bruno, and C. H. Peterson. 2014. Marshes with and without sills protect estuarine shorelines from erosion better than bulkheads during a Category 1 hurricane. Ocean & Coastal Management 102: 94-102.
[5] Filippo, F., M. W. Beck, C. Storlazzi, F. Micheli, C. Shepard, and L. Airoldi. 2014. The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature Communications 10.1038/ncomms4794.
[6] Smith, C., R. Gittman, I. Neylan, S. Scyphers, J. P. Morton, F. J. Fodrie, J. Grabowski, and C. H. Peterson. 2017. Hurricane damage along natural and hardened shorelines: Using homeowner experiences to promote nature-based coastal protection. Marine Policy 10.1016/j.marpol.2017.04.013.
[7] Hilke, C., J. Ritter, J. Ryan-Henry, E. Powell, A. Fuller, B. Stein, and B. Watson. 2020. Softening Our Shorelines: Policy and Practice for Living Shorelines Along the Gulf and Atlantic Coasts. Washington, DC: National Wildlife Federation.
[8] Reguero, B. G., M. W. Beck, D. N. Bresch, J. Calil, and I. Meliane. 2018. Comparing the cost-effectiveness of nature-based and coastal adaptation: A case study from the Gulf Coast of the United States. PLOS ONE 10.1371/journal.pone.0192132.
[9] Economic Analysis Predicts Minimum 4-1 Return on Restoring the Everglades Ecosystem.
[10] 11Anonymous. 2013. Green Infrastructure Case Studies. Joint-Industry White Paper. The Nature Conservancy, Dow Chemical, Swiss Re, Shell, Unilever.
[11] Schuster, E. 2014. Lower Cape May Meadows ecological restoration: Analysis of economic and social benefits. Report. The Nature Conservancy, New Jersey Chapter, USA.
[12] Naturally Resilient Communities. Case study: Mingo Creek, Tulsa, OK. White Paper.
[13] Nielsen-Pincus, M., and C. Moseley. 2010. Economic and employment impacts of forest and watershed restoration in Oregon. Ecosystem Workforce Program Briefing Paper Number 24. Institute for a Sustainable Environment, University of Oregon, Eugene, Oregon, USA.
[14] Office of Surface Mining Reclamation and Enforcement. 2019. Report on abandoned mine land reclamation economic development pilot program (AML pilot program) for FY 2016- FY 2018.
[15] Evans, A., S. Auerbach, L.W. Miller, et al. Evaluating the Effectiveness of Wildfire Mitigation Activities in the Wildland-urban Interface. Madison, WI: Forest Stewards Guild.
[16] Botts, H., T. Jeffery, S. Kolk, et al. 2015. Wildfire Hazard Risk Report. Irvine, CA: CoreLogic.
[17] U.S. Forest Service. 2017. Fiscal Year 2018 Budget Justification. Washington, DC: U.S. Department of Agriculture, Forest Service
[18] Safford, H.D., J.T. Stevens, K. Merriam, M.D. Meyer, and A.M. Latimer. 2012. Fuel treatment effectiveness in California yellow pine and mixt conifer forests. Forest Ecology and Management 274: 17-28.
[19] National Fire Protection Association. 2018. Firewise ® USA site in Florida takes on two wildfires and survives. Quincy, MA: National Fire Protection Association.
[20] Collier, S.J., R. Elliott, and T.K. Lehtonen. 2021. Climate change and insurance. Economy and Society 50: 158-172.
[21] For example, a recent study concludes that climate change-induced sea level rise accounted for 13 percent of the damage caused by Hurricane Sandy (approximately $8.1 billion of the $62.5 billion in total damages) and 54 percent of the people affected (71,000 people out of the total of 131,000 people affected). Strauss, B.H., Orton, P.M., Bittermann, K. et al Economic damages from Hurricane Sandy attributable to sea level rise caused by anthropogenic climate change. Nat Commun 12, 2720 (2021). https://doi.org/10.1038/s41467-021-22838-1.
[22] NOAA National Centers for Environmental Information (NCEI) U.S. Billion-Dollar Weather and Climate Disasters (2021) (https://www.ncdc.noaa.gov/billions/), DOI: 10.25921/stkw-7w73 (inland flooding "caused by billion-dollar hurricanes (i.e., Harvey, Florence, Matthew) has also increased").
[23] E&E News, Anne C. Mulkern, Climate drives rise in global damage from storms — study, July 12, 2021; Madakumbura, G.D., Thackeray, C.W., Norris, J. et al. Anthropogenic influence on extreme precipitation over global land areas seen in multiple observational datasets. Nat Commun 12, 3944 (2021). https://doi.org/10.1038/s41467-021-24262-x.
[24] [24] Inside Climate News, New Study Shows Global Warming Intensifying Extreme Rainstorms Over North America, June 2, 2020; Megan C. Kirchmeier-Young, Xuebin Zhang, Human influence has intensified extreme precipitation in North America, Proceedings of the National Academy of Sciences Jun 2020, 117 (24) 13308-13313; DOI:10.1073/pnas.1921628117.
[25] NOAA High Tide Flooding Report, 2021 State of High Tide Flooding and Annual Outlook.
[26] Union of Concerned Scientists. Underwater: Rising Seas, Chronic Floods, and the Implications for US Coastal Real Estate (2018).
[27] Thomas Frank, Flooding Disproportionately Harms Black Neighborhoods, Scientific American (June 2, 2020).
[28] Maya K Buchanan *et al,* Sea level rise and coastal flooding threaten affordable housing, *Environ. Res. Lett.,* 15 124020/ (2020).
[29] National Academies of Sciences, Engineering, and Medicine 2019. Framing the Challenge of Urban Flooding in the United States. Washington, DC: The National Academies Press. https://doi.org/10.17226/25381.

[30] Buchanan *et al,* Sea level rise and coastal flooding threaten affordable housing (see footnote 8).
[31] Gerardo Ceballos, Ehrlich Paul, Raven Peter, Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. Proceedings of the National Academy of Sciences Jun 2020, 117 (24) 13596-13602; DOI: 10.1073/pnas.1922686117 ("The ongoing sixth mass extinction may be the most serious environmental threat to the persistence of civilization, because it is irreversible. . . . the sixth mass extinction is human caused and accelerating. . . . species are links in ecosystems, and, as they fall out, the species they interact with are likely to go also. . . . Our results reemphasize the extreme urgency of taking massive global actions to save humanity's crucial life-support systems.")
[32] Stein, B. A., L. S. Kutner, J. S. Adams eds. 2000. Precious Heritage: The Status of Biodiversity in the United States. New York: Oxford University Press.
[33] Jelks, H. L., S.J. Walsh, N.M. Burkhead, et al. 2008. Conservation status of imperiled North American freshwater and diadromous fishes. Fisheries. 33: 372-407.
[34] Williams, J. D., M. L. Warren, K. S. Cummings, J. L. Harris, and R. J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. Fisheries 18: 6–22; Lydeard, C., R. H. Cowie, W. F. Ponder, et al. 2004. The global decline of nonmarine mollusks. BioScience 54 321-330.
[35] Stein, B. A., N. Edelson, L. Anderson, J. Kanter, and J. Stemler. 2018. Reversing America's Wildlife Crisis: Securing the Future of Our Fish and Wildlife. Washington, DC: National Wildlife Federation.
[36] T.E. Dahl and S.M. Stedman. 2013. Status and trends of wetlands in the coastal watersheds of the Conterminous United States 2004 to 2009. U.S. Department of the Interior, Fish and Wildlife Service and National Oceanic and Atmospheric Administration, National Marine Fisheries Service. (46 pp); Dahl, T.E. 2006. Status and trends of wetlands in the conterminous United States 1998 to 2004. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. (112 pp); Dahl, T.E. 2000. Status and trends of wetlands in the conterminous United States 1986 to 1997. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. (82 pp); Dahl, T.E., and Johnson, C.E., 1991, Status and trends of wetlands in the conterminous United States, mid-1970's to mid-1980's. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. (28 pp).
[37] Report to Congress by the Secretary of the Interior, The Impact of Federal Programs on Wetlands, Volume II, at 145 (1994). Approximately 80 percent of the bottomland hardwood wetlands in the lower Mississippi River basin have already been lost approximately. Report to Congress by the Secretary of the Interior, The Impact of Federal Programs on Wetlands, Volume I at 39.
[38] U.S. Geological Survey, Ecological Health in the Nation's Streams, Fact Sheet 2013-3033 (July 2013); Carlisle, D.M., Meador, M.R., Short, T.M., Tate, C.M., Gurtz, M.E., Bryant, W.L., Falcone, J.A., and Woodside, M.D., 2013, The quality of our Nation's waters—Ecological health in the Nation's streams, 1993–2005: U.S. Geological Survey Circular 1391 (120 pp).
[39] American Rivers, Unnatural Disasters, Natural Solutions: Lessons From The Flooding Of New Orleans (2006) (quoting USACE, from Massachusetts Department of Fish and Game, *Functions of Riparian Areas for Flood Control*, http://www.mass.gov/dfwele/river/pdf/riparian_factsheet_1.pdf.
[40] Narayan, S., Beck, M.B., Wilson, P., et al., The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA. Scientific Reports 7, Article number 9463 (2017), doi:10.1038/s41598-017-09269-z. Available at https://www.nature.com/articles/s41598-017-09269-z.
[41] Bob Marshall, *Studies abound on why the levees failed. But researchers point out that some levees held fast because wetlands worked as buffers during Katrina's storm surge,* The New Orleans Times-Picayune (March 23, 2006).
[42] Glick, P., E. Powell, S. Schlesinger, J. Ritter, B.A. Stein, and A. Fuller. 2020. The Protective Value of Nature: A Review of the Effectiveness of Natural Infrastructure for Hazard Risk Reduction. Washington, DC: National Wildlife Federation, https://www.nwf.org/protective-value-of-nature.
[43] Restore America's Estuaries, *Jobs & Dollars BIG RETURNS from coastal habitat restoration* (September 14, 2011), http://www.estuaries.org/images/81103-RAE_17_FINAL_web.pdf.
[44] Domke, G.M., B.F. Walters, D.J. Nowak, J Smith, S.M. Ogle, and J.W. Coulston. 2019. Greenhouse gas emissions and removals from forest land, woodlands, and urban trees in the United States, 1990-2017. *Resource Update FS-178.* Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station.
[45] U.S. Environmental Protection Agency (EPA). 2019. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2017.* EPA 430-R-19-001. U.S. Environmental Protection Agency: Washington, D.C.
[46] Nowak, D.J., E.J. Greenfield, R.E. Hoehn, and E. Lapoint. 2013. Carbon storage and sequestration by trees in urban and community areas of the United States. Environmental Pollution 178, pp. 229-236.
[47] Wright, Christopher K., and Michael C. Wimberly. 2013. "Recent Land Use Change in the Western Corn Belt Threatens Grasslands and Wetlands." Proceedings of the National Academy of Sciences of the United States of America 110(10): 4134–39.
[48] Cornell Laboratory of Ornithology, State of the Birds 2019, https://www.stateofthebirds.org/2019/download-pdf-report/
[49] National Academies of Sciences, Engineering, and Medicine. 2017. Coastal Blue Carbon Approaches for Carbon Dioxide Removal and Reliable Sequestration: Proceedings of a Workshop— in Brief. Washington, DC: The National Academies Press. doi.org/10.17226/24965.
[50] Mulligan, J., et al. 2020. CarbonShot: Federal Policy Options for Carbon Removal in the United States. Working Paper. Washington, DC: World Resources Institute.