

# **National Seed Strategy**

## **for Rehabilitation and Restoration**



# **Progress Report**

## **for 2022 and 2023**



The Plant Conservation Alliance (PCA) is a collaboration of public and private partners who share the same goal: to protect native plants by ensuring that native plant communities and their habitats are maintained, enhanced, and restored. The PCA Federal Committee, now chaired by the U.S. Fish and Wildlife Service, developed the “National Seed Strategy for Rehabilitation and Restoration” in cooperation with federal and non-federal partners.

This publication is dedicated to all the hardworking botanists, ecologists, farmers, and community members who are on the frontline of protecting, conserving, and restoring native plant communities throughout the United States.

For more information on the Plant Conservation Alliance and its members and activities, please visit [www.blm.gov/pca](http://www.blm.gov/pca).

Copies of this publication may be obtained online at [www.blm.gov/seedstrategy](http://www.blm.gov/seedstrategy).

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## Introduction

The National Seed Strategy (Seed Strategy; PCA 2015) was developed in 2015 by 12 federal agencies and 300+ cooperators of the Plant Conservation Alliance (PCA) to address a national shortage of native seed and other native plant materials (hereafter referred to as native seed). Native seed is an essential ingredient for conserving and restoring healthy, resilient, biodiverse ecosystems. The United Nations has declared 2021-2030 the Decade on Ecosystem Restoration, and the restoration needs in the U.S. are growing dramatically. The effects of extreme weather events, wildfires, floods, and drought are compounded by climate change and widespread ecosystem disturbance. Restoration with native seed is a nature-based solution that benefits the environment by buffering against extreme weather events and natural disasters, enhancing habitat, safeguarding food and drinking water, sequestering carbon, and mitigating the effects of climate change. Restoring with native seeds is also of cultural importance to safeguarding traditional foods and cultural practices. As this report shows, the Native Seed Development Process has wide-reaching socioeconomic benefits by creating jobs, supporting local agronomic economies, and training the next generation of the ecological restoration workforce and land stewards.

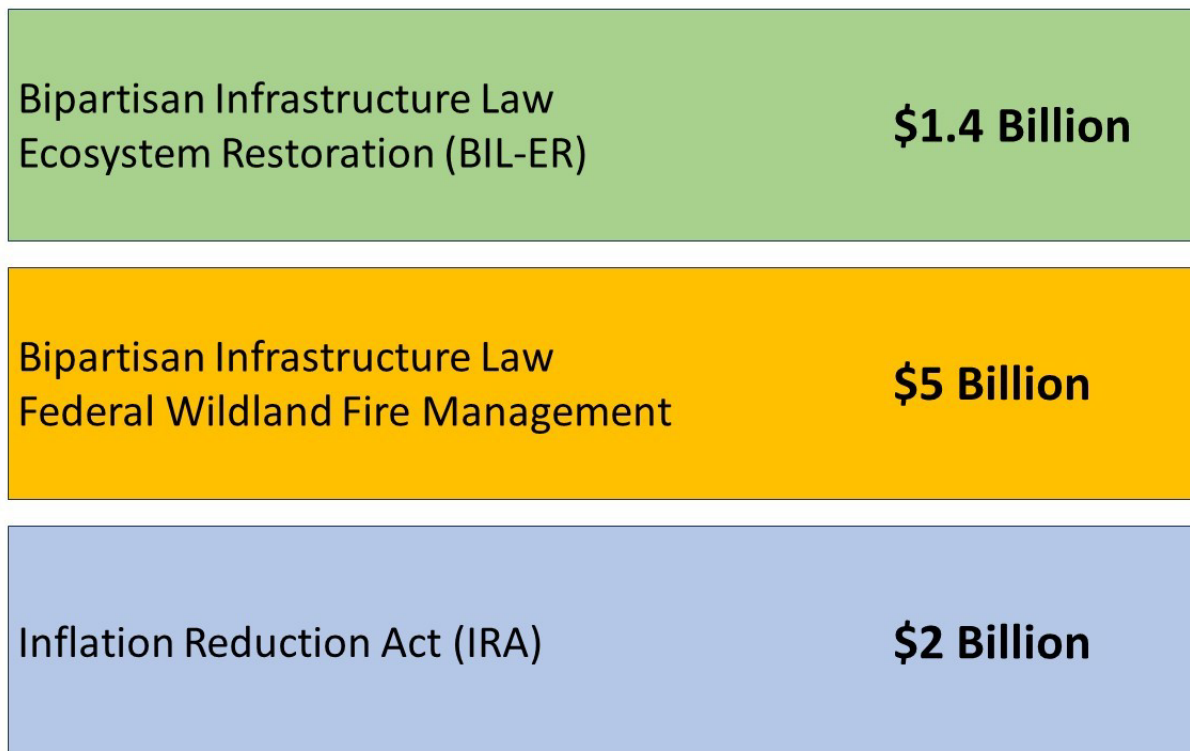
This Progress Report for 2022 and 2023 is the third in a series highlighting the accomplishments of federal agencies and their partners in achieving the goals of the Seed Strategy. It also outlines future steps for implementing the Seed Strategy. Our progress since 2015 underscores the Seed Strategy's importance in meeting the nation's needs for resilient restoration. This report highlights how Administration and Departmental priorities have significantly advanced the implementation of the Seed Strategy and demonstrates how interagency efforts have aligned with and contributed to these priorities, as well as addressed recent recommendations from the National Academies of Sciences, Engineering, and Medicine (NASEM).



**Photo 1.** High Mesa Grassland Wilderness Study Area in Colorado, Credit: Bob Wick, BLM.

**Key Legislative and Departmental Advancements Supporting Seed Strategy Implementation:** The Biden-Harris Administration’s *Investing in America* agenda has prioritized conservation and restoration through key legislative measures that strengthen implementation of the Seed Strategy (see Figure 1). The Bipartisan Infrastructure Law (BIL), enacted in November 2021, allocated \$1.4 billion for Ecosystem Restoration (BIL-ER) over five years. Recognizing the Seed Strategy’s critical role in conserving and restoring healthy, resilient ecosystems, this law directed \$200 million toward native plant community restoration projects associated with the Seed Strategy, distributing \$70 million to the Department of the Interior (DOI) and \$130 million to the U.S. Department of Agriculture Forest Service (USFS). In addition, to support wildland fire management, BIL also allocated \$3.5 billion to USFS and approximately \$1.5 billion to the DOI. The DOI invested \$325 million of these funds to prioritize native plant materials development to support BIL-Burned Area Rehabilitation (BIL-BAR). Another significant piece of legislation, the Inflation Reduction Act (IRA), enacted in August 2022, provided DOI with \$2 billion to restore lands and waters and enhance climate resilience. This funding included \$17.6 million for the development of an interagency Seeds of Success Seedbank and several ecoregional hubs to enhance the diversity and quantity of native seeds available for commercial production by growers.

In December 2023, the DOI demonstrated its strong support for the Seed Strategy by establishing the National Seed Strategy Keystone Initiative (NSSKI) and developing an Action Plan (DOI Action Plan). This plan outlines DOI priorities and the necessary steps to achieve the Seed Strategy’s goals and to address the recommendations of the NASEM Report, *An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report* (NASEM 2023).



**Figure 1.** The *Investing in America* legislative agenda allocated portions of these funding sources to implement the Seed Strategy, addressing the nation’s native seed needs for ecosystem restoration, burned area rehabilitation, and advancing climate resilience.

## Methods

The information in this report was gathered through a voluntary data collection effort focused on projects supporting the Seed Strategy during Fiscal Years (FY) 2022 and 2023 (hereafter, 2022 and 2023) and Agency Summaries. The request for information was distributed to PCA federal agencies in early 2024 and the agency summaries were submitted by PCA federal liaisons who were invited to summarize their contributions and accomplishments in implementing the Seed Strategy in 2022 and 2023. To stay compliant with the Paperwork Reduction Act– requiring that federal agencies obtain approval before collecting information from the public– this report was directly informed only by information from federal employees. However, all projects reported here include significant contributions from non-federal PCA partners. There has been a significant contribution by many of the PCA Cooperators (400+) who are supporting or conducting seed collection, seed production, and research, all of which implements the Seed Strategy.

Progress is underrepresented in this report because it relies solely on the voluntary submission of information from federal agencies and does not represent submissions from all our non-federal partners. The total effort to implement the Seed Strategy far exceeds the 176 projects reported herein. Capacity constraints of federal agencies may have hindered the ability to report effectively. The lack of plant programs, shortage of botanical staff (plant ecologists, seed scientists, restoration ecologists, etc.), and few dedicated full-time employees to implement the Seed Strategy remain as major obstacles.



**Photo 2.** Shortbur seablush (*Plectris congesta*) in a field of common camas (*Camassia quamash*) near Lower Table Rock in southwest Oregon. Credit: Tuula Rebhahn, The Understory Initiative.

## Major Accomplishments in 2022 and 2023

During this period, 20 federal agencies and partners contributed to 176 projects aimed at implementing the Seed Strategy. Many projects were national in scope and addressed all phases of the Native Seed Development Process (Figure 2). Over half the projects involved interagency collaboration, including partnerships with more than 40 Tribal Nations and organizations, as well as 251 non-federal partners (Appendix 1). This collaboration highlights the effectiveness of uniting agencies and partners to pursue shared objectives and develop collective solutions to natural resource challenges. Accomplishments from 2022 and 2023 include over 1,900 native seed collections, 59 research publications (see Appendix 2), and more than 98 restoration projects. Additionally, more than 35 projects received funding through BIL or IRA legislation, ensuring continued support for this critical work in the coming years.



**Figure 2. Accomplishments in Native Seed Development.** Submissions reflect advancements made at every stage of the Native Seed Development Process, including: **Collection**, where native seeds are harvested from wild populations, cleaned, tested and banked for both long-term conservation and immediate seed increase; **Evaluation and development**, which involves research on species traits such as germination, pollination, and seed transfer zones; **Field establishment**, where agricultural protocols are developed for growing seed; **Production**, in which seeds are increased through agricultural practices; **Procurement**, where seeds are tested and purchased; **Storage**, where increased seeds are preserved for future restoration and rehabilitation; and **Restoration**, where native seeds are used to restore native plant communities.



***An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report*** was released in December 2023 by the National Academies (hereafter NASEM Report, NASEM 2023). The NASEM Report was commissioned by the Bureau of Land Management (BLM) to fulfill Objective 1.1 of the Seed Strategy: *Assess the seed needs of federal agencies and the capacity of private and federal producers*. Authored by a committee of experts appointed by the National Academies, the NASEM Report provides an independent evaluation of the needs and capacity for supplying native plant seeds for ecological restoration in the United States. It summarizes input from over 400 federal and state agencies, Tribal Nations, and seed suppliers and includes 10 recommendations for improving the Nation’s native seed supply (Table 1). Since its release in 2023, the NASEM committee has given more than 12 formal briefings on the report, including at the request of 5 federal agencies.

**Table 1.** Recommendations to strengthen the native seed supply from the National Academies of Sciences, Engineering, and Medicine Report, [An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report](https://nap.nationalacademies.org/catalog/26618/an-assessment-of-native-seed-needs-and-the-capacity-for-their-supply) (<https://nap.nationalacademies.org/catalog/26618/an-assessment-of-native-seed-needs-and-the-capacity-for-their-supply>).

<p><b>Recommendation 1.0:</b> The leadership of the Departments of the Interior (DOI), Agriculture (USDA), and Defense (DOD) should move quickly to establish an operational structure that facilitates sustained interagency coordination of a comprehensive approach to native plant materials development and restoration.</p>	<p><b>Recommendation 6.0:</b> The federal government should commit to an expanded research and development agenda aimed at expanding and improving the use of native seeds in ecological restoration.</p>
<p><b>Recommendation 2.0:</b> Federal land-management agencies should participate in building regional programs and partnerships to promote native plant materials development and native plant restoration, helping to establish such regional programs in areas where they do not yet exist.</p>	<p><b>Recommendation 7.0:</b> Federal agencies and other public and private partners, including seed suppliers, should collaborate on expanding seed storage and seed-cleaning infrastructure that can be cooperatively cost-shared regionally.</p>
<p><b>Recommendation 3.0:</b> The Bureau of Indian Affairs should work with the Inter-Tribal Nursery Council to promote and expand tribal nurseries.</p>	<p><b>Recommendation 8.0:</b> The BLM’s Seed Warehouse System needs to be expanded, particularly in its capacity for cold storage, and supported by staff with up-to-date knowledge of seed science to manage the seed inventory.</p>
<p><b>Recommendation 4.0:</b> The public agencies that purchase native seed should assist suppliers by taking steps to reduce uncertainty, share risk, increase the predictability of purchases, and help suppliers obtain stock material.</p>	<p><b>Recommendation 9.0:</b> BLM should identify and conserve locations in which native plant communities provide significant reservoirs of native seeds for restoration.</p>
<p><b>Recommendation 5.0:</b> Federal land-management agencies should work with their regional partners to launch an outreach program to provide seed suppliers with critical tools and information.</p>	<p><b>Recommendation 10.0:</b> The Plant Conservation and Restoration Program (PCRP) should be empowered with the capacity to plan and oversee restoration and to build stocks of seed.</p>

**The National Native Seed Conference** was held from March 27-31, 2023, in Washington, D.C. Hosted and organized by the Institute for Applied Ecology, the event connected seed scientists, commercial seed industry leaders, land managers, and restoration professionals from federal and non-federal sectors. With the theme of “Cultivating the Restoration Supply Chain,” the conference provided a platform for exchanging scientific research findings and best practices in restoration, fostering regional seed partnerships, and addressing the shortage of native seeds needed for U.S. restoration efforts.

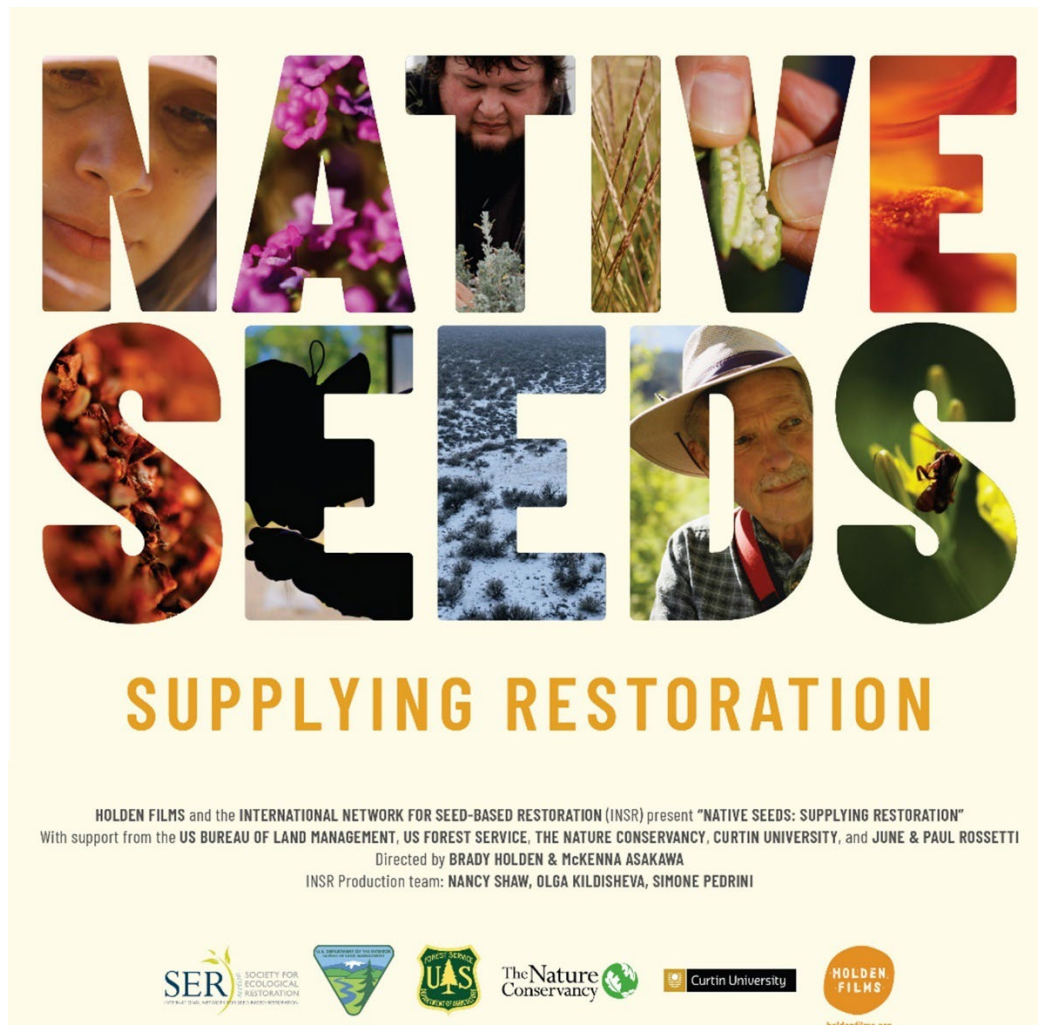
This conference was timely, amid global recognition of the importance of restoring resilience to ecosystems as acknowledged by the U.N. Decade on Ecosystem Restoration (2021-2023; [www.decadeonrestoration.org](http://www.decadeonrestoration.org)). Sponsored by the BLM, U.S. Fish and Wildlife Service (USFWS), USFS, Natural Areas Association, National Wildlife Federation, Hedgerow Farms, and United Plant Savers, the conference attracted over 500 attendees from 44 U.S. states, Puerto Rico, and 8 countries including Australia, Brazil, Canada, England, Finland, Germany, and Korea. With more than 170 presentations delivered by over 200 speakers, topics included western perspectives and Traditional Ecological Knowledge on issues ranging from wild seed collection, seed quality, dormancy, germination, and seed-based restoration in a changing climate. For more information, please visit the [2023 Native Seed Conference website](https://appliedeco.org/2023-native-seed-conference/) (<https://appliedeco.org/2023-native-seed-conference/>).



**Photo 3.** 2023 National Native Seed Conference reception at the United States Botanic Garden, credit: Anna Lindquist, BLM.

**"Native Seeds: Supplying Restoration"** debuted in 2023 as both a nine-part video series and a feature-length documentary film exploring the native seed supply chain across the western U.S. Filmed over four seasons, the series integrates footage of seed collectors, farmers, researchers, and land managers collaborating to enhance the native seed supply chain and meet increasing restoration demands. The film covers various aspects of the native seed supply chain, including planning, collection, production, pollination, seed cleaning and storage, seed testing and certification, seeding treatments and technologies, and planting.

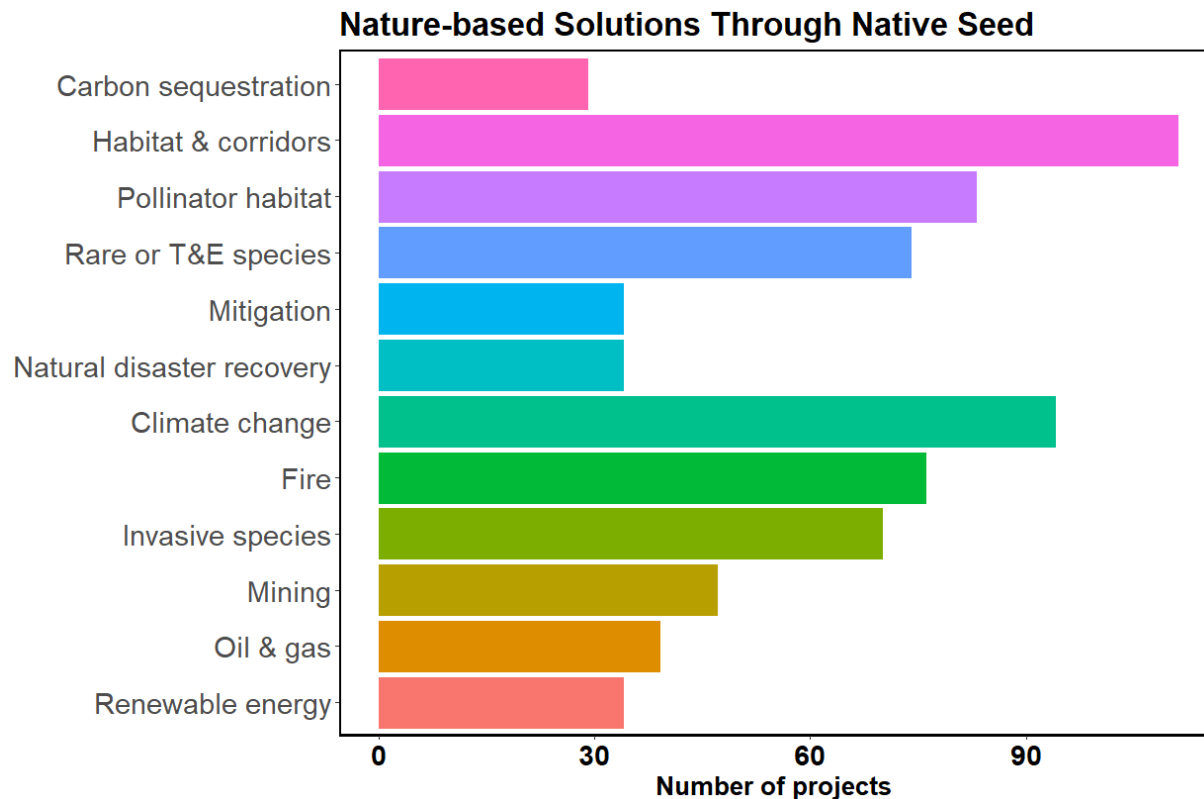
Produced by the International Network for Seed-Based Restoration (INSR) and Holden Films, the project received support from organizations such as BLM, USFS, The Nature Conservancy, Curtin University, and June & Paul Rossetti. As of June 2024, the film and the videos have been screened or viewed over 30,000 times, and the film has been translated into Mandarin. Both the feature-length film and series of 9 videos are available for viewing on the [Society for Ecological Restoration-INSR website \(https://ser-insr.org/native-seed-film\)](https://ser-insr.org/native-seed-film).



**Figure 3. Movie poster for *Native Seeds: Supplying Restoration*.** The feature-length film premiered at the 2023 National Native Seed Conference.

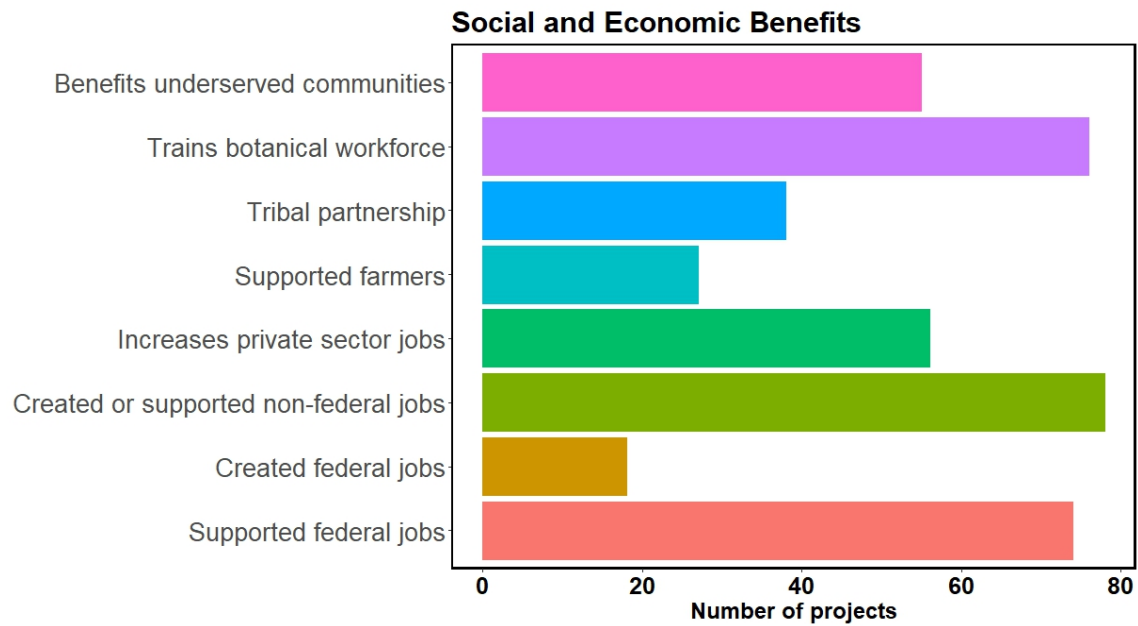
## How do projects benefit the environment, society, and the economy?

Ecological restoration involves restoring native plant communities, which serve as the foundation of ecosystems. Restoration with native seed provides nature-based solutions to address ecological challenges (Figure 4) and to benefit communities (Figure 5). As seen in Figure 4, 73% of the 2022 and 2023 projects address habitat restoration, including for pollinators and rare or T&E species (Threatened & Endangered Species), while 63% of the projects focused on natural disaster recovery, climate change, and fire. Ensuring an adequate supply of native seed for ecological restoration is a climate-adaptation strategy, as native plant communities sequester carbon in plant tissue and soils and can mitigate the effects of climate-driven disturbances like wildfire, drought, and flooding.



**Figure 4. Nature-based solutions through native seed to address ecological challenges.** In addition to habitat restoration and disaster recovery, 35% of the projects requiring native seed address mitigation, mining, oil & gas, and renewable energy. This demonstrates the need for native seed spans many types of activities, from conservation to mitigation. T&E refers to Threatened and Endangered Species.

Implementing the Seed Strategy generates a spectrum of socioeconomic benefits, strengthens the restoration economy, and actively works towards environmental justice. As seen in Figure 5 and Photos 4-6, increasing the supply of native plants for restoration creates jobs, trains the workforce, and benefits growers and seed producers. Moreover, it creates economic opportunities for underserved communities, including historically marginalized rural or agricultural communities and Tribal Nations that depend on healthy ecosystems. Developing and using locally adapted native seed for restoration will boost climate change resilience within these communities. As seen in Figure 5, 82% of the projects created or supported jobs and 45% benefitted underserved and rural communities, including Tribal partnerships & farmers.



**Figure 5. Social and economic benefits of native seed projects** including supporting underserved communities through workforce training, partnerships with Tribal Nations, and support for growers, while increasing private sector employment and creating or supporting non-federal and federal jobs.



**Photo 4.** The Snake River Correctional Institute crew from the Sagebrush in Prisons Project celebrate preparing sagebrush seedlings for restoration. The Sagebrush in Prisons Project is an environmental partnership between the Institute for Applied Ecology, Department of Corrections, and Bureau of Land Management. In addition to producing plants for restoration, the Sagebrush in Prisons Project provides unique and meaningful ecological activities and horticultural training to incarcerated people, allowing them to develop skills that are relevant to environmental jobs upon release. Credit: The Institute for Applied Ecology.



**Photo 5.** Fort Belknap Indian Community (FBIC) Community Conservation Fellows celebrate a successful field season at a closing ceremony. The FBIC, BLM, and Society for Ecological Restoration Seeds of Success Native Seed and Grassland Restoration Project includes seed collection through Seeds of Success, ecological monitoring, and ecological restoration with a focus on Traditional Ecological Knowledge (TEK) on BLM and adjacent FBIC lands on Montana's Northern Great Plains. By bridging the gap between TEK and Western science, this program advances social justice and supports the wellbeing to Native American community by providing education, job training, and jobs. Credit: Erin LeMere, Rezolution Photos.

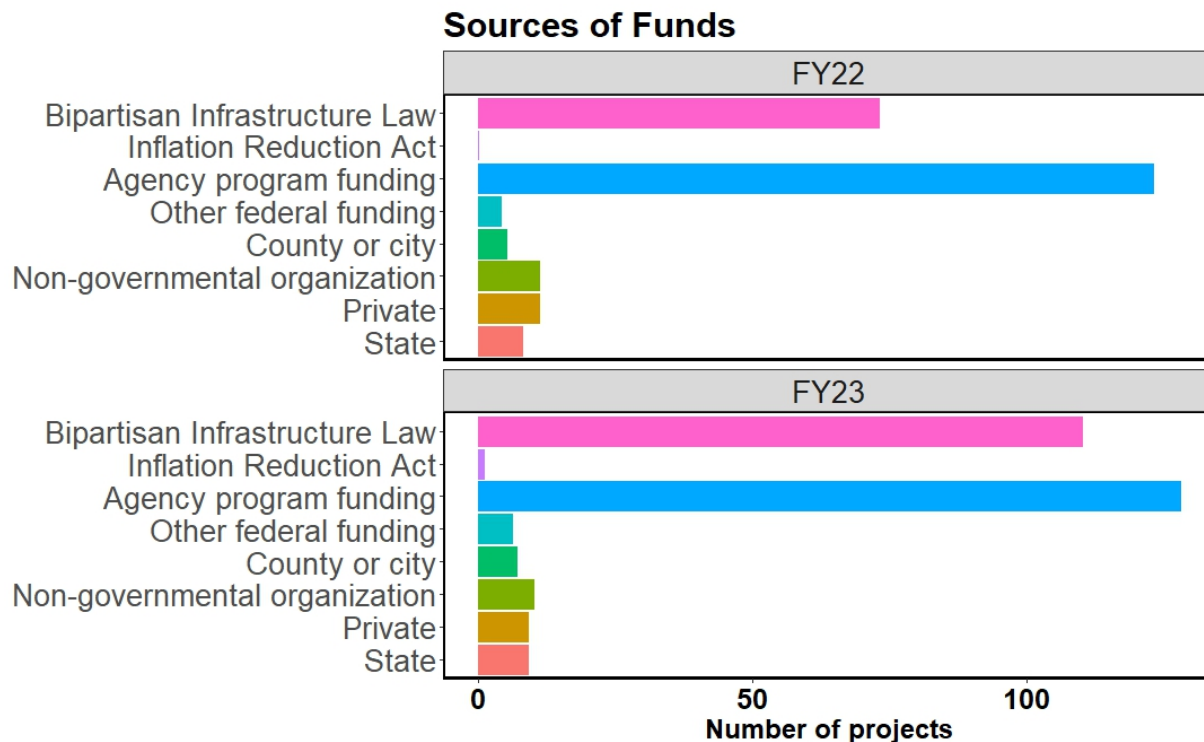


**Photo 6.** Implementing the Seed Strategy creates jobs and provides career-building opportunities for students and early career professionals. Here, Washington State University students transplant Indian ricegrass (*Achnatherum hymenoides*) accessions for the Plant Germplasm Introduction and Testing Research Unit of the USDA Agricultural Research Service (ARS) National Plant Germplasm System (NPGS). The NPGS is a collaborative effort to safeguard the genetic diversity of agriculturally important plants. Indian ricegrass plants are being grown to replenish/regenerate seed in the genebank collection and to characterize genetic structure and diversity. Understanding the collection's genetics allows for more effective conservation and management. Credit: Bailey Hallwachs, ARS.

### How were projects funded?

Federal agencies reported over \$100.9 million in projects to implement the Seed Strategy in 2022 and 2023. Agency program funds were responsible for most project funding, followed by BIL funds (Figure 6). IRA funds were not yet allocated to most agencies during the reporting period, which means that few IRA investments were reported. Almost half of the projects received in-kind funding, where organizations provide staff or volunteer hours or supplies to help with projects. However, in-kind funding is not easily quantifiable and so are not reflected in Figure 6.

The influx of funds to implement the Seed Strategy through BIL and programmatic funding increased the average annual investment for 2022-2023 to \$50.4 million per year, an increase from the average annual investment of \$33.4 million per year, as reported in the 5-year progress report of 2015-2020 (PCA 2021). Increased national investments through BIL, IRA, and enhanced programmatic funding are essential to support these efforts. However, the National Seed Strategy Business Plan (Olwell & Bosak, 2015) projected that approximately \$72 million annually would be required to achieve the Seed Strategy’s objectives during its initial five-year period. Adjusted for inflation, the Business Plan estimate in today’s dollars approaches \$95 million annually. Securing funding to develop and use native seed for ecological restoration is crucial for preserving and improving resilient ecosystems in a changing climate. Each dollar invested in implementing the Seed Strategy contributes to resilient native plant communities, thus helping to maintain and enhance biodiversity.



**Figure 6. Sources of funds** for native seed projects in 2022 and 2023. These data include projects submitted to the 2022 and 2023 data call and data from the USFS Agency Summary.

### Where are projects located?

Projects occurred at national, regional, and local scales in all 50 U.S. states (Figure 7). These projects were carried out on federal, Tribal, state, and private lands. Nearly 40% of projects boundaries spanned multiple land management types, and nearly half were conducted on non-federal lands. This demonstrates that federal investments and funding allocated to implement the Seed Strategy supports conservation efforts and native seed development across various types of land management, not limited to federal lands alone. This pattern reflects an inclusive approach to native seed development and ecosystem management that involves partnerships with diverse land managers and landowners.

Most projects were concentrated in the western U.S. (Figure 7), reflecting the extensive amount of federally managed lands in that region, as well as the significant effort and funding dedicated to it. Additionally, western states often face considerable threats from wildfires, droughts, and shifting precipitation patterns, which jeopardize native plant populations and necessitate conservation efforts.

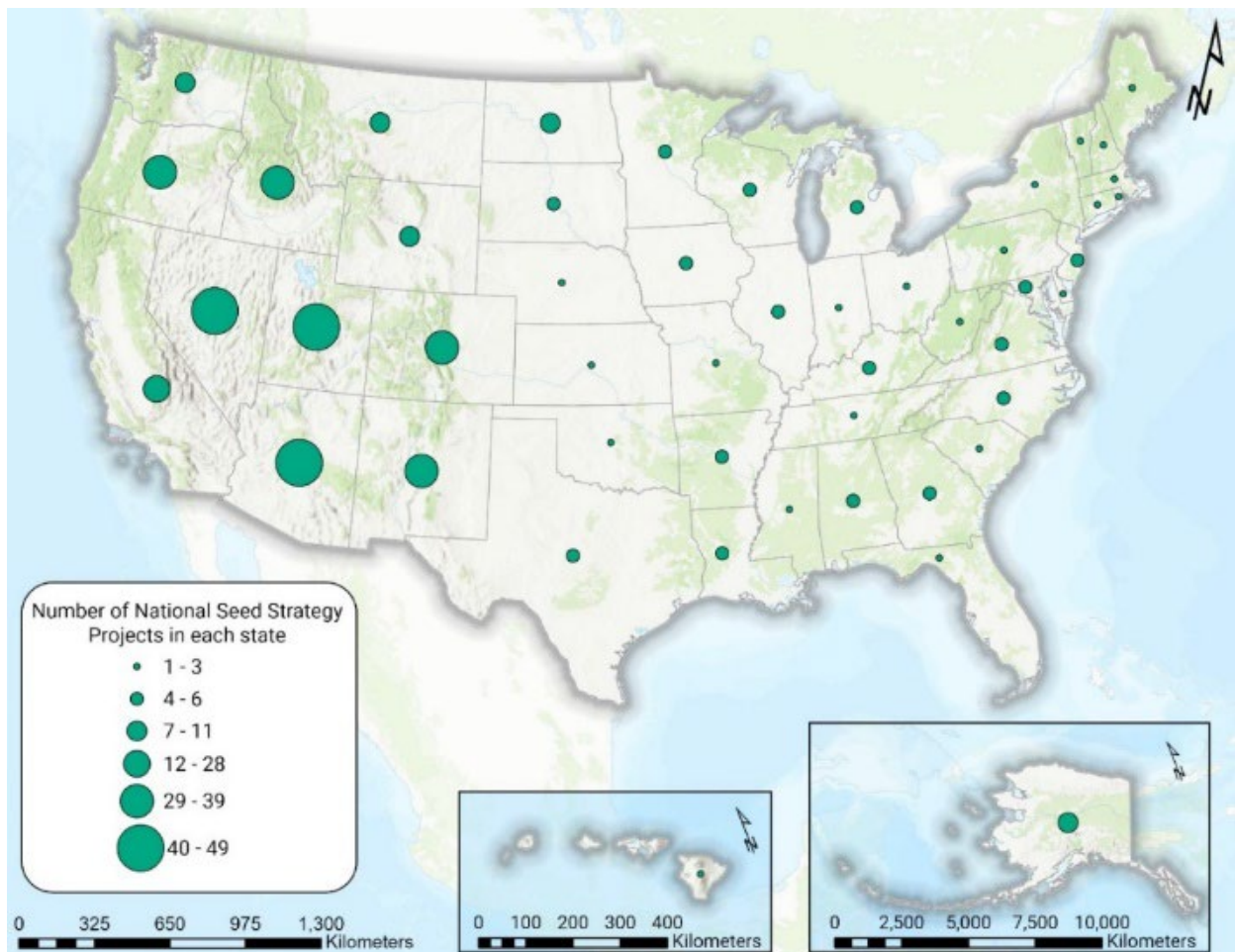
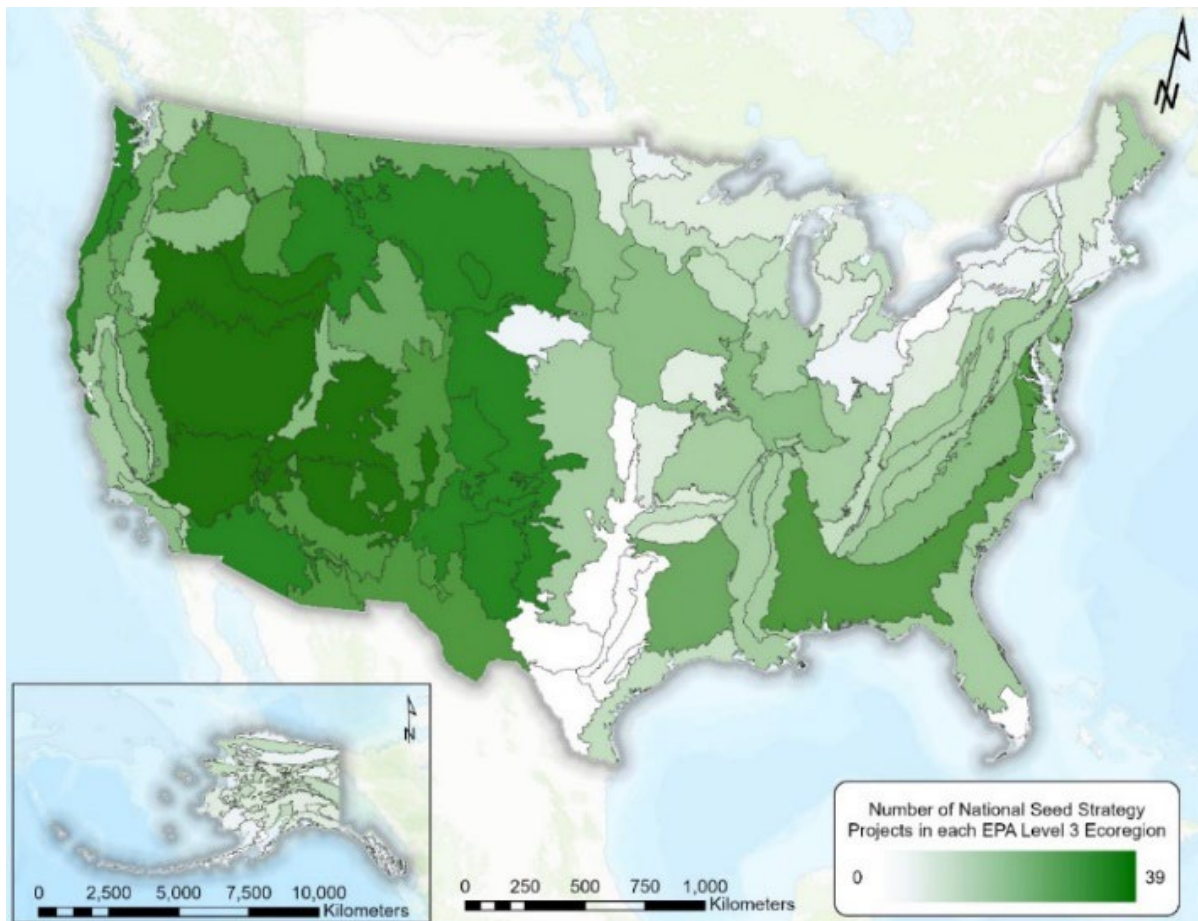


Figure 7. Project locations and frequency by U.S. state.



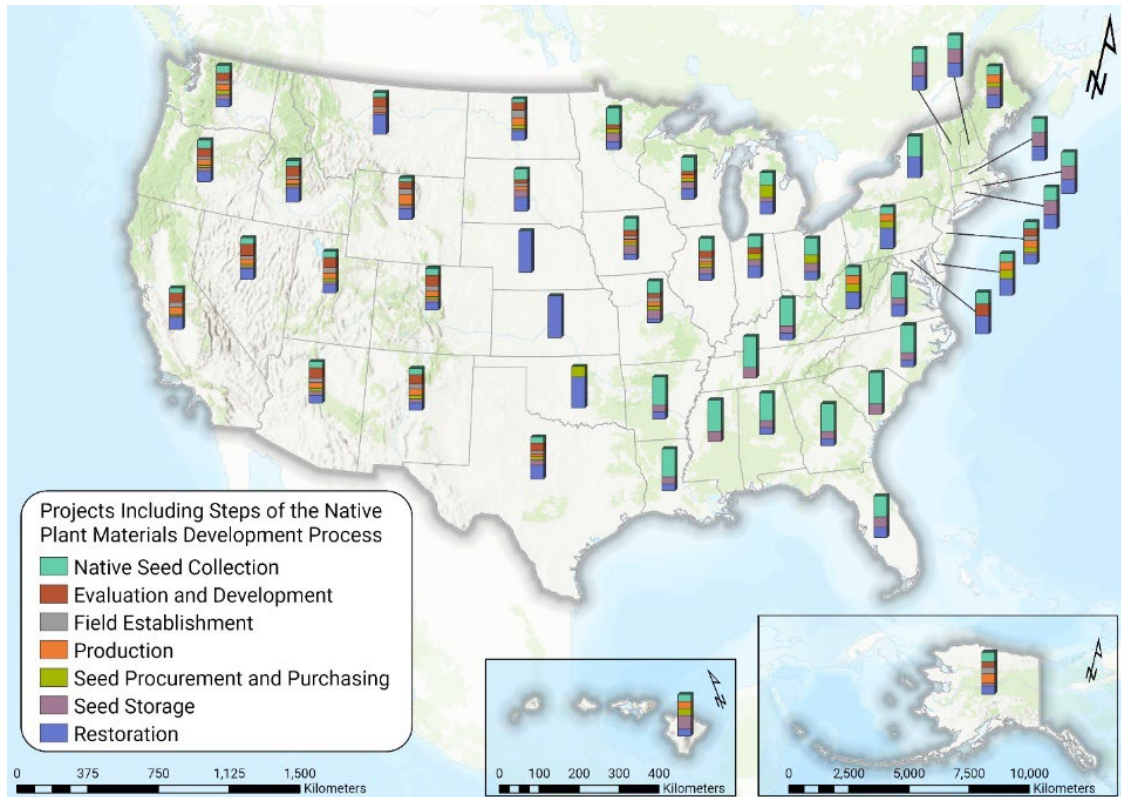
Accomplishments in 2022 and 2023 also reflect significant efforts in the Great Basin, Colorado Plateau, Mojave Desert, and Southeastern United States, where regional native plant programs have been developed and funded since 2001, 2007, 2016, and 2020, respectively (see Figure 8). These ecoregions provide a spatial framework for research, management, and monitoring. Plants do not follow political boundaries like states or counties; instead, they thrive in specific environmental conditions found in ecoregions, such as temperature and precipitation. Land managers and researchers commonly use Environmental Protection Agency (EPA) Level 3 Ecoregions (Omernik 1987) to assess ecosystems and monitor native plant communities.

Another significant accomplishment is the expansion of native plant partnerships and programs, which supports Recommendation 2.0 of the NASEM Report. These include the Dine Native Plants Program, Great Basin Native Plant Project, Nevada Native Seed Partnership, Rogue Native Plant Partnership, Southwest Seed Partnership, Texas Native Seeds Program, and the Umpqua Native Plant Partnership (Appendices 1, 2). Native plant programs facilitate collaboration between federal and non-federal entities for regional seed collection, production, and ecological restoration. Such partnerships are essential for advancing the Seed Strategy, promoting resource sharing, and fostering a unified approach across regions and ecoregions.



**Figure 8. Project locations by EPA Level 3 Ecoregions.** Projects occurred in 94 of the Nation’s 105 EPA Level 3 Ecoregions.

Figure 9 illustrates regional trends in states prioritizing various steps of the Native Seed Development Process. Recall that there are multiple steps to this process (Figure 2), which include seed collection, evaluation and development, field establishment, production, procurement, storage, and restoration. Projects focused on seed collection in the southeast, restoration in the Great Plains, and a more comprehensive approach in other areas to address multiple steps in the process. Understanding these trends is essential for developing effective conservation strategies and optimizing resource allocation.



**Figure 9.** State trends in the Native Seed Development Process. The bars in each state represent the proportion of projects contributing to each step of the Native Seed Development Process in that state.

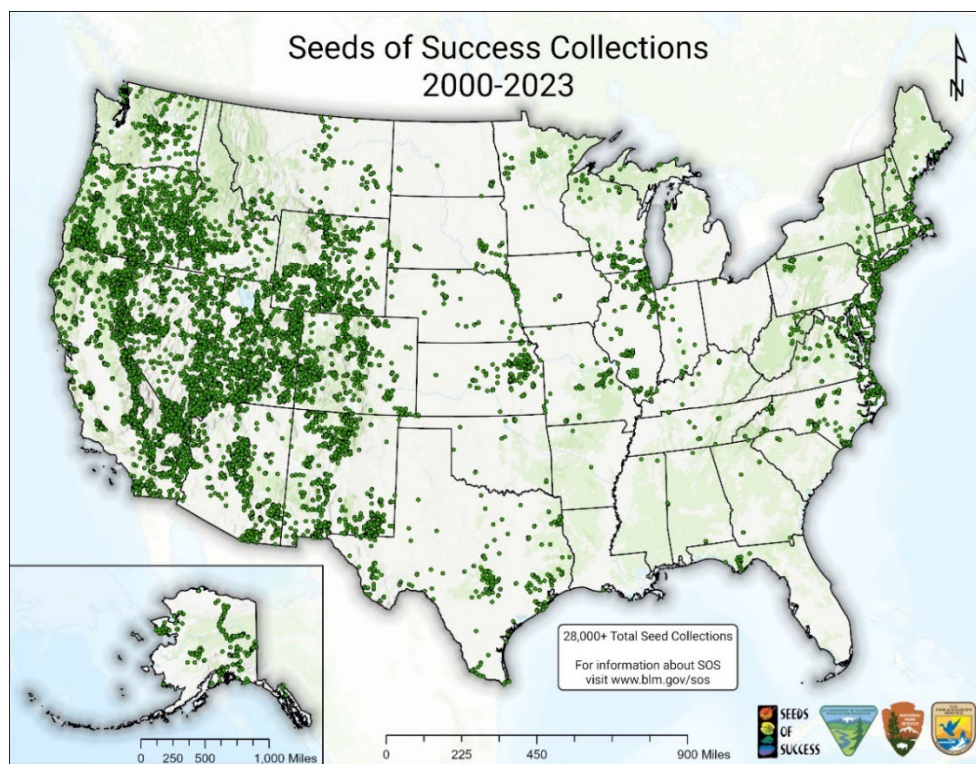


**Photo 7.** Seeds of Success collection of sturdy bulrush (*Bolboschoenus robustus*) in Louisiana. Credit: SOS FWS0402.

## Spotlight on: Collection

Collecting seed from wild native plant populations is the first step in the Native Seed Development Process. Over 80 projects involved seed collection, which represents about half of the 2022 and 2023 projects. Respondents reported over 1,900 native seed collections in 2022 and 2023, with 90% collected through the Seeds of Success (SOS) program, underscoring its significant contribution to national native seed efforts. The SOS program is a native seed collection program led by the BLM in collaboration with the National Park Service (NPS) and USFWS. These agencies work in close partnership with other federal agencies, Tribal Nations, and non-federal partners on seed collection, cleaning, testing, seed storage, data management, processing voucher specimens, and more. The SOS mission is to collect wildland native seed for ecosystem restoration, germplasm conservation, and for research on genetics, germination, and planting strategies. Since 2000, SOS collection teams have made over 28,000 collections from 49 U.S. States (Figure 10; Table 2). Recognized as a Justice40 covered program, SOS addresses the needs of communities disproportionately affected by pollution and climate change.

In this two-year time frame, 87 federally led SOS collection teams made over 1,700 native seed collections from 51 unique taxa that had not been collected before, including expanded collection efforts throughout the eastern U.S. (Table 2). Seed collection teams typically contain 2-3 people, and often employ students or early career professionals. The 2022 SOS collection season presented both opportunities and challenges, as continued drought in the West made finding viable seed difficult. Nevertheless, teams were able to make a considerable number of collections. Since many collections were made during the drought, these seeds may play a key role in developing native plant materials that are more resilient to dry conditions.



**Figure 10. Seeds of Success collections from 2000-2023.** Each green dot represents an individual SOS collection from all SOS participating agencies.

In 2023, SOS expanded with the signing of a Memorandum of Understanding (MOU) between three land managing DOI agencies: BLM, NPS, and USFWS. The MOU demonstrates a commitment across the three agencies to collaborate on this national effort and streamline coordination, find efficiencies, and maximize impact using the established science-based SOS framework to achieve mutually beneficial outcomes, namely:

- Working together to collect, conserve, and restore native plant communities and wildlife habitats across the United States;
- Ensuring the availability of more genetically appropriate native seed needed to meet our restoration needs; and
- Achieving our missions to maintain the health, productivity, and diversity of public lands to meet the needs of present and future generations.

The 2023 SOS collecting season benefitted from strong collaboration among BLM, USFWS, and NPS and favorable weather conditions, including a wet spring in the West and a heavy monsoon season, which facilitated numerous unique collections of underrepresented annuals and other species. In Alaska, BLM teams collected many crucial taxa, including several rarely gathered from tundra habitats, filling critical gaps in seed banking and restoration seed supply. The growing season in Alaska was three weeks ahead of schedule, underscoring the importance of these collections in the face of climate change. The earlier growing season in Alaska indicates shifts in climate patterns, which can affect plant life cycles and ecological balances. Collecting seeds during this time is crucial for ensuring the availability of native species that can adapt to these changes, thereby supporting ecosystem resilience and restoration efforts in a rapidly changing environment.

In the Midwest and Southeast, partnerships between USFWS and non-federal partners facilitated collecting in new states and ecoregions, resulting in the first SOS collections in Alabama, Georgia, Louisiana, Mississippi, South Carolina, and Tennessee while expanding efforts throughout the eastern U.S. These collections not only increased the representation of regional flora but also strengthens conservation efforts in ecosystems that are often underrepresented.

The NPS contributed their first SOS collections with 81 collections across Alaska, California, New Mexico, North Dakota, and South Dakota. Similarly, the NPS's first SOS collections across multiple states help to fill gaps in seed banking and support ecological restoration efforts. Together, these efforts contribute to a more comprehensive national native seed supply, which is vital for addressing the impacts of climate change and habitat loss.

**Table 2. Seeds of Success By the Numbers.**

	2022 & 2023 Accomplishments	Total number in SOS
Native Seed Collections	1,741 new collections added	28,185 collections
Unique Taxa	51 unique taxa added	5,955 unique taxa
U.S. States	6 additional states collected from	49 states with collections
EPA Level 3 Ecoregions	1 new ecoregion represented	96 ecoregions

These developments mark a crucial expansion of native seed collection into new geographic areas, enhancing the availability of local native seeds for growers. The SOS seeds are used for germplasm conservation, research and development, and the cultivation of native seed crops to restore resilient ecosystems. As a Justice40 covered program, SOS activities bolster the restoration economy by fostering engagement and potential funding, often in rural or agricultural communities, for growers, nurseries, seed cleaning and storage facilities, and researchers.

Wild seed collection is essential for obtaining genetically diverse seeds that capture the natural genetic variation found in wild populations adapted to local environmental conditions. These seeds carry traits that enhance resilience to pests, diseases, and climate change, making them vital for the success of restoration efforts. This genetic diversity increases the likelihood of successful establishment and growth in restored areas, leading to more effective and sustainable restoration outcomes. The SOS seed collection protocol incorporates science-based practices that prioritize conservation, ensuring the preservation of genetic diversity while preventing overcollection of wild material.



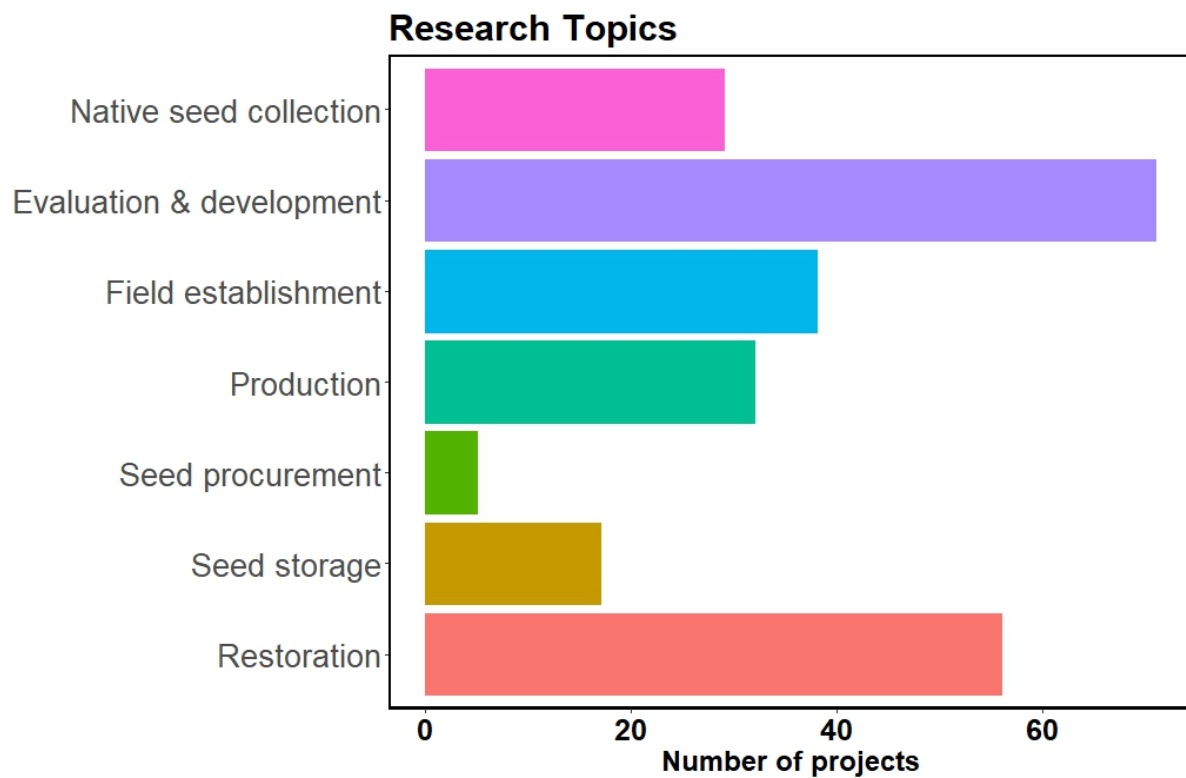
**Photo 8.** The Southeast Grasslands Institute’s first SOS collection of 2023. Phoebe Judge, Gus Rasich, and Vero Tessier collected Small’s ragwort (*Packera anonyma*). Credit: SGI-SOS FWS0400.

### Spotlight on: Research

Scientific research is essential to guide native seed collection, production, and use in ecological restoration. However, the majority of seed research has focused on agronomic seed development rather

than ecological seed development of native plants. Goal 2 of the Seed Strategy is to identify research needs and conduct research to provide genetically appropriate seed and improve technology for seed production and ecosystem restoration. In 2022 and 2023, a significant portion of the projects (57%) focused on research, leading to the development of over 59 publications and reports (Appendix 2). Research was conducted on every step of the Native Seed Development Process, focusing primarily on evaluation and development, followed by restoration of native plant communities (Figure 11). Evaluation and development projects involve researching native plant species biology, including germination requirements, pollinators, seed production technology, seed transfer zones, and other related topics. Restoration research projects focus on identifying effective strategies for restoring native plant communities and their ecosystems.

Several research projects explored diverse topics, including plant conservation and propagation for culturally significant native plants in partnership with Tribal Nations and organizations; the impact of seed collection and farming practices on plant genetics to enhance native seed; and best practices for restoring ecosystems damaged by fire, mineral extraction, energy development, and other disturbances.



**Figure 11.** Research topics across the Native Seed Development Process.

The Seed Strategy also emphasizes the need to communicate research with land managers and the public through education, outreach, training programs, and online tools. Half of the research projects in 2022 and 2023 involved developing tools that enable land managers to make timely, informed seeding decisions for ecological restoration (Goal 3 of the Seed Strategy) and developing strategies for internal and external communication (Goal 4 of the Seed Strategy). Seventy-five solution resources for land managers have been developed or are in progress, with several currently available to the public. These include tools for seed selection based on climate (U.S. Geological Survey [USGS] Climate Smart Restoration Tool), methods and outcomes of past public land treatments (USGS Land Treatment Exploration Tool), and habitat suitability models for invasive species (USGS INHABIT) (Appendix 3).



**Photo 9.** The USGS Fire, Invasives, Restoration, and Ecology in Sagebrush Steppe (FIREss Team) plants a common garden of rubber rabbitbrush (*Ericameria nauseosa*) near Boise, Idaho in collaboration with USFS. The FIREss team has grown to 20 young plant scientists from diverse backgrounds who have made substantive contributions to the BIL-ER efforts to increase native plants in the sagebrush steppe, with a focus on breaking the annual grass-fire cycle via adaptive restoration with federal, Tribal, and other partners. Research efforts include evaluating seed sources and planting methods, biology and control of exotic annual grasses and other invaders, assessing metrics for restoration success and monitoring techniques, and modeling fire risk. To date, the FIREss team has seeded or planted over 1,000 acres and thousands of plots on megafire restoration projects, in protected areas, or experimental trials such as in the photos have been established, evaluated, and communicated in dozens of scientific publications and used to guide land management. Credit: Matt Germino, USGS.

### Spotlight on: Restoration

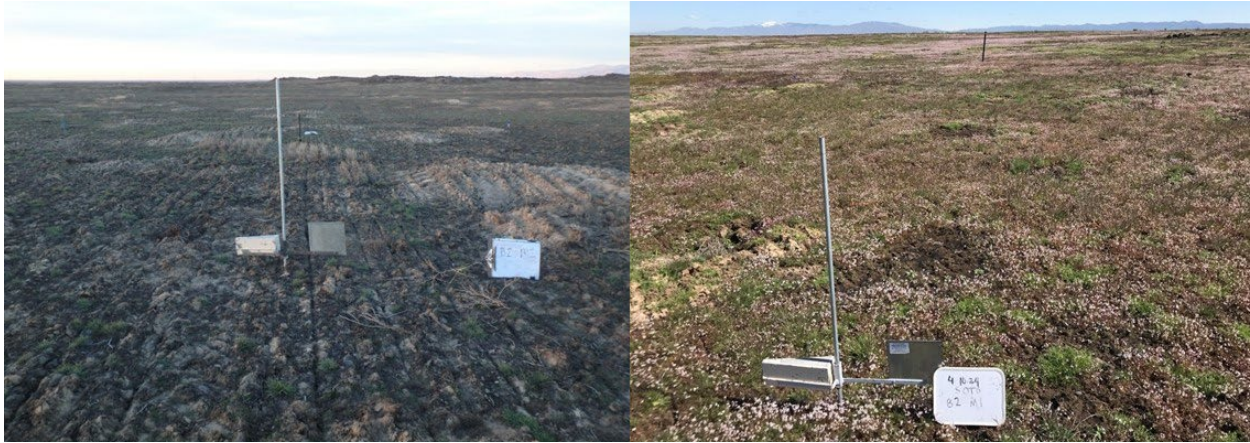
Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. Ecosystems are increasingly altered and their ability to provide critical ecosystem services diminished due to natural disasters—such as wildfires, hurricanes, and tornadoes—as well as other disturbances, making restoration essential. Native plant communities are the basis of healthy, resilient ecosystems, and a reliable supply of native, genetically appropriate seed is necessary for effective restoration. Restoration was the most frequently addressed step in the Native Seed Development Process during 2022 and 2023, with 56% of the projects focused on researching, planning, conducting, or evaluating restoration efforts. Additionally, 44 projects involved on-the-ground restoration, seeding or planting more than 27,000 acres. Most of these projects (95%) are monitoring for restoration effectiveness and outcomes, either in the short-term (under five years, 46% of projects), or long-term (five years or longer, 49% of projects) (Figure 12). This dual focus helps ensure that future management practices and strategies are informed by the effectiveness of the restoration and its specific outcomes for specific ecosystems or regions.

### Are projects monitoring for restoration outcomes?



**Figure 12. Are native seed projects monitoring for restoration outcomes?** For projects that involved on-the-ground restoration, 49% included long-term monitoring (over five years), 46% included short-term monitoring (under 5 years), and 5% of projects are not being monitored.





**Photo 10.** A restoration site near Boise, Idaho, is shown just after drill seeding native seed (left) and during the next growing season (right). The USFS Rocky Mountain Research Station and partners compare broadcast and drill seeding restoration treatments on this site, which burned in 2023. The Seeding Evaluation and Experimental Design Strategies project, involving researchers and land managers from federal agencies and the Great Basin Fire Exchange, uses innovative experimental designs to evaluate and compare seeding practices alongside standard Emergency Stabilization and Rehabilitation and Burned Area Emergency Response treatments. This project received partial funding from BIL-ER.

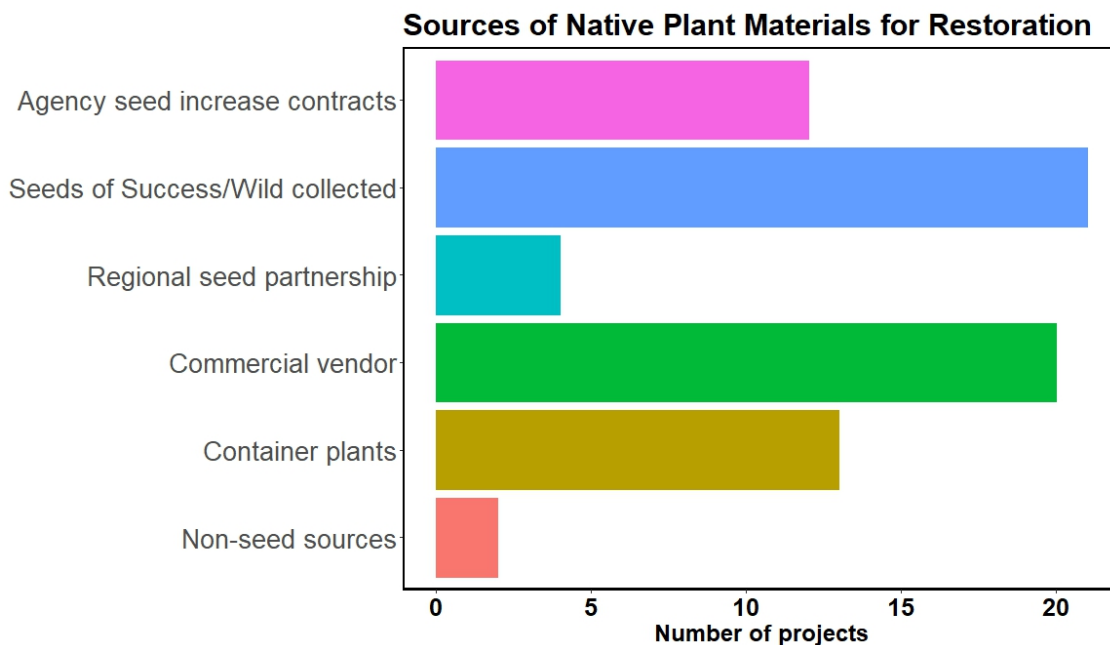


**Photo 11.** Staff from BLM and Salcha-Delta Soil and Water Conservation District plant native materials produced at the Alaska Plant Material Center for streambank restoration of Jack Wade Creek (JWC) in interior Alaska. JWC, an abandoned placer mining operation, is part of the Gravel to Gravel BIL-ER Keystone Initiative for salmon habitat restoration. This stream reclamation effort is unique in its aim to create a demonstration area that will serve as an outdoor classroom for miners to evaluate different natural stream bank stabilization methods and explore ways to enhance fish habitat diversity. Credit: Charles Ebbers, BLM.

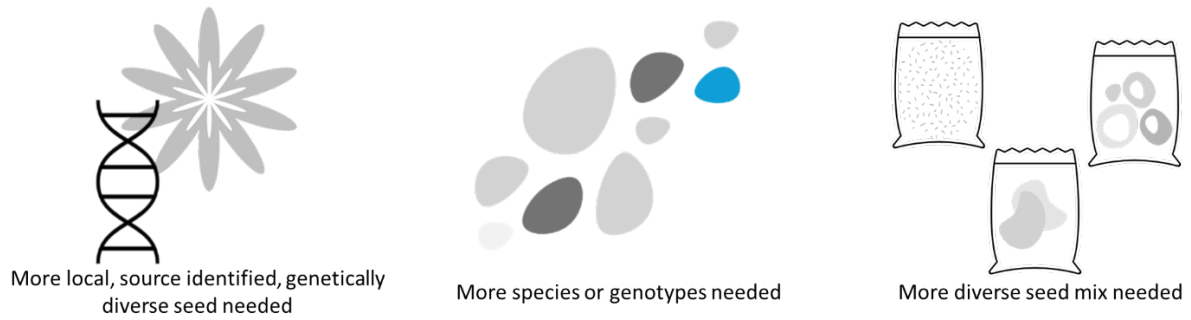
## Do projects have the seed they need?

The Seed Strategy was created to develop a reliable supply of genetically appropriate seeds to meet the increasing restoration and rehabilitation needs across the United States. Since its publication in 2015, progress has been made toward this goal; however, the native seed supply pipeline remains inadequate (NASEM 2023). Native plants adapt to local conditions (such as elevation, climate, and soil type) as well as biotic interactions with other species, which are crucial for their survival (Baughman et al. 2019, Lortie & Hierro 2020). From an ecological restoration perspective, genetically appropriate seeds are those adapted to the specific environmental conditions of the restoration site and that promote interactions within the local ecosystem. Using genetically diverse, locally adapted seeds can improve restoration outcomes and ecosystem functions (Johnson et al. 2010; Baughman et al. 2019, Erickson & Halford 2020). This underscores the need to diversify the range of species and seed sources available to land managers.

How federal agencies obtain native seeds for restoration provides insights into their ability to meet project goals and objectives. The 2022 and 2023 projects obtained seed primarily from commercial vendors both through direct seed purchasing and seed increase contracts, followed by seed obtained from the wild, including those collected through the SOS program (Figure 13). Assessments of seed availability for meeting project objectives varied (Figure 14), with about half of the agencies reporting they had sufficient native seed (53%). This high percentage may be skewed, reflecting the views of federal agency staff actively engaged in initiatives to enhance the native seed supply, rather than representing the overall seed availability across all agencies and projects. Although the national seed supply has improved under the Seed Strategy, there is still much work to ensure that every project has the right seed, in the right place, at the right time.



**Figure 13. Native seed suppliers and sources.** Note that agency seed increase contracts include the BLM Indefinite Delivery Indefinite Quantity contract, the BLM Consolidated Seed Buy, Blanket Purchase Agreements, and other third-party contract grow-outs.



**Figure 14. Addressing native seed shortages in projects.** Key areas identified by respondents for native seed needs include more local, source identified, genetically diverse seed; more species or genotypes needed; and/or more diverse seed mix needed.



**Photo 12.** Spike dropseed (*Sporobolus contractus*) seed, Credit: SOS NM930.

## Plant Conservation Alliance Federal Agency Summaries

All PCA federal agencies were invited to summarize their contributions and accomplishments in implementing the Seed Strategy in 2022 and 2023. The following summaries underscore the value of cross-sector collaboration and research in advancing the production and effective application of native seed to restore native plant communities resilient to climate change and other disturbances.



**Photo 13:** Glacier National Park, Credit: Linsday Dose, USGS contractor.

Department of the Interior (DOI)



## Department of the Interior (DOI) Bureau of Land Management (BLM)

### Agency mission as it relates to the Seed Strategy

As the largest public land manager, BLM oversees 245 million acres—about 10% of the nation’s total land area. This land includes the dryland ecosystems of the western U.S., which are increasingly threatened by drought, wildfire, and human activities. The BLM works to sustain the ecological health, economic vitality, and productivity of these lands, ensuring they remain available for the use and enjoyment of current and future generations.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

Through the Biden-Harris Administration’s Investing in America agenda, the Bureau selected 21 Restoration Landscapes as focal areas for conservation and restoration. The BLM investments from the Inflation Reduction Act (IRA) and Bipartisan Infrastructure Law (BIL) demonstrate its commitment to restoring native plant communities. The Bureau plays a central role in implementing the Seed Strategy, contributing nearly half of the projects (79 out of 176) in this progress report, with 37 additional projects listing BLM as a key partner. Seeds of Success (SOS), the national native seed collection program, led by the BLM, expanded its collection program with the National Park Service and U.S. Fish & Wildlife Service.

The BLM funded the National Academies of Sciences, Engineering, and Medicine (NASEM) to develop *An Assessment of Native Seed Needs and the Capacity for Their Supply*, released in 2023 with 10 recommendations for federal agencies that highlighted the need for strong federal leadership and coordinated federal-private partnerships to increase the native seed supply.

The BLM, along with other DOI bureaus, developed the National Seed Strategy Keystone Initiative Action Plan (DOI Action Plan), released in December 2023. The DOI Action Plan describes eight foundational goals to operationalize the Seed Strategy and addresses the NASEM Report on the nation’s native seed needs. The top three priorities in the DOI Action Plan are to create and support the National Interagency Seed and Restoration Center (NISRC); to create or augment Plant Programs in DOI bureaus and request appropriations; and to develop DOI ecoregional plant material hubs. With the groundwork done in 2023, the Secretary of the Interior launched the NISRC in February 2024, establishing a transformational approach for the DOI and other federal agencies to work together for a sustainable and stable national native seed supply chain. The NISRC is to be the logistical, support, and scientific hub for restoring the nation’s ecosystems and house the new SOS Native Seed Bank.

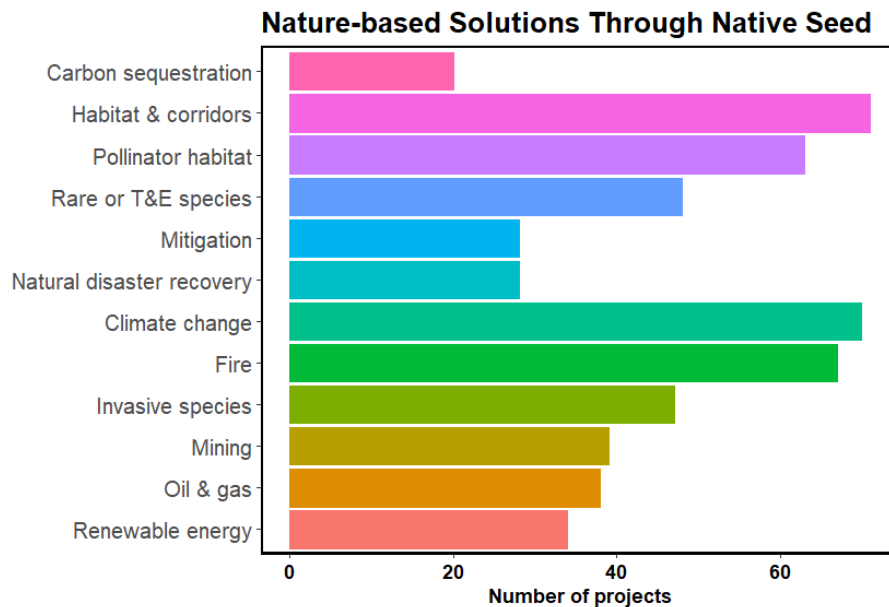
In 2023, the BLM entered into a Memorandum of Understanding with the U.S. Fish and Wildlife Service and National Park Service on SOS to substantially expand native seed collections. This interagency collaboration, led by BLM Plant Conservation and Restoration Program (Plant Program), will standardize native seed collection and storage protocols across the majority of public lands.

The BLM received \$15.5 million from the BIL in 2022 and 2023 to support the Seed Strategy. The BIL funding supported 8 projects in 2022 and 2023. The BLM also received \$17.6 million in IRA funding to develop and support the Seeds of Success Seedbank. BLM programmatic funding for the BLM Plant Program from \$9.6 million in 2021 to \$10.6 million in 2022 to \$20.6 million in 2023 to fund projects that met the goals of the seed strategy. Between 2022 and 2023, the BLM increased botanical capacity with five new government positions created that supported the Seed Strategy. Additionally, the BLM Plant Program and BIL Burned Area Rehabilitation funding supported federal and non-federal positions, and contributed to the restoration economy in rural areas.

Project Highlight: Oregon State University (OSU) Tribal Conservation Corps: The BLM Plant Program leveraged funds to support a three-year (FY22-FY24) Pacific Northwest ethnobotany native plant seed collection and Tribal conservation corps ecocultural restoration pilot project, led by OSU College of Forestry. Working in partnership with Western Oregon Tribal Nations, the Institute for Applied Ecology, and other partners, the project implemented the Seed Strategy by following SOS protocols to help ensure a stable and economical supply of native plant materials for restoration and rehabilitation efforts on public lands in SW Oregon. Primary activities consist of establishing Assessment, Inventory, and Monitoring/Current Vegetation Survey plots and making SOS collections of native seeds within a 200 m radius of those plots. Additional activities include ethnobotany, soil health, pollinator studies, fire ecology, and wildlife surveys. The above elements will create a stronger BLM conservation stewardship legacy by expanding public land inter-cultural collaboration in ecological restoration to build resiliency to climate change and improve pollinator and wildlife habitat. A total of 22 non-federal employees were supported through this project.

The funding received from the BIL combined with increased BLM Plant Program funding allowed the BLM to collaborate on restoration with Tribal Nations and supported applied research on restoration techniques. Conservation and restoration communication tools such as the Western Forb Guide, the Mojave Native Plant Guide, and the National Native Seed Conference were highly effective at getting knowledge in the hands of practitioners (Appendix 3).

Our collaboration with other government agencies, Tribal Nations, and non-agency partners has expanded our reach and increased our knowledge. The BLM’s progress has resulted in real on the ground improvements to ecosystem health through active restoration projects and improved knowledge on best restoration practices. Climate change improvements are expected from increased carbon sequestration from restoration activities and conservation of plant communities. These benefits will improve resilience of our public lands and provide ecosystem security for the Nation (Figure 15).



**Figure 15.** Number of projects led by or involving BLM in collaboration with other agencies to accelerate nature-based solutions. BLM projects occurring in 2022 and 2023 were most often focused on mitigating the impacts from climate change and wildfires. Additionally, BLM projects were directed at collecting and developing native seed to restore habitats and corridors for plant and animal species and to create pollinator habitat.

## Department of the Interior (DOI) National Park Service (NPS)

### Agency mission as it relates to the Seed Strategy

NPS preserves unimpaired the natural and cultural resources and values of the 85 million acres of land across 424 park units of the national park system and conserves the scenery, the natural and historic objects, and the wildlife of these special places for the enjoyment, education, and inspiration of current and future generations. NPS management policies overlap with the Seed Strategy in that they require the use of native, genetically appropriate plant species in restoration areas.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

NPS funding in FY22 and FY23 from the Bipartisan Infrastructure Law – Ecosystem Restoration (BIL-ER) National Seed Strategy Keystone Initiative amounted to over \$2.9 million and from the Inflation Reduction Act (IRA) amounted to over \$2.8 million. There was an additional \$65,000 in FY23 programmatic funding increases that supported native plant materials, namely the purchase of native seed and collection of rare plant seed for long term conservation. BIL-ER has allowed for strides to be made in increasing botanical personnel capacity with the hiring of seed collection crews in Alaska, California, and New Mexico and the increase of native plant materials with seed production fields that address restoration needs for over 20 park units. The increase in funding for native plant materials has also facilitated greater collaboration and synergy of efforts between NPS and other federal agencies (Bureau of Land Management, U.S. Fish and Wildlife Service, U.S. Geological Survey, U.S. Forest Service) and a multitude of non-federal organizations through such actions as the 2023 Seeds of Success Memorandum of Understanding, contracts and agreements for shared seed collection teams and production fields, and cooperation on shared native plant materials research needs.

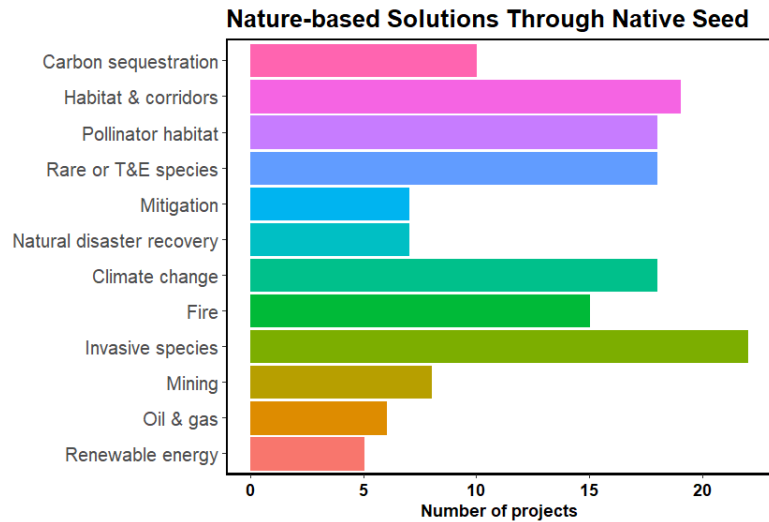
### Project highlights:

Although not formally tracked, NPS estimates that over a hundred native plant revegetation projects, in campsites and trails, facilities, and a wide range of disturbed lands have been planned and/or implemented in 2022 and 2023. Nine of those projects were submitted to the data call by the NPS and 26 projects from other agencies listed NPS as a collaborator (see Figure 16). Projects supported all four goals of the Seed Strategy (Goal 1: 20, Goal 2: 20, Goal 3: 15, Goal 4: 18) and they supported all steps of the Native Seed Development Process (Native seed collection: 20, Evaluation & Development: 17, Field establishment: 8, Production: 13, Seed procurement: 10, Seed storage: 14, Restoration: 22).

### Restoration project highlights include:

- Seed collection of 16 native plant species on Tribal and federal lands performed by the InterTribal Buffalo Council, Buffalo SeedKeepers for the Northern Great Plains ecoregion
- Thirty acres of shortgrass prairie and prairie chicken habitat restoration and native seed production of two species in conjunction with Colorado Parks and Wildlife
- Alpine restoration trials in Acadia National Park in collaboration with the Schoodic Institute and other partners
- The NPS California Invasive Plant Management Team supported 11 NPS units in California with funding for seed collection, seed production, and nursery infrastructure
- Restoring ~400 acres of grasslands in six Appalachian park units in collaboration with Austin Peay State University





**Figure 16.** Number of restoration projects lead by or involving NPS in collaboration with other agencies to accelerate nature-based solutions. NPS conducted restoration projects between 2022 and 2023 that centered on mitigating the impacts of construction disturbance, wildfires, and invasive species, while also establishing and bolstering habitats and corridors for plants and animals, pollinators, and rare, threatened, or endangered species, aligning with both agency and national priorities.

NPS restoration efforts and therefore ecosystem health have greatly benefitted from the influx of BIL-ER and IRA funds, which have allowed for the acquisition of much larger volume of native, locally/genetically appropriate plant materials. Using these native, local materials has in turn improved the success of restoration efforts. Significant increases in collaboration with federal and non-federal partners have also provided NPS with opportunities to share costs, plant materials/restoration expertise, and infrastructure, which have ultimately led to improved and increased restoration capacity within park units across the U.S.



**Photo 14.** Restoration trial plots on the summit of Cadillac Mountain in Acadia National Park.

## Department of the Interior (DOI) U.S. Fish and Wildlife Service (USFWS)

### Agency mission as it relates to the Seed Strategy

Resilient, native plant communities are vital to achieving the mission of the USFWS: to work with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. The USFWS manages over 95 million acres of land, including more than 570 National Wildlife Refuges and 38 wetland management districts. Cooperative restoration projects on private or other partner lands are key to our work to provide primary trusteeship for migratory birds, anadromous fish, and over 1,500 threatened and endangered species.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

Implementation of the Seed Strategy at USFWS is co-led by the National Wildlife Refuge System and Ecological Services Program, with strategic coordination from the Chair of the Plant Conservation Alliance Federal Committee within the International Affairs Program. The USFWS Seed Strategy Implementation Team includes representatives from Science Applications, other Headquarters Programs, and the Regions, meeting regularly to coordinate on-the-ground efforts. Prior to 2022, project funding was typically sourced from individual programs, which may have limited the scale and impact of Seed Strategy implementation.

In 2022 and 2023, Bipartisan Infrastructure Law (BIL) funds facilitated a national approach to Seed Strategy implementation, guided by the agency's Seed Strategy plan, recommendations from the National Academies on native seed needs, and the DOI's cross-bureau BIL spending plan and National Seed Strategy Keystone (NSSKI) DOI Action Plan:

- To implement the Seed Strategy at USFWS, a detailed plan would establish a six-member coordination team, create a cohesive framework and budget, launch regional seed collection teams, enhance local seed availability, support ecoregional research, provide training on native plants, and strengthen interagency coordination for climate-related restoration.
- The National Academies issued 10 recommendations to strengthen ecological restoration goals, focusing on improving interagency coordination for native plant materials, enhancing ecoregional collaboration, and promoting responsible seed collection and conservation.
- The DOI released the DOI Action Plan, outlining eight actions to improve native seed conservation and restoration. Key priorities include establishing a National Interagency Seed and Restoration Center, enhancing Plant Programs in DOI bureaus, and developing ecoregional plant material hubs for localized seed collection and distribution.

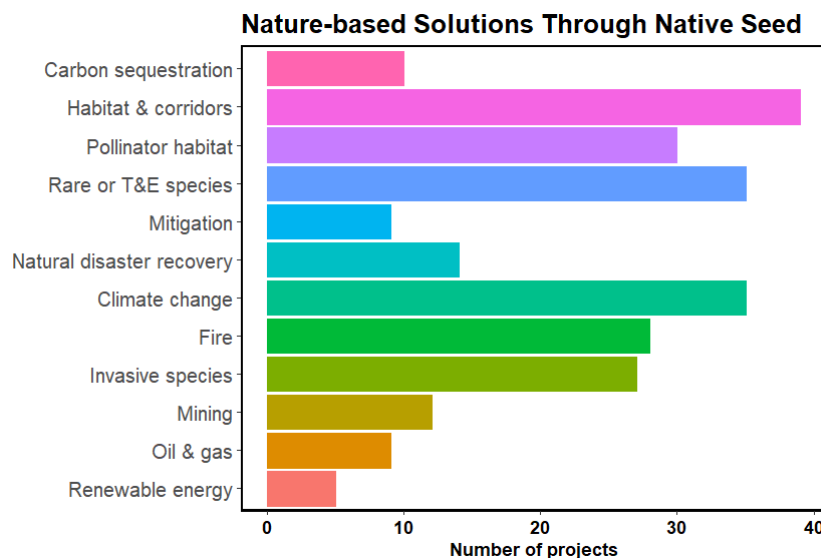
To support the NSSKI, the USFWS co-led a cross-bureau team with the Bureau of Land Management (BLM), guiding nine DOI offices to prioritize seed collection, production, and ecoregional coordination. The USFWS BIL investments of \$7 million funded 24 projects nationwide to build capacity for Seed Strategy coordination and enhance habitat restoration for wildlife, plants, and pollinators, including the establishment of two key positions. A permanent Native Plant Restoration Biologist was hired within the National Wildlife Refuge System in 2023 to aid in all aspects of Seed Strategy implementation at USFWS. These duties include analysis and improvement of agency processes, development and maintenance of partnerships, project development and implementation, and progress reporting. Additionally, a national Native Seed Coordinator oversees USFWS seed collecting teams to ensure the agency's participation in the Seeds of Success (SOS) national seed collection program, formalized by a Memorandum of Understanding (MOU) signed with the BLM and National Park Service (NPS) in 2023. As a result, the

number of USFWS-led SOS teams increased from two (2017-2022) to nine in 2023, focusing on seed collection across the Midwest (1 team), Southeast (5 teams), Southwest (2 teams), and Pacific Southwest (1 team). In 2023, USFWS added 142 SOS collections of 65 genera and 88 unique taxa to the national repository for long-term storage. Using native seeds effectively is crucial for harnessing native plant communities in nature-based solutions (NbS) for ecosystem restoration and resilience. Research from USFWS Seed Strategy projects has enhanced the capacity for ecological restoration through NbS (Figure 18).

Engagement with Tribal partners remains a priority for USFWS. In 2022 and 2023, BIL investments supported initiatives like the Rogue and Umpqua Native Plant Partnerships (USFWS Region 1: Pacific), hiring of a Tribal Native Plant Development Coordinator (USFWS Region 2: Southwest), and the Partnership for Landscape Action with Native Seed (USFWS Region 7: Alaska). These initiatives help restore culturally significant plants and their habitats by identifying native plant material needs, developing technical capacity, and exploring funding mechanisms for Tribal land restoration, such as Tribal Wildlife Grants. This collaboration honors traditional ecological knowledge and emphasizes the cultural significance of these plants to Indigenous communities.

Progress to date supports efforts toward an interagency seed and restoration center, as announced by the DOI Secretary in August 2023. This initiative is crucial for enhancing collaboration among federal agencies for improved seed banking, conservation, and ecological restoration strategies. It aligns with the USFWS Seed Strategy implementation plan and supports key National Academies recommendations, particularly establishing interagency coordination for native plant materials (Recommendation 1.0), improving ecoregional collaboration (Recommendation 2.0), and promoting responsible seed collection and conservation through the BLM-FWS-NPS SOS MOU (Recommendation 4.3).

The developments in 2022 and 2023 have increased internal awareness of the Seed Strategy and facilitated cross-programmatic and external collaboration, enhancing the diversity and quantity of native plants available for restoration. This reflects USFWS commitment to fulfilling its mission by developing partnerships, assessing native seed needs, and building capacity for effective ecological restoration that benefits fish, wildlife, plants, and human communities, while also aiming to strengthen Tribal land restoration initiatives for healthier ecosystems and greater resilience against environmental challenges.



**Figure 17.** Number of research projects led by or involving USFWS from 2022 to 2023 focuses on accelerating nature-based solutions to mitigate climate change, wildfires, and invasive species, while also establishing and strengthening habitats for plants and animals, pollinators, and rare, threatened, or endangered species, in alignment with agency and national priorities.

## Department of the Interior (DOI) U.S. Geological Survey (USGS)

### Agency mission as it relates to the Seed Strategy

The mission of the USGS is to monitor, analyze, and predict current and evolving Earth-system interactions and deliver actionable information at scales and timeframes relevant to decision makers. The USGS supports the Seed Strategy by providing and communicating science relevant to native seed and plant material development, ecological restoration and revegetation, land management, and climate adaptation. The Seed Strategy is supported by research across the USGS Ecosystems Mission Area. The Plant Conservation Alliance (PCA) provides a forum to share or co-produce the science with land managers and decision makers who are striving to produce and use native plant materials to restore and rehabilitate ecosystems that are resilient to natural disasters, biological threats, and climate change.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

In 2022 and 2023, numerous projects at the USGS supported implementation of the Seed Strategy. Most USGS research projects are in partnership with other DOI bureaus and U.S. Department of Agriculture agencies. They are aimed at supporting the information needs of diverse partners including the DOI and USDA, as well as Tribal Nations, state agencies, industry, and non-governmental organizations. Funding from the Bipartisan Infrastructure Law-Ecosystem Restoration (BIL-ER) allowed USGS scientists to initiate new projects to support research needs identified in the Seed Strategy. The USGS also engaged in the PCA and interagency working groups including the BIL-ER National Seed Strategy Keystone Initiative (NSSKI) and Federal Implementation Working Group for the Seed Strategy. USGS staff also supported the development of the aforementioned DOI Action Plan in December 2023.

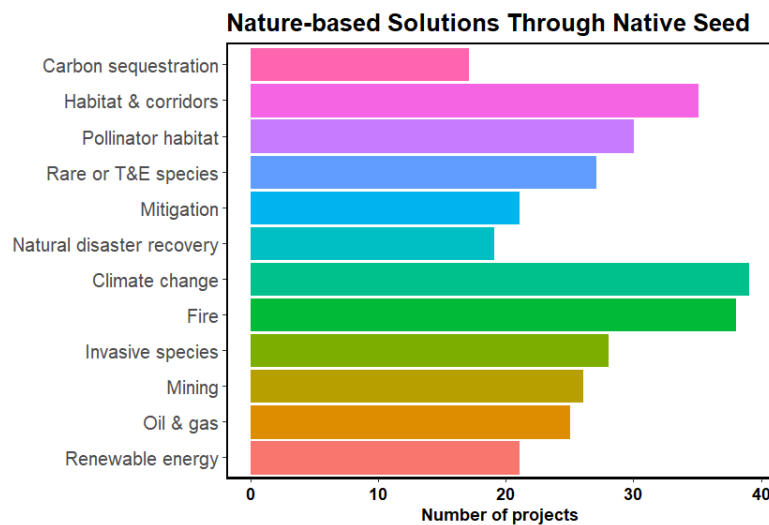
USGS activities supported the four goals of the Seed Strategy, with most projects meeting research and communication needs (Goal 2, Undertaking research and improving technologies for seed production and use, and Goal 3, Developing tools for land managers). USGS research is critical to meeting Recommendation 6.0 of the National Academies of Sciences, Engineering, and Mathematics Report, *An Assessment of Native Seeds and the Capacity for Their Supply: Final Report* (NASEM 2023): to commit to an expanded research and development agenda aimed at expanding and improving the use of native seeds in ecological restoration. The projects (highlighted below) generated 35 research publications, reports, and products in 2022 and 2023 that may improve restoration and reclamation outcomes, help ecosystems recover from wildfire, and combat invasive plant species. More broadly during 2022 and 2023, the USGS has published over 100 peer-review publications that contribute to the understanding of native seeds and vegetation in relation to stressors or ecosystem function and benefits.

The projects below are a few examples of how USGS research and tools advance the Seed Strategy:

- The USGS partners with the Bureau of Land Management's ecoregional Native Plant Programs to support a broad research agenda. For example, USGS scientists are studying priority plant species in the Mojave Desert that are important to restore habitat for desert tortoise and pollinators; and studying seed dormancy to inform commercial seed production and quantifying traits that are expected to mediate climate impacts in Joshua tree seedlings. On the Colorado Plateau, USGS scientists are studying the genetic and phenotypic impacts of agricultural increase on native plant materials and creating publicly available [seed transfer zones](https://research.fs.usda.gov/pnw/products/dataandtools/datasets/seed-zone-gis-data) (see <https://research.fs.usda.gov/pnw/products/dataandtools/datasets/seed-zone-gis-data>)<sup>1</sup>.

- USGS scientists provide important research to understand revegetation, restoration, and reclamation practices with native seeds across ecoregions. For example, the [Land Treatment Exploration Tool](https://www.usgs.gov/apps/land-treatment-exploration-tool/) (https://www.usgs.gov/apps/land-treatment-exploration-tool/) integrates research findings into a practical tool to inform the selection of revegetation practices that might be most effective given a site’s characteristic. Similarly, scientists – through a network of restoration sites, [RestoreNet](https://www.usgs.gov/sbsc/restorenet) (https://www.usgs.gov/sbsc/restorenet) – have developed information to guide the design and selection of restoration and reclamation approaches.
- The [USGS Invasive Species Habitat Tool \(INHABIT\)](https://gis.usgs.gov/inhabit) (https://gis.usgs.gov/inhabit) is co-produced with managers and delivers habitat suitability models of invasive plant species, which can help land management partners, including the National Park Service, Bureau of Land Management, and Department of Defense, prioritize monitoring, eradication, and restoration efforts. The Tool is national in scope and funded by the BIL-ER program’s Keystone Initiative on invasive species.
- In the Northern Prairies, USGS scientists study establishment rates of native forbs from seed mixes, colonization of non-seeded forbs, and bee utilization of forbs on private lands enrolled in the U.S. Department of Agriculture’s conservation programs.
- The USGS Fire, Invasives, Restoration, and Ecology in Sagebrush Steppe Team (FIREss Team) is BIL-ER funded and aims to increase native plants in the Sagebrush Steppe with a focus on reducing the wildfire risk due to invasive, annual grass. The FIREss Team co-produces science for adaptive management and ecological restoration with federal and Tribal partners. Part of this work includes optimizing post-fire native seeding for sagebrush restoration.
- USGS scientists develop new research methods to assess ecological resilience of America’s native grasslands. Using pollinator environmental DNA (eDNA) they can determine which plants are being visited by which pollinators. This information can guide native plant community restoration and species conservation across 11 states in the Northwest and Midwest. This work received funding from BIL-ER to implement the Seed Strategy.

USGS research and tools have wide reaching benefits for agency, Tribal, and private partners, as well as the Nation at large by providing nature-based solutions to environmental challenges (Figure 18).



**Figure 18.** Number of research projects the USGS led in 2022 and 2023 in partnership with other agencies to provide science in support of restoration efforts. These research projects aim to inform revegetation efforts using native plants that deliver ecosystem benefits such as carbon sequestration, animal or plant habitat including pollinator habitat, biodiversity, natural disaster recovery. In addition, the research supports management in reducing the impacts of climate change, fire, and invasive species.

1: Massatti, R. 2022. Genetically informed seed transfer zones for *Astragalus lonocarpus*, *Cleome serrulate*, and *Heliomeris multiflora* across the Colorado Plateau and adjacent regions: U.S. Geological Survey data release. <https://doi.org/10.5066/P9H9M79K>



## U.S. Department of Agriculture (USDA) National Institute of Food and Agriculture (NIFA)

### Agency mission as it relates to the Seed Strategy

NIFA is the extramural research funding agency at the U.S. Department of Agriculture's Research, Education, and Economics mission area. NIFA's mission is to invest in and advance agricultural research, education, and extension, to ensure all Americans have access to safe, nutritious, and affordable foods; our farmers, ranchers and producers have equitable access to markets; and we are protecting and enhancing our environment with adoption of climate-smart agriculture and forestry practices. We do this by leading and funding programs that address six goals described in the [NIFA Strategic Plan 2022-2026](https://www.nifa.usda.gov/sites/default/files/2023-01/NIFAstrategicPlan_22-26_0123.pdf) ([https://www.nifa.usda.gov/sites/default/files/2023-01/NIFAstrategicPlan\\_22-26\\_0123.pdf](https://www.nifa.usda.gov/sites/default/files/2023-01/NIFAstrategicPlan_22-26_0123.pdf)). Of the six, the following three goals guide NIFA to support implementation of the Seed Strategy:

- *Strategic Goal 1: Combat Climate Change to Support America's Working Lands, Natural Resources, and Communities*
- *Strategic Goal 2: Ensure America's Agricultural System is Equitable, Resilient, and Prosperous*
- *Strategic Goal 5: Expand Opportunities for Economic Development and Improve Quality of Life in Rural and Tribal Communities*

NIFA's mission and the Seed Strategy are in alignment because native plants and their communities provide critical ecosystem services including food, fiber, fuel, wildlife habitat, carbon sequestration, clean water, and clean air. Native plants are also integral to building resilient landscapes that are adaptive to climate change. And native plants are critical to the quality of life in rural communities, and essential to lifeways in Tribal Communities.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

Successful hiring efforts from FY21 through FY23 increased NIFA's botanical capacity across NIFA's funding priority areas. These new hires are helping NIFA return to staffing levels and staffing expertise similar to the agency's capacity prior to NIFA's move to Kansas City, MO, in October 2019.

Rather than having one specific funding program to support the use of native plants to restore ecosystem structure and function, and to maximize the provision of ecosystem services, NIFA uses numerous federal funding authorities to advance innovative research, extension, and education efforts resulting in many competitive funding programs where native plant work is supported. In addition, capacity funding supports native plant research and extension activities in 1862, 1890, 1994 land-grant institutions. These non-competitive funding resources strengthen the infrastructure and research capabilities of the land-grant institutions and provide critical resources that allow for the maintenance of long-term research, the ability to nimbly respond to emerging needs, and leverage opportunities for multi-state efforts.

Through competitive funding authorities, NIFA funds research, extension, and education that directly support objectives of the Seed Strategy. Many projects are funded under the Agriculture Food Research Initiative (AFRI) priority areas; however, there are several other funding authorities that support Seed Strategy related work, including some of our Tribal funding programs.

Examples of capacity projects aligning with the Seed Strategy goals:

- **Assessing ecotypic variation to improve seed-transfer zones for USFS Region 1 National Forests (University of Montana, McIntire-Stennis Project):** To improve native plant material selection for restoration and revegetation projects, the project leaders created seed-transfer zones for nine understory species and developed trait by environment relationships to predict seed transfer suitability under future climate scenarios.
- **Environmental and genetic determinants of seed quality and performance (Multistate Project W-4168):** Fundamental knowledge on seed traits is critical to improving seed performance in the field. As part of this multistate project, South Dakota State University is conducting experiments on germination response to smoke on 350 species of commercially available seeds used in rangeland restoration. They are using their improved understanding of seed biology to develop methods to improve seed performance in the field.

Examples of competitive projects aligning with the Seed Strategy goals:

- **Capitalizing on the 'early life experiences' of tree seedlings to enhance restoration success in changing climates (University of Wisconsin, AFRI Sustainable Agroecosystems Program, A1451):** Researchers at University of Wisconsin are studying factors such as nursery management and seedlings' microbial communities, to determine management factors that can be used to increase resilience of tree seedlings to stressors such as drought.
- **Geographical and ecological constraints on recruitment of wiregrass, an essential component of longleaf pine (University of Florida, AFRI Foundational Knowledge of Agricultural Production Systems Program, A1102):** This project is facilitating restoration of longleaf pine ecosystems by identifying the mechanisms that limit establishment of wiregrass populations.
- **Pelletized fire mosses to enhance soil health after high severity forest fire (Northern Arizona University, AFRI Soil Health Program A1401):** Following intense fire, many ecosystems face soil loss and altered hydrology. This project is developing field methods to reduce ecosystem damage following fire by using innovative techniques to establish fire moss spores through pellets.

Example of a Tribal Partnership aligning with the Seed Strategy goals:

- **Grassland restoration and pollinator conservation on Tribal lands degraded by annual invasive grasses (Salish Kootenai College, Tribal Colleges Research Grants Program):** This project team is restoring grasslands of the Flathead Indian Reservation in Montana. These grasslands comprise the easternmost extent of the Palouse Prairie, which has been 85% extirpated from its former range making it a critically endangered ecosystem. The team is restoring native pollinator forbs and shrubs and they are also developing tools for restoring native pollinator plants while controlling competitive invasive annual grasses.



## U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS)

### Agency mission as it relates to the Seed Strategy

NRCS's mission is to deliver conservation solutions so agricultural producers can protect natural resources and feed a growing world. NRCS provides America's farmers, ranchers, and private landowners with financial and technical assistance to voluntarily put natural resource conserving measures on the ground. NRCS provides technical assistance to private landowners to address resource concerns including soil erosion, soil health, reduced water quality, degraded plant conditions, and reduced wildlife and pollinator habitat. A suite of [conservation practices](https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-standards) (<https://www.nrcs.usda.gov/resources/guides-and-instructions/conservation-practice-standards>) are tailored to address every scenario. Each of these practices require adapted plant materials, both native and introduced, to address the resource concerns. Practices that establish vegetation for wildlife and pollinators, vegetative buffers, and natural areas typically require native plants. More than 1.5 million acres are planted with native plants annually.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

NRCS's 25 [Plant Materials Centers \(PMCs\)](https://www.nrcs.usda.gov/plant-materials) (<https://www.nrcs.usda.gov/plant-materials>) are the agency's in-house program to develop vegetative solutions to critical natural resource concerns. Products from the PMC program include new plant material development for release to commercial growers, and technical information for the effective establishment, use, and maintenance of plants. PMCs have an 85-year history of plant evaluation and development activities which have been emulated around the world. The plants developed by PMCs form the foundation of today's commercial conservation and native seed and plant industry. All PMC plant releases support NRCS conservation activities on private lands and many benefit public land efforts.

The PMC program is funded by an annual appropriation within the NRCS discretionary budget. Additional funding was received in FY22 and FY23 for PMCs to address climate mitigation and adaptation efforts. Almost half of the additional funds received were used to evaluate plant adaptation information for existing conservation plants to determine tolerance to projected climate changes and extreme climate events, while remaining funds accelerated efforts for new plant development, evaluating establishment and management strategies, and developing information and providing training to increase the climate literacy of conservation planners.

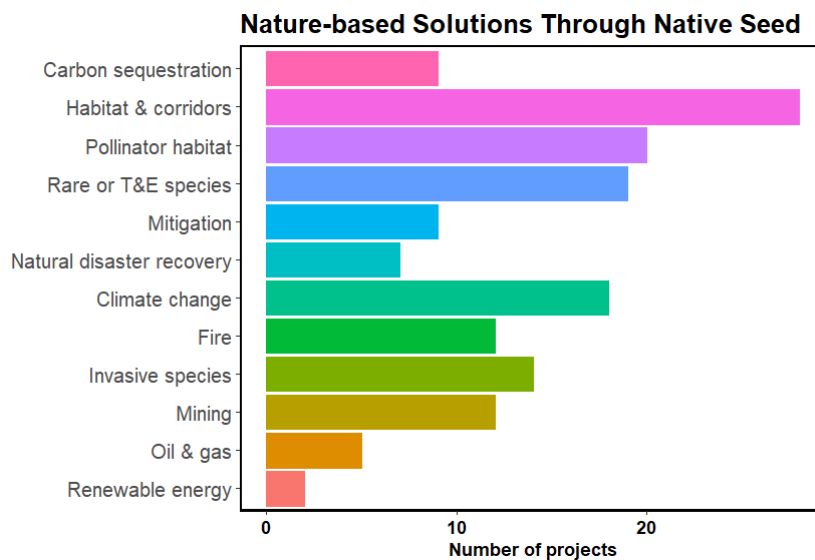
PMCs are currently focused on the evaluation and development of native plants to improve wildlife and pollinator habitat, mitigate and improve degraded sites, study rare or threatened and endangered plant species, or stabilize sites after invasive species removal (Figure 19). PMC plant development releases new plants to commercial growers under Association of Official Seed Certifying Agencies pre-varietal germplasm certification programs. In 2023, the Plant Materials Program updated its plant development guidelines to include requirements for genotyping to ensure that new conservation plants have broad genetics to accommodate future adaptation to changing climates, and field testing to ensure that plants will perform as intended in diverse outplanting sites.

Notable examples of PMC-led native plant projects include

- Developing new native plants, such as plains muhly (*Muhlenbergia cuspidata*) and cup plant (*Silphium perfoliatum*) at the Bismarck PMC in North Dakota, curlycup gumweed (*Grindelia*

*squarrosa*) at the Aberdeen PMC in Idaho, and Indian ricegrass (*Achnatherum hymenoides*) at the Great Basin PMC in Nevada,

- Evaluating rare species found in Oregon’s Willamette Valley, and the work of the Corvallis PMC in Oregon to study germination and propagation techniques, outplanting methodologies, and seed production,
- Testing the adaptation of released conservation plants at PMCs throughout the Southeast United States,
- The Cape May PMC in New Jersey evaluating saltmeadow cordgrass (*Spartina patens*) and other coastal species as agricultural crops alternatives on coastal lands that are subject to saltwater intrusion resulting from rising oceans, and
- Evaluation of bush muhly (*Muhlenbergia porteri*) and big galleta (*Pleuraphis rigida*) at the Tucson PMC in Arizona, in cooperation with the Bureau of Land Management.



**Figure 19:** The NRCS Plant Materials Program develops nature-based solutions for natural resource concerns such as soil erosion, poor- or low-quality pollinator and wildlife habitat, and water quality. NRCS conservation planners, partners, and other land managers use Plant Materials Program conservation plant releases and technology to respond to both perennial and acute needs, such as disaster recovery, with scientifically sound information and tools.

NRCS is the premiere federal agency to provide voluntary technical and financial assistance to farmers, ranchers, and private landowners. The resource conservation activities of NRCS help protect soil, water, and air resources, enhance productive habitats for both wild and domestic animals, create more resilient landscapes, and support a healthier environment for generations of Americans to come. NRCS, through increased Inflation Reduction Act funding for Farm Bill programs, is accelerating climate mitigation efforts by delivering quantifiable reductions in greenhouse gas emissions and/or increases in carbon sequestration associated with agricultural and forestry activities. Many of the climate mitigation practices also offer co-benefits that help agricultural operations build climate change resilience while addressing other natural resource concerns such as soil health, water quality, pollinator and wildlife habitat and air quality.

NRCS relies on vegetative information and products from its PMCs when implementing conservation programs, and native plants are a critical component to the work NRCS does to improve the health and resilience of ecosystems and the sustainability of agriculture. The efforts of PMCs, often in cooperation with other agencies participating in the Seed Strategy, ensures that NRCS, other Federal agencies, and the public have access to appropriate commercially available plant materials for revegetation and restoration efforts.

## U.S. Department of Agriculture (USDA) Forest Service (USFS)

### Agency mission as it relates to the Seed Strategy

The mission of the USDA USFS is to sustain the health, diversity, and productivity of the nation's forests and grasslands, caring for the land and serving the diverse needs of people. Within the National Forest System (NFS), which covers 193 million acres, genetically appropriate native plant materials are the first choice in restoration and revegetation projects based on NFS policy. The NFS processes, develops, and supplies high quality native trees and plant materials through the NFS National Nursery System. In other Branches of the USFS, Research and Development (R&D) works at the forefront of science to improve the health and use of our nation's forests and grasslands, and State, Private, and Tribal Forestry, including the National Seed Lab, provides community assistance through cooperation with state, commonwealth, territory, and Tribal governments.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

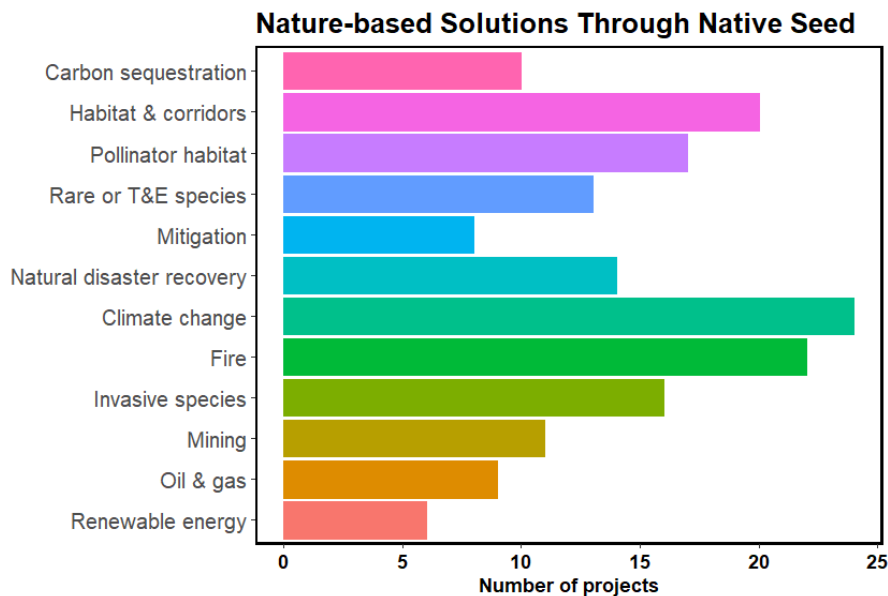
Increases in federal funding have enabled USFS to increase the pace and scale of restoration to address existing needs and prepare for future events. Under the Bipartisan Infrastructure Law (BIL), the National Forest Botany, Pollinator, and Native Plant Material Programs received \$13.4 million in the National Revegetation Effort provision and \$2 million for the Restore Native Vegetation on Previously Mined Lands provision in FY22 and FY23 combined. In those same years, State, Private, and Tribal Forestry allocated \$13.5 million to 35 states, four territories and commonwealths, and seven Tribal Nations, to fund the modernization of existing tree nurseries and seed programs. In Research and Development in FY23, 30 research projects were funded using \$20 million in BIL-Ecosystem Restoration dollars. The NFS currently collects and/or processes an estimated 15,000 pounds of native seed, processes thousands of bushels of conifer cones, and produces more than 28 million tree and native plant seedlings annually. The NFS gained 45 permanent botanists in FY22 and FY23, increasing the number of professional agency botanists from 126 in FY21 to 171 in FY24.

Highlights from a subset of USFS-led Revegetation Projects include:

- **Rocky Mountain Research Station (R&D)** Researchers with R&D are developing climate-smart seed transfer zones, landscape-scale revegetation experiments to guide revegetation in high fire risk landscapes in the Great Basin and Intermountain West, integrative strategies for restoring soil, supporting pollinator populations, developing Tribal nursery seed increase capacity, and assessing climate seed transfer and plant community transitions.
- **Forest Service Washington Office (WO)** partnered with the Chicago Botanic Garden to hire and train 29 native seed collection interns in five USFS Regions, with the State Botanical Garden of Georgia to map, collect, and develop native seed sources throughout the piedmont of Georgia, South Carolina, and Alabama, and with the Institute for Applied Ecology in support of updates to the Native Seed Network, an interactive website that connects seed producers and buyers.
- **Northern Region, R01** has helped to form the Montana Native Seed Network and the Northern Great Plains Native Seed Partnerships. They are working with the NFS National Nursery System to process and increase of 21 native plant species and 29 native seed mixes for use in revegetation and restoration post-disturbance (recreation areas, timber sales, invasive plant treatment areas), and are restoring pollinator habitat.
- **Southwestern Region, R03** is increasing the availability of native seed for restoration in Arizona and New Mexico, as part of the Southwest Seed Partnership, which they co-founded in 2015 with the Institute of Applied Ecology and others. Vulnerable plant seed banking is occurring in Wildland Fire Crisis landscapes in partnership with the Center for Plant Conservation.

- **Intermountain Region, R04** is partnering with State Universities and R&D to address successful native plant establishment practices in dryland ecosystems and with the U.S. Geological Survey to restore biological soil crusts on four National Forests. The Region is revegetating riparian and upland sagebrush-steppe with multiple partners, assessing rare and endangered plant populations for increase and recovery, and using seed balls to increase restoration success. The Region is working with the NFS National Nursery System to process and increase 21 native plant species across seven national forests.
- **Pacific Northwest, R06** works with the NFS National Nursery System and with native seed collection and production contractors to produce 46,000 pounds of genetically appropriate native seed, and grow 35,100 seedlings for restoration, including post-fire and riparian restoration and to support pollinators.
- **Southern Region, R08** partnered with East Texas Native Seeds at Texas A&M University to form the West Gulf Coastal Plain Seed Development Project. Several native plant species, including native cane, have been planted in seed increase fields at East Texas Plant Materials Center and the Stuart Seed Orchard on the Kisatchie National Forest. The Southern Region also collaborates with the Eastern Band of the Cherokee to collect, propagate, and out-plant river cane and other culturally significant plants on NFS lands.

The USFS is using funding from BIL to increase the development and use of native plant materials and trees for use in revegetation, reforestation, and restoration across lands. This funding has enabled the agency to increase revegetation and restoration skills and capacity, improve nursery infrastructure, and to develop a diversity of native plant partnerships, including stakeholders from underserved communities and Tribal Nations.



**Figure 20.** USFS, in collaboration with other federal agencies, is increasing the use and availability of native plant materials as a nature-based solution to multiple challenges on public lands including climate change, extreme wildfire, and non-native invasive species. This figure is based on project data submitted by federal partners.

## Federal Highway Administration (FHWA)

### Agency mission as it relates to the Seed Strategy

FHWA is an agency within the U.S. Department of Transportation (DOT) that oversees State programs on interstate and State highways that use Federal funds. FHWA also acts as a technical resource and information clearinghouse for these programs. Each State's program is unique. There are an estimated 4.2 million miles of roadway in the U.S. and millions of acres of roadsides (source: [FHWA Highway Statistics Series](https://www.fhwa.dot.gov/policyinformation/statistics/2022/vmt421c.cfm) <https://www.fhwa.dot.gov/policyinformation/statistics/2022/vmt421c.cfm>). This land requires care that assures water quality, improves erosion control, maintains wildlife habitat, reduces mowing and spraying, enhances natural beauty, and protects natural heritage. The FHWA Roadside Vegetation Program serves as a technical resource for the care of the land.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

The Bipartisan Infrastructure Law requires FHWA to administer \$3 million in grants for Roadside Pollinator Programs (RPP), establishing priority best management practices for Roadside Pollinator Programs. Eligible recipients of RPP grants include State DOTs, Federal land management agencies, and Tribal Nations. The RPP Notice of Funding Opportunity was published on April 8, 2024. FHWA also provides financial and technical assistance for research projects, tools and resources related to pollinators, vegetation establishment and management, and seed establishment for stakeholders. Published resources include:

- [FHWA Roadside Revegetation: An Integrated Approach to Establishing Native Plants and Pollinator Habitat](https://www.environment.fhwa.dot.gov/env_topics/ecosystems/roadside_revegetation/ch01.aspx) ([https://www.environment.fhwa.dot.gov/env\\_topics/ecosystems/roadside\\_revegetation/ch01.aspx](https://www.environment.fhwa.dot.gov/env_topics/ecosystems/roadside_revegetation/ch01.aspx))
- [Ecoregional Revegetation Application](https://www.nativer Revegetation.org/era/) (<https://www.nativer Revegetation.org/era/>)
- [Native Revegetation Resources Library](http://resources.nativer Revegetation.org/) (<http://resources.nativer Revegetation.org/>)
- [Roadside Best Management Practices that Benefit Pollinators: Handbook for Supporting Pollinators through Roadside Maintenance and Landscape Design](https://www.environment.fhwa.dot.gov/env_topics/ecosystems/Pollinators_Roadsides/BMPs_pollinators_landscapes.aspx) ([https://www.environment.fhwa.dot.gov/env\\_topics/ecosystems/Pollinators\\_Roadsides/BMPs\\_pollinators\\_landscapes.aspx](https://www.environment.fhwa.dot.gov/env_topics/ecosystems/Pollinators_Roadsides/BMPs_pollinators_landscapes.aspx))
- [Pollinators and Roadsides: Best Management Practices for Managers and Decision Makers](https://www.environment.fhwa.dot.gov/env_topics/ecosystems/Pollinators_Roadsides/BMPs_pollinators_roadside.aspx) ([https://www.environment.fhwa.dot.gov/env\\_topics/ecosystems/Pollinators\\_Roadsides/BMPs\\_pollinators\\_roadside.aspx](https://www.environment.fhwa.dot.gov/env_topics/ecosystems/Pollinators_Roadsides/BMPs_pollinators_roadside.aspx))

These resources along with numerous other publications related to integrated vegetation management, invasive control and native plants restoration, and FHWA's website information help emphasize the importance of native plant and seed material and identify many useful practices. FHWA also provides financial and technical support for the Nationwide Monarch Candidate Conservation Agreement with Assurances on Energy and Transportation Lands.

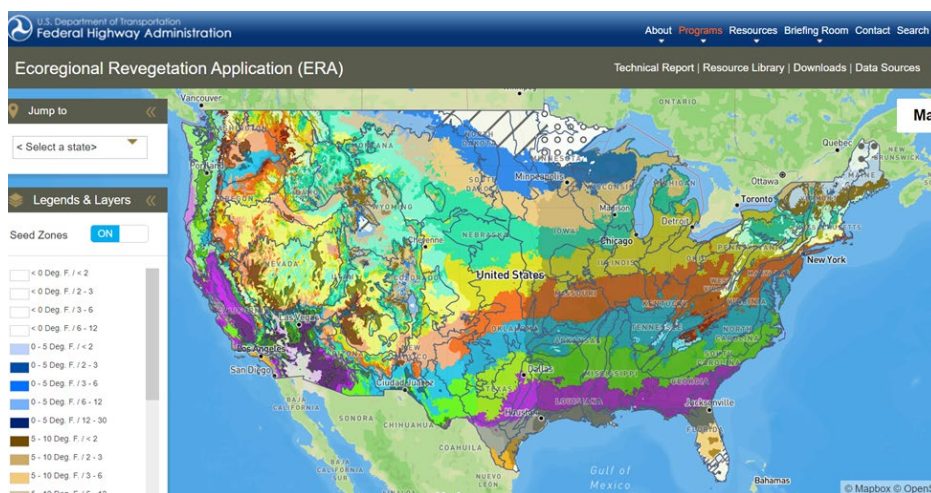
Federal highway law requires States to use certain sums of their apportionments only for special purposes such as planning and research activities (23 U.S.C. 505) and landscaping and scenic enhancement (23 U.S.C. 319). 23 U.S.C. The law, 23 U.S.C. 505, allows States to develop research and implement solutions unique to their State. Respectively, 23 U.S.C. 319 provides that at least one-quarter of one percent of funds expended for such landscaping projects is used to plant native wildflower seeds, seedlings, or both.

FHWA accomplishes its work and mission by collaborating with a variety of stakeholders, including government agencies at the Federal, State, Tribal, and local levels, organizations such as the American Association of State Highway Officials (AASHTO) and the Plant Conservation Alliance. FHWA also collaborates with the National Cooperative Highway Research Program (NCHRP), stakeholders representing associations, academic institutions, foreign transportation ministries and organizations, private entities, and advocacy groups. For example, FHWA’s website links to [16 web-only regional guides about pollinators](https://www.trb.org/NCHRP/NCHRPWOD362.aspx?srcaud=NCHRP) (<https://www.trb.org/NCHRP/NCHRPWOD362.aspx?srcaud=NCHRP>), an AASHTO/NCHRP-led effort.

A notable collaborative effort with the U.S. Forest Service provided high-quality habitat with locally sourced seed on the Interstate 90 (I-90) Snoqualmie Pass Project. The FHWA, Washington State Department of Transportation, and the U.S. Forest Service collaborated to enhance vegetation diversity and resilience on the project. From 2022 through 2023, this effort resulted in about 12 pounds of cleaned seed from 10 species, and about 31 pounds of cleaned seed from nine species, respectively. Collections from 12 species are still in progress. In 2023, about 800 pounds of native seed was applied to I-90.



**Photo 15.** Upper Keechelus Lake near-shore habitat before (left, October 2015) and after (right, August 2019) restoration as part of the I-90 Snoqualmie Pass Project. Credit: Kelly Evans (USFS).



**Photo 16.** Website homepage for the Federal Highway Administration’s [Ecoregional Revegetation Application](https://www.nativerrevegetation.org/era/) (<https://www.nativerrevegetation.org/era/>)

## Smithsonian Institution (SI)

### Agency mission as it relates to the Seed Strategy

The SI is a leader in conducting top-quality research and educating the public about the importance of native plants in everyday life. Scientific research, public outreach, and native plant habitat enhancement take place at five Smithsonian research centers: National Museum of Natural History (NMNH), National Zoo and Conservation Biology Institute (NZCBI), Smithsonian Environmental Research Center (SERC), Smithsonian Tropical Research Institute, and Smithsonian Gardens.

### Accomplishments implementing the Seed Strategy in 2022 and 2023

NMNH is home to the U.S. National Herbarium, one of the largest and most complete plant collections of North American plants. These specimens represent a 200-year history of plant cover in North America. They paint an incredibly rich picture of biodiversity and, as such, are irreplaceable, unambiguous national records. NMNH's Department of Botany provides curation services and identifications for plant collections made by other federal agencies in support of their own biological mission. Understanding which plant species are appropriate for restoration in specific localities relies on an understanding of plant distributions which in turn depend on collection data and herbarium records. Voucher specimens, including those of the Seeds of Success program, are deposited, mounted, prepared, digitized, transcribed, and stored at the U.S. National Herbarium. As of May 2022, the Department of Botany and the Smithsonian Digitization Program Office completed a seven-year effort to digitize all pressed and packeted plant specimens in the herbarium, resulting in 3.8 million new specimen images, 2.8 million new label transcriptions, and over 80,000 new taxonomic names added to the data catalog which is available to all online.

Scientists in NMNH's Department of Paleobiology are studying the fossil record to learn more about plants, their surrounding environments, and how those environments changed over time. By uncovering clues about periods of past climate change, they can develop a better understanding of current and future climate change. Museum scientists are working on ways to extrapolate information from past dramatic shifts in global climate and applying it to the faster and more drastic events of today.

Scientific research on native plants at NZCBI and SERC has focused on restoration projects and management methods. These research teams are conducting long-term, large-scale experiments in restoring naturally diverse forests and grasslands. The results from the experimental plots will help generate new information to share with restoration ecologists and landowners about restoring disturbed habitats using native plants. The Smithsonian's Forest Global Earth Observatories, or ForestGEO, provides long-term scientific data about biodiversity, ecological, hydrological, soil, and meteorological processes associated with climate change at local, regional, and global scales. This research platform enables Smithsonian scientists and their university and federal agency partners to better understand the storage and movement of carbon and water in temperate and tropical forests, as well as the impacts of climate change on the relationships of forests with wildlife, the atmosphere, and sources of fresh water. ForestGEO coordinates with the National Science Foundation's Long Term Ecological Research Program and National Ecological Observatory Network through multiple shared sites.

The Smithsonian has a strong role in educational outreach and shares with the public information about the importance of native plants and the Seed Strategy. Smithsonian Gardens maintains 40 urban acres in Washington DC surrounding SI's museum complexes as a Living Museum and Botanical Garden. Native plants are frequently incorporated in the Gardens' displays and interpretive panels. NMNH also uses its educational galleries to educate the public about the importance of the Seed Strategy.



**Photo 17:** Voucher specimens collected through the SOS program are housed at the Smithsonian Institution's U.S. National Herbarium. Approximately 17,000 SOS voucher specimens to date have been deposited, mounted, prepared, and transcribed by Smithsonian staff, contractors, and volunteers. Image credit: Smithsonian Institution.



## Conclusion: Progress and Future Direction

Restoring healthy, resilient, and biodiverse ecosystems is crucial for the Nation’s future. Since the release of the National Seed Strategy in 2015, progress has been made in native seed development and formulating strategies for restoring native plant communities. The Biden-Harris Administration’s Investing in America agenda accelerated the Seed Strategy’s implementation in 2022 and 2023. Projects funded by the Bipartisan Infrastructure Law (BIL) and Inflation Reduction Act (IRA), along with programmatic spending, such as the \$10 million increase in Congressional appropriations for the Bureau of Land Management Plant Conservation and Restoration Program, supported native seed collection, research, development, production, and ecological restoration efforts. Together, these legislative measures underscore the importance of dedicated funding to implement the Seed Strategy.

The 2023 National Academies of Sciences, Engineering, and Medicine (NASEM) Report outlined ten key recommendations for federal agencies to improve the national native seed supply chain. These recommendations emphasized the need for national interagency coordination, partnerships at state and regional levels, and enhanced support for federal agencies as well as seed suppliers and producers. Projects undertaken during this period reflect efforts to align with NASEM recommendations, such as bolstering regional native plant programs and fostering partnerships to address local biodiversity challenges. Significant work has been done to establish an interagency operational structure and advance research to optimize the use of native seeds in ecological restoration.

Continued commitment from federal agencies is essential to fully implement the NASEM recommendations and achieve the goals of the Seed Strategy. A sustainable native seed supply in the U.S., built on our collective and strategic efforts, requires dedicated botanical program funding and staff. Decisive actions are required to safeguard our Nation’s ecosystems for years to come.



**Photo 18:** A thriving native plant community in the Sonoran Desert, photo by Laura Shriver (USGS).

## Acknowledgments

We would like to thank the federal agencies who participate in the Plant Conservation Alliance (PCA) and took the time to help with this progress report. Many thanks to the progress reporting team who led the data collection and reporting effort: Laura Shriver (USGS), Patricia De Angelis (USFWS), Peggy Olwell (BLM), Elizabeth Krone (USFWS), Kristy Snyder (BLM), Regina Zweng (BLM), and Holly Hovis (BLM). We would like to thank all the PCA federal liaisons for coordinating input from their agencies, providing feedback, as well as agency communications staff for assisting with outreach. Thank you to the federal employees who submitted projects to the data call. Thanks to Sarah Hill (BLM), Kelly Thomas (BLM), Alexis Larson (Institute for Applied Ecology), Robin Schoen (NASEM), and Rob Massattii (USGS) for their feedback on sections of this report. Thank you to Samuel Jordan (USGS), Claudia Mengelt (USGS), and Regina Zweng (BLM) for reviewing the report, and to Alex Croydon (USGS) for editing and cleaning data. Finally, thanks to all the federal and non-federal partners who work tirelessly to implement the National Seed Strategy towards restoring degraded lands and mitigating the effects of climate change. Funding for the writing of this report came from the BLM Plant Conservation and Restoration Program and the USGS Southwest Biological Science Center's Restoration Assessment and Monitoring Program for the Southwest within the USGS Ecosystems Missions Area. Any use of trade, product, or firm name in this paper is for descriptive purposes only and does not imply endorsement by the US Government.

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## Appendix 1: Federal, Tribal and Non-federal organizations partners

The following list includes federal agencies, Tribal Nations and organizations, and non-federal organizations were listed as project participants or partners on the 2022 and 2023 data call, or in Agency Summaries. We acknowledge that more organizations are involved in implementing the Seed Strategy than were captured here. Please see the full list of Plant Conservation Alliance non-federal cooperators list here: <https://www.plantconservationalliance.org/cooperators>

### Federal Agencies:

Agricultural Marketing Service (USDA)  
Agricultural Research Service (USDA)  
Bureau of Indian Affairs (DOI)  
Bureau of Land Management (DOI)  
Bureau of Reclamation (DOI)  
Department of Defense  
Department of Energy  
Environmental Protection Agency  
Federal Highway Administration  
National Aeronautics and Space Administration  
National Institute of Food and Agriculture (USDA)  
National Park Service (DOI)  
National Resources Conservation Service (USDA)  
Office of Surface Mining and Reclamation (DOI)  
Smithsonian Institution  
U.S. Army Corp of Engineers  
U.S. Botanic Garden  
U.S. Fish and Wildlife Service (DOI)  
U.S. Forest Service (USDA)  
U.S. Geological Service (DOI)

### Tribal Nations and Organizations:

Blackfeet Nation  
Burns Paiute Tribe  
Cheyenne River Sioux Tribe  
Choctaw Nation of Oklahoma  
Confederated Salish and Kootenai Tribes  
Confederated Tribes of Coos, Lower Umpqua and Siuslaw  
Confederated Tribes of Grand Ronde  
Confederated Tribes of Siletz  
Confederated Tribes of the Umatilla Indian Reservation  
Confederated Tribes of the Warm Springs  
Coquille Indian Tribe  
Cow Creek Band of Umpqua Tribe of Indians  
Diné Native Plant Program  
Eastern Band of Cherokee  
Flathead Indian Reservation  
Fort Belknap Indian Reservation  
InterTribal Buffalo Council, Buffalo SeedKeepers  
Hopi Tribe  
Kawerak Inc.  
Knik Tribe  
Klamath Tribes  
Lower Brule Sioux Tribe  
Modoc Nation

## Tribal Nations and Organizations

### (continued):

Nalaquq, LLC  
Native Village of Eklutna  
Navajo Nation  
Nueta Hidatsa Sahnish College  
Oglala Sioux Tribe  
Pueblo of Isleta  
Qanirtuuq Inc.  
Saginaw Chippewa Indian Tribe of Michigan  
Salish Kootenai College  
Santa Ana Pueblo  
Shoshone-Paiute Tribes  
Southern Paiute  
Tolani Lake Enterprises, Inc.  
United Tribes Technical College  
Ute Mountain Ute Tribe  
Wyandotte Nation  
Yavapai Tribe

### Non-federal Partners:

29 Palms Inn  
Alaska Center for Conservation Science  
Alaska Plant Materials Center  
American Conservation Experience  
American Forests Foundation  
Anadarko Petroleum Corporation  
Anchorage Soil and Water Conservation District  
Antelope Valley Resource Conservation District  
Arizona Game and Fish Department  
Austin Peay State University  
Avimor Properties

Babbitt Ranches  
Bamert Seed Company  
Bandon High School  
Bears Ears Partnership  
Bee Inspired Gardens Moab  
Benson Farms  
BFI Native Seeds LLC  
Bird Conservancy of the Rockies  
Boise State University  
Borderlands Restoration Network  
Boulder County Parks & Open Space  
Brigham Young University  
Caerus Oil and Gas LLC  
California Botanic Garden  
California Conservation Corps  
California Department of Corrections and Rehabilitation  
California Polytechnic State University  
California State Coastal Conservancy  
California State University, Dominguez Hills  
California State University, Northridge  
Canyon County Discovery Center  
Canyonlands Research Center  
Celanese Corporation  
Center for Natural Lands Management  
Channel Islands Restoration  
Chicago Botanic Garden  
City of Albuquerque, NM  
City of Boise, ID  
City of Palmer, Alaska  
Clark College  
Clark County Nevada Desert Conservation

Clark County School District	Friends of Acadia
Coastal San Luis Resource Conservation District	Friends of Verde River Greenway
Colorado Natural Heritage Program	Get Outdoors Nevada
Colorado Parks and Wildlife	Grand Staircase Escalante Partners
Colorado State University	Granite Seed
Comstock Seed	Great Basin Fire Science Exchange
Conservation Corps New Mexico	Great Basin Institute
Conservation Management Institute VT	Great Basin Native Plant Program
Coos Watershed Association	Great Basin Seed
Copper River Watershed Project	Greenbelt Land Trust
Crop Jet Aviation LLC	Hedgerow Farms
Curtin University	Homer Soil and Water Conservation District
Denver Botanic Gardens	Ice Age Trail Alliance
Deschutes Basin Native Plant Seedbank	Idaho Department of Correction
Desert Botanical Garden	Idaho Department of Fish and Game
Desert Research Institute	Idaho Department of Lands
Diablo Trust	Idaho Department of Lands
Douglas County, Oregon	Institute for Applied Ecology
Douglas Soil and Water Conservation District	International Network for Seed-based
Dow Chemical Company	Restoration
Ducks Unlimited	Jackson Soil and Water Conservation District
Early Childhood Education Center	Jones Center at Ichauway
East Cascades Native Plant Hub	Jornada Experimental Range
East Texas Natives Project	Kansas Department of Wildlife and Parks
Elder Oaks Native Plant Nursery	Kern River Valley Heritage Foundation
Eleanor Roosevelt Community Learning Center	Klamath Watershed Partnership
Elk Mountain Farms	Klamath-Siskiyou Oak Network
ENVU Corporation	L&H Seeds
EOG Resources, Inc.	Lancaster County Conservation District
Fallbrook Land Conservancy	Latah Soil and Water Conservation District
Foundation for California University of	Lewis and Clark State College
Pennsylvania	

Limahuli National Tropical Botanical Garden & Preserve	Natural Areas Association
Lomakatsi Restoration Project	NatureServe
Makauwahi Cave Reserve	Nebraska Game and Parks Commission
Malama Learning Center	Nevada Department of Agriculture
Maricopa County	Nevada Department of Correction
Marshall University	Nevada Department of Wildlife
Mayberry Native Plant Center	Nevada Division of Forestry
McDowell-Sonoran Preserve	Nevada Native Seed Partnership
Michigan Department of Attorney General	New Jersey Audubon
Michigan Department of Environment, Great Lakes, and Energy	New Mexico Land Conservancy
Michigan Department of Natural Resources	New Mexico State University
Mid-Atlantic Regional Seed Bank	North Carolina Botanical Garden
Middle Fork Energy Partners, LLC	North Dakota Natural Resource Trust
Middle Rio Grande Conservancy District	Northern Arizona University
Minnesota Land Trust	Northern Illinois University
Minnesota Zoo	Ojai Valley Land Conservancy
Mojave Desert Land Trust	Oregon Conservation Corps
Montana Conservation Corp	Oregon Department of Agriculture
Montana Department of Resource Conservation	Oregon Department of Correction
Montana Natural History Center	Oregon Dept of Fish and Wildlife
Moorestown Township, NJ	Oregon Small Woodlands Association
Mountain High Nursery	Oregon State Parks
National Audobon Society	Oregon State University
National Forest Foundation	Oregon Watershed Enhancement Board
National Tropical Botanic Garden	Occidental petroleum
National Wild Turkey Foundation	Pacific Rim Institute for Environmental Stewardship
National Wildlife Federation	Pheasants Forever
Native Plant Society of Colorado	Phoenix School of Roseburg
Native Plant Society of Oregon	Practical Farmers of Iowa
Native Plant Trust	Querencia Institute
	Rainwater Basin Joint Venture

Red Butte Garden	Stevenson Intermountain Seed, Inc.
Rim to Rim Restoration	Student Conservation Association
Rio Grande Return	Texas Native Seeds Program
River Partners	Texas Parks and Wildlife Department
Rock Creek Conservancy District	The Arboretum at Flagstaff
Rogue Native Plant Partnership	The Ecostudies Institute
Rose Creek Seed	The Living Desert Zoo and Gardens
Sacramento Tree Foundation	The Nature Conservancy
Salcha Delta Soil and Water Conservation District	The Understory Initiative
Salmon River Restoration Council	Tolani Lake Enterprises, Inc.
Salmon Valley Stewardship	Trinity University
San Diego Natural History Museum	Truax Company, Inc.
Santa Barbara County, CA	Umpqua Native Plant Partnership
Santa Monica Mountains Fund	Umpqua Oak Partnership
Santa Rita Experimental Range	Umpqua Watershed, Inc
Schoodic Institute	UNC Charlotte Botanic Garden
Scottsdale Community College	Uncompahgre Watershed Partnership
Sea Girt, NJ	United Plant Savers
Sequoia Riverlands Trust	University of Alabama
Sky Island Alliance	University of Alaska, Anchorage
Society for Ecological Restoration	University of Arizona
South Dakota Game, Fish and Parks	University of California, Davis
South Dakota State University	University of California, Riverside
South Slope Reclamation & Consulting	University of Colorado, Boulder
Southeastern Grasslands Initiative	University of Connecticut
Southeastern Utah Riparian Partnership	University of Delaware
Southern Utah University	University of Georgia
Southwest Seed Partnership	University of Hawai'i
Southwest Seed, Inc.	University of Idaho
State Botanical Garden of Georgia	University of Maine
State of Alaska Palmer Plant Material Center	University of Montana
	University of Nevada, Las Vegas



University of Nevada, Reno

University of Wisconsin

University of Wyoming

Upper Colorado Environmental Plant Center

Utah Crop Improvement Association

Utah Division of Wildlife Resources

Utah Friends of Monarchs

Utah State University

Verdesian Life Sciences, LLC

Victor Valley College

Virginia Tech

Walama Restoration Program

Walker Basin Conservancy

Washington Department of Fish and Wildlife

Washington State Parks Commission

Washington State University

Western Foothills Land Trust

Weyerhaeuser Company

Wild Farmlands Foundation

Wild Salmon Center

Wildlife Corridors Inc.

Willamette College

Wyoming Department of Corrections



**Photo 19.** Kathryn Prive of the Rogue Native Plant Partnership (RNPP) tracks seed lot data at their seed storage and processing facility. The RNPP is a consortium of state and federal agencies, non-government entities, private growers, and members of the public. Credit: Tuula Rebhahn, The Understory Initiative.

## Appendix 2: Publications Submitted to the Progress Report

Over 59 research publications cover diverse themes in native plant restoration and ecosystem recovery, especially in sagebrush steppe and drylands, emphasizing the importance of functional composition and genetic diversity in enhancing restoration outcomes. Additionally, a focus on practical applications—such as decision-support frameworks for seed selection and the use of drones and thermal imaging for plant health monitoring—deepens our understanding of restoration ecology and effective strategies for sustainable practices.

Anthony, C., C. Applestein, and M. Germino. 2023. Satellite-derived prefire vegetation predicts variation in field-based invasive annual grass cover after fire. *Applied Vegetation Science* 26.

Anthony, C. R., and M. J. Germino. 2023. Does post-fire recovery of native grasses across abiotic-stress and invasive-grass gradients match theoretical predictions, in sagebrush steppe? *Global Ecology and Conservation* 42:pe02410.

Applestein, C., C. Anthony, and M. J. Germino. 2024. Analysis adapted from text mining quantitatively reveals abrupt and gradual plant-community transitions after fire in sagebrush steppe. *Landscape Ecology* 39:64.

Applestein, C., and M. J. Germino. 2023. Satellite-derived plant cover maps vary in performance depending on version and product. *Ecological Indicators* 155:110950.

Applestein, C., and M. J. Germino. 2024. Systematic Process for Determining Field-Sampling Effort Required to Know Vegetation Changes in Large, Disturbed Rangelands Where Management Treatments Have Been Applied. *Rangeland Ecology & Management* 92:68–72.

Balazs, K., S. Munson, and B. Butterfield. 2022. Functional composition of plant communities mediates biomass effects on ecosystem service recovery across an experimental dryland restoration network. *Functional Ecology* 36.

Beaury, E. M., C. S. Jarnevich, I. Pearse, A. E. Evans, N. Teich, P. Engelstad, J. LaRoe, and B. A. Bradley. 2023. Modeling habitat suitability across different levels of invasive plant abundance. *Biological Invasions* 25:3471–3483.

Chung, Y. A., T. A. Monaco, J. B. Taylor, and P. B. Adler. 2023. Do plant–soil feedbacks promote coexistence in a sagebrush steppe? *Ecology* 104:e4056.

Colgan, A. M., R. G. Hatfield, A. Dolan, W. Velman, R. E. Newton, and T. A. Graves. 2024. Quantifying effectiveness and best practices for bumblebee identification from photographs. *Scientific Reports* 14:830.

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Farrell, H., S. Munson, B. Butterfield, M. Duniway, A. Faist, E. Gornish, C. Havrilla, L. Larios, S. Reed, H. Rowe, K. Laushman, and M. McCormick. 2023. Soil surface treatments and precipitation timing determine seedling development across southwestern US restoration sites. *Ecological Applications* 33.

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## Appendix 3: Project Websites

### Native plant partnerships and programs:

- [Diné Native Plants Program \(https://www.nndfw.org/dnpp/homepage.html\)](https://www.nndfw.org/dnpp/homepage.html)
- [Great Basin Native Plant Project \(https://greatbasinnpp.org/\)](https://greatbasinnpp.org/)
- [Nevada Native Seed Partnership \(https://www.partnersinthesage.com/nevada-native-seed-partnership\)](https://www.partnersinthesage.com/nevada-native-seed-partnership)
- [Texas Native Seeds Program \(https://www.ckwri.tamuk.edu/research-programs/texas-native-seeds-program-tns\)](https://www.ckwri.tamuk.edu/research-programs/texas-native-seeds-program-tns)
- [The Southwest Seed Partnership \(https://southwestseedpartnership.org/\)](https://southwestseedpartnership.org/)
- [The Rogue Native Plant Partnership \(https://www.roguenativeplants.org/\)](https://www.roguenativeplants.org/)
- [Umpqua Native Plant Partnership \(https://www.umpquanativeplants.org/\)](https://www.umpquanativeplants.org/)

### Webpages:

- [BLM Colorado Plateau Native Plant Program \(https://cpnpp-natureserve.hub.arcgis.com\)](https://cpnpp-natureserve.hub.arcgis.com)
- [BLM Ecoregional Programs \(https://www.blm.gov/programs/natural-resources/native-plant-communities/native-plant-and-seed-material-development/ecoregional-programs\)](https://www.blm.gov/programs/natural-resources/native-plant-communities/native-plant-and-seed-material-development/ecoregional-programs)
- [BLM Mojave Desert Native Plant Program \(https://www.arcgis.com/apps/MapSeries/index.html?appid=7198\)](https://www.arcgis.com/apps/MapSeries/index.html?appid=7198)
- [BLM Plants and Seeds \(https://www.blm.gov/programs/natural-resources/native-plant-communities\)](https://www.blm.gov/programs/natural-resources/native-plant-communities)
- [Climate Smart Restoration Tool \(https://www.climate restoration tool.org\)](https://www.climate restoration tool.org)
- [INHABIT \(https://gis.usgs.gov/inhabit\)](https://gis.usgs.gov/inhabit)
- [International Network for Seed-Based Restoration \(https://ser-insr.org/\)](https://ser-insr.org/)
- [Land Treatment Exploration Tool \(https://www.usgs.gov/apps/land-treatment-exploration-tool/\)](https://www.usgs.gov/apps/land-treatment-exploration-tool/)
- [NASA Greenbelt Meadows \(https://www.nasa.gov/goddard/memd/meadows/\)](https://www.nasa.gov/goddard/memd/meadows/)
- [NASEM An Assessment of Native Seed Needs and the Capacity for Their Supply: Final Report \(https://nap.nationalacademies.org/read/26618/chapter/1\)](https://nap.nationalacademies.org/read/26618/chapter/1)
- [National Native Seed Conference 2023 \(https://appliedeco.org/2023-native-seed-conference/\)](https://appliedeco.org/2023-native-seed-conference/)
- [National Whitebark Pine Restoration Plan \(https://whitebarkfound.org/our-work/national-whitebark-pine-restoration-plan/\)](https://whitebarkfound.org/our-work/national-whitebark-pine-restoration-plan/)
- [Native Plant Seed Mapping Toolkit \(https://www.usgs.gov/apps/seed-toolkit/\)](https://www.usgs.gov/apps/seed-toolkit/)
- [Natural Areas Association \(https://www.naturalareas.org/\)](https://www.naturalareas.org/)
- [Nevada Seed Certification \(https://agri.nv.gov/Plant/Seed\\_Certification/Seed\\_Certification\\_Home/\)](https://agri.nv.gov/Plant/Seed_Certification/Seed_Certification_Home/)
- [NPS Native Plant Nursery Video \(https://www.nps.gov/media/video/view.htm?id=0FE9F7EF-1DD8-B71B-0BDADC2877E8B440\)](https://www.nps.gov/media/video/view.htm?id=0FE9F7EF-1DD8-B71B-0BDADC2877E8B440)
- [Plant Conservation Alliance \(https://www.plantconservationalliance.org/\)](https://www.plantconservationalliance.org/)
- [Rare Seed Longevity Research \(https://saveplants.org/seed-longevity-research/\)](https://saveplants.org/seed-longevity-research/)
- [Sagebrush Conservation Initiative \(https://wafwa.org/initiatives/sci/\)](https://wafwa.org/initiatives/sci/)
- [Sagebrush in Prisons Project \(https://appliedeco.org/education/sagebrush-in-prisons-project/\)](https://appliedeco.org/education/sagebrush-in-prisons-project/)
- [SageSTEP Sagebrush Steppe Treatment Evaluation Project \(https://sagestep.org/\)](https://sagestep.org/)

- [Seeding Evaluation and Experimental Design Strategies \(SEEDS\) For Restoration](https://greatbasinpp.org/project/seeding-evaluation-and-experimental-design-strategies-seeds-for-restoration/) (<https://greatbasinpp.org/project/seeding-evaluation-and-experimental-design-strategies-seeds-for-restoration/>)
- [Seeds of Success](https://www.blm.gov/programs/natural-resources/native-plant-communities/native-plant-and-seed-material-development/collection) (<https://www.blm.gov/programs/natural-resources/native-plant-communities/native-plant-and-seed-material-development/collection>)
- [Southeast Grasslands Institute](https://www.segrasslands.org/) (<https://www.segrasslands.org/>)
- [The Joshua Tree Genome Project](https://joshuatreegenome.org/) (<https://joshuatreegenome.org/>)
- [The MT Native Seed Network](https://dnrc.mt.gov/Forestry/Conservation-Nursery/Native-Seed-Program) (<https://dnrc.mt.gov/Forestry/Conservation-Nursery/Native-Seed-Program>)
- [USDA-ARS Forest and Range Research](https://www.ars.usda.gov/pacific-west-area/logan-ut/forage-and-range-research/) (<https://www.ars.usda.gov/pacific-west-area/logan-ut/forage-and-range-research/>)
- [USDA-ARS Germplasm Resources Information Network \(GRIN\)](https://www.ars-grin.gov) (<https://www.ars-grin.gov>)
- [USDA-ARS Grass, Forage, and Rangeland Agroecosystems](https://www.ars.usda.gov/natural-resources-and-sustainable-agricultural-systems/grass-forage-and-rangeland-agroecosystems/) (<https://www.ars.usda.gov/natural-resources-and-sustainable-agricultural-systems/grass-forage-and-rangeland-agroecosystems/>)
- [USDA-ARS Plant Germplasm Introduction and Testing Research](https://www.ars.usda.gov/pacific-west-area/pullman-wa/plant-germplasm-introduction-and-testing-research/) (<https://www.ars.usda.gov/pacific-west-area/pullman-wa/plant-germplasm-introduction-and-testing-research/>)
- [USDA FS Bend Seed Extractory](https://ser-insr.org/news/2017/5/1/us-forest-service-bend-seed-extractory-1) (<https://ser-insr.org/news/2017/5/1/us-forest-service-bend-seed-extractory-1>)
- [USDA FS Bend Seed Extractory poster](https://fs.usda.gov/t-d/programs/ref/images/seedextractory/BendExtractoryPoster.pdf) (<https://fs.usda.gov/t-d/programs/ref/images/seedextractory/BendExtractoryPoster.pdf>)
- [USDA FS National Seed Laboratory](https://fs.usda.gov/nsl/) (<https://fs.usda.gov/nsl/>)
- [USDA FS Native Plant Materials](https://www.fs.usda.gov/wildflowers/Native_Plant_Materials/) ([https://www.fs.usda.gov/wildflowers/Native\\_Plant\\_Materials/](https://www.fs.usda.gov/wildflowers/Native_Plant_Materials/))
- [USDA FS Nurseries and Seed Extractories](https://www.fs.usda.gov/managing-land/forest-management/vegetation-management/nurseries) (<https://www.fs.usda.gov/managing-land/forest-management/vegetation-management/nurseries>)
- [USDA FS Rocky Mountain Research Station](https://research.fs.usda.gov/rmrs) (<https://research.fs.usda.gov/rmrs>)
- [USDA FS Seed Testing](https://www.fs.usda.gov/science-technology/nsl/seed-testing) (<https://www.fs.usda.gov/science-technology/nsl/seed-testing>)
- [USDA NRCS East Texas Plant Materials Center](https://www.nrcs.usda.gov/plant-materials/etpmc) (<https://www.nrcs.usda.gov/plant-materials/etpmc>)
- [USDA NRCS Plant Materials](https://www.nrcs.usda.gov/plant-materials) (<https://www.nrcs.usda.gov/plant-materials>)
- [USFWS Coastal Program](https://www.fws.gov/program/coastal) (<https://www.fws.gov/program/coastal>)
- [USFWS Lesser-prairie chicken habitat conservation](https://www.fws.gov/press-release/2022-06/lesser-prairie-chicken-habitat-conservation-plan-oil-and-gas-development) (<https://www.fws.gov/press-release/2022-06/lesser-prairie-chicken-habitat-conservation-plan-oil-and-gas-development>)
- [USFWS New Mexico Ecological Services Field Office](https://www.fws.gov/office/new-mexico-ecological-services/new-mexico-partners-fish-and-wildlife) (<https://www.fws.gov/office/new-mexico-ecological-services/new-mexico-partners-fish-and-wildlife>)
- [USFWS Tittabawasseee River Natural Resource Damage Assessment and Restoration](https://dnrc.mt.gov/Forestry/Conservation-Nursery/Native-Seed-Program) (<https://dnrc.mt.gov/Forestry/Conservation-Nursery/Native-Seed-Program>)
- [USGS Dryland Ecohydrology Team](https://sites.google.com/view/dryland-ecohydrology-team) (<https://sites.google.com/view/dryland-ecohydrology-team>)
- [USGS Informing seed transfer guidelines and native plant materials development](https://www.usgs.gov/centers/southwest-biological-science-center/science/informing-seed-transfer-guidelines-and-native?qt-science_center_objects=0#qt-science_center_objects) ([https://www.usgs.gov/centers/southwest-biological-science-center/science/informing-seed-transfer-guidelines-and-native?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/centers/southwest-biological-science-center/science/informing-seed-transfer-guidelines-and-native?qt-science_center_objects=0#qt-science_center_objects))
- [USGS National Early Detection and Rapid Response \(EDRR\) Framework](https://www.usgs.gov/tools/national-early-detection-and-rapid-response-edrr-framework) (<https://www.usgs.gov/tools/national-early-detection-and-rapid-response-edrr-framework>)

- [USGS POPMAPS: An R package to estimate ancestry probability surfaces](https://www.usgs.gov/software/popmaps-r-package-estimate-ancestry-probability-surfaces)  
(<https://www.usgs.gov/software/popmaps-r-package-estimate-ancestry-probability-surfaces>)
- [USGS RAMPS: Restoration Assessment & Monitoring Program for the Southwest](https://www.usgs.gov/sbsc/ramps)  
(<https://www.usgs.gov/sbsc/ramps>)
- [USGS RestoreNet](https://www.usgs.gov/sbsc/restorenet) (<https://www.usgs.gov/sbsc/restorenet>)
- [USGS Southwest Energy Exploration, Development, and Reclamation \(SWEDR\)](https://www.usgs.gov/centers/southwest-biological-science-center/science/southwest-energy-exploration-development-and#overview)  
(<https://www.usgs.gov/centers/southwest-biological-science-center/science/southwest-energy-exploration-development-and#overview>)
- [USGS Understanding the use of habitat models for managing and conserving rare plants on western public lands](https://www.usgs.gov/centers/fort-collins-science-center/science/understanding-and-fostering-use-habitat-models-rare) (<https://www.usgs.gov/centers/fort-collins-science-center/science/understanding-and-fostering-use-habitat-models-rare>)
- [USGS Using Pollinator Environmental DNA to Assess the Ecological Resilience of America's Grasslands](https://www.usgs.gov/labs/pacific-northwest-environmental-dna-laboratory/science/using-pollinator-environmental-dna) (<https://www.usgs.gov/labs/pacific-northwest-environmental-dna-laboratory/science/using-pollinator-environmental-dna>)
- [USGS Well Pad Reclamation and Research](https://www.usgs.gov/centers/southwest-biological-science-center/science/well-pad-reclamation-and-research) (<https://www.usgs.gov/centers/southwest-biological-science-center/science/well-pad-reclamation-and-research>)
- [USGS Western Bumble Bee and Native Pollinator Research](https://www.usgs.gov/centers/norock/science/western-bumble-bee-and-native-pollinator-research)  
(<https://www.usgs.gov/centers/norock/science/western-bumble-bee-and-native-pollinator-research>)
- [Western Forbs](https://westernforbs.org/) (<https://westernforbs.org/>)



## Appendix 4: Acronyms

AMS – Agricultural Market Service (USDA)  
ARS – Agriculture Research Service (USDA)  
BIA – Bureau of Indian Affairs (DOI)  
BIL – Bipartisan Infrastructure Law  
BIL-ER – Bipartisan Infrastructure Law – Ecosystem Restoration  
BIL-BAR – Bipartisan Infrastructure Law – Burned Area Rehabilitation  
BLM – Bureau of Land Management (DOI)  
DOD – Department of Defense  
DOI – Department of the Interior  
EPA - Environmental Protection Agency  
FSA – Farm Service Administration (USDA)  
IRA – Inflation Reduction Act  
NASEM – National Academies of Sciences, Engineering, and Medicine  
NASA – National Aeronautics and Space Administration  
NIFA – National Institute for Food and Agriculture (USDA)  
NPS – National Park Service (DOI)  
NRCS – National Resource Conservation Service (USDA)  
NSSKI – National Seed Strategy Keystone Initiative  
PCA – Plant Conservation Alliance  
SI – Smithsonian Institution  
SOS – Seeds of Success  
USFS – U.S. Forest Service (USDA)  
USACE – U.S. Army Corp of Engineers  
USBG – U.S. Botanic Garden  
USDA – U.S. Department of Agriculture  
USFWS – Fish and Wildlife Service (DOI)  
USGS – U.S. Geological Survey (DOI)

## Appendix 5: Glossary

The glossary describes terms referenced in the National Seed Strategy and Progress Reports.

**Blanket Purchase Agreement (BPA).** A flexible procurement instrument which allows the procurement agent the authority to purchase multiple items under a broad “blanket” of goods and services.

**Common garden experiment.** An experiment where different genotypes, populations, or varieties are grown together in the same environment such that environmental effects on trait expression are minimized and genetic differences are more readily observed.

**Cultivar (Plant Variety).** A cultivated variety of a plant species, as opposed to a species that occurs only in nature. Cultivars are distinct varieties of plant species that are produced and maintained by cultivation.

**Ecoregion.** Areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources. They are designed to serve as a spatial framework for the research, assessment, management, and monitoring of ecosystems and ecosystem components.

**Forb.** Non-woody and non-grass vascular plants. Sometimes colloquially called wildflowers.

**Genetically appropriate native seed and plant materials.** Native seed and plant materials that are genetically adapted to a restoration site and are likely to establish, persist, and promote community and ecological relationships. These seeds or plants are genetically diverse and can respond and adapt to changing climates and environmental conditions and are unlikely to cause genetic contamination and undermine local adaptations, community interactions, and function of resident native species.

**Indefinite Delivery Indefinite Quantity contract (IDIQ contract).** A flexible procurement instrument that provides for an indefinite quantity of services for a fixed time. They are used when the precise quantities of supplies or services that the government will require during the contract period cannot be determined.

**Indigenous Knowledge.** The body of observations, oral and written knowledge, innovations, practices, and beliefs developed by Tribal Nations and Indigenous Peoples through interaction and experience with the environment. Often developed over millennia, Indigenous Knowledge continues to develop and includes understanding based on evidence acquired through direct contact with the environment and long-term experiences, as well as extensive observations, lessons, and skills passed from generation to generation.

**Locally adapted native seed and plant materials.** From an area geographically near a planting site that are environmentally adapted and likely to establish and persist.

**Native plants.** Indigenous terrestrial and aquatic species that have evolved and occur naturally in a particular region, ecosystem, or habitat. Species native to North America are generally recognized as those occurring on the continent prior to European settlement. Native plant species represent a number of different life forms including conifer trees, hardwood trees, shrubs, grasses, forbs, and others.

**Native plant material.** Plant materials refers to any propagatable part of a native plant (i.e. seeds, cuttings, plugs, seedlings, and entire plants) that may be used for rehabilitation or restoration.

**Nonnative species.** An organism is considered nonnative (alien, foreign, nonindigenous, exotic) when it has been introduced by humans to a location(s) outside its native or natural range.

**Phenology.** The study of cyclic and seasonal natural phenomena, especially in relation to climate and plant and animal life.

**Radio frequency tagging.** A technology relying on thin electronic circuits capable of receiving a radio signal and replying with a unique identifying code. Radio frequency tagging is more efficient than typical inventory technologies because RF tags can store more information than a barcode and because RF tags can be scanned in groups from a distance of several yards away.

**Rehabilitation.** Rehabilitation emphasizes the restoration of ecosystem processes, productivity, and services, whereas the goals of restoration also include the reestablishment of the preexisting biotic integrity in terms of species composition and community structure.

**Restoration.** The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed.

**Seed supply chain.** The sequence of steps involved in growing, harvesting, storing, sorting, testing, and shipping seed in quantities adequate for use by land managers for restoration projects.

**Seed Transfer Zone.** A mapped area with fixed boundaries in which seeds or plant materials can be transferred with minimal risk of maladaptation.

**Shrub.** A woody, bush-like plant, typically growing relatively close to the ground.

**Soil seedbank.** The natural storage of seeds, often dormant, within the soil of ecosystems.

**Stabilization.** The implementation of emergency treatments to minimize threats to life or property or to stabilize and prevent unacceptable degradation to natural and cultural resources resulting from the effects of disturbances.

**Traditional Ecological Knowledge.** The evolving knowledge of a specific location acquired by Indigenous and local peoples, including the relationships between plants, animals and the physical environment.

## Appendix 6: Captions for full-page photo spreads

For pages with multiple photos, the photos are listed clockwise from the top left corner

**Front cover:** Desert lilies (*Hesperocallis undulata*) and desert sand verbena (*Abronia villosa*) blooming in Desert Lily Preserve, California, credit: Bob Wick, BLM.

**Page before Introduction:** Erin Tapley taking biomass samples, Credit: NRCS; Desert marigold (*Baileya multiradiata*) in southern New Mexico, credit: NM080, Seeds of Success; Monitoring in Glacier National Park, credit: Lindsay Dose, USGS contractor.

**Page 25:** Rachel Guinea collects clustered tarweed (*Deinandra fasciculata*) at Lake Matthews, Riverside County, California for Seeds of Success in 2023, credit: Rachel Guinea, CA610, Seeds of Success; Monitoring plant emergence at a RestoreNet experimental site in northern Arizona, credit: Laura Shriver, USGS; Sagebrush (*Artemisia tridentata*) seedling, grown through the Sagebrush in Prisons project, planted after the Martin Fire in the BLM Winnemucca District Office, credit: Institute for Applied Ecology.

**Page 34:** University of Florida researcher Dr. Jennifer Fill and technician April Zee inspecting a research site addressing the ecological constraints on wiregrass (*Aristida stricta*) recruitment, photo submitted by Dr. Raelene Crandall, University of Florida; Derek Tilley, Manager of the NRCS Aberdeen Plant Materials Center, demonstrating the Tilley Bubbler Method for testing seed viability, credit: USFS Salmon Valley Stewardship; Seedballs laid out along a transect, credit: USFS Salmon Valley Stewardship.

**Page 47:** Native plant community in Georgia, credit: FWS0403, Seeds of Success; Measuring year-end switchgrass growth in the native warm season adaptation study in Csoffeeville, Missouri, credit: NRCS; Coulter's lupine (*Lupinus sparsiflorus*) growing in a RestoreNet research site in the Sonoran Desert, credit: Laura Shriver, USGS.

**Back cover:** Seed collection in Point Reyes National Seashore, credit: NPS; A Duskywing butterfly nectaring on *Dipterostemon*, a perennial wildflower in a Southwest Oregon meadow, photo Tuula Rebhahn, The Understory Initiative

