



# NATIONAL SEED STRATEGY



for Rehabilitation and Restoration

*Making Progress*





The Plant Conservation Alliance (PCA) is a public-private partnership of organizations that share the same goal: to protect native plants by ensuring that native plant populations and their communities are maintained, enhanced, and restored. The PCA Federal Committee, chaired by the Bureau of Land Management, developed the “National Seed Strategy for Rehabilitation and Restoration 2015-2020” in cooperation with federal and non-federal partners.

For more information on the Plant Conservation Alliance and its members and activities, please visit <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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# NATIONAL SEED STRATEGY FOR REHABILITATION AND RESTORATION



## VISION

The right seed in the right place at the right time.

## MISSION

To ensure the availability of genetically appropriate seed to restore viable and productive plant communities and sustainable ecosystems.

# National Seed Strategy for Rehabilitation and Restoration: *Making Progress*

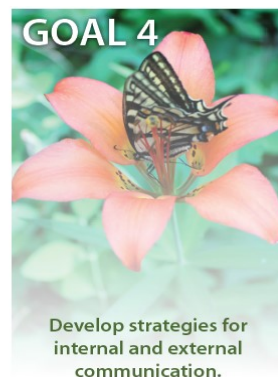
The National Seed Strategy for Rehabilitation and Restoration (Seed Strategy) recognizes the importance of native plants and healthy plant communities in our lives, in our economy, and in our future. Native plants and native plant communities are nature’s infrastructure. Native plants provide the appropriate plant materials to reclaim lands used for energy and minerals production. Native plants are in demand nationwide to address land management needs of post-disaster response and site stabilization, invasive plant management, and habitat improvements for numerous species including pollinators. Federal agencies and non-governmental partners developed the National Seed Strategy for Rehabilitation and Restoration 2015-2020 (hereafter Strategy) and released it August 17, 2015. The overall goal of the Strategy is to provide “the right seed in the right place at the right time.”

This report identifies progress toward the four Seed Strategy goals. The following sections outline advances in science and management by individual partners of the Plant Conservation Alliance (PCA) and a range of projects highlighting partnerships among federal, state, local, and non-government partners.

The Seed Strategy calls for coordinated

networks of diverse partners to accelerate the pace and scale of restoration. National efforts will be built on numerous local collaborations as partners develop organizational, ecological, and financial efficiencies to address rehabilitation or restoration needs at the right scale. Collaborative, multi-jurisdictional groups are working together to confront large-scale, ecoregional problems that overlap with several Seed Strategy topics, such as wildfires and fuel regimes, invasive species, endangered species habitats, and genetic variation of plant species.

This document highlights work being done to address each goal of the Seed Strategy, followed by ecoregional projects that illustrate the extent of collaborations that are underway to lay the foundation for a more comprehensive network of collectors, testers, and growers to make native plants more available across the country. Appendix 1 features numerous activities on the ground and in the lab to address specific Seed Strategy objectives. Appendices 2 and 3 highlight important efforts to build upon existing knowledge and broaden participation to address discrete issues. Appendix 4 contains a list of acronyms used in this report, as well as the list of PCA federal member agencies.





# Status by Goal



## Goal One

The ability of land managers to respond effectively to both emergency and planned restoration needs is dependent on commercial availability of native seed. This requires comprehensive and integrated seed planning and production, as well as seed storage systems that provide sufficient quantities of suitable seeds when and where they are needed. The Bureau of Land Management (BLM) contracted the National Academies of Sciences (NAS) to develop a National Assessment of Seed Needs and Capacities. This assessment will enable all sectors to know what the seed needs are and where to find them so the private sector commercial native seed industry can provide plants that land managers across the nation need for the sustainable reclamation,

rehabilitation and restoration of native plant communities. In an important first step to a National Assessment, the NAS hosted a scoping session in February 2017, with 30 representatives from industry, government, universities, and non-governmental organizations to gauge the information needs across federal, state, tribal, and private sectors.

### SOS East

Seeds of Success (SOS) is the national native seed collection program led by the BLM with numerous federal agencies and non-federal partners. The first step to making wild native plants available for restoration is to collect wildland native seed for research, development, germplasm conservation, and ecosystem restoration. The overall goal is to increase the quality and quantity of native plants needed to restore and maintain resilient ecosystems. Since inception, the SOS program has made 23,500 collections mainly in western states but with a notable expansion in the eastern United States since 2015.

Following the devastation of Hurricane Sandy, the U.S. Department of the Interior's Sandy Supplemental Mitigation fund awarded BLM a \$3.5 million for seed collection in coastal habitats from Virginia to Maine. New York City's Greenbelt Native Plant Nursery, in partnership with New England Wildflower Society and North Carolina Botanic Garden, worked with Chicago Botanic Garden's Conservation and Land Management (CLM) Internship Program to hire 35 interns for SOS East collecting teams. The CLM program provides hands-on experience to motivated and highly skilled recent college graduates. Since 2015, the SOS East teams have made more than 2,100 collections of 345 unique taxa spanning 72 plant families, 11 states, and 15 ecoregions.

**Contact:** Ed Toth (edward.toth@parks.nyc.gov)

**Website:** [www.marsb.org/sosmemberinfo](http://www.marsb.org/sosmemberinfo)

Although a full assessment of our plant needs is still in progress, we already know many species of native plants are not commercially available. This is especially true of forbs (wildflowers). Locally adapted forbs form an important component of plant communities across the country. Certain species are more difficult to

grow than others; they may require specific knowledge or equipment; perennial plants take several years to grow and may have low yields. As such, private growers frequently avoid such potentially risky business endeavors as growing native plants. Projects initiated by public and private sectors across the country are increasing the economic viability and commercial availability of native plants, such as efforts to restore diverse sagebrush communities.

BLM partnered with the Institute for Applied Ecology to develop the Sagebrush in Prisons Project which works with 10 prisons in six states throughout the range of the greater sage grouse to produce sagebrush and bitterbrush plants, including establishing sagebrush seed orchards on prison grounds. Additionally, the USDA Forest Service (USFS) Intermountain Mountain Region collaborated with the Great Basin Research Center to increase the quantity of seed for five sage grouse and pollinator-friendly forb species, sulphur-flower buckwheat, redroot buckwheat, Gray's biscuitroot, nineleaf biscuitroot and aspen fleabane. Programs and projects like these will stabilize and grow the native seed market as we share, learn, build, and improve stewardship of our natural resources.

### **Working together to Restore Native Plant Communities on Tribal Lands**

The USFS Reforestation, Nurseries, and Genetic Resources Team is strengthening tribal partnerships by providing a forum for Native American tribes that fosters cooperative efforts to produce and restore native plants through networking. This team has already collaborated with 80 tribes and more than 500 tribal members to promote best practice propagation.

Native peoples are working hard to restore their lands with culturally significant native plants. At the request of tribes, the Rocky Mountain Research Station (RMRS) is writing propagation protocols on almost 300 culturally significant native plants. The RMRS team's efforts have been awarded the Earle R. Wilcox Award from the Intertribal Timber Council for their outstanding quality and effectiveness.

In 2017, USFS scientists co-organized the 16th Intertribal Nursery Council annual meeting, hosted by the Seneca Nation of Indians in Buffalo, NY. Bringing together tribes from across the United States, federal agencies, universities, tribal colleges, county governments, and organizations from the private sector, the meeting included presentations on native plants, seed zones, and forest health. The Intertribal Nursery Council is a USFS-managed and funded tribally guided organization for advancing the interests of native peoples involved with plant production in nurseries.

*Figure 1. 16th Annual Workshop Intertribal Nursery Council Meeting Participants.*





**Identify research needs and conduct research to provide genetically appropriate seed and to improve technology for native seed production and ecosystem restoration.**

## Goal Two

Native plants are needed to restore lands disturbed by activities such as coal and hardrock mining reclamation. To meet the demand of land managers, additional research is required to ensure native plant materials are commercially available. This research includes developing and testing seed zones; developing reliable protocols for seed testing, storage, and production; and defining effective restoration strategies and monitoring systems. Since the Seed Strategy's release in 2015, there have been many collaborative efforts that promote shared conservation stewardship among land managers, scientists, seed regulatory agencies, and the private sector seed industry. Seed zones were developed for more than 12 plants. Several partners, such as the Chicago Botanic Garden, conducted seed germination trials that studied the germination requirements of populations of eight priority restoration forb

species in the Colorado Plateau. The Great Basin Native Plant Project (GBNPP), BLM - Idaho State Office, and the Great Basin Fire Science Exchange cooperated to develop a forb manual that will include cultivation practices and other data on the more than 90 forb species that have been researched by GBNPP. The University of Nevada, in collaboration with USDA-National Institute of Food and Agriculture (NIFA), are working to improve restoration success and associated ecosystem services by changing seed sources and seeding strategies. They are planting some areas with a "high-performance restoration mix" (made up of combinations of plants selected from multiple high quality populations) and comparing that to plant mixes that were collected from single locations. The research being conducted under Goal 2 is essential to the development of decision tools described in Goal 3.

### **Restoration Assessment and Monitoring Program for the Southwest (RAMPS)**

The Restoration Assessment and Monitoring Program for the Southwest was developed in 2016 to help U.S. Department of the Interior (DOI) and other land management agencies successfully implement mitigation, restoration, and rehabilitation activities specifically in the arid Southwest. RAMPS allows for interdisciplinary collaboration between land managers, practitioners, and scientists in the Southwest. RAMPS is producing a variety of tools for land managers and serving as a clearinghouse for research to assist in restoration success, including guidance for selecting plant materials and access to georeferenced seed sources.

RAMPS also provides data synthesis consultation, cost-benefit analysis of management practices, field trial networks and experimental sites, and monitoring protocols. These monitoring protocols increase accountability and save money in the long run by promoting more effective management practices. Through all of these services RAMPS creates a community of practice through which knowledge is exchanged.

**Contact:** Molly McCormick (mmccormick at usgs.gov)





**Develop tools that enable managers to make timely, informed seeding decisions for ecological restoration.**

### Goal Three

Restoration goals must be placed in the context of economic, social, and site-specific ecosystem recovery potential. In addition, managers and decision makers are often faced with uncertainty and having to work with incomplete information and varying availability of native plant materials. Tools are necessary to help managers assess the risks, guide the scope, and predict the efficacy of restoration treatments. At the 2017 National Native Seed Conference (see Appendices 2 and 3), task force on Training Tools for Practitioners, Producers, and Stakeholders on the Use of Native Seed was formed to focus on Action 3.1.1. of the Seed Strategy. The Training Tools task force sought to identify gaps between available training and the training needed to better understand restoration principles and the use of native seed across multiple agencies (federal, state, tribal, and local), nongovernmental organizations,

private sector industries, and universities. They identified 59 training courses or educational materials (See [BLM.gov/SeedStrategy](http://BLM.gov/SeedStrategy)) and found a need for more training tools to educate restoration professionals on collecting native seeds and using native plants in restoration. Given funding limitations, more online options are needed, and existing courses could be modified to include more native plant information. The use of nonlocal seed in restoration risks the movement of nonlocal genes into local populations. Potential effects must be clearly defined and disclosed so that restoration managers can make informed choices. Prioritizing efforts and being responsive to emerging information on past successes and failures will help ensure native plant communities are resilient and resistant to historical and novel stressors.

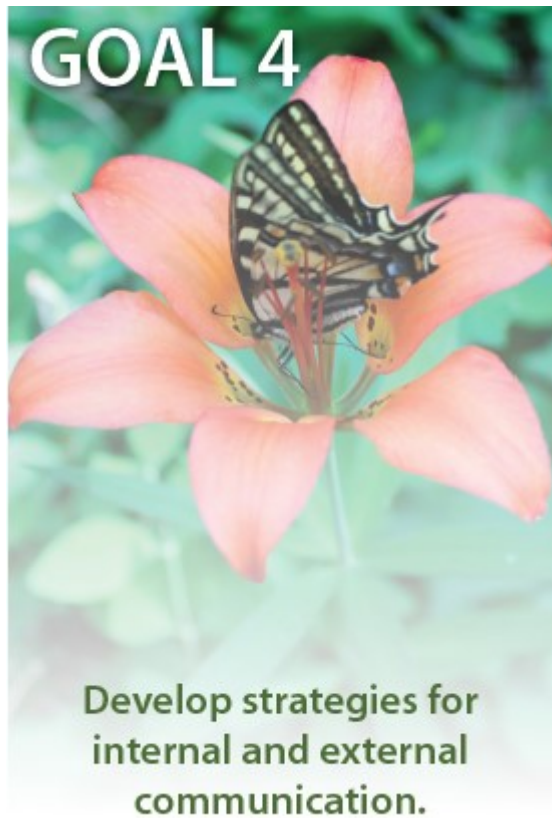
#### Seedlot Selection Tool

USFS created the Seedlot Selection Tool (SST), a web-based mapping application designed to help natural resource managers match seedlots with planting sites based on climatic information. Populations of native plants are genetically different from one another and are adapted to different climatic conditions, so natural resource managers must match the climatic adaptability of their plant materials to the climatic conditions of their reforestation or restoration sites. For forest trees, and increasingly for other native plants, this has typically been done using geographically defined seed zones or seed transfer rules.

Managers and other stakeholders can use the SST to map either current or future climates based on selected climate scenarios. Users can select a transfer limit method (an established seed zone or a customized one), and a set of relevant climate variables to map seedlots appropriate for planting on a particular site or sites appropriate for a particular seedlot. The tool allows consideration of seedlots that may be adapted to various future climates.

**Contact:** Matt Horning (mhorning at fs.fed.us )

**Website:** [www.seedlotselectiontool.org/sst](http://www.seedlotselectiontool.org/sst)



### Goal Four

The Seed Strategy is a unifying collaborative national effort and requires broad communication of both goals and accomplishments. The first objectives under Goal 4 are to produce external and internal communication plans to conduct Seed Strategy education and outreach throughout the Plant Conservation Alliance network. A Seed Strategy Communications task force produced an electronic toolkit, including a presentation and

fact sheets, which is easily accessible to PCA collaborators and the general public. To assist PCA member agency communications, the Bureau of Land Management (BLM) led an interagency group of communications experts who prepared a Seed Strategy briefing package to explain and find synergies for implementing the Seed Strategy within their respective agencies. PCA-member agencies have also developed tailored communications. The USFS distributed their own Native Seed Strategy 2016 Annual Report in August 2017 from which success stories, lessons learned, and recommendations for improvements are highlighted. These communications products and materials help ensure the Seed Strategy remains relevant and responsive to evolving restoration and rehabilitation needs.



*Figure 2. Phlox longifolia (longleaf phlox) seeds, photo by Bend Seed Extractory*

### Smithsonian Opens New Garden Lounge with Exhibit Focusing on Seeds

An exhibit opened on November 15, 2017 at the National Museum of Natural History in Washington, DC that aims to provide a quiet and contemplative space for all museum visitors. With mobile device charging stations, benches, natural sunlight, and live plants, the space offers a respite from the energized hustle and bustle of the rest of the museum. Because the hall provides a contemplative venue containing living plants, plant biology is an appropriate theme for an associated exhibition and interpretive material. In particular, stories that focus on seeds and seed dispersal the primary focus. One panel highlights the goals of the U.S. National Seed Strategy for Restoration and Rehabilitation.

**Contact:** Gary Krupnick (krupnick at si.edu)

**Website:** [www.si.edu/exhibitions/the-garden-lounge-6215](http://www.si.edu/exhibitions/the-garden-lounge-6215)





## Ecoregional Case Studies

Implementation of the Seed Strategy at the right scale depends on implementation by multiple stakeholders across multiple jurisdictions. Below, are highlights of work that is laying the foundation for a more comprehensive network supporting collection, testing, production, and use of locally appropriate native plant materials across the country.

### Eastern States

#### Eastern Seed Zone Forum

In order to implement sustainable forest management while considering ecosystem restoration challenges in a uniform manner across regional and political boundaries, the National Forest System developed the Eastern Seed Zone Forum.

The USFS Reforestation, Nurseries, and Genetic Resources Team has been tasked with developing seed zones for the Northeastern Region and the Southern Region (Regions 9 and 8, respectively), which include 24 total states. The USFS develops these seed zones in a way that can be adopted by seed producers, state partners, USDA, DOI, state forestry agencies, and non-governmental organizations.

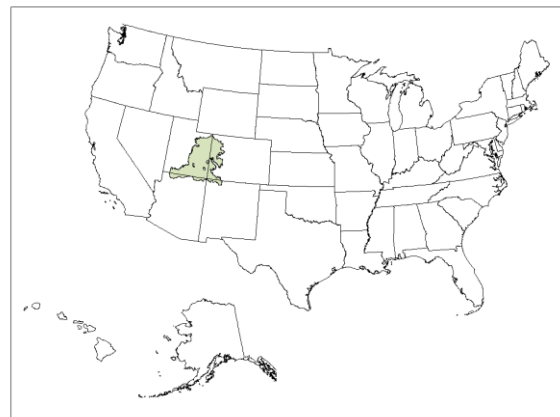
The purpose of this project is to develop seed zones for trees and smaller subzones for non-woody plants and promote discussion of “*what is local?*” when working across jurisdictional barriers. Although this project is not intended to provide seed transfer guidelines or to move seed across a landscape, the research may help land managers in the future with assisted migration. The Eastern Seed Zone Forum developed a website to foster discussion and information sharing. Through this site, collaborators can:

- Listen to webinars.
- Share any additional science articles, partners, or potential speakers.
- Engage with others to form a regional working team to help construct seed zones for a specific area.

**Contact:** Dr. George Hernandez (ghernandez at fs.fed.us) or Dr. Carolyn Pike (cpike at fs.fed.us)

**Website:** (<http://eszf.sref.info/>).

### Colorado Plateau



#### Shared Conservation Stewardship in Utah

Native plant materials are in high demand in the Colorado Plateau for restoration projects following wild fires, oil and gas activity, and other land disturbances, but those available commercially are generally not of local genetics. Southeastern Utah is home to a diverse array of plant species that are of interest for both research and restoration purposes, and most of these have not been collected for use in plant materials development. Given the vast amount of BLM in Utah as well as the variations in elevation and geology, collecting seed throughout the region’s many different landscapes is critical.





Figure 3. Milkweed Seedlings growing at the Desert Botanical Gardens include whitestem milkweed, Arizona milkweed, desert milkweed, pineneedle milkweed, Mojave milkweed, antelope horns milkweed, butterfly weed, and whorled milkweed. Photo by Lisa Thornley.

During the past few years, there has been only one seed collecting team (stationed in Moab, UT) for all of Grand and San Juan counties in southeast Utah. This is a huge amount of ground for one team to cover. The Four Corners School of Outdoor Education (FCS) partnered with the Colorado Plateau Native Plant Program (CPNPP) to help support a Monticello, UT,-based wildland seed collection crew and botanist who work out of the Canyon Country Discovery Center. The FCS team joined the network of five other SOS collection teams located throughout Utah and filled the seed collection gap in the far southeastern corner of the state. As part of the multi-state CPNPP, the FCS team completed more than 30 seed and tissue collections that will be used for long-term storage, restoration, genetic research, and development of seed transfer zones, seed, and seedling production.

FCS partnered with CPNPP to implement the Colorado Plateau Native Plant Program for Milkweed and Nectar Species, providing additional funds matched by the National Fish & Wildlife Foundation Monarch Conservation

Fund and used to support collection, development, and increasing available milkweed and nectar-producing species.

## Desert Southwest Locally Sourced Seed for Monarch Habitat Restoration

Across the country, private landowners and public land managers are eager to enhance and restore habitat for the monarch butterfly. Monarchs need native plants at each stage of their life cycle – most importantly: Milkweed! Milkweed provides essential food and shelter for monarch caterpillars. But it is hard to find commercially available milkweed – even in Arizona, home to 30 milkweed species but where only two species are typically grown for sale: the more commonly available desert milkweed (*Asclepias subulata*) and the Arizona milkweed (*A. angustifolia*).

To address the critical shortage of native milkweed plants, Arizona BLM partnered with the Desert Botanical Garden in January 2016 to initiate a mass propagation effort to bring more Arizona-native milkweed species into production and to develop a public campaign to promote native milkweeds for monarch conservation. Targeting at least eight different Arizona species, including Antelope horns milkweed (*Asclepias albicans*) and Pineneedle milkweed (*A. linaria*), seeds are collected across the state, including from public lands, and are augmented with seeds collected from the Botanical Garden's living collection. Plants are grown out, and growing protocols are developed because different species often have different growing requirements. The goal is to build seed supplies that would produce at least 6,000 new milkweed seedlings, and distribute or plant at least 4,000 of them in the first year.

By engaging and supporting the broader community, schools, businesses, and land management agencies in monarch conservation, this multi-pronged effort to grow and distribute native milkweed plants generates awareness about using appropriate host and nectar plants for the benefit of pollinators and increases the appreciation and availability of locally native plants.

Contact: Lisa Thornley (lthornley at blm.gov)

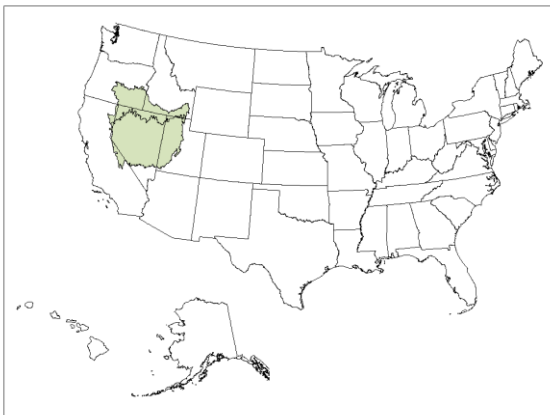
Websites: [www.blm.gov/programs/natural-resources/native-plant-communities/about-native-plants/arizona](http://www.blm.gov/programs/natural-resources/native-plant-communities/about-native-plants/arizona)

[www.dbg.org/milkweed](http://www.dbg.org/milkweed)



Figure 4 Milkweed seedling growing at the Desert Botanical Gardens

## Great Basin



## Great Basin Native Plant Project: Providing knowledge, technology, and availability of native plant materials across the Great Basin



[The Great Basin Native Plant Project](#) (GBNPP) aims to increase the availability of genetically appropriate native plant materials to meet the ever-increasing demand for native seed, particularly in federal agencies. Established in 2001, GBNPP is a multi-state, collaborative research project founded by the BLM [Plant Conservation Program](#) and the Grassland, Shrubland, and Desert Ecosystem Research Program of the Rocky Mountain Research Station (RMRS). USFS researchers and partners are growing native plant varieties, such as bluebunch wheatgrass, and developing the knowledge and technology needed to restore native plant communities. With more than 30 major cooperators across nine states, GBNPP made progress on 29 projects in 2017. Some examples include:

- Testing the efficacy of seed zones for re-establishing and adaptation of bluebunch wheatgrass.
- Population and species-level variation in germination strategies of cold desert forbs.
- Seed production of Great Basin native forbs, with special attention to irrigation requirements.
- Drought effects on the symbiosis between Wyoming big sagebrush seedlings and arbuscular mycorrhizal fungi.

Contact: Fred Edwards, Ecoregional Coordinator, BLM (fsewards at blm.gov) and Francis Kilkenny, Research Biologist, USFS, (ffkilkenny at fs.fed.us)



## Gulf/Southwest

### South Texas Natives and Texas Natives Seed Projects Yield Big Results for Habitat Restoration

South Texas Natives (STN) got its start from local landowners concerned by the use of non-native species for revegetation along rights of way and the potential spread of non-native species onto private ranchlands. In 2001, the collaboration was formalized between private, state and federal entities to develop and promote regionally appropriate native plants for the restoration and reclamation of habitats on private and public lands. The STN effort combines the goals of evaluating and commercializing native Texas seed sources, developing practical restoration and reclamation techniques for these species, and educating constituents, the public, landowners, and agencies about restoration and native plants. STN is managed by the Caesar Kleberg Wildlife Research Institute at Texas A&M University in Kingsville, TX, in cooperation with the USDA- Natural Resources Conservation Service. “Kika” de la Garza Plant Materials Center, Texas A&M AgriLife Research, Texas Department of Transportation, Rio Farms, Douglas King Seed, and Pogue AgriPartners Company. The effort has to date released to the public 30 new plants to commercial growers. Today, more than 47,000 pounds of seed per year of locally adapted native seeds are commercially available annually for planting up to 30,000 acres in south Texas. Some of the south Texas ecotypes now available include shortspike windmillgrass, hooded windmillgrass, bristlegrass, Arizona cottontop, hairy grama, Texas grama, slender grama, sand dropseed, and red lovegrass. The success of this effort spawned a statewide initiative in 2011 called Texas Native Seeds (TNS) to replicate this success in central and west Texas, with additional partners and support including the U.S. Fish and Wildlife Service (USFWS) and the Texas State Soil and Water Conservation Board through 143 Soil and Water

Conservation Districts. Today, 20 or more regionally specific seed releases for each region are being evaluated for possible release. Among these are the Texas-native Zizotes milkweed (*Aesclepias oenotheroides*) and other forbs beneficial to monarchs on a seed production program.

**Contact:** Forrest Smith, Director Texas Native Seeds Program (Forrest.Smith at tamuk.edu)

**Websites:**

**STN:** [www.ckwri.tamuk.edu/research-programs/south-texas-natives](http://www.ckwri.tamuk.edu/research-programs/south-texas-natives)

**TNS:** [www.ckwri.tamuk.edu/research-programs/texas-native-seeds](http://www.ckwri.tamuk.edu/research-programs/texas-native-seeds)

## Midwest/Tallgrass Prairie Prairie Reconstruction Initiative



Prairie reconstruction from seed seems like a practical way for conservation organizations and landowners to create buffers or enlarge existing prairie remnants, build a semblance of historic prairie where it no longer exists, and improve water quality or create habitat. But the results are not always uniform: They range from highly diverse, functional prairies to disappointingly weedy places, with few native species. Why such a difference? The Prairie Reconstruction Initiative (PRI) aims to find out.

Formed by the Eastern Tallgrass Prairie and Big Rivers Landscape Conservation Cooperative, the PRI brings together land managers, scientists, and other prairie practitioners representing

more than 11 conservation organizations to better understand prairie reconstruction successes and failures from each diverse prairie reconstruction attempt so future efforts are successful and cost-effective.

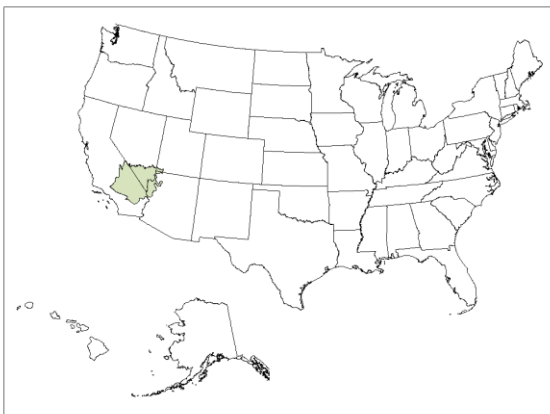
The information needed to systematically compare plantings is often missing. So the PRI developed a prototype database to record and preserve these data. Post-planting monitoring can demonstrate how closely the seed mix matches the developing plant community. Monitoring and database information can reveal the most important influences on the developing character of prairie plantings. Thus, by recording the appropriate monitoring data, the database can provide land managers instant feedback.

This database, which will eventually be available for wider use, could provide key insights about effective reconstruction and management strategies to efficiently and consistently achieve highly diverse prairies.

**Contact:** Amanda McColpin (amanda\_mccolpin at fws.gov)

**Website:** [tallgrassprairiebcc.org/issue/prairie-restoration](http://tallgrassprairiebcc.org/issue/prairie-restoration)

## Mojave



## Using Landscape-scale Plant Genetics to Inform Planting Decisions (a.k.a. Seed Transfer Zones)

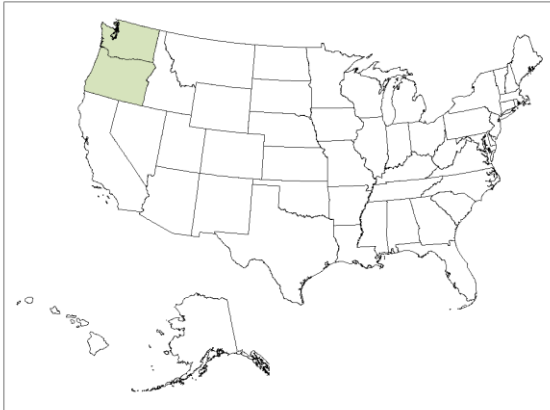
A growing human presence brings significant ecological changes to the Mojave Desert. Non-native grasses introduced by humans allow wildfires to spread quickly between widely spaced native shrubs. The fires destroy food and shelter plants the native, endangered desert tortoise (*Gopherus agassizii*) depends on. For example, desert tortoise favor the desert plantain (*Plantago ovata* var. *fastigiata*) for food in the spring. So land managers need an ample supply of locally sourced, genetically appropriate seed to restore areas after fire or other disturbances.

The Conservation Program at Rancho Santa Ana Botanic Garden (RSABG), in collaboration with the BLM and U.S. Geological Survey, is helping the effort by studying genetic variation of the desert plantain. Field botanists collected leaves from 12-15 plants from each of 66 locations throughout the Mojave Desert. Then they extracted DNA from the leaves to generate genotypes using RADSeq, a next generation sequencing method that reveals patterns of variation in the DNA sequence. When analyzed in the context of environmental variables, such as elevation, precipitation, and temperature, these genetic data will identify species-specific seed transfer zones – areas where collected seed can be planted back without negative impact on the gene pools of established plant populations.

**Website:** [www.botanicgardens.org](http://www.botanicgardens.org)



## Pacific Northwest



### Plant Development in the Pacific Northwest Aids Habitat Restoration for Endangered Species

The Corvallis Plant Materials Center (PMC) worked with more than 20 native plant species to aid the endangered Oregon silverspot butterfly's recovery. Working with federal partners and private landowners, quality habitat for this butterfly has doubled. Additionally, the Corvallis PMC provided seed to high schools, prisons, private growers, nurseries, and Soil & Water Conservation

Districts to encourage planting these important species.

In another project, the Corvallis PMC helped recover Willamette Valley threatened and endangered plant species. Producing and making available all seven of the listed plant species in the Willamette Valley have provided federal, state, and local government and private conservation partners with appropriate plant material for restoration and recovery efforts. Several areas in the Willamette Valley now meet local recovery targets for some species, with others close behind. In fact, golden paintbrush, which was extirpated from Oregon, is on track to for delisting within the next three years.

This work, in addition to agreements with BLM, USFS, and USFWS, provided the Corvallis PMC with more than 50 native plant species. The information acquired from this work is included in the [Native Seed Production Manual for the Pacific Northwest](#) and numerous plant propagation protocols on the Native Plant Network.

**Website:** <https://npn.rngr.net/propagation>

*Figure 5 Seed increase field of golden paintbrush as the Corvallis Plant Materials Center*





*Figure 6. Seed Increase at Alaska DNR Plant Materials Center*

## Alaska

### Uniquely Alaskan Native Plants

The native seed program in Alaska has spent the last 15 years collecting seed for a multitude of programs. One of the most pressing needs for native seed is for revegetation of disturbed areas such as reclaimed mine lands. The Alaska Department of Natural Resources operates the Plant Materials Center (PMC), which has collaborated with the BLM in several ways, such as making many Alaskan native plant varieties available for reclamation. In developing these seed mixes, BLM and its partners have identified a wide variety of plants (mostly grasses); however, some of the species are not available commercially either in Alaska or from outside sources. Certain species are more difficult to grow than others, and because of the limited market, fewer private growers are willing to take the risk to grow these species.

The PMC has been working for several years to increase Seeds of Success (SOS) collections to quantities that could be available for growers to commercially produce native seeds in amounts needed for revegetation projects. The PMC has

produced some species at quantities sufficient for native seed mixes that the commercial operators have not been interested in growing.

Pollinator-friendly plant species have been very difficult to increase the SOS collections into quantities large enough for commercial growers to take interest. Because that PMC stores all the BLM seed collections and is in touch with all growers in Alaska, they have been able to act as catalyst for moving the pollinator-friendly plant species up into production. In the fall of 2017, one of the commercial growers expressed an interest in growing more forbs for revegetation and wildflower seed mixes. They have been able to draw on the PMC forb seed lots to begin commercial production in the 2018 season. These seeds will provide a critical component to Alaska BLM native seed mixes to support pollinator species on revegetation projects.

The close association between the University of Alaska Anchorage Center for Conservation Science in making the SOS collections; the PMC in cleaning, storing, and increasing the seeds



collected; and BLM in encouraging commercial growers is gradually leading to a native seed mixture from known Alaska sources for revegetation of disturbed sites within the state of Alaska.

## Hawaii



## Laukahi, the Hawai'i Plant Conservation Network

Laukahi, the Hawai'i Plant Conservation Network, is a voluntary alliance of agencies, organizations, and individuals who work together to protect Hawai'i's plant species. Laukahi, which means "single leaf" in the Hawaiian language, has a growing number of partners who collaborate to implement the

*Figure 7* *Ma'o Hau Hele Hibiscus brackenridgei ssp. Mokuleianus - Hawai'i State Flower*



Hawai'i Strategy for Plant Conservation. Activities include fieldwork to protect native habitats, propagating and securing propagules in ex situ facilities, and conducting research to inform strategies and conservation.



*Figure 8 Viola chamissoniana (Violaceae)*

Laukahi also helped formalize the Hawai'i Seed Bank Partnership (HSBP), which began in 2012 with just four members, representing four active seed banks in Hawai'i. Today, the HSBP includes more than 30 representatives from 15 organizations. This group of cooperating partners practices seed banking, based on scientific research, to preserve genetic diversity of Hawaiian native plant species for conservation and for restoration. Like most tropical flora, the seeds of many Hawaiian plants do not remain viable if they are dried and frozen for storage the way most temperate seeds do. Working with experts from across the globe, the HSBP is engaged in cutting-edge research to develop technology for long-term storage of tropical native seeds.

**Contact:** Dr. Lauren Weisenberger  
(lauren\_weisenberger at fws.gov)

**Website:** <http://laukahi.org/>

## Way Forward

The February 2017 National Native Seed Conference, held in Washington, D.C., brought together more than 330 plant and seed conservation professionals. With sponsors including several USDA and DOI agencies, as well as several non-federal organizations, the 2017 National Native Seed Conference provided an important opportunity for researchers, industry, land managers and restoration specialists to share information about the collection, research and development, production, and use of native plant materials. The agenda focused on meeting research and information needs outlined in the objectives of the Seed Strategy (see Appendix 2 for the list of presentations). In addition, several task forces, aligned by Seed Strategy Goals and Objectives, formed to identify initial tasks to address the following topics:

### Policy and Funding

- Develop ways to incorporate seed needs in ecological restoration as an adaptation mechanism and insurance policy in response to wildfires, hurricanes, and other extreme weather events.
- Identify existing federal seed and restoration policies and guidance.
- Explore opportunities to use USDA programs to fund native plant research and development for ecological restoration and rehabilitation.

### Research and Tools

- Incorporate soil-related research needs and decision tools into seed production and revegetation
- Plan, implement, and help publicize native plant demonstration sites in different ecoregions across the United States.



*Figure 9 Bureau of Land Management's Arizona collecting team working out of the Desert Botanical Garden in the field on a collecting trip looking for prairie acacia (*Acacia angustissima*)*

- Develop basic guidance and communication for land managers who may not yet be accustomed to considering native species.
- Develop consistency for seed collections across the United States.
- Identify gaps between training courses offered and training needs to increase understanding of restoration principles and the use of native seed across multiple agencies (Federal, state, tribal, and local), nongovernmental organizations, private sector industries, and universities

### Communication

- Identify various deliverables of the Strategy and provide recommendations on mechanisms and opportunities for communicating and disseminating information in a coordinated way.
- Develop ways to use momentum behind wildlife species to support the use and development of native plant materials in habitat management decisions.
- Bring together public and private sector land managers with private sector seed growers to learn how to improve seed development partnerships that can serve all parties' needs.

See Appendices 2 and 3 for more information.



## Acknowledgments

The participating federal agency Members of the Plant Conservation Alliance include:

- Bureau of Indian Affairs
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- Smithsonian Institution
- U.S. Botanic Garden
- USDA Agricultural Research Service
- USDA Forest Service
- USDA National Institute of Food and Agriculture
- USDA Natural Resources Conservation Service
- U.S. Fish and Wildlife Service
- U.S. Geological Survey

The non-federal Cooperators are chaired by:

- Chicago Botanic Garden

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## Appendix 1: Progress Summary Tables (150+ Accomplishments)

\*See Appendix 4 for a list of acronyms.

### Goal 1: Identify seed needs and ensure the reliable availability of genetically appropriate seed reserves

Objective 1.1: Assess the plant production needs and capacity of federal agencies

Action	Agency/Org*	Progress
1.1.1 Conduct a needs and capacity assessment for all federal agencies and their offices that provide or use seed.	BLM, NAS	Developed scoping meeting for the National Assessment of Seed Needs and Capacities, February 2017. BLM contracted NAS to conduct the assessment in FY19.
1.1.1 Conduct a needs and capacity assessment for all federal agencies and their offices that provide or use seed.	SWSP, BLM, USFS	Initial target lists developed for 3 NM and AZ ecoregions and under review. Multiple public (USFS, BLM, NM DoT, NRCS, etc.) and private seed users have provided input to lists. A restoration “seed needs” survey has been developed and is ready for distribution. A species selection subcommittee will continue to refine these lists.
1.1.1 Conduct a needs and capacity assessment for all federal agencies and their offices that provide or use seed.	USFS-R4	The Intermountain region identified 80 pollinator friendly native plant species as high priority for seed production. This core list of native forbs and shrubs is suitable for enhancing existing pollinator habitat as well as improving pollinator habitat in disturbed areas during revegetation activities.
1.1.1 Conduct a needs and capacity assessment for all federal agencies and their offices that provide or use seed.	USFWS	Developed and distributed a scoping survey to USFWS programs across the country to answer core questions about native plant use in the field.
1.1.2 Identify and inventory agency and private sector seed collections, nurseries, and storage capacity.	CBG	Compiled a database of all native plant sellers in the US and the species they sell; data shared with USFS and FHWA to support the new FHWA revegetation manual and species selection tool. A paper summarizing the state of the US native plant industry and species availability is in preparation for submission to <i>Restoration Ecology</i> .
1.1.2 Identify and inventory agency and private sector seed collections, nurseries, and storage capacity.	Botanic Gardens Conservation International US (BGCI)	Compiled a directory of wild plant seed conservation expertise in the US, including individuals in the federal government.  Compiled a list of seed banks in the US and determined which ones hold native plant species, including seed banks maintained by the federal government.
1.1.2 Identify and inventory agency and private sector seed collections, nurseries, and storage capacity.	BLM	Worked with consultant to develop web-based data entry portal for Seeds of Success collections’ provenance information.  Supports BLM National Seed Warehouse system which serves 40 BLM Field Offices in 11 Western States and has increased its storage capacity to 2.1 million pounds.
1.1.2 Identify and inventory agency and private sector seed collections, nurseries, and storage capacity.	Great Basin Native Plant Project	Compiled a database of GBNPP native seed collections available for seed increase projects, housed at USFS Lucky Peak Nursery in Idaho, USFS-RMRS shrub lab in Provo and UDWR seed warehouse in Ephraim, Utah.
1.1.3 Identify existing federal seed and restoration policies.	PCA	A task force formed at the National Native Seed Conference is identifying federal policies related to the development and use of plant materials and restoration. A report assessing compatibilities, gaps, and challenges across federal agencies is expected.
1.1.4 Analyze results of needs and capacity assessment (Fed)		

1.1.5 Analyze results of policy and guidance assessment and develop restoration program		
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Objective 1.2: Assess capacity and needs of tribes, states, private sector seed producers, nurseries, and other partners

Action	Agency/Org	Status
1.2.1 Conduct a needs and capacity assessment of tribal, state, local, private sector, and nonprofit seed storage and distribution facilities.	SWSP	Grower outreach/presentations at multiple venues (i.e., NMSU Northern Pueblos Ag Day, State Seedsman Association, community farm board meetings, & CPNPP) with 5 individual farm visits to assess capacity and expertise. More than 10 SW producers (2 tribal nurseries, 3 commercial producers, and several small scale farmers) have expressed an interest in participating in the program. A grower survey has been developed and is ready for distribution.  Coordinating continues with NM and AZ tribes, agency tribal liaisons, and watershed councils to further facilitate tribal farms in native species production.
1.2.1 Conduct a needs and capacity assessment of tribal, state, local, private sector, and nonprofit seed storage and distribution facilities.	USFS	Rocky Mountain Research Station writing nearly 300 native plant propagation protocols requested by different tribes.
1.2.1 Conduct a needs and capacity assessment of tribal, state, local, private sector, and nonprofit seed storage and distribution facilities.	USFS	Co-organized the 16 <sup>th</sup> Annual Intertribal Nursery Council workshop in Buffalo, NY.
1.2.1 Conduct a needs and capacity assessment of tribal, state, local, private sector, and nonprofit seed storage and distribution facilities.	NNHP	Acquired funding for interns to conduct a needs assessment survey targeting Navajo agencies involved in ecological restoration to get a baseline understanding of native plant needs for buyers on Navajo. Interns will also conduct community outreach at 15 chapters throughout the Nation to gauge interest in a native plants program. Survey results will be compiled into a report that will be used to guide future decisions about the scope and direction of the Navajo native plants program.
1.2.1 Conduct a needs and capacity assessment of tribal, state, local, private sector, and nonprofit seed storage and distribution facilities.	BGCI	Compiled a directory of wild plant seed conservation expertise in the US.  Compiled a list of seed banks in the US and determined which ones hold native plant species.
1.2.2 Work with partners to leverage strengths and address deficiencies in distribution and availability of genetically appropriate seed.	GGNPC	Multi-agency seed collection projects underway that involve collaboration of several federal, state, and local agencies and non-profit partners in the San Francisco Bay area.
1.2.2 Work with partners to leverage strengths and address deficiencies in distribution and availability of genetically appropriate seed.	GRI	Administered an assessment of 10-year capacity and needs of regional partners.
1.2.2 Work with partners to leverage strengths and address deficiencies in distribution and availability of genetically appropriate seed.	IAE	Coordinating the Willamette Valley Native Plant Materials Partnership (30 participating organizations) to pool demand, seed collections, and production efforts to provide high quality seed for the Willamette Valley ecoregion.



1.2.2 Work with partners to leverage strengths and address deficiencies in distribution and availability of genetically appropriate seed.	USFWS, LBJWC, UT Austin, NRCS	Project Milkweed is bringing partners together to help provide a bulk seed source for milkweed ecotypes that are native to Central Texas. The project focuses on ten milkweed species across four ecoregions and is collecting seeds, propagating plants and distributing the milkweeds to schools to plant educational gardens, to local growers to help stimulate commercial production of native milkweed species, and for seedbanking and restoration efforts.
1.2.2 Work with partners to leverage strengths and address deficiencies in distribution and availability of genetically appropriate seed.	Monarch Joint Venture with USGS, LCCs	Producing maps to prioritize native plant habitats for restoration and enhancement to benefit monarchs.
1.2.2 Work with partners to leverage strengths and address deficiencies in distribution and availability of genetically appropriate seed.	USFWS with private landowners	Delivering on-the-ground habitat conservation, using seed mixes, planting strategies, and land management practices to ensure availability of native milkweeds and other native host plants.
1.2.3 Analyze results of needs and capacity assessment.	GRI	Creating regional priority species propagation list and will assign targets to partners according to capacity and expertise.

**Objective 1.3: Increase the supply and reliable availability of genetically appropriate seed**

Action	Agency/Org	Progress
1.3.1 Expand and improve facilities and plant production capacity.	SWSP	Funding secured for 4-8 production fields in NM and AZ. First production fields will be contracted in 2017. A harvest is anticipated in 2018-19 (annual species).
1.3.1 Expand and improve facilities and plant production capacity.	USFS – Coeur d’Alene Nursery	More than 72,000 containers were distributed to Region 1, 2, 4, and 6 and to Montana BLM. There were 66 native plant species including shrubs, forbs, grasses, and grass-like plants. These include pollinator friendly plants as well as riparian and upland plants.
1.3.1 Expand and improve facilities and plant production capacity.	USFS–R4, RMRS, GBNPP	Collaborated with Great Basin Research Center-UDWR to bulk up seed quantity for 5 sage grouse and pollinator friendly forb species sources collected from the Colorado Plateau Ecoregion.
1.3.1 Expand and improve facilities and plant production capacity.	IAE	Through the Coordinating the Willamette Valley Native Plant Materials Partnership, maintained 14 established native seed production fields, put one new species into production, collected 5.6 pounds of wild seed of six native species used in restoration projects, distributed 488 pounds of seven species of native seed to partners, added two new members to the Partnership, and finalized a sustainability model to help the Partnership transition from relying on partner contributions to funding operations through seed sales.
1.3.1 Expand and improve facilities and plant production capacity.	GBNPP, USFWS	Collaborated with Benson Farms Incorporated to develop a Nevada-based accession of bluebunch wheatgrass for use in commercial production
1.3.1 Expand and improve facilities and plant production capacity.	GBNPP, Oregon State University	Collaborated with Oregon State University to bulk up seed zone based collections of bluebunch wheatgrass.
1.3.1 Expand and improve facilities and plant production capacity.	GGNPC	Invested in and completed facility improvements to follow BMP for plant pathogen control. Upgrades include new protocols, footbaths, soil steamer, and more.
1.3.2 Improve capability to plan for seed needs by seed zone.	USFS–R1	Seed zones under development for 4 species including 2 pollinator-friendly species. Bluebunch wheatgrass seed is available for forest and grassland use. A common garden study was established for Sandberg’s bluegrass. There are 13 species being tested for delivery to specific ranges using genetic and morphological traits.

1.3.2 Improve capability to plan for seed needs by seed zone.	NRCS, NPS	Several NRCS Plant Materials Centers have interagency agreement with the NPS to propagate and increase native seed and plants for NPS units.
1.3.2 Improve capability to plan for seed needs by seed zone.	GBNPP, CBI	Developing the Climate Smart Restoration Tool, which will allow managers to utilize seed zones, climate, and other underlying data from common garden studies to plan seed needs for restoration projects. Beta version near completion.
1.3.2 Improve capability to plan for seed needs by seed zone.	GBNPP, USFS-R6	Develop the Seed Zone Mapper smartphone application, so that seed collectors and managers can determine where they are in a seed zone while in the field. Beta version available.
1.3.3 Assess and implement alternative seed production methods for “workhorse” shrub species.	BLM, IAE	The Sagebrush in Prisons Program is working with 10 prisons in 6 states throughout the range of Greater Sage-grouse to increase sagebrush and bitterbrush, including establishing seed orchards of sagebrush on prison grounds.
1.3.3 Assess and implement alternative seed production methods for “workhorse” shrub species.	BLM	BLM established multiple seed “orchards” for sagebrush in the Great Basin.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	SWSP	Seed collection crews covered 6 ecoregions (AZ NM Mountains, AZ NM Plateau, S. Rocky Mountains, Chihuahuan Desert, SW Tablelands, and Colorado Plateau). Collections were made in the Madrean Archipelago in 2015. The 2016 seed collections were represented by 21 families, 54 genera, and 79 unique species and collections were made from over 200 populations. Half of the total collections were from forb species. Seed is being cleaned and placed in cold storage until ample diversity is available to deliver to seed producers.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	USFS-R1	More than 40 grass and forb species in bulk seed production. Many are pollinator friendly, and new plots were established to increase production. Additions include Western showy aster ( <i>Aster conspicuus</i> ). Couer d’Alene Nursery provides storage for native grass seed until ready for use by forests and grasslands.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	MARSB	A portion of each seed collection from the Seed Banking for Resiliency project is donated to Seeds of Success for long term germplasm storage for preservation. The balance will be available for use in designated restoration projects. Fish and Wildlife Refuges from southern New England to North Carolina will use this to revegetate damaged areas from Superstorm Sandy. In 2016, the Prime Hook National Wildlife Refuge in Delaware seeded approximately 250 pounds of cleaned smooth cordgrass seed from the PMC. Some of the seed will also be transferred to commercial growers to help facilitate larger-scale production and commercial availability of these locally adapted native species.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	ARS	Provides long term backup storage for SOS accessions within the USDA’s National Plant Germplasm System. Seed quality is assessed prior to storage.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	BLM	SOS East, established 2015, made 2,200 collections.  BLM SOS collecting teams have made over 23,000 native seed collections across the nation.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	NNHP	Collecting seed for target species on Navajo lands.

1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	Santa Barbara Botanic Garden	Made 18 SOS collections representing 13 unique plants at Carrizo Plain National Monument in 2017. Made 26 conservation seed bank collections representing 20 unique plants from Carrizo Plain National Monument, Fort Ord National Monument, and Clear Creek Management Area.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	CPNPP, partners	In 2017, SOS crews from federal agencies, non-profit organizations, and universities visited 207 collection sites to make 145 SOS collections and 62 non-SOS collections representing 95 species across the Colorado Plateau. CPNPP helped direct and fund sampling efforts.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	USGS, CPNPP	Genetic data are being utilized to inform 2018 SOS collecting for 3 priority Colorado Plateau restoration species. The data will guide SOS crews to target locations that are genetically underrepresented by current SOS collections.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	MBG	MBG Seed Bank is working on a project to collect examples of Missouri's entire flora. Small amounts of seed are available for request for a variety of uses including research and education.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	GRI	Piloting a regional (Oak Openings of MI/OH) cryobanking program, with submissions to CBG.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	NRCS	The NRCS Cape May Plant Materials partners with Seeds of Success-East under an interagency agreement to clean and test seed collections in NJ and NY. Seed is then used to restore coastal environments impacted by Hurricane Sandy. A sample of seed is also sent for preservation.
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	BLM, USFWS, USFS, NDF, Eastern Nevada Landscape Coalition	Established interagency SOS teams to collect across the Great Basin. SOS teams targeted a priority list of grasses and forbs for both research and development as well as seed increase.
1.3.5 Engage federal procurement specialists to assess contracting regulations and practices; correct deficiencies.	USFS, BLM	Researchers evaluated seed weight variation to show that subspecies of big sagebrush can be differentiated based on seed weight. This research has now been developed into a seed testing protocol and adopted as a seed certification step in the BLM seed procurement contract.

## Goal 2: Identify research needs and conduct research to provide genetically appropriate seed and to improve technology for native seed production and ecosystem restoration

Objective 2.1: Characterize genetic variation of restoration species to delineate seed zones, and provide seed transfer guidelines for current and projected future environmental conditions

Action	Agency/Org	Progress
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	USFS-R4	Collaborated with Rocky Mountain Research Station on contract production of 3 provisional seed zone sources of thickleaf penstemon ( <i>Penstemon pachyphyllus</i> ).
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	RSABG	Collaborated with Rocky Mountain Research. RSABG is working in partnership with BLM and USGS by studying genetic variation of a common desert annual in the Mojave. Field collectors made tissue collections of nearly 1,000 individuals of <i>Plantago ovata</i> (desert plantain) from 66 populations throughout the Mojave Desert. The goal is to understand the geographic patterns of genetic diversity in desert plantain.



2.1.1 Conduct genetic research to develop seed zones for key restoration species.	USGS, CPNPP	Projects have been developed and initiated for 9 priority restoration species across the Colorado Plateau. Genetic data will be used to elucidate geographic patterns of genetic diversity and population structure in each species, as well as to resolve the environmental gradients driving adaptation. Results will inform plant materials development, the deployment of restoration materials, and SOS collecting.
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	USGS, CPNPP	Seeds zones based on adaptive genetic variation are being developed for 2 grasses and 1 pollinator-friendly forb across the Colorado Plateau.
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	GBNPP, USDA-ARS, UNR	Empirical seed zones developed for Thurber's needlegrass (Rangeland Ecology and Management 70: 509-517).
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	GBNPP, USFS-R2 & R6	Empirical seed zones developed for bottlebrush squirreltail, zones are preliminarily available, manuscript to be submitted in 2018.
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	GBNPP, USDA-ARS	Developed genetic and seed zone based releases of Utah trefoil. Rangeland Ecology and Management 70: 691-699.
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	GBNPP, Brigham Young University	Morphological and genetic characterization of blue penstemon. PhD dissertation in progress.
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	NAU, GBNPP	Conducted common garden research on 9 priority grass species for the Great Basin and Colorado Plateau to identify seed sources for increase that maximize functional diversity within a species.
2.1.1 Conduct genetic research to develop seed zones for key restoration species.	CBG	Conducting common garden research on 5 priority restoration forbs collected from multiple populations in the Colorado Plateau and comparing them with available germplasm from outside the region.
2.1.2 Develop predictive models of climate change effects.	MBG	Developed phenotype and species distribution models to predict how climate change affects the future size and distribution of big bluestem ( <i>Andropogon gerardii</i> ), a dominant C4 grass of Midwestern grasslands. Results have important implications for seed sourcing for restoration and grassland reconstructions. Paper published in <i>Global Change Biology</i> 23: 4365-4375.
2.1.2 Develop predictive models of climate change effects.	USGS, CPNPP	Researchers are examining if populations of galleta grass <i>Pleuraphis jamesii</i> collected from across the Colorado Plateau are adapted to their local precipitation seasonality or if they have plastic responses to precipitation timing (in growth, phenology, and ecophysiology). Findings suggest that while the galleta populations have diverged in key traits across the gradient, most of the traits are not affected by precipitation seasonality.
2.1.2 Develop predictive models of climate change effects.	NAU, CPNPP	Analyzed potential for "pre-restoration" - use of species that will persist now and into the future - on the Colorado Plateau using current priority species. Identified additional species that would make up for losses incurred by current priority species. Paper published in <i>Restoration Ecology</i> 25(S2): S155-S163
2.1.2 Develop predictive models of climate change effects.	USFS, USGS	Scientists analyzed vegetative responses, including survival, growth, and carbon isotope ratios in two common gardens that included 26 populations from a range-wide collection of blackbrush ( <i>Coleogyne ramosissima</i> ). Found blackbrush possesses considerable adaptive genetic variation across its distribution and minimum temperatures greatly affect growth and survival of certain populations.

Objective 2.2: Conduct species-specific research to provide seed technology, storage, and production protocols for restoration species

Action	Agency/Org	Progress
2.2.1 Conduct seed germination studies and develop seed testing protocols for key restoration species.	USFS-R1 & R4	The Northern and Intermountain Regions implementing the 2017 Sage-Grouse Habitat Seed Transfer Zone Study project. The project will ensure appropriate plant material is available and in quantities needed to improve sage grouse habitat following wildfire and other disturbances.
2.2.1 Conduct seed germination studies and develop seed testing protocols for key restoration species.	CBG	Conducted research on seed germination requirements of multiple populations of 8 priority restoration forb species in the Colorado Plateau, with a manuscript accepted for publication in Plos ONE.
2.2.1 Conduct seed germination studies and develop seed testing protocols for key restoration species.	RSABG	Rancho Santa Ana Botanic Garden is currently running several germination experiments to develop germination protocols for <i>Juniperus californica</i> .
2.2.1 Conduct seed germination studies and develop seed testing protocols for key restoration species.	GBNPP, UNR	Assessed multiple forb species for germination requirements in various environments. Reported in Oecologia 185: 437-452.
2.2.1 Conduct seed germination studies and develop seed testing protocols for key restoration species.	BGCI	Collaborating with Cincinnati Zoo and Botanical Garden on developing an Exceptional Plant Conservation Network to focus on species that cannot be seed banked using conventional methods. Refining a list of North American exceptional species.
2.2.1 Conduct seed germination studies and develop seed testing protocols for key restoration species.	USFWS, BLM	Joint funding to University of Nevada, Reno to conduct studies using native annuals in seed mixes.
2.2.2 Develop storage guidelines for key restoration species to improve maintenance of seed viability.	USFS, NMSU	Researchers examined germination rates of 32 collections of blackbrush seed after 12 to 27 years of storage at room temperature. Found that blackbrush seed can be maintained in storage for long periods of time (up to 10-12 years).
2.2.3 Develop species-specific protocols for seed and seedling production practices to maintain genetic diversity.	GGNPC	In addition to published <i>Nursery Manual</i> , created database to record and analyze collection and propagation data. Also implemented new BMPs based on recommendations from the regional Phytophthora working group.
2.2.3 Develop species-specific protocols for seed and seedling production practices to maintain genetic diversity.	USFS, CBG, GBNPP	Initiated research to assess changes in neutral and potentially adaptive genetic variation in multi-source seed production and use of <i>Penstemon pachyphyllus</i> .
2.2.3 Develop species-specific protocols for seed and seedling production practices to maintain genetic diversity.	UCECP	UCECP is trialing the production of 80 forbs that are candidates for native plant materials development. Results will help generate species-specific production protocols, as well as inform which species may be most amenable to production.

2.2.3 Develop species-specific protocols for seed and seedling production practices to maintain genetic diversity.	GBNPP, Oregon State University	Cooperating with Oregon State University Malheur Experiment Station to develop cultivation practices for seed production of Great Basin native flowering plants. 7 species completed and published (HortScience, 51(10): 1270-1277; HortScience, 52(9): 1188-1194), 3 more species in prep for publication.
2.2.3 Develop species-specific protocols for seed and seedling production practices to maintain genetic diversity.	USFS, BLM	Researchers are examining whether vertical root pruning will cause more shoots to develop in seed increase beds therefore producing more flowers and seeds.
2.2.3 Develop species-specific protocols for seed and seedling production practices to maintain genetic diversity.	GBNPP, BLM - Idaho State Office, Great Basin Fire Science Exchange	Cooperating to develop a Forb Manual that will include cultivation practices and other data on the over 90 forb species that have been researched by GBNPP
2.2.3 Develop species-specific protocols for seed and seedling production practices to maintain genetic diversity.	GRI	Secured funding for a scholar to collate literature searches on and distribute propagation protocols for regionally rare and difficult to produce species.

**Objective 2.3: Conduct research on plant establishment, species interactions, and ecological restoration**

Action	Agency/Org	Progress
2.3.1 Develop site preparation and seeding and transplanting strategies that improve plant establishment and diversity.	GBNPP	Completed a cooperation with Boise State University to determine the effect of mycorrhiza inoculation on sagebrush seedling survival. Mycorrhiza. 26: 595-608
2.3.1 Develop site preparation and seeding and transplanting strategies that improve plant establishment and diversity.	NAU, CPNPP	Developing predictive models of restoration success based on matching species trait values to environmental conditions of restoration sites across the Colorado Plateau. Paper forthcoming.
2.3.1 Develop site preparation and seeding and transplanting strategies that improve plant establishment and diversity.	NAU, CPNPP	Determined that there is a high degree of dependency of a native C4 grass ( <i>Bouteloua gracilis</i> ) on co-adapted native soil organisms in novel environments; grass biomass is often greater when growing in the presence of soil organisms from the same source site, even in a new location. Also determined that soil properties need not be considered as part of seed transfer zone development for these grasses. Initiating similar experiment with another native C4 grass ( <i>Pleuraphis jamesii</i> ).
2.3.1 Develop site preparation and seeding and transplanting strategies that improve plant establishment and diversity.	USDA-NIFA, UNR	Assessing if restoration success, and associated ecosystem services, can be improved by changing seed sources and seeding strategies by comparing combined, high quality populations of species in a high-performance restoration mix to collections from single locations of potentially coevolved communities.
2.3.2 Within seed zones, examine capacity of native plants to establish and persist.	UA-SNRE	Developing experiments to investigate relationships between drought tolerant traits and restoration capacity in the southwestern US.
2.3.2 Within seed zones, examine capacity of native plants to establish and persist.	GBNPP, USFS RMRS and PNW, USGS, Oregon State University	Tested the efficacy of previously developed bluebunch wheatgrass seed zones in 15 common gardens spanning four states (ID, NV, OR, WA). Over 20,000 plugs were planted and have been followed for three years. The first manuscripts will be coming soon.
2.3.2 Within seed zones, examine capacity of native plants to establish and persist.	Missouri Botanical Garden	Conducted germination and seedling establishment trials in the field and greenhouse with 6 common native woodland herbs to determine which species were most suitable for revegetating burn pile scars in restored woodlands of the Ozark plateau. Draft manuscript available; currently preparing for submission to peer-reviewed journal.



2.3.3 Advance investigations to diversify depleted native communities.	USFS-R2	Bessey Nursery collected, cleaned, stratified and grew seeds of the endangered blowout penstemon restricted to stabilized sand dunes in NE and WY. Planting them in their preferred habitat provides benefits for pollination and wildlife habitat as a whole.
2.3.3 Advance investigations to diversify depleted native communities.	USGS, NMSU	Determination of the way soil seed banks facilitate and/or compete with active seeding in order to inform what seeds are likely to be most successful in what places. Researchers are working to develop a cross-site seed bank framework that would allow resource managers to predict what seeds are in their seed bank, which is information that could improve manager's ability to prioritize restoration and their success in active seeding efforts.
2.3.3 Advance investigations to diversify depleted native communities.	USDA-NIFA, USU	Develop and testing a model of rangeland restoration that could improve restoration success and provide ecosystem services by pre-emptively targeting at-risk areas before they become highly degraded.
2.3.3 Advance investigations to diversify depleted native communities.	MMB	Developing and trialing native woodland seed mixes for restoring woodlands after the removal of invasive shrubs in the Ozark plateau.
2.3.4 Assess soil degradation, and develop treatments, soil amendments, and other site preparation techniques.	GBNPP, NAU	Studying the impacts of climate change and exotic species on native plant and soil microbial interactions.
2.3.4 Assess soil degradation, and develop treatments, soil amendments, and other site preparation techniques.	USGS, NMSU, BLM's Joint Fire Science Program	Studying the relationships between fire, biological soil crusts, and the germination success of native vs. exotic seeds. This study compares relationships between fire, soil chemistry, and native seed success across the Colorado Plateau, Great Basin, and Sonoran deserts.
2.3.4 Assess soil degradation, and develop treatments, soil amendments, and other site preparation techniques.	USGS and NPS	Implementing an adaptive management strategy in Canyonlands and Arches National Parks using connectivity modifiers to promote native grass seeding success in persistently degraded grasslands.
2.3.4 Assess soil degradation, and develop treatments, soil amendments, and other site preparation techniques.	NAU and USGS	Analysis of long-term trends in land treatment practices associated with restoration on BLM lands in the southwestern US. Results include increased proportion of native species and greater number of species used in seed mixes, increasing complexity of restoration goals, and a greater variety of vegetation types represented in treatments (published in Restoration Ecology – Copeland et al. 2017).
2.3.4 Assess soil degradation, and develop treatments, soil amendments, and other site preparation techniques.	USGS, NAU and CPNPP	Establishing a field trial network to understand interactive effects of the environment and species functional traits, in monocultures and mixes, on erosion control and other ecosystem services across the Colorado Plateau and Central Arizona.
2.3.4 Assess soil degradation, and develop treatments, soil amendments, and other site preparation techniques.	USDA-NIFA, CU-Boulder, USGS	Studying novel approaches to restoring highly degraded land and evaluating trade-offs with current livestock management
2.3.4 Assess soil degradation, and develop treatments, soil amendments, and other site preparation techniques.	GBNPP, USFS RMRS, USU, NRCS, USDA-ARS	Testing techniques to enhance soil moisture in restoration forb island plantings in the Great Basin.

Objective 2.4: Develop or modify monitoring techniques and investigate long-term restoration impacts and outcomes

Action	Agency/Org	Progress
2.4.1 Analyze new and existing monitoring methodologies to evaluate restoration outcomes.	GRI	A regional rapid assessment method for planted restoration sites is under development and will be vetted against FQAI.
2.4.2 Quantify ecological and economic costs/benefits of planting native and nonnative plants on public lands.		
2.4.3 Study selected native plant restoration projects to evaluate short-and long-term responses.	CBG	Analyzing data from the Colorado Plateau Restoration Outcomes Database for publication and have shared the data with USGS and grad students at NAU and CU-Boulder.
2.4.3 Study selected native plant restoration projects to evaluate short-and long-term responses.	GBNPP, USDA-ARS	Assessment of sagebrush post-fire restoration methods across a large elevation gradient in eastern Oregon. Two field seasons completed.
2.4.3 Study selected native plant restoration projects to evaluate short-and long-term responses.	BLM	Arcata Field Office propagated and increased seed of western dog violet ( <i>Viola adunca</i> ) for use in coastal grasslands in the King Range National Conservation Area
2.4.3 Study selected native plant restoration projects to evaluate short-and long-term responses.	GBNPP, USU	Assessment of seeded restoration species: factors controlling establishment and persistence in three physiographic regions. Two field seasons completed.
2.4.3 Study selected native plant restoration projects to evaluate short-and long-term responses.	GBNPP, USFS RMRS, UDWR, Brigham Young University	Analyzing long-term vegetation succession (over 15 years) in post-fire seedings in the Tintic Valley of Utah, that were seeded with conventional mixes as well as all native mixes. Data collection wrapped up in summer 2017.
2.4.3 Study selected native plant restoration projects to evaluate short-and long-term responses.	MBG	Analyzing long-term changes (decade) in woodland plant communities of the Ozark plateau following the reintroduction of fire and removal of invasive woody plants.

**Goal 3: Develop tools that enable managers to make timely, informed seeding decisions for ecological restoration**

Objective 3.1: Develop training programs for practitioners, producers, and stakeholders on the use of genetically appropriate seed for restoration

Action	Agency/Org	Progress
3.1.1 Develop a cadre of experts, and work with partners to establish a restoration certification program.	USFS –R6	The Region 6 (Pacific Northwest) Restoration Services Team provided revegetation consultations and trainings for R6 personnel, as well as assistance on complex projects. The team also provides revegetation services to an increasing array of federal, state, and county partners throughout the PNW.
3.1.1 Develop a cadre of experts, and work with partners to establish a restoration certification program.	BLM, SER	SER Restoration Practitioner Certification Program
3.1.1 Develop a cadre of experts, and work with partners to establish a restoration certification program.	IAE	Developed Sagebrush in Prisons protocol for contractors and others to grow sagebrush at prison facilities. Provide trainings for contractors to teach sagebrush and bitterbrush production to inmates.
3.1.2 Use and where appropriate, expand the network of restoration field sites and demonstration areas.	USFS-R1 & R4	The Northern and Intermountain Regions work with the Western Federal Lands Highway Division of FHA, providing native plant materials for roadside restoration.
3.1.2 Use and where appropriate, expand the network of restoration	USFS-R2	Bessey Nursery collected seed of 3 different milkweed species, used to grow 1,200 container plants that will be used for revegetation to

field sites and demonstration areas.		public in 4H camps, Ranch Expos, Husker Days, and the Nebraska Conservation District Conference.
3.1.2 Use and where appropriate, expand the network of restoration field sites and demonstration areas.	GGNPC	In partnership with many federal, state, and local agencies, supporting the “Tunnel Tops” project, an innovative landscape project that will turn the space above highway tunnels into new parklands. The plans include native plant acreage, outdoor youth learning center, and recreation areas.
3.1.2 Use and where appropriate, expand the network of restoration field sites and demonstration areas.	PCA – Seeing is Believing Task Force	A task force formed at the National Native Seed Conference is developing a database of native plant demonstration areas across the country to educate the public on the beauty and need for locally native plants and to connect land managers by facilitating the sharing of best practices for restoration.
3.1.2 Use and where appropriate, expand the network of restoration field sites and demonstration areas.	UA-SNRE	Developing experiments to investigate relationships between drought tolerant traits and restoration capacity in the southwestern US. This will involve the deployment of new restoration field sites and demonstration areas.
3.1.2 Use and where appropriate, expand the network of restoration field sites and demonstration areas.	DBG, USFWS, others	With financial assistance from USFWS-Partners for Fish and Wildlife, DBG will continue the Great Milkweed Grow Out! in 2018 by creating 3 pollinator habitats in the metro Phoenix area: A ¼-acre plot to grow out 4 different milkweeds species to use in plantings; a second to expand DBGs existing monarch habitat, where 150,000 visitors come each year; and a third that will be part of the Spaces of Opportunity, an 18-acre area being converted from a vacant lot to a community garden.
3.1.2 Use and where appropriate, expand the network of restoration field sites and demonstration areas.	Cornell Botanic Gardens/Finger Lakes Native Plant Society	Continuing to provide/expand seed exchange for more than 50 species, including site provenance.
3.1.3 Develop resources for managers to highlight successful/unsuccessful projects, including site visits.	SWSP	Large audiences have been reached through numerous native seed presentations and workshops, including a native seed collection workshop (Rio Mora NFW Refuge, NM) and a milkweed/grower outreach workshop (Los Lunas Plant Materials Center, NM).
3.1.3 Develop resources for managers to highlight successful/unsuccessful projects, including site visits.	MBG	The MBG-Shaw Nature Reserve and Grow Native! developed and hosted Restoration of Oak-Hickory Woodland and Bush Honeysuckle management project. Workshop featured tour of two demonstration woodlands undergoing restoration with native seed addition. Ongoing classes are held to teach techniques for prairie, savanna, and wetland re-establishment.

**Objective 3.2: Develop native seed source availability data and tools for accessing the data**

Action	Agency/Org	Progress
3.2.1 Support regional/nongovernmental native seed networks that provide seed with seed zone origin.	IAE	Developed a SW restoration seed buyer informational brochure.
3.2.1 Support regional/nongovernmental native seed networks that provide seed with seed zone origin.	RSABG	Been a key partner in the development of a new collaborative effort to establish a regional seed bank/network in greater Los Angeles, CA.
3.2.1 Support regional/nongovernmental native seed networks that provide seed with seed zone origin.	BLM	BLM supports 4 interagency ecoregional programs (Great Basin, Colorado Plateau, Mojave, and Pacific Northwest)



3.2.1 Support regional/nongovernmental native seed networks that provide seed with seed zone origin.	IAE	The Native Seed Network website is providing information on regional seed production programs and creating resources for developing native seed networks.
3.2.1 Support regional/nongovernmental native seed networks that provide seed with seed zone origin.	GRI	Established the Native Plant Working Group, a network of native plant materials producers and consumers in the OH/MI Oak Openings region.
3.2.2 Maintain a website with seed zone maps and publications and develop a web-based seed selection tool to match seed source/planting site.	The Calflora Database	Live website with planting guide for California: <a href="http://www.calflora.org/entry/palette.html">www.calflora.org/entry/palette.html</a>
3.2.2 Maintain a website with seed zone maps and publications and develop a web-based seed selection tool to match seed source/planting site.	USFS-WWETAC, GBNPP, USFS-R6	All seed zones and publications developed by GBNPP and USFS Region 6 (Pacific Northwest) are maintained by WWETAC
3.2.2 Maintain a website with seed zone maps and publications and develop a web-based seed selection tool to match seed source/planting site.	GBNPP, CBI	See "Climate Smart Restoration Tool" in 1.3.2
3.2.2 Maintain a website with seed zone maps and publications and develop a web-based seed selection tool to match seed source/planting site.	USGS, CPNPP	Climate partitioning tool: <a href="https://seedmapper.shinyapps.io/climate_partitioning_app">https://seedmapper.shinyapps.io/climate_partitioning_app</a> ; stratifies climate to suggest environmentally disparate collecting locations.
3.2.2 Maintain a website with seed zone maps and publications and develop a web-based seed selection tool to match seed source/planting site.	USGS, CPNPP	Seed selector tool: <a href="http://seedmapper.shinyapps.io/seed_selector">http://seedmapper.shinyapps.io/seed_selector</a> ; explore predicted performance of candidate plant materials across region of interest.
3.2.2 Maintain a website with seed zone maps and publications and develop a web-based seed selection tool to match seed source/planting site.	UA-SNRE	Developing an online accessible guide to identifying restoration candidates for the southwestern U.S. based on management goals.
3.2.2 Maintain a website with seed zone maps and publications and develop a web-based seed selection tool to match seed source/planting site.	IAE	The Native Seed Network website is expanding its database to integrate available source-identified plant materials with environmental characteristics of collection sites. This data will be available in an interactive map tool with provisional seed zones.
3.2.3 Create a multiagency and non-federal partner seed inventory system.	SI-NMNH	More than 2.5 million plant specimens of the approximately 5 million specimens housed in the U.S. National Herbarium are now accessible through a digital record. Additionally, 1.3 million specimens have been imaged, including all specimens in 24 plant families/groups (e.g., Asteraceae, Campanulaceae, Caprifoliaceae, Cucurbitaceae, Cyperaceae, Fabaceae, Onagraceae, Pinaceae, Pteridophytes, Rubiaceae, and Sapotaceae).
3.2.3 Create a multiagency and non-federal partner seed inventory system.	USFS-R6	Clarno Hardwood Production Facility provides locally sourced willow and cottonwood cuttings to 16 federal lands partners for riparian restoration plantings. This facility also produces native milkweed seed for monarch butterfly habitat enhancement in central and eastern OR.

3.2.4 Develop/enhance federal agreement/procurement tools for multiagency seed acquisition.	BLM	BLM developed a West-wide IDIQ seed procurement tool for source identified forbs and grasses that are not commercially available
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Objective 3.3: Integrate and develop science delivery tools to support restoration project development and implementation

Action	Agency/Org	Status
3.3.1 Identify available restoration guides and protocols by ecoregion.	BLM	Distributed National Seed Strategy and Business Plan, Native Plant Materials Directory, National Native Plant Curriculum, New Mexico and Oregon Curricula, Natural Areas Journal Special Editions on Native Plant Materials and Pollinators to BLM staff and public as requested.
3.3.2 Write and distribute ecoregional native plant project reports.	CBG	Reports on research into establishment trials testing outcomes in regionally sourced material of priority restoration forbs and grasses published on the CPNPP Conservation Registry website, presentation given at CPNPP annual meeting.
3.3.2 Write and distribute ecoregional native plant project reports.	BLM/USFS	A 2015 Great Basin Native Plant Project progress report is now available.
3.3.2 Write and distribute ecoregional native plant project reports.	GBNPP	GBNPP reports annually on project status, conducts a cooperator meeting, and produces webinars available to managers and the public.
3.3.2 Write and distribute ecoregional native plant project reports.	GRI	Native Plant Working Group submitted annual regional native plant materials usage report to GRI steering committee for distribution to partner agencies.
3.3.3 Support field implementation of restoration tools.	USFS-R1 & R4	The Northern and Intermountain regions increasing Aspen fleabane ( <i>Erigeron speciosus</i> ) for sage grouse habitat improvement projects.
3.3.3 Support field implementation of restoration tools.	BLM	\$15.6 million went to implementing the Seed Strategy in FY17

Objective 3.4: Build on ecological assessments and disturbance data and provide training that will allow managers to anticipate needs and establish spatially explicit contingency strategies

Action	Agency/Org	Status
3.4.1 Identify/inventory climate-based geospatial tools to inform decisions on restoration site priority/methods.		
3.4.2 Develop crosswalk of agency habitat restoration priorities/tools by provisional seed zone and plant community		
3.4.3 Assess climate modeling and soil/water remote sensing to forecast seedling establishment and persistence.	USGS	Developed seeding probability tool using NOAA weather prediction data and the known growth rates for specific species.
3.4.3 Assess climate modeling and soil/water remote sensing to forecast seedling establishment and persistence.	USGS, NPS	Use of SoilWat2 model to predict vegetation change across soil types in specific vegetation communities based on soil moisture. The tool can be adapted for any species in any soil in various locations, and used to guide management decisions.
3.4.4 Develop GIS-based tools with disturbance data for prioritizing seed needs/projects.	GBNPP, CBI	See "Climate Smart Restoration Tool" in 1.3.2

3.4.5 Use risk-based assessment tools to prioritize treatment locations and refine strategies based on wildfire.		
3.4.6 Develop a decision tool of belowground assessment and treatment.		
3.4.7 Develop informational tools and guidelines on the appropriate use of cultivars, hybrids, and noninvasive nonnative species.	Cornell Botanic Gardens	Provide guidelines on native plant cultivation techniques.

## Goal 4: Develop strategies for internal and external communication

Objective 4.1: External communications: Conduct education and outreach through the Plant Conservation Alliance network

Action	Agency/Org	Status
4.1.1 Develop a communications plan.	BLM/ Communication's Working Group & PCA Communication task force	Electronic toolkit, including PPT presentation, briefing paper, fact sheet, talking points, key messages, and the communications plan are easily accessible to PCA members to share the Seed Strategy with their internal audiences.  National Seed Strategy website (developed)
4.1.2 Involve the Plant Conservation Alliance in communications.	CBG	Regular communications provided to all 357 PCA non-federal Cooperators, session organized on Plant Blindness and Plant Conservation at National Native Seed Conference.

Objective 4.2: Internal Communications: Distribute and implement the strategy across agencies and provide feedback mechanisms

Action	Agency/Org	Status
4.2.1 Develop internal communications plans.	SWSP	A SWSP Steering Committee, comprising 12 representatives/resource experts from public and private organizations, met in April 2016 and identified 1) areas of overlap and gaps for native seed development, 2) opportunities collaboration or leadership, 3) a process for prioritizing target species, determining seed transfer zones, and helping seed users project seed needs into the future, and 4) funding strategies and initial recommendations for structuring a seed partnership for the southwest. SWSP presentations were provided to FS R3 Biologist Annual Meeting, FS Supervisors Meeting, and NM BLM state office resource managers. Coordination meetings with BLM NM field offices (Rio Puerco, Socorro, and Taos) and Region 3 Forests (Tonto, Coronado, Kaibab, Santa Fe, Coconino, Cibola, and Carson) also occurred in 2016.
4.2.1 Develop internal communications plans.	USGS	The RAMPS program at SBSC engaged over 70 partners: government agencies, private industry, and landowners at 39 presentations, meetings, workshops, and tours. RAMPS produced 15 peer-reviewed publications related to restoration and plant materials. This work is increasing efficiency and efficiency of restoration work and the use of native seeds in water-limited systems in the Southwest.
4.2.1 Develop internal communications plans.	BLM	Gave DOI Policy Analysis Seminar on National Seed Strategy



4.2.1 Develop internal communications plans.	USFWS	Our Southwest Region formed a cross-programmatic Seed Team in early 2017 comprised of ten staff in Arizona, Texas, and New Mexico. The group is working to build out their team (to include Oklahoma), to prioritize seed needs, and to better network across programs and with partners across the region to meet those needs.
4.2.2 Identify and use communication mechanisms for implementing the Strategy.	USGS, CBG, IAE, BLM	The communications working group from the National Native Seed Conference developed a speakers bureau of qualified professionals able to present on the NSS, a list of national and international conferences relevant to the NSS missions, and a NSS poster that can be printed for conferences.
4.2.2 Identify and use communication mechanisms for implementing the Strategy.	USFWS, BLM, DoD	Published the feature article in DoD's Fall 2017 Natural Selections newsletter to inform natural resource managers on DoD installations about the Seed Strategy and inviting their collaboration to implement the Seed Strategy to meet their needs for healthy native plant communities on DoD lands.
4.2.3 Make existing agency native plant policies available to the public.	GRI	Developed landowner registry plant materials distribution protocol. Public may trade volunteer hours for seed and other plant materials.
4.2.4 Incorporate Strategy goals and key messages into landscape-scale restoration initiatives.	GRI	Included Seed Strategy goals in the 10-year Oak Openings Region native plant materials strategic plan.

**Objective 4.3: Report progress, recognize achievements, and revise strategy**

Action	Agency/Org	Status
4.3.1 Establish mechanism to report progress, including successful native plant projects and lessons learned.	GGNPC	Representative on Tools for Collectors task force.
4.3.1 Establish mechanism to report progress, including successful native plant projects and lessons learned.	CBG	Work with federal PCA partners to solicit progress reports from non-federal Cooperators and synthesize information for annual report.
4.3.1 Establish mechanism to report progress, including successful native plant projects and lessons learned.	GRI	Native Plant Working Group submits annual reports to GRI steering committee.
4.3.2 Recognize/promote achievements/needed improvements across all agencies and partners.	SWSP	Native seed topics and SWSP information was presented to Native Plant Society (3 chapters), Albuquerque Wildlife Federation, NM Game & Fish NM Undercover meetings and Quivira Coalition, Society for Ecological Restoration, and the Colorado Plateau Native Program conferences. Meetings to engage a broad group of native seed stakeholders, both users and producers, in NM and AZ are scheduled for 2017.
4.3.2 Recognize/promote achievements/needed improvements across all agencies and partners.	PCA members	Presentations at key national and international conferences and meetings, such as the IUCN World Conservation Congress and Natural Areas Association conference.
4.3.2 Recognize/promote achievements/needed improvements across all agencies and partners.	PCA members	Written articles for diverse audiences, published in a variety of publications, from <i>Bioscience</i> to <i>LA Times</i> .
4.3.3 Review and revise the Strategy every 5 years or as needed.		

## Appendix 2: National Native Seed Conference Presentations Implementing National Seed Strategy in the United States

The following list highlights the companies, agencies, and organizations that addressed specific National Seed Strategy objectives in their presentations at the National Native Seed Conference.

Organization	Seed Strategy Objectives	Topics
Austin Peay State University (TN)	1.1, Assess Agency Seed Needs	Southern Grasslands
BFI Native Seeds (WA)	1.3, Increase Seed Supply 2.3, Plant Establishment	Forb Production
BG-BASE, Inc. (TX)	3.2, Seed Data Development	SOS Web Portal
Borderlands Restoration L3C (NM)	1.3, Assess Agency Seed Needs	Madrean Archipelago
Brigham Young University (UT)	2.3, Plant Establishment	Survival of Fall Sown Seeds
Bureau of Land Management (AK, DC, IL, ID, WA)	1.3, Increase Seed Supply 2.3, Plant Establishment 2.4, Monitoring and Outcomes	Seed Collection/Production Tool Development
Chesapeake Natives, Inc. (MD)	1.3, Increase Seed Supply	MD Native Seed
Chicago Botanic Garden Northwestern University (IL)	2.1, Seed Zones and Transfer Protocols 2.2, Seed Storage and Production 2.3, Plant Establishment 3.3, Science Delivery for Restoration	Native Seed Market Phenological Diversity for Pollinators Tallgrass Prairie Seed Bank Seed Sourcing
Colorado Office of Resilience and Recovery (CO)	1.3, Increase Seed Supply	CO Resilience Framework
Colorado Parks and Wildlife (CO)	2.3, Plant Establishment	Cheatgrass
Comstock Seed (NV)	1.3, Increase Seed Supply	Seed supply
Duke University (NC)	2.3, Plant Establishment	Phenology
Eat Wild (MA)	4.1, Education and Outreach	New England Native Plants
Environmental Protection Agency (DC)	2.2, Seed Storage and Production 3.3, Science Delivery for Restoration	Wetland Assessment Native Seed for Superfund Sites
Friends of Verde River Greenway (AZ)	4.2, Interagency Communications	AZ Restoration
Hawaii Department of Land and Natural Resources (HI)	2.1, Seed Zones and Transfer Protocols	Provisional Seed Zones

Institute for Applied Ecology (AZ, NM, OR)	4.2, Interagency Communications	SW Seed Partnership
International Union for Conservation of Nature (IUCN) (DC)	2.3, Plant Establishment	Forest Restoration
U.S. Department of Defense (WA)	2.3, Increase Seed Supply	Prairie Native Seed
Lyon Arboretum (HI)	1.3, Increase Seed Supply	HI Seed Banking
Mid-Atlantic Regional Seed Bank (NY)	1.1, Assess Agency Seed Needs 3.3, Science Delivery for Restoration	SOS East
Montana State University (MT)	2.2, Seed Storage and Production	Heavy Metal Tolerance
National Academy of Sciences (DC)	1.1, Assess Agency Seed Needs	National Assessment
National Association of Counties	1.3, Increase Seed Supply	Resilience Policies
National Bobwhite Conservation Initiative (IA)	3.3, Science Delivery for Restoration 4.2, Interagency Communications	Bobwhite Habitat and Farm Bill
National Invasive Species Council	2.3, Plant Establishment	Invasive Plants

<b>Organization (State)</b>	<b>Seed Strategy Objectives</b>	<b>Topics</b>
National Park Service (CO)	1.3, Increase Seed Supply	National Park Service (CO)
National Wildlife Federation (DC)	1.3, Increase Seed Supply	Resilience Policies
NY Office of Storm Recovery (NY)	1.3, Increase Seed Supply	Emergency Preparedness
Northern Arizona University (AZ)	2.1, Seed Transfer Zone Guidance 2.3, Plant Establishment	Seed Sourcing
Pacific Coast Seed (CA)	1.1, Assess Agency Seed Needs	Seed Strategy and California
Rancho Santa Ana Botanic Garden (CA)	2.2, Seed Storage and Production	Germination testing
State University of New York (NY)	2.2, Seed Storage and Production	Germination trials
Texas A&M University (TX)	1.3, Increase Seed Supply	TX Native Seed
The Field Museum (IL)	3.4, Training Tools	Adaptation
The Morton Arboretum (IL)	3.4, Training Tools	Ash Seed Collection
United States Geological Survey (USGS) (AZ, VA)	2.1, Seed Transfer Zone Guidance 3.3, Science Delivery for Restoration	Gene Sequencing
University of California, Davis Arboretum (CA)	3.3, Science Delivery for Restoration	Western Rare Plants
University of Cincinnati (OH)	3.4, Training Tools	American Chestnut



University of Hawaii at Manoa (HI)	4.1, Education and Outreach	Hawaii Native Plants
University of Maryland Extension	3.1, Restoration Training	Extension Volunteers
University of Minnesota (MN)	2.1, Seed Transfer Zone Guidance 2.3, Plant Establishment	Prairie Grasses
University of Montana (MT)	2.1, Seed Transfer Zone Guidance	Seed Transfer Guidelines
University of Nevada Reno (NV)	2.3, Plant Establishment	Soil Seed Bank
University of Northern Iowa (IA)	3.3, Science Delivery for Restoration	Tallgrass Prairie Seed Mix
University of Washington (WA)	2.2, Seed Storage and Production	Seed Dormancy And Germination
University of Wyoming (WY)	2.3, Plant Establishment	Cultivars
USDA Agricultural Research Service (CO, DC, ID, MD, UT)	1.3, Increase Seed Supply 2.3, Plant Establishment 3.3, Science Delivery for Restoration 3.4, Training Tools 4.2, Interagency Communications	Legume Seed Development Germination in Field Tools for Restoration Planning
USDA Forest Service (CA, DC, ID, OR)	1.2, Assess Non-Federal Capacity/Need 2.1, Seed Transfer Zone Guidance 2.3, Plant Establishment 3.2, Seed Data Development 3.3, Science Delivery for Restoration 4.1, Education and Outreach	Seed Transfer Zones Fire Management Strategy Molecular Genetics Seedlot Selection and Reforestation Bend Seed Extractory Common Garden Network
USDA Natural Resource Conservation Service (MO, TX)	1.3, Increase Seed Supply	Evaluate Little Bluestem
Utah Division of Wildlife Resources (UT)	1.3, Assess Agency Seed Needs 2.3, Plant Establishment	Native Seed Development
Utah State University (UT)	2.3, Plant Establishment	Native Forb Establishment
Westscape Wholesale Nursery (MT)	3.4, Training Tools	Reclamation
Wild Seed Project (MA)	1.3, Increase Seed Supply	New England Native Plants

## Appendix 3: National Seed Strategy Task Forces

### Implementing National Seed Strategy in the United States

The following task forces were formed at the 2017 National Native Seed Conference (see Appendix 2 for more information on the Conference). A federal/non-federal Steering Committee helped to establish and oversee the task force efforts.

	Task Force
Policy and Funding	Before the Storm – The Need for Seed
	Identification of Existing Federal Seed and Restoration Policy
	USDA Programs and Native Plants
Research and Tools	Soil Activities under the National Seed Strategy
	Seeing is Believing: Demonstration Sites for Native Plants
	Selecting the Right Seed for the Right Place Right Now
	Tools for Seed Collectors
	Training Tools on the Use of Native Seed
Communication	Communicating the National Seed Strategy
	Native Plant Advocacy (nonfederal partners only)
	Native Plants Support Native Wildlife
	Public/Private Partnerships

Steering Committee Members: Rob Fiegner (IAE), Evelyn Williams, Steve Bosak, & Lindsey Riebe, succeeded by Leah Prescott & Andrea Kramer (CBG), Sarah Kulpa & Patricia De Angelis (USFWS), Elizabeth Rieben (BLM)

More information on the formation of these task forces can be found on the Native Seed Network website at: <https://nativeseed.info/task-forces/>

Task force accomplishments results are also being made available at: <https://on.doi.gov/2NTUxHW>

## Appendix 4: Organization Acronyms

Acronym	Name
ARS	Agricultural Research Service (USDA*)
BGCI	Botanic Gardens Conservation International
BIA	Bureau of Indian Affairs (DOI*)
BLM	Bureau of Land Management (DOI*)
CBG	Chicago Botanic Garden
CBI	Conservation Biology Institute
CPNPP	Colorado Plateau Native Plant Program
CU-Boulder	University of Colorado Boulder
DBG	Desert Botanical Gardens
DNR	Department of Natural Resources
DOD	Department of Defense
DOI	Department of the Interior
DOT	Department of Transportation
FHWA	Federal Highway Administration*
FCS	Four Corners School of Outdoor Education
GBNPP	Great Basin Native Plant Project
GGNPC	Golden Gate National Parks Conservancy
GRI	Green Ribbon Initiative
IAE	Institute for Applied Ecology
LBJWC	Lady Bird Johnson Wildflower Center
LCCs	Landscape Conservation Cooperatives
MARS-B	Mid-Atlantic Regional Seed Bank
MBG	Missouri Botanical Garden
NAU	Northern Arizona University
NDF	Nevada Department of Conservation & Natural Resources-Nevada Division of Forestry
NEWFS	New England Wild Flower Society
NIFA	National Institute of Food and Agriculture (USDA*)
NMSU	New Mexico State University
NNHP	Navajo Fish and Wildlife-Navajo Natural Heritage Program
NPS	National Park Service (DOI*)
NRCS	Natural Resources Conservation Service (USDA*)
NGO	Non-Governmental Organizations
PCA	Plant Conservation Alliance
PMC	Plant Materials Center
RMRS	Rocky Mountain Research Station
RSABG	Rancho Santa Ana Botanic Garden
SBR	Seed Banking for Resiliency
SOS	Seeds of Success
SER	Society of Ecological Restoration
SI-NMNH	Smithsonian Institution-National Museum of Natural History
SWSP	Southwest Seed Partnership
UA-SNRE	University of Arizona - School of Natural Resources & the Environment
UDWR	Utah Department of Wildlife Resources
UNR	University of Nevada-Reno

USBG	U.S. Botanic Garden*
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish & Wildlife Service (DOI*)
USFS	Forest Service (USDA*)
USGS	U.S. Geological Survey (DOI*)
USU	Utah State University
UT Austin	University of Texas at Austin
WWETAC	Western Wildland Environmental Threat Assessment Center

\*Plant Conservation Alliance MOU Signatory Agencies







