DRAFT NATIONAL SEED STRATEGY FOR REHABILITATION AND RESTORATION 2015-2020

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 National Seed Strategy for Rehabilitation and Restoration was developed through the PCA Federal Committee, chaired by the Bureau of Land Management with representatives from 12 federal agencies.

The Plant Conservation Alliance participating federal agencies are:

- Bureau of Indian Affairs (BIA)
- Bureau of Land Management (BLM)
- Federal Highway Administration (FHWA)
- National Park Service (NPS)
- Smithsonian Institution (SI)
- United States Botanic Garden (USBG)
- United States Department of Agriculture (USDA) Agricultural Research Service (ARS)
- USDA Forest Service (USFS)
- USDA National Institute of Food and Agriculture (NIFA)
- USDA Natural Resources Conservation Service (NRCS)
- U.S. Fish and Wildlife Service (USFWS)
- U.S. Geological Survey (USGS)

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

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INTRODUCTION

Healthy native plant communities are an essential foundation for ecosystem integrity and diversity. They create habitat for animals, provide ecosystem services that sustain people, communities and their economies and have intrinsic and irreplaceable biotic value that will become increasingly important in the future. However, the spread of invasive plant species, altered wildfire regimes, habitat modification, land overuse and climate change have negatively affected many native plant communities, as well as their component species and associated ecological processes. The problem of degraded plant communities has long ago expanded from local sites or timber stands to large areas across all biomes in the U.S. To slow and ultimately reverse these trends, managers and decision makers need a reliable supply of appropriate seed to facilitate restoration projects.

Restoring native plant communities on a landscape scale poses special challenges. Land managers must often replant large acreages quickly to avoid severe erosion or colonization by non-native invasive plants. Adding to the challenges are the expense and difficulty of obtaining and delivering adequate quantities of appropriate seed to meet the need, which is often difficult to predict. This seed must be available for use at the right time and in the right place.

> *To the extent practicable, utilize locally-adapted seeds and native plant materials appropriate to the location, conditions, and management objectives for vegetation management and restoration activities, including strategic sourcing for acquiring, storing, and utilizing genetically appropriate seeds and other plant materials native to the sagebrush-steppe ecosystem.*
>
> *–SECRETARIAL ORDER NO. 3336 Rangeland Fire Prevention, Management and Restoration, January 5, 2015*

Although great strides have been made in developing seed reserves and infrastructure to support land managers in obtaining optimal native seed and plant materials for site restoration, expanded and accelerated success on a national scale will require additional investment to increase native seed supplies, perform research, improve decision tools and enhance communication.

Key to this effort will be the research, development and technology transfer necessary to provide genetically appropriate seed and seedlings for stabilizing and restoring damaged and degraded areas. Genetically appropriate plant materials are those that "will produce plants that are environmentally-adapted to a restoration site and that are likely to establish, survive and promote community and ecological relationships" (U.S. Forest Service 2008). In addition, seed suppliers need protocols and guidelines for assessing seed quality and producing high quality seed in agricultural settings while maintaining genetic diversity. Use of high quality, genetically appropriate seed along with improved restoration equipment and methodologies will increase our ability to restore successful plant communities. The transition to a reliance on native plant materials will be guided by coordinated efforts in fundamental and applied research. In addition, new decision support tools and monitoring applications will aid managers throughout the restoration process from planning through implementation to effectiveness monitoring.

The Departments of Agriculture and the Interior shall establish a reserve of native seed mixes, including pollinator-friendly plants, for use on post-fire rehabilitation projects and other restoration activities. – Section 3 (f)

–Presidential Memorandum: Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators, June 20, 2014

THE STRATEGY

The National Seed Strategy for Rehabilitation and Restoration 2015-2020 (Strategy) presented in this document outlines a plan for achieving the 4 major goals within the Strategy, recognizing that success will depend on strong public/private partnerships, participation of many stakeholders, and strong funding and leadership commitment.

This Strategy provides guidance for, and implements a number of major national initiatives such as the President's Climate Action Plan, the National Fish, Wildlife & Plants Climate Adaptation Strategy (NFWPCAP 2012), Pollinator Health Task Force (Office of the White House 2014), Interior Department Secretarial Orders 3330 on mitigation and 3336 on rangeland fire, Executive Order 13112 on Invasive Species.

As the lead agency on the Plant Conservation Alliance (PCA) Federal Committee, the Bureau of Land Management (BLM) worked closely with the PCA and others to develop the National Seed Strategy. The goals and objectives resulted from the June 2014 Seed Conference held in Washington D.C. that brought together federal agency leadership (Kornze 2015). The Alliance is an umbrella organization of 12 federal agencies and more than 300 non-federal partners who

work together to conserve and restore native plant populations and communities across the United States.

Land managers have implemented successful restoration projects using native plants for decades, but increased coordination and capacity is necessary to accelerate the pace and scale of restoration and provide native plant materials when and where they are needed. The National Seed Strategy builds on the achievements and progress made through efforts such as the BLM's Interagency Native Plant Materials Development Program, including Seeds of Success, the USDA Forest Service Native Plant Restoration Program, USDA Natural Resources Conservation Service's Plant Materials Program, the Agricultural Research Service's National Plant Germplasm System and other public/private efforts to conserve native plant diversity.

The PCA federal committee is developing a business plan to accompany this Strategy. It will include anticipated costs of Strategy implementation so that federal partners can develop an interagency budget initiative and non-federal partners can determine opportunities to raise non-federal funds to support the Strategy's work.

SCOPE

This Strategy is national in scope and engages both federal and non-federal partners working toward restoration on public, tribal, state, municipal, and private lands over the next 50 years. Products and collaborations developed through the Strategy will help land managers select appropriate plant materials to use in public and private ecological restoration efforts at all scales.

It is aimed at providing all land managers – federal, tribal, state, county, and NGO – the tools they need to address ecological restoration across the United States. The Strategy seeks to develop seed and other plant materials[1] that will meet long-term goals to maintain and improve the biological and physical conditions at a site, ranging from reclamation to restoration. Use of genetically appropriate plant materials is strongly encouraged; however, this Strategy does not preclude the use of non-native plant materials in the instances where and when they are appropriate. Although land managers in some agencies may plant non-native species occasionally to achieve site stabilization, wildfire breaks, or invasive plant control, use of non-natives should be limited to transitional, non-invasive species that can be replaced by natives in subsequent ecological restoration or during natural successional processes.

With almost 30 percent of U.S. lands under federal management, this Strategy encourages large scale habitat restoration on federal lands, however smaller scale restoration will benefit from large-scale public investment in commercial native seed production. Ultimately this Strategy will benefit U.S. landscapes to support ecosystem services provided by plant communities: clean air, temperature regulation, carbon storage, aesthetics, habitat for other organisms, recreational opportunities, food, fiber, and potential commercial products, as well as habitat for other species,

[1] The term "plant materials" encompasses seed as well as other plant materials, including seedlings and container stock

from game to pollinators. The primary focus of this Strategy is native forbs, shrubs, and grasses. The Strategy is focused on restoration species and does not address rare endemic plants.

Within the scope of the National Seed Strategy is creating a national network of native seed reserves and storage facilities (federal, tribal, state, local and private facilities) that would serve all partners and provide both cold and general storage capabilities. This network would support the Presidential Memorandum on Pollinators and help increase the availability of native seed to a broader user base.

This Strategy does not set agency policy – many agencies have different authorizing legislation or charters, missions, and policies – but it supports the science and values the use of appropriate native plant materials in all land management activities

THE FOUR GOALS OF THE NATIONAL SEED STRATEGY FOR REHABILITATION AND RESTORATION

- ***GOAL ONE:*** Identify seed needs and ensure the reliable availability of genetically appropriate seed reserves.

- ***GOAL TWO:*** Identify research needs and conduct research to provide genetically appropriate seed reserves and to improve technology for seed production and ecological restoration.

- ***GOAL THREE:*** Develop tools that enable managers to make timely and informed seeding decisions for ecological restoration.

- ***GOAL FOUR:*** Develop strategies for internal and external communication.

Native plant communities, especially those containing forbs essential to ecosystem integrity and diversity, provide ecosystem services that sustain wildlife, such as greater sage-grouse and native pollinators. The spread of invasive species, altered wildfire regimes, habitat fragmentation, and climate change negatively affected many native plant communities and the species that depend upon them. To slow and ultimately reverse these trends in the greater sage-grouse habitat areas requires a reliable supply of genetically appropriate and locally adapted seed, as well as seeding technology and equipment for successful and expanded effective restoration of the sagebrush-steppe ecosystem.

–Secretarial Order 3336, Initial Report, Section 7(b) ix. - Seed Strategy.

BACKGROUND AND DEVELOPMENT

The critical shortage of native plant materials available for seeding following the extensive wildfires of 1999 and 2000 led Congress to direct the BLM and Forest Service to facilitate development of a long-term program to provide a stable and economical supply of native plant materials for restoration and rehabilitation efforts on public lands (USC HR 2000). The Forest Service and BLM responded to this by establishing the Native Plant Restoration Program and the Native Plant Materials Development Program. The immediate focus was to increase the availability of diverse native plant materials and to foster more efficient management of that supply.

The House Interior Appropriations Conference Report for fiscal year 2002 re-iterated Congress' order to the agencies to "continue to implement the long-term program to manage and supply native plant materials for use in various Federal land management restoration and rehabilitation needs" (USC HR 2001). In April 2002, USDI and USDA issued the "*Report to the Congress, Interagency program to supply and manage native plant materials for restoration and rehabilitation on federal lands*" (USDI & USDA 2002) which called for a commitment to native plant materials research, production and use that included a recommendation for financial and organizational support from the Department of the Interior (DOI) and the U.S. Department of Agriculture (USDA). In this report, DOI and USDA also stated their intent to improve and expand partnerships in cooperation with the private seed and nursery industry, develop and enhance science delivery to practitioners, and expand outreach and education to the general public.

The agencies have made great achievements since establishing the Native Plant Materials Development and Restoration Programs. For example, provisional and species-specific seed zones are increasingly being used to guide the selection of genetically appropriate seed for

ecological restoration projects, thereby increasing the potential for success (Rogers and Montalvo 2004, Johnson et al. 2010). Seed production research has provided cultural practices for growing a wider array of restoration species, while improved equipment, seeding and planting technologies and decision tools provide users with greater flexibility when dealing with complex seeding mixes and site conditions (USDI BLM 2009). Importantly, Seeds of Success collection teams have made more than 15,000 native seed collections covering more than 5,000 taxa for use in developing native seed crops and *ex situ* conservation (Haidet and Olwell 2015).

Multiple agencies – federal, tribal, state, NGOs and universities – are collaborating through ecoregional programs to provide plant materials suitable for restoration in specific ecoregions. The Great Basin Native Plant Project led by the Forest Service and BLM, for example, was established in 2002 (Shaw et al. 2012). Its goal is to increase seed availability and develop the knowledge and technology to restore native plant communities across millions of acres of burned lands, with a focus on restoring native sagebrush habitat and increasing native forb production. Partners in the Colorado Plateau (Wood et al. 2015), Mojave (DeFalco et al. in preparation; Shrylock et al. in preparation) and the Pacific Northwest (Riley et al. 2015, Erickson 2008) are conducting similar programs. Through the BLM ecoregional programs alone, seed from more than 200 native plant populations have been made available for restoration projects, conservation gene banking and commercial markets (USDI BLM 2009). To ensure coverage across the United States, these programs will need to be established in those areas of the U.S. where they currently do not exist.

Achievement of long-term goals of the Native Plant Materials Development Program will require an even greater commitment to collaboration across agencies and with other partners to share expertise and facilities and to produce and use plant materials more efficiently. Leaders of the 12 federal members of the Plant Conservation Alliance met in Washington, D.C. in June 2014 to celebrate 20 years of plant conservation collaboration and to renew the Memorandum of Understanding that established the partnership. The meeting provided a forum for agency leaders and staff to initiate discussions on development of a National Seed Strategy to address long term goals for the program. The Plant Conservation Alliance Federal Committee served as the Steering Committee for this Strategy. Members of this Committee, or their representatives, worked with agency experts on the Seed Supply, Research, Decision Tools, and Communication teams to further develop priority objectives and collaborative actions for accomplishing these objectives, and to better describe measurable outcomes.

Implementation of the National Seed Strategy will enhance coordination and forge strong partnerships among agencies, tribes, states, and non-governmental organizations, as well as with the private seed and nursery industry. Such partnerships are vital to the success of ecological restoration efforts throughout the United States.

VISION AND MISSION

NATIONAL SEED STRATEGY FOR REHABILITATION AND RESTORATION VISION

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

NATIONAL SEED STRATEGY FOR REHABILITATION AND RESTORATION MISSION

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

GUIDING VALUES AND PRINCIPLES

- Native plant communities provide ecosystem services that sustain people, communities, and their economies.

- Native plant communities are key to ecosystem integrity, resilience, and provide essential habitat and food sources for wildlife, including pollinators.

- Native plant communities have intrinsic and irreplaceable biotic value that will become increasingly important in the future.

- Native seed is a critical natural resource asset that deserves greater recognition in light of the ecological challenges of the 21st century.

- Native, locally adapted seed sources are vital for restoration and management because they reflect the evolutionary and adaptive capability of plants in an area.

- Native plants contain unique properties and the full benefit of these may not yet be recognized but should be preserved for future generations.

- Botanical, ecological and genetic scientific expertise plays a vital role in providing information to support and guide ecological restoration.

- Non-native species may occasionally be used to achieve site stabilization, wildfire breaks, or invasive plant control. Their use should be limited to transitional, non-invasive species that will be replaced by natives in subsequent ecological restoration or during natural successional processes.

- Revegetation strategies will frequently diverge from direct planting of desired community outcomes to include early seral, hybrid or non-native species for short term site stabilization, weed control or ecological facilitation – expanding on the types of seeds managers need in their toolbox.

- Interagency collaboration is essential to advance ecological management and research activities, reduce costs and avoid duplication.

- Non-federal partners such as tribes, state, private sector and nonprofit organizations make important and valuable contributions to the development of native seed.

- The Strategy recognizes the value of using the native seed bank that exists in the soil; not all disturbances require active reseeding to restore habitat.

- The Strategy recognizes the value of partnering with a diverse group of stakeholders.

- Strategy participants support opportunities to:

    - Maintain or increase the number of acres of native plant communities that provide ecosystem services.

    - Include Federal, tribal, state and local governments, academic institutions, nonprofits and the private sector when addressing restoration issues.

    - Improve the availability of genetically appropriate seed required to restore healthy native plant communities.

    - Develop strategies and tools for conducting more effective restoration.

    - Promote research, science delivery and education required to meet new restoration challenges imposed by increasing threats.

    - Communicate the value of native plant communities and restoration to the general public.

GOAL 1: IDENTIFY SEED NEEDS AND ENSURE THE RELIABLE AVAILABILITY OF GENETICALLY APPROPRIATE SEED RESERVES

BACKGROUND/RATIONALE

The ability of federal land management agencies and other land managers to respond effectively to both emergency and planned restoration needs – and to advance ecological management and research activities – is highly dependent on the reliable availability of genetically appropriate seed. This requires comprehensive and integrated seed planning and production, as well as seed storage systems that provide sufficient quantities of suitable plant materials when and where they are needed. Actions under this goal will assess seed needs and fulfillment capacities, with an eye toward targeting infrastructure investments, increasing coordinated wildland seed collection and field production, and expanding cooperation and partnerships within and among public and private sectors. Increased financial and organizational support for achieving this work is essential, as is coordinating and communicating with the private seed industry. A number of actions in Goal 1 will inform actions in Goal 2 and 3.

OBJECTIVE 1.1: ASSESS THE PLANT PRODUCTION NEEDS AND CAPACITY OF FEDERAL AGENCIES

Among federal agencies, there is a wide variance in the ability to access and produce native plant materials. Actions under this objective will lead to a better understanding of federal agencies' overall capacity to meet their stabilization, rehabilitation, and restoration needs with native plant materials. The assessment would capture those needs that relate to current priorities for pollinators and climate change adaptation, as well as projections for both planned restoration and emergency response. To ensure that input is meaningful and manageable, Strategy implementers will give careful consideration to the scope of the initial needs and capacity assessments. After the initial baseline assessment, agencies may repeat a revised needs and capacity assessment every 5 years to provide measures of progress and inform priorities over time as recommended under Objective 4.3 Report Progress, Recognize Achievements and Revise Strategy.

This objective also aims to evaluate existing databases and reporting systems that can contribute to the seed needs and capacity planning processes. In the long-term (5- to 10-year timeframe), this objective should seek to assess the conservation value of existing collections (i.e., the genetic diversity captured by current accessions) and take steps to correct deficiencies.

Action 1.1.1 Conduct a needs and capacity assessment for all agencies and their offices that provide or use seed.

This assessment will capture the types and quantities of seed each agency needs for its restoration projects, including those targeting pollinator habitat enhancement, to comply with the Presidential Memo on pollinators. Agencies should seek to include all relevant program areas and field offices that provide or use seed. This assessment can review current policies and

guidance regarding legal origin and sourcing requirements for seed within and across agencies, analyze who and what expertise is involved in seed choice decision-making and assess training needs. Identification of seed needs may also examine plant associations based on regional or national classification systems and seed zones, which may facilitate efforts to prioritize seed needs. The needs assessment could also solicit input regarding concerns and benefits associated with using native plant materials, such as cost, technology, and availability.

By projecting seed needs over a 5-year period, this assessment will track with the renewal periods under the federal Memorandum of Understanding of the Plant Conservation Alliance. Ultimately, the needs assessment could help identify appropriate time frames for projecting longer-term needs.

TARGET DATE(S): 2015-2016
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS: Connecticut Department of Energy and Environmental Protection – Natural Diversity Data Base

Action 1.1.2 Identify and inventory agency seed collections, production, and storage capacity and needs.

This action will identify existing agency seed supplies and related staff, storage facilities, tools, equipment, and costs. It will seek information specifically on seed supplies that meet management needs such as weed competition and food species for at risk species including pollinators. It will also identify strengths and weaknesses in agency seed production and facilities networks and needs for new infrastructure, staffing, and training. Production and facilities networks include nurseries, seed extractories, plant materials centers, seed production, and storage facilities, some of which may be held by non-federal partners (see Action 1.2.1).

Within this action, agencies will identify policies, guidance, or publications that inform management practices for seed collection and production methods. Within the second year of implementing this action, Strategy implementers will have identified and catalogued agency infrastructure and will have evaluated databases and reporting systems for seed use, seed inventory, and field performance monitoring.

TARGET DATE(S): 2015-2016
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS: Connecticut Department of Energy and Environmental Protection – Natural Diversity Data Base

Action 1.1.3 Identify existing federal seed and restoration policies.

This action will ensure that the Strategy captures all current federal policies related to development and use of plant materials and restoration. Outputs for this action will include identification of plant and restoration policy compatibilities, gaps and challenges across federal agencies. This action provides information for actions in Goal 4, as well.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS:

Action 1.1.4 Analyze results of needs and capacity assessment to determine if current federal policies, seed collections, and storage and production facilities meet agencies' needs.

Reviewing results to determine strengths and correct weaknesses in federal seed systems should lead to specific actions to improve proactive short- and long-term planning capabilities and to expand agency staffing so they can respond to projected restoration needs within the third year of implementing the Strategy. Seed and capacity needs could be prioritized by habitat (e.g., pollinators, sage-grouse) and/or by seed zone.

Other results of this action would include the creation of a map of agency production and storage facilities, the evaluation of investment needs and seed use policies, and the discussion of concerns and benefits related to the use of native plant materials. Actions to address deficiencies should be incorporated under actions identified under Objectives 1.2 and 1.3, and other goals, as appropriate.

TARGET DATE(S): 2016-2017
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS: Institute for Applied Ecology/Native Seed Network

Action 1.1.5 Analyze results of assessment of restoration policies and develop a comprehensive restoration program with consistent funding to restore native plant communities on a landscape-scale across public lands.

Using the output from Action 1.1.3, review results of assessment of restoration policies to determine strengths and correct weaknesses in federal restoration policies and to determine agency staffing so they can respond to projected restoration needs within the third year of implementing the Strategy. Other results of this action would include the development of a restoration program with consistent funding to consistently buy native seed for restoring native plant communities on a landscape scale. Actions to address deficiencies should be incorporated under actions identified under Objectives 1.2 and 1.3, and other goals, as appropriate.

TARGET DATE(S): 2017-2018
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICPANTS:

OBJECTIVE 1.2: ASSESS CAPACITY AND NEEDS OF TRIBES, STATES, PRIVATE SECTOR SEED PRODUCERS, NURSERIES, AND OTHER PARTNERS

To achieve this objective, agencies will work with tribal, state, private sector, and non-profit partners to assess non-federal sector interest in and capacity to collect and produce native seed. Results of this objective may lead to expanded contractor pools, changes in contract specifications and timelines to minimize risk and uncertainty, creation of an annual seed forum,

or the organization of field tours to grower farms. Accomplishing this objective may require identifying a liaison to work with farmers and seed producers to provide mechanisms for regular communications regarding federal seed needs, to assist with equipment needs, and to help producers navigate the federal procurement system.

Action 1.2.1 Conduct a needs and capacity assessment of tribal, state, local, private sector, and non-profit seed storage and distribution facilities.

This assessment will capture the seed production and storage capacity of non-federal entities. This action will require collaboration with partners who can work with key sectors to obtain the necessary information. Guidance developed to implement this action should also elicit information on growers' expertise and ability to provide training about tools, techniques, and capacity for seed collection, germination and establishment of native plant communities. This assessment can also elicit information on states' capacities to certify location and origin and it should gather information on procurement processes. Upon obtaining collaborator input, discrete milestones should be identified for anticipated achievements within each of the first 5 years of implementing the Strategy.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): BIA, NRCS
OTHER PARTICIPANTS: American Seed Trade Association, Florida Association of Native Nurseries, Mid-Atlantic Regional Seed Bank

Action 1.2.2 Work collaboratively with private seed producers, nurseries and other partners to leverage strengths and address deficiencies in the distribution and availability of genetically appropriate seed.

This action may identify training needs and opportunities, such as working with small farms to assist with smaller-scale, niche market seed production. This action should also explore promoting a seed market system that is responsive to regional native seed needs of the agencies (see Objective 1.3). This action should result in a regular assessment of collaboration efforts that can be summarized and shared. Outcomes under this action might include identifying mechanisms to increase collaboration by 2017 and to overcome barriers to collaboration with the private sector by 2020.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS: American Seed Trade Association, Florida Association of Native Nurseries, Mid-Atlantic Regional Seed Bank, Native Seed Network, NatureServe/Natural Heritage Network

Action 1.2.3 Analyze results of non-federal needs and capacity assessment to determine if current seed collections, as well as storage and production facilities, meet restoration needs.

Reviewing results to determine strengths and challenges in non-federal seed systems will lead to a better understanding of non-federal seed system capabilities. This review can inform agencies

on how they could work with nonfederal partners to improve availability of seed in non-federal system.

Actions to address deficiencies should be incorporated under actions identified under Objectives 1.3, and other goals, as appropriate.

TARGET DATE(S): 2016-2017
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS: Native Seed Network

OBJECTIVE 1.3: INCREASE THE SUPPLY AND RELIABLE AVAILABILITY OF GENETICALLY APPROPRIATE SEED

The actions under this objective will require an analysis of the seed needs and capacity assessments completed under Objectives 1.1 and 1.2. Achieving these actions should include setting goals for increasing collection, cleaning, testing, storage, and application capacity. Accordingly, implementation needs should set goals for achieving these milestones under each action.

Action 1.3.1 Expand and improve facilities and plant production capacity.

This action draws from the capacity and needs assessments and should result in adequate facilities and plant production capacity to meet seed needs. It will target expansion and improvement of federal capacity and will also encourage the commercial seed industry to enhance capacity. This may include new processes to streamline planning and increase coordination for collecting, propagating, and sharing seed among the agencies, possibly through a Memorandum of Understanding by 2020.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BIA, BLM, NPS, NRCS, USFS, USFWS
OTHER PARTICIPANTS: American Seed Trade Association, Chicago Botanic Garden, Florida Association of Native Nurseries

Action 1.3.2 Improve agency and partner capability to plan for seed needs and to use common seed zones.

This two-pronged action will increase planning and coordination within and among agencies and external partners in collecting, propagating, procuring, and sharing plant materials from priority seed zones, and increase the use of genetically appropriate seed in both emergency and planned restoration. This action would build upon research emanating from other Strategy actions, such as Action 2.1.1 (*Conduct genetic research to assist in the development of seed zones)*, and may include coordinating multi-agency procurement planning and seed sharing, where appropriate.

Existing regional seedbanking networks between growers and end-users, such as the Deschutes Basin Native Plant Seed Bank and Mid-Atlantic Regional Seed Bank, may serve as models for accomplishing this goal. This Action should include considerations for creating (or improving) a

national online database that provides source-identified seed availability. Note: Some databases already exist, as informed by Action 1.1.1.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): BIA, BLM, NPS, ARS, NRCS, USFS, USFWS
OTHER PARTICIPANTS: Chicago Botanic Garden, Florida Association of Native Nurseries, Mid-Atlantic Regional Seed Bank

Action 1.3.3 Assess and implement alternative seed production methods for 'workhorse' shrub and forb species to augment wildland seed collection.

This action aims to increase the supply of genetically appropriate seed that can be used across large seed transfer zones. To satisfy needs for larger quantities of such plant material, alternative production methods might include creation of shrub orchards or protection of wildland or private land stands for seed harvesting if wildland and full-scale commercial production are not options (e.g., sagebrush seed orchards).

This action will consider existing research and will be informed by outcomes resulting from actions 1.3.1 and 1.3.2. Options may include the identification of production areas by empirical and provisional seed zones. Deliverables may include best management practices to reduce damage to wildland populations, increased adaptation of plant materials, reduced availability bottlenecks, and increased supply of genetically appropriate seed that can be used across large seed transfer zones.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): BLM, NPS, USFS, USFWS
OTHER PARTICIPANTS: Chicago Botanic Garden

Action 1.3.4 Expand collection, conservation, and assessment of native plant genetic resources for use now and into the future through Seeds of Success and other complementary efforts.

This action will lead to field collections of seed that represent the genetic diversity of species populations for use in seed zone development, seed production, restoration, research, and conservation. It would include training collection teams on seed collection methods. The outcome would be the conservation, assessment, and distribution of genetic resources through the USDA ARS National Plant Germplasm System (and other agencies and institutions) and regional seedbanks, such as the Mid-Atlantic Regional Seed Bank.

This action should also identify *in situ* and *ex situ* reserve areas important for native plants, such as wilderness areas and research natural areas, and it could inform efforts to improve conservation strategies for these species. This would include improving agency permitting for seed collection on federal lands, writing best management practices for seed collection and potentially developing programmatic National Environmental Policy Act documents to streamline the permit process, where needed.

This action may consider whether or how to prioritize germplasm collection for species based on rarity, including salvage of seed material prior to activities that will damage the landscape. One tool resulting from this action could be a database that tracks seed collection sites on federal lands.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NPS, NRCS, SI, USFS, USFWS
OTHER PARTICIPANTS: Chicago Botanic Garden

Action 1.3.5 Engage federal procurement specialists to assess current contracting regulations and practices to identify strengths and take actions to correct deficiencies.

This action should explore how existing procurement practices (e.g. reacting to fires) may contribute to price fluctuations and seed demand due to unpredictability in wildfires and other impacts to the land. This action should result in improved federal procurement tools to encourage the commercial seed industry to meet seed needs (e.g., Indefinite Delivery/Indefinite Quantity Contract, Blanket Purchase Agreement, permitting practices). Additional deliverables under this action may include developing a planning framework to deliver seed for emergency stabilization and burned area rehabilitation and providing training to small business owners on navigating the federal procurement system. Strategy implementers can also examine procurement staffing and training needs under this Action.

TARGET DATE(S): 2015-2017
COORDINATING AGENCY(IES): BLM, NPS, NRCS, USFS, USFWS
OTHER PARTICIPANTS: American Seed Trade Association, Florida Association of Native Nurseries, Mid-Atlantic Regional Seed Bank, Native Seed Network

GOAL 2: IDENTIFY RESEARCH NEEDS AND CONDUCT RESEARCH TO PROVIDE GENETICALLY APPROPRIATE SEED AND IMPROVE TECHNOLOGY FOR NATIVE SEED PRODUCTION AND ECOSYSTEM RESTORATION

BACKGROUND/RATIONALE

Use of native plants to restore disturbed communities is essential to provide diversity, improve ecosystem functioning, facilitate adaptation to climate change and meet management objectives. To ensure that adapted plant materials are available to provide long-term sustainability, additional research is required. This includes development and testing of seed zones; developing reliable protocols for seed testing, storage and seed production and defining effective restoration strategies and monitoring systems. Under the following objectives and actions, agencies will assess research priorities in each of these areas in order to provide the knowledge, plant materials, and technology essential for conducting fully functioning plant materials programs where needed. Accomplishing these actions will entail collaboration among managers, scientists,

seed regulatory agencies, and the private sector seed industry. Agency support for seed collection and increase, specialized equipment and targeted research will be essential. Outcomes will contribute to development of tools for the application of research results as described in Objective 3.

OBJECTIVE 2.1: CHARACTERIZE GENETIC VARIATION FOR RESTORATION SPECIES TO DELINEATE SEED ZONES AND PROVIDE SEED TRANSFER GUIDELINES FOR CURRENT AND PROJECTED FUTURE ENVIRONMENTAL CONDITIONS

Because seed zones and seed transfer guidelines are lacking for most non-commercial species, research is urgently needed to aid managers in selecting genetically appropriate seed materials for restoration. Improving plant material availability entails collaboration among land managers within ecoregions, seed zones or other biogeographical areas to identify key restoration species, including those currently in use, and additional species required to meet restoration and management goals. Actions within this goal will foster the research needed to further refine climate-based provisional seed zones used for the many species for which genetic data is lacking. For widespread, commonly used restoration species, studies of genetic variation are required to develop empirical seed zones and seed transfer guidelines. Models based on these research results can be used to predict climate change effects on plant distributions and inform restoration efforts.

Action 2.1.1 Conduct genetic research to develop seed zones for key restoration species.

Collaboration between the research and management community is needed to communicate the application and value of seed zones to provide adapted materials for restoration. Restoration species and diversity components will be identified for use in provisional seed zones and habitats within those seed zones. Key restoration species collaboratively identified by managers and researchers will determine priorities for studies of ecological genetics. For these species, planned and ongoing common garden and reciprocal transplant studies will be completed to identify adaptive plant traits that can be used to develop species-specific empirical seed zones. Seed zones and other environmental data (e.g. soil descriptions, habitat type descriptions) will be employed using tools identified in Goal 3 to guide collection and deployment of genetically diverse materials adapted to restoration site conditions.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NIFA, NRCS/Plant Materials Centers, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Great Basin Research Center, Institute for Applied Ecology, Mid-Atlantic Regional Seed Bank, NatureServe, Utah Department of Natural Resources, universities

Action 2.1.2 Develop predictive models of climate change effects on target restoration species and genetic diversity using 20-year or mid-century climate models.

Predictive models or climate change effects are used to assess threats to important restoration species and opportunities for targeting, prioritizing and implementing restoration projects in light of potential changes in species distributions. Models will identify changes in species distributions and seed zone boundaries that will aid in identifying potential refugia areas, bottlenecks to species' movement, and selection of appropriate populations for inclusion in restoration projects to reduce the risk of future maladaptation.

TARGET DATE(S): 2016-2020
COORDINATING AGENCY(IES): ARS, NIFA, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Institute for Applied Ecology, NatureServe, universities,

OBJECTIVE 2.2: CONDUCT SPECIES-SPECIFIC RESEARCH TO PROVIDE SEED TECHNOLOGY, STORAGE, AND SEED PRODUCTION PROTOCOLS FOR RESTORATION SPECIES

Reliable species-specific protocols are required for evaluating seed quality and maintaining viability of seed in storage if seed reserves are to be available when needed. Similarly, guidelines for producing seed of restoration species, particularly native forbs, in agricultural settings are required to reduce economic risks to growers. Accomplishing this action will require that research needs be identified and prioritized by users, growers, seed analysts and others and communicated to seed technologists and agronomists having appropriate areas of expertise (e.g. seed biology and technology, crop science, pollinator biology, soil science). Federal liaisons to private sector growers, as recommended under Objective 1.2 could provide coordination for this process. Outcomes will include additions to the Association of Official Seed Analysts Rules for Testing Seeds, guidance for construction of regional and local storage facilities, and improved equipment and technology for native seed production. Resolution of information gaps and production bottlenecks is often essential to expanded and economical production and use of individual species. Timelines for all research described in this Objective are dependent upon funding availability and time requirements for individual studies.

Action 2.2.1 Conduct seed germination studies and develop seed testing protocols for key restoration species.

This action will support research to determine the germination biology and provide the Association of Official Seed Analysts (AOSA) accepted seed testing protocols for commonly seeded restoration species as well as species in demand but not currently in use. Publications on germination biology and ecology for these species will be reviewed. Knowledge gaps will be identified and prioritized by managers, growers and researchers. The resulting research will inform seeding practices (e.g. requirements for dormancy release, seed pretreatments, seeding rates, dates, depths) for seed production fields and wildland seedings. Studies designed to formulate standardized germination tests procedures for individual species are refereed by AOSA prior to acceptance into the Rules for Testing Seeds. Close coordination with the AOSA Native Seed Testing Committee is required to schedule referee testing. The Rules are used by certified seed laboratories across the country to increase uniformity in results. Standardized testing procedures are needed to evaluate seed lot quality in order to set market prices, determine

seeding rates, and monitor seed longevity in storage. Outcomes of this action and existing data will be synthesized and compiled in existing or new databases.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NIFA, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Great Basin Research Center, Institute for Applied Ecology, private seed testing laboratories and seed companies, state seed laboratories, universities

Action 2.2.2 Develop storage guidelines for restoration species to improve maintenance of seed viability.

This action aims to provide species-specific requirements needed to manage stored seed supplies and conserve seed quality. Seed handling and management protocols to maintain viability from harvest through conditioning, storage and use are lacking for most restoration species. Optimal temperature and relative humidity requirements to maximize seed longevity in storage have rarely been identified. Although many restoration species can be stored successfully in warehouses under ambient conditions for short periods, others lose viability rapidly, resulting in lost profits to growers or lost reserves to users. Available database information, literature, storage records and observational reports will be reviewed on a regional or seed zone basis to identify problematic species and prioritize research. Public and private researchers including certified seed laboratory personnel will be solicited to conduct required studies. Response may be limited due to the long-term nature of the research and availability of suitable facilities and equipment for conducting the studies. Products in addition to publications will include storage protocols, expanded seed technology databases and synthesis documents.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NIFA, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Great Basin Research Center, private seed testing laboratories and seed companies, state seed laboratories, universities, Utah Department of Natural Resources

Action 2.2.3 Develop species-specific protocols for seed and seedling production practices that maintain genetic diversity.

This action fosters research needed to aid growers in producing seed crops and nursery seedlings efficiently and economically while maintaining genetic diversity. Bottlenecks to successful production often appear when wildland species are grown as monocultures in seed fields or nurseries. Review of seed needs assessments by ecoregion or seed zone combined with an examination of pertinent literature, databases and surveys of growers, nurserymen and researchers is needed to identify obstacles to the successful production of individual species. Regional liaisons may be required to aid in prioritizing and expediting research. Scientists with expertise in improving stand establishment, weed control, irrigation, pollinator management, plant pathology, root and soil micro-organisms and facilitators, and a wide array of other disciplines may be called upon to resolve specific problems. Input from geneticists is required to set guidelines for maintaining genetic diversity from seed collection through seed conditioning

and seed or seedling production. Outcomes of this work, in addition to seed supplies and nursery seedlings, will include publications, technical notes, databases, webinars, workshops and field days.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NIFA, NRCS, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Great Basin Research Center, Institute for Applied Ecology, public and private seed producers and nurseries, state agencies, universities

OBJECTIVE 2.3: CONDUCT RESEARCH ON PLANT ESTABLISHMENT, SPECIES INTERACTIONS, AND ECOLOGICAL RESTORATION

Increasing the use of native species requires greater knowledge of requirements for seedling establishment, species interactions (among natives and between natives and exotics), and more effective strategies for conducting restoration in ecological settings ranging from wetlands to semi-arid landscapes. Actions under this objective will encourage collaboration among agency personnel, private sector seed industry and restoration contractors, and federal and non-federal scientists to prioritize research needs by plant association. Although studies of seedling establishment and species interactions may be completed within the 5-year timeframe, restoration research will be long-term, collaborative among all involved parties, and interdisciplinary. Research outcomes will be reported through publications and also transmitted to users via tools described in Objective 3. It is expected that outcomes may indicate a need for added agency support, personnel trained in restoration ecology and investment in infrastructure.

Action 2.3.1 Develop site preparation and seeding and transplanting strategies that improve plant establishment and community diversity.

This action will identify issues limiting successful restoration and prioritize needed research activities. Available literature, seeding and planting records, and practitioner surveys will be reviewed and synthesized to provide immediate guidance and to identify research needs on an ecoregional or seed zone basis. Broad research topics will likely include factors limiting plant establishment, species interactions (among natives and native competition with exotic weeds and forage species), and strategies for meeting challenging restoration situations, ranging from localized to landscape scales and including urban and wildland/urban interface restorations. Prioritization of needs will be completed in the first two years of the Strategy. However, many of the required studies will be long-term and interdisciplinary, requiring collaboration among agencies, landowners, and researchers from public agencies and universities. Products will include, but not be limited to new chemical, physical and biological (including biocontrol and bio-pesticide) methods and strategies for site preparation, seeding and transplant strategies for re-establishing varied communities and habitats, and seed mix recommendations that include early colonizers and later-colonizing perennials where appropriate and effective for restoration.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NIFA, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Great Basin Research Center, Institute for Applied Ecology, universities

Action 2.3.2 Within seed zones, investigate the capacity of native plant materials to establish and persist with invasive species while maintaining plant diversity/function.

Native communities across the country are threatened by the encroachment of exotic invasives that compete with native species for resources and often preclude establishment of their seedlings. This action will facilitate research within seed zones to examine populations of native species that have undergone rapid evolution when growing within populations of exotic annual or perennial invasives. These native populations may have potential value as restoration material if their competitive ability is heritable and if they have not become competitive to the extent that they will preclude establishment of other native species in a seed mix. Literature reviews and surveys of researchers working in this newly evolving field will be compiled to identify potential native species and exotic invasive combinations that may lend themselves to study for potential plant material development. The interaction of identified competitive natives with target exotic species will be examined, and traits indicative of increased competitive ability with target weeds identified. Assessment of the benefits and risks of competitive natives on the diversity and function of native plant communities and ecosystems will be an essential component of the research.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NIFA, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Great Basin Research Center, Institute for Applied Ecology, universities

Action 2.3.3 Advance investigations to diversify depleted native communities to improve structure and functioning and to replace exotic monocultures with native communities.

Actions are recommended for adding structure and diversity to a wide variety of plant communities that have been depleted by inappropriate livestock grazing, wildfires or other disturbances at scales ranging from local to landscape. Successful diversification is essential to restore ecosystem functioning, provide critical habitat, and increase sustainability. Agencies are in need of recommendations for enhanced establishment and persistence of native species, including plant material recommendations as well as seeding and planting equipment and technology for adding species to potentially competitive existing communities. Strategies are in place for some communities, but approaches or more effective techniques are required for others. Agencies are also seeking guidance for replacing certain or some exotic grass seedings that are planted on millions of acres of federal lands. Diversifying some seedings often proves unsuccessful due to the competitiveness of the exotics and their ability to recover following treatments, thus technology to improve replacement is essential. Collaborative identification of local or regional research needs should provide a basis for formulation of studies that include examination of species interactions, treatment requirements, and overall strategies for successful diversification or replacement. Research need may be prioritized over the first two years, but timelines for this work will likely extend beyond the 5-year framework of the initial Seed Strategy.

TARGET DATE(S): 2015-2020

COORDINATING AGENCY(IES): ARS, BLM, NIFA, NPS, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Great Basin Research Center, Institute for Applied Ecology, universities

Action 2.3.4 Assess soil degradation and develop treatments, soil amendments and other site preparation techniques that enhance germination, establishment, and development of healthy communities capable of resisting invasion by exotic species.

Consideration of soil condition is often not adequately incorporated into restoration planning. Addressing gaps in our understanding of soil's role in restoration will result in more successful restoration. Agencies require tools to aid in assessing site conditions and making informed decisions regarding soil treatments, amendments and site preparation practices. A synthesis of assessment methods and technologies to stabilize soils and improve the establishment and persistence of native species will provide a starting point that will provide guidance for practitioners and identify research gaps. This synthesis can be completed within two years. Research will require interdisciplinary collaboration among federal and non-federal scientists. Outcomes will contribute to tools and training sessions described in Objective 3.

TARGET DATE(S): 2015-2018
COORDINATING AGENCY(IES): ARS, BLM, NIFA, NPS, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, NatureServe, Great Basin Research Center, Institute for Applied Ecology, NatureServe, universities

OBJECTIVE 2.4: DEVELOP OR MODIFY MONITORING TECHNIQUES AND INVESTIGATE LONG-TERM RESTORATION IMPACTS AND OUTCOMES

Monitoring techniques and their application vary among agencies. Techniques used to evaluate restoration projects are often modified from standard ecological monitoring methods and may or may not provide needed data, particularly for evaluating early establishment of seedings. Increased capabilities for compiling retrospective and current monitoring data from seedings into electronic databases provides an additional tool for evaluating the efficacy of standardly used plant materials and seeding techniques, the ability of seedings to meet management goals, and seeding response to environmental conditions. Actions outlined in this objective will foster needed research and enable users to evaluate past seeding mixes and techniques for meeting current goals and to obtain improved data on response of the their restoration efforts.

Action 2.4.1 Evaluate new and existing monitoring methodologies to evaluate restoration outcomes.

Actions in this objective will include agency analyses of current monitoring techniques for their effectiveness in evaluating the success of restoration projects over short and long time periods. An additional consideration will be the ability of these methodologies to measure progress toward meeting management priorities (e.g. establishment of pollinator habitat). Adequacies and deficiencies identified through these analyses will be synthesized at ecoregional or other appropriate scales to recommend needed research to modify existing techniques or formulate new ones. The results will provide guidelines for improved and cost effective short- and long-

term monitoring that informs restoration practices and guides ecologically robust adaptive management post-seeding.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NIFA, NRCS, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Florida Association of Native Nurseries, Great Basin Research Center, Institute for Applied Ecology, universities

Action 2.4.2 Quantify major short- and long-term ecological and economic costs and benefits of planting native or non-native plants on public lands (e.g. value to pollinators, biodiversity, and ecosystem functions).

Many federal initiatives, policies, regulations, and other documents encourage the use of native species to protect native germplasm and diversity and to provide healthy, functioning ecosystems. Questions, however, remain regarding costs, establishment, competitive ability with exotic invasives and longevity of natives, particularly on arid and semi-arid sites. Although many exotic species have been seeded successfully and economically to provide forage and soil stabilization, their ability to support diversity and provide functioning ecosystems to meet multiple use mandates is limited. With improving ability to select genetically appropriate plant materials and seed diverse species, it is important for practitioners to have data available that provides guidance when planning restoration projects and selecting plant materials. This research will focus on specific systems where exotic species are commonly used to aid in better defining alternative materials and tradeoffs resulting from plant materials decisions.

TARGET DATE(S): 2016-2017
COORDINATING AGENCY(IES): ARS, BLM, DOI, NIFA, NPS, NRCS, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Florida Association of Native Nurseries, Institute for Applied Ecology, universities

Action 2.4.3 Conduct retrospective studies of selected native plant restoration projects to evaluate short- and long-term plant community responses to these treatments and to biotic and abiotic conditions.

This action will accelerate agency compilation of regional monitoring data from historic and current seedings as one means of evaluating agencies current and planned restoration practices. Researchers will examine available retrospective data to evaluate short- and long-term responses of restoration projects to treatments, seed mixes, and environmental conditions to characterize variation in establishment and longevity of individual plant materials. This data will also be used to examine the role of weather conditions and other environmental variables on plant community development and ability to resist exotic species invasions. Estimates of economic and ecological costs and benefits of restoration will be strengthened by the availability of long-term data from multiple seedings.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, NIFA, NPS, NRCS, USFS, USGS

OTHER PARTICIPANTS: Chicago Botanic Garden, Florida Association of Native Nurseries, Great Basin Research Center, Institute for Applied Ecology, universities

GOAL 3: DEVELOP TOOLS THAT ENABLE MANAGERS TO MAKE TIMELY, INFORMED SEEDING DECISIONS FOR ECOLOGICAL RESTORATION

BACKGROUND/RATIONALE

Restoration goals must be placed in the context of economic, social and political considerations as well as 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. New tools are needed to help managers assess the risks, guide the scope, and predict the efficacy of restoration treatments. This would include tools that (1) help prioritize treatment locations and refine site and species-specific strategies; (2) improve mechanisms to obtain suitable native seed; and (3) determine genetically appropriate plant materials and seed zones in order to maximize restoration success in light of the most reliable short-term (10-30 year) anticipated climate changes. Manipulation of gene flow, which invariably attends restoration, has risks related to the use of non-local genotypes. Potential effects must be clearly defined and disclosed so that restoration managers can make informed choices. Addressing these challenges requires syntheses of research on native species ecology and the development of tools to communicate and apply relevant knowledge. Prioritizing efforts and being responsive to emerging information on past successes and failures will help ensure that native plant communities are resilient and resistant to historical and novel stressors.

OBJECTIVE 3.1: DEVELOP TRAINING PROGRAMS TO EDUCATE PRACTITIONERS AND STAKEHOLDERS ON THE USE OF GENETICALLY APPROPRIATE SEED FOR RESTORATION

Training programs and a certification program that promote and strengthen professional standards in all activities devoted to the use of genetically appropriate seed and ecological restoration should be developed. The training programs will increase the understanding of restoration principles and the certification program will help evaluate the education and professional experience of restoration biologists thus ensuring more successful restorations on public lands.

Action 3.1.1 Develop a training cadre of multi-disciplinary restoration experts and work with external partner(s) to establish a restoration practitioner certification program.

An output of this action will be a list of past and current training courses offered across agencies and restoration partners. Implementers will identify gaps between training offerings and needs. This should lead to resources to support costs of local or regional trainings for field managers.

TARGET DATE(S): 2016-2020
COORDINATING AGENCY(IES): BIA, BLM, FHWA, NIFA, NPS, NRCS,

USFS, USFWS
OTHER PARTICIPANTS: Chicago Botanic Garden, Institute for Applied Ecology, Society for Ecological Restoration
Ecology/Native Seed Network,

Action 3.1.2 Use and, where appropriate, expand network of existing restoration field sites and demonstration areas.

Plan and implement development of one to three demonstration areas per year distributed across ecoregions and provisional seed zones. Work with appropriate partners and available resources to prioritize the work.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BIA, BLM, FHWA, NIFA, NPS, NRCS, USFS, USFWS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden

Action 3.1.3 Develop resources for managers to highlight successful as well as unsuccessful native plant projects, including site visits.

Outputs for this action may include ecoregional, interagency site visits, webinars, trainings, and other activities to inform managers on successful native plant projects. Implementers will consider developing and maintaining a restoration website that is broken up by eco-region and provides one-stop-shopping for links to webinars, contacts, and resources for managers to visit when needed. Existing sites such as http://ser.org/restorations/restorations-list-view or http://www.globalrestorationnetwork.org/ should be reviewed.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BIA, BLM, FHWA, NIFA, NPS, NRCS, USFS, USFWS, USGS
OTHER PARTICIPANTS: Institute for Applied Ecology/Native Seed Network, New York City Parks, Society for Ecological Restoration

OBJECTIVE 3.2: DEVELOP NATIVE SEED SOURCE AVAILABILITY DATA AND TOOLS FOR ACCESSING THE DATA FOR USE BY ALL AGENCIES

To increase the development and use of genetically appropriate seed by federal, tribal and state agencies as well as non-government partners, it will be necessary to develop national/ecoregional data, databases and websites with seed needs and seed availability with provisional or empirical seed zones identified.

Action 3.2.1 Building on local practitioner knowledge and needs, support regional and non-governmental native seed networks that provide seed with provisional and empirical seed zone origin designations.

Outputs for this action will include incorporating provisional and empirical seed zones into national or linked series of regional databases listing commercially available native seed. Information on site of origin (e.g. soil type) will be included. This action includes work with local nonprofits. Examples could include the Native Seed Network database or NatureServe's Biotics database.

TARGET DATE(S): 2016-2020
COORDINATING AGENCY(IES): BLM, NRCS
OTHER PARTICIPANTS: Institute for Applied Ecology/Native Seed Network, NatureServe

Action 3.2.2 Maintain a website with all available seed zone maps and publications, and develop a dynamic web-based, seed selection tool to match seed source with planting site.

Continuously update the USFS Western Wildland Environmental Threat Assessment Center's Seed Zone Mapper website with new publications and maps and publications for provisional and empirical seed zones. Maps will be provided in a variety of formats. Develop web-based tools that match seed lots with planting sites or project areas at regional or national levels.

TARGET DATE(S): 2016-2020
COORDINATING AGENCY(IES): ARS, USFS, USGS
OTHER PARTICIPANTS: Institute for Applied Ecology/Native Seed Network, NatureServe

Action 3.2.3 Work with partners to create a multi-agency and non-federal partner seed inventory system.

This action's output would provide updates of seed availability and a list of commercial growers and nurseries to help identify additional partners to increase native species.

TARGET DATE(S): 2016-2020
COORDINATING AGENCY(IES): BLM, NRCS, USFS/Reforestation, Nurseries and Genetic Resources
OTHER PARTICIPANTS: Institute for Applied Ecology/Native Seed Network, NatureServe

Action 3.2.4 Develop and enhance existing federal interagency agreement and procurement tools to facilitate multi-agency seed acquisition.

This action would encourage collaboration among managers and procurement officials from federal agencies to develop interagency agreements and procurement and agreement tools that would facilitate seed acquisition between agencies. (See also Action 1.2.3.)

TARGET DATE(S): 2016-2018
COORDINATING AGENCY(IES): BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS
OTHER PARTICIPANTS:

OBJECTIVE 3.3: INTEGRATE AND DEVELOP SCIENCE DELIVERY TOOLS TO SUPPORT RESTORATION PROJECT DEVELOPMENT AND IMPLEMENTATION

Ecological restoration is a science with different tools, protocols and species that are dependent upon the ecological region where the restoration is occurring. Standard restoration practices used in the eastern deciduous forest may not work in the desert southwest. Therefore it will be necessary to work on an ecoregional basis in developing guides and techniques for practitioners to use.

Action 3.3.1 Work with federal and state agencies, NGOs and other partners to identify available restoration guides and protocols by ecoregion.

Conduct survey and assessment of ecoregional restoration guides, and identify ecoregional gaps. This action will determine where ecoregional restoration guides exist and which ecoregions need guides. Further, it would lead to revision of outdated guides and preparation of guides needed to fill gaps.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, Institute for Applied Ecology/Native Seed Network, Landscape Conservation Cooperatives, Mid-Atlantic Regional Seed Bank, NatureServe

Action 3.3.2 Write and distribute ecoregional native plant project reports.

Develop a template for ecoregional reports. Then develop native plant project reports using the common format (e.g. Great Basin, Colorado Plateau, Pacific Northwest, Longleaf Pine Project). Reports summarize research accomplishments, findings and needs.

TARGET DATE(S): 2016, then annually
COORDINATING AGENCY(IES): BLM, NPS, NRCS, USFS
OTHER PARTICIPANTS: Chicago Botanic Garden, NGOs

Action 3.3.3 Support field implementation of restoration tools.

Develop “scientist-manager-practitioner” tools, and “grower-to-grower” models of technology transfer along with science delivery through vehicles such as the Joint Fire Science Exchanges. To ensure these newly developed tools are used in the field, support the broad distribution and delivery. These models include federal and non-federal partners.

TARGET DATE(S): 2016-2020
COORDINATING AGENCY(IES): ARS, BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, contractors, land lessees

OBJECTIVE 3.4: BUILD ON ECOLOGICAL ASSESSMENTS AND DISTURBANCE DATA AND PROVIDE TRAINING THAT WILL ALLOW MANAGERS TO ANTICIPATE NEEDS AND BUILD SPATIALLY-EXPLICIT CONTINGENCY STRATEGIES

Managers need to evaluate their restoration project within the context of the larger landscape to determine genetically appropriate plant materials and seed zones to maximize restoration success in light of the most reliable short-term (10-30 year) anticipated climate changes. The ecoregional context must be clearly defined and disclosed so that restoration managers can make informed choices.

Action 3.4.1 Identify and inventory available climate-based geospatial tools to inform decisions regarding restoration site prioritization and methods.

Conduct an inventory and assess applicability of climate-based geospatial tools and provide access via appropriate websites.

TARGET DATE(S): 2015
COORDINATING AGENCY(IES): ARS, BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS, USGS
OTHER PARTICIPANTS: Institute for Applied Ecology/Native Seed Network

Action 3.4.2 Develop a cross-walk of existing agency habitat restoration priorities and tools by provisional seed zone and plant community type.

Outputs would include a list of ongoing and past efforts by agencies that prioritize habitats for restoration and conservation planning and list primary implementation practices and databases that are similar or different across plant communities and agencies. The lists should help managers identify needs and information gaps that could be informed by climate- and soil- based geospatial tools. Geodatabases will be developed that include information on past and current restoration activities to aid in planning future efforts.

TARGET DATE(S): 2015
COORDINATING AGENCY(IES): ARS, BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS, USGS
OTHER PARTICIPANTS: Institute for Applied Ecology/Native Seed Network

Action 3.4.3 Assess soil-water and climate modeling for its ability to predict likelihood of seedling establishment and persistence.

An output would be a tool, linked to the USCA NRCS Web Soil Surveys that relates onsite soil conditions to a prediction of restoration success. We need a suite of tools focused on specific geographic areas or plant communities, such as the resistance and resiliency science and the FIAT process.

TARGET DATE(S): 2016 for testing; 2017 for version 1

1259 COORDINATING AGENCY(IES): NPS, NRCS, USGS
1260 OTHER PARTICIPANTS:
1261
1262

Action 3.4.4 Develop GIS based tools for prioritizing seed needs and projects that incorporate factors such as disturbance and climate change into decisions.

Output would be dynamic tools linked to the USFS Western Wildland Environmental Threat Assessment Center's Seed Zone Mapper website.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, USFS, USGS
OTHER PARTICIPANTS: Chicago Botanic Garden, NatureServe

Action 3.4.5 Use wildfire risk-based assessment tools to help prioritize treatment locations and refine site and species-specific strategies based on wildfire disturbance and severity.

Tools will be developed to aid in analyzing site conditions post-wildfire to determine treatment needs and priorities.

TARGET DATE(S): 2015-2020
COORDINATING AGENCY(IES): ARS, BLM, USFS, USGS
OTHER PARTICIPANTS:

Action 3.4.6 Develop a decision tool of belowground assessment and treatment.

Build on research identified in Goal 2 to better understand belowground drivers and interactions with native plant establishment and competition with non-native species. The tool is intended to minimize the number of potential analyses and site treatments a manager will need to consider. Initiate with literature review in 2015, continue into 2018 as research from Goal 2 develops.

TARGET DATE(S): 2015-2018
COORDINATING AGENCY(IES): NPS, NRCS, USFS, USGS
OTHER PARTICIPANTS:

Action 3.4.7 Develop informational tools and guidelines on the use of appropriate cultivars, hybrids, and non-invasive non-native species in limited circumstances.

This Strategy does not preclude the use of non-native plant materials, in the instances where and when they are appropriate. Although land managers in some agencies may plant non-native species occasionally to achieve site stabilization, wildfire breaks, or invasive plant control, use of non-natives should be limited to transitional, non-invasive species that can be replaced by natives in subsequent ecological restoration or during natural successional processes. Guidance will be developed for species effectiveness under different response scenarios, and issues with ultimate restoration of native species.

TARGET DATE(S): 2016-2020
COORDINATING AGENCY(IES): BLM
OTHER PARTICIPANTS:

GOAL 4: DEVELOP STRATEGIES FOR INTERNAL AND EXTERNAL COMMUNICATION

BACKGROUND/RATIONALE

Successful implementation of the National Seed Strategy will require broad communication and outreach to engage agency staff and stakeholders in the shared goals of the Strategy. Both federal and non-federal partners play an important role in achieving the Strategy's goals. Key to implementation will be the ability to foster progress as a collaborative multi-agency effort. Communications should be tailored to key audiences, including agency partners, collaborators, other stakeholders and interested publics. Each agency will take steps to incorporate actions into their own policies and programs and communicate with their key stakeholders. Each agency will report progress on Strategy implementation to leadership and other participants in the Strategy. An emphasis on feedback, evaluation and improvement of the Strategy will help ensure it remains relevant and responsive to evolving needs. And finally, success stories, lessons learned, and recommendations for improvements should be highlighted in communications products and materials.

OBJECTIVE 4.1: EXTERNAL COMMUNICATIONS: CONDUCT EDUCATION AND OUTREACH THROUGH THE PLANT CONSERVATION ALLIANCE NETWORK

The importance of the National Seed Strategy and the significant role of collaboration in meeting the Strategy's goals should be shared with a broad audience and incorporated into partner communications and materials, as appropriate.

Action 4.1.1 Develop a communications plan, including goals and key messages.

Working together, the agencies and partners should develop and implement a broad communications plan that outlines how the Strategy will be introduced and promoted within and outside of the partner organizations. The communications plan would define communication goals, audiences, and key messages that would influence the development of appropriate communication products or methods. Each agency would then develop an agency-specific communications approach to implement the plan. The agency communication plans might also include as deliverables the training, collaboration, and technology transfer objectives of the other goals in this Strategy (e.g. see Goal 3, in particular, OBJ. 3.1; and actions 3.3.2, 3.3.3).

TARGET DATE(S): 2015
COORDINATING AGENCY(IES): DOI, DOT, USDA, SI
OTHER PARTICIPANTS: PCA Cooperators

Action 4.1.2 Involve the Plant Conservation Alliance in communications for the National Seed Strategy.

Including the National Seed Strategy as a focus of the Plant Conservation Alliance (PCA) annual meetings and adding the Seed Strategy as a standing agenda item on bi-monthly webinar meetings will provide important opportunities to share expertise and highlight key information needs. The PCA website and list are effective vehicles for connecting with collaborating institutions and the public. Efforts should be made to increase participation of agencies and partners currently not yet involved in the PCA. The PCA Seed Strategy Steering Committee is a source of expertise on issues pertaining to using and developing native plant materials and can help identify resources, information and additional expertise as needed. PCA expertise comes from a broad spectrum of botanical, horticultural, agronomic, and species experts.

TARGET DATE(S): Ongoing
COORDINATING AGENCY(IES): DOI, USDA, DOT, SI
OTHER PARTICIPANTS: PCA Cooperators

OBJECTIVE 4.2: INTERNAL COMMUNICATIONS: DISTRIBUTE AND IMPLEMENT THE NATIONAL SEED STRATEGY ACROSS AGENCIES AND PROVIDE FEEDBACK MECHANISMS

Internal communication within the agencies will ensure that appropriate staff members are given opportunities to become fully informed about the Strategy and its relevance to their work. Greater awareness of the Strategy within the agencies will also enhance collaboration and facilitate linkages between the Strategy and related agency initiatives.

Action 4.2.1 Develop internal communications plans.

Federal partners will develop internal communication plans to increase awareness and facilitate implementation of the Strategy. Plans will incorporate the key messages developed in Action 4.1.1, and describe how the Strategy supports the agency mission and national initiatives, such as climate change, invasive species, and pollinator initiatives. Internal communications should consider key programmatic areas that will be contributing to or benefiting from information, training, and products emanating from the Strategy.

TARGET DATE(S): 2015
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS:

Action 4.2.2 Identify and use mechanisms for implementing the National Seed Strategy.

Each agency will coordinate its own implementation plan for the Strategy, as it pertains to agency initiatives and objectives. Outputs may include instruction memoranda, policy directives, native plant policies, information bulletins, and handbooks. Agencies should identify key programmatic and field contacts and networks to assist in implementing the Strategy, and appropriate channels for reporting progress within their agency (to inform Action 4.3.1).

TARGET DATE(S): Ongoing
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS: PCA Cooperators

Action 4.2.3 Identify and collect existing agency native plant policies.

This action aims to collate agency policies and guidance on the use of native plant materials and provide them in a web-based format to make policies and guidance more accessible to Strategy collaborators and other interested parties. Several actions under Goals 1, 2, and 3 of this Strategy may inform this deliverable, such as source-verification and origin requirements (Action 1.1.1), and access and research policies (Action 1.1.2). Content should also be incorporated into the Plant Conservation Alliance (PCA) Federal Member Agency interface pages which link the PCA website to each federal member's website. This action may require assistance from appropriate agency outreach and technical web experts.

TARGET DATE(S): 2015
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS:

Action 4.2.4 Incorporate the National Seed Strategy's goals and key messages into appropriate existing landscape-scale restoration initiatives.

Many ongoing restoration activities encompass the aims of the National Seed Strategy. Incorporating goals and key messages into those relevant initiatives will facilitate collaboration and set the stage for feedback mechanisms to inform the Strategy.

TARGET DATE(S): 2016
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS:

OBJECTIVE 4.3: REPORT PROGRESS, RECOGNIZE ACHIEVEMENTS, AND REVISE STRATEGY

Actions under this objective will encourage two-way communication and feedback, and raise the visibility of restoration efforts that result from actions outlined in the National Seed Strategy. Planning for progress, achievements, and revisions to the Strategy will help ensure that the goals remain relevant.

Action 4.3.1 Establish a mechanism to report on the progress achieved through the National Seed Strategy, including successful native plant projects and lessons learned.

Under this action, Plant Conservation Alliance annual meetings could provide a feedback mechanism for collaborators to report achievements and facilitate production of an annual report to track progress on the Strategy, for use and analysis in 5-year progress measures and future directions. Agencies will have identified appropriate channels for reporting progress within their agency, and data calls might coincide with the end of the fiscal year with a goal of providing

information early the following year, i.e. by Feb. 1. This action relates to action 3.3.2 and efforts should be coordinated.

TARGET DATE(S): 2015
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS:

Action 4.3.2 Recognize and promote achievements made and improvements needed in implementing the National Seed Strategy across all agencies and partners.

This action would promote successes as well as elicit recommendations for improvement and future direction. Recognition is achieved through a number of venues, such as new or existing award programs – potentially through the Plant Conservation Alliance – press events, articles, etc.

TARGET DATE(S): 2016 and beyond
COORDINATING AGENCY(IES): DOI, DOT, USDA
OTHER PARTICIPANTS:

Action 4.3.3 Review and revise the National Seed Strategy every 5 years or as needed.

This action will result in a dynamic Strategy, with actions that evolve and are endorsed by agency leaders through the Plant Conservation Alliance (PCA) Federal Steering Committee. To implement this action, consider prospects for revisions to be made as needed, and also timing and other considerations for revisions when the PCA federal Memorandum of Understanding is renewed.

TARGET DATE(S): Ongoing
COORDINATING AGENCY(IES): DOI, USDA, DOT
OTHER PARTICIPANTS:

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GLOSSARY

The glossary below describes terms referenced in the National Seed Strategy. These terms are defined with the intent of providing clarity for their use in this Strategy. These terms may have been previously described by Federal agencies, professional societies and in scientific literature however the terms below may have been modified to meet the purposes of this document. Sources Include: Aubry et al. (2005), Bower (2014), Havens (2015), Kramer (2015), NFWPCAP (2012), NISC (2006), SER (2004), USDI BLM (2009), U.S. Forest Service (2008)

Adaptation (Adapted)
A change or the process of change in structure or habits by which a species or organism becomes better suited to its environment.

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

Ecological Genetics
The study of how ecologically relevant traits evolve in natural populations.

Ecology
The relationships of organisms to one another and their environments.

Ecological Restoration
See Restoration

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

Ecosystem
The biota (plants, animals, microorganisms) within a given area, the environment that sustains it, and their interactions.

Ecosystem Services
The benefits people and wildlife obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services such as the regulation of climate, floods, disease, wastes, and water quality; cultural services such as recreation, aesthetic enjoyment, identity, and spiritual fulfillment; and supporting services such as soil formation, photosynthesis, and nutrient cycling.

Empirical Seed Zone
Specific knowledge or data available on local adaptation and population differentiation is used to link genetic variation across the landscape with collection location environments. Empirical seed zones are developed through the following steps: germplasm collections are made to represent

diverse geographic and climatic features of the targeted region; plants from collection locations across the region are evaluated in common gardens for production, morphology, phenology, and physiological traits; and then statistical analyses are completed to develop regression models that models are projected and mapped to delineate seed zones for studies species and geographic areas.

Establishment
The stage at which the seedling has exhausted the food reserves stored in the seed and must grow, develop, and persist independently.

***Ex situ* Conservation**
The technique of conserving all levels of biological diversity outside their natural habitats through such means as botanical gardens, zoos or seed banks.

Gene Flow
The transfer of alleles or genes from one population to another.

Genetically Appropriate Plant Materials
Plant materials environmentally adapted to a restoration site that are likely to establish, persist, and promote community and ecological relationships. Such plants would be: sufficiently genetically diverse to respond and adapt to changing climates and environmental conditions; unlikely to cause genetic contamination and undermine local adaptations, community interactions and function of resident native species within the ecosystem; not likely to become invasive and displace other native species; and not likely to be a source of non-native invasive pathogens; likely to maintain critical connections with pollinators.

Genotype
The genetic makeup of a cell, an organism, or an individual. The genetic code of an organism.

Germination
Events beginning with water uptake by a seed and ending with the beginning of elongation of the embryonic axis through the surrounding structures.

Habitat
The dwelling place of an organism or community that provides the requisite conditions for its life processes.

Invasive Species
A species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human, animal or plant health.

Locally Adapted Plants
Plants from an area geographically near a planting site that are environmentally adapted and likely to establish and persist.

Maladaptation
A species that has traits that are poorly suited or adapted to a particular situation or set of conditions.

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

Non-native Species
An organism is considered non-native (alien, foreign, non-indigenous, exotic) when it has been introduced by humans to a location(s) outside its native or natural range. This designation applies to a species introduced from another continent, another ecosystem, another seed zone, and even another habitat within an ecosystem. With respect to a particular ecosystem this includes any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem. This definition of non-native will vary depending on the scope and context of projects and partners.

Protocol
A standardized method containing detailed steps.

Provisional Seed Zone
Provisional seed zones are based on climate data and intended for use with species for which there is no specific knowledge or data available on local adaptation and population differentiation. Provisional seed zones in combination with established ecoregions, can be used to guide movement of plant materials for restoration.

Reciprocal Transplant Studies
Studies using plants from multiple populations of a species that are planted in a set of sites that represent local and non-local climates to test questions of adaptation of the populations to their local environments. Such studies are useful for evaluating the effectiveness of seed transfer guidelines and seed zones. When sites represent extreme environments, these studies have been used effectively to predict how plants will respond to future climate change as climates shift toward new extremes.

Reclamation
Actions to stabilize the terrain, assure public safety, improve aesthetics, and usually to return the land to what, within the regional context, is considered to be a useful purpose. Reclamation projects that are more ecologically based can qualify as rehabilitation or even restoration.

Rehabilitation
Rehabilitation emphasizes the reparation of ecosystem processes, productivity and services, whereas the goals of restoration also include the re-establishment of the pre-existing biotic integrity in terms of species composition and community structure.

Resilience
The degree to which an ecosystem is able to regain structural and functional attributes after it has suffered harm from stress or disturbance.

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

Seed Reserve
A national network of storage facilities for seed that can be used by land managers for restoration projects. Seed reserve will include seeds of pollinator-friendly plants.

Seed Transfer Guidelines
Recommendations for protecting the integrity of the natural pattern of adaptive variation of wild populations by restricting seed transfer to areas within which seed can be moved about freely with the expectation that they will grow and reproduce successfully and will produce no adverse genetic effects.

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

Stabilization
To determine the need for and to prescribe and implement emergency treatments to minimize threats to life or property or to stabilize and prevent unacceptable degradation to natural and cultural resources resulting from the effects of a fire.

Stakeholder
Stakeholders include individuals, organizations, and intergovernmental partners who are involved in or contribute valuable knowledge to and support for implementing the actions outlined in this Strategy, or who may be directly or indirectly impacted by the actions of the Strategy. Those who have an interest in the Strategy's outcome.

Treatment
An action or actions taken to ameliorate or repair ecosystem damage. These activities vary with objectives, but occur along the repair continuum, which includes restoration, rehabilitation, and reclamation.

Workhorse Species
Species that are locally-adapted native plants that are abundant across a wide range of ecological settings, establish quickly, and produce high ground cover on disturbed sites.

APPENDIX: ACTION SUMMARY TABLES

KEY TO ORGANIZATIONS

Name	Acronym
American Seed Trade Association	ASTA
Bureau of Indian Affairs	BIA
Bureau of Land Management	BLM
Chicago Botanic Garden	CBG
Connecticut Department of Energy and Environmental Protection	CTDEEP
Department of the Interior	DOI
Department of Transportation	DOT
Federal Highway Administration	FHWA
Florida Association of Native Nurseries	FANN
Great Basin Research Center	GBRC
Institute for Applied Ecology	IAE
Landscape Conservation Cooperatives	LCC
Mid-Atlantic Regional Seed Bank	MARS-B
National Park Service	NPS
Plant Conservation Alliance	PCA
Non-Governmental Organizations	NGO
Reforestation, Nurseries and Genetic Resources	RNGR
Smithsonian Institution	SI
Society for Ecological Restoration	SER
Seeds of Success	SOS
U.S. Fish and Wildlife Service	USFWS
U.S. Geological Survey	USGS
United Stated Department of Agriculture	USDA
USDA Agricultural Research Service	ARS
USDA Forest Service	USFS
USDA National Institute of Food and Agriculture	NIFA
USDA Natural Resources Conservation Service	NRCS
Utah Department of Natural Resources	Utah DNR

GOAL 1 TABLES

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	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
1.1.1 Conduct a needs and capacity assessment for all agencies and their offices that provide or use seed.	DOI, DOT, USDA	CTDEEP	2015-2016
1.1.2 Identify and inventory agency seed collections, production and storage capacities and needs.	DOI, DOT, USDA	CTDEEP	2015-2016
1.1.3 Identify existing federal seed and restoration policies.	DOI, DOT, USDA	To be determined	2015-2020
1.1.4 Analyze results of needs and capacity assessment to determine if current federal policies, seed collections, and storage and production facilities meet agencies' needs.	DOI, DOT, USDA	IAE/Native Seed Network	2016-2017
Action 1.1.5 Analyze results and develop restoration program.	DOI, DOT, USDA	To be determined	2017-2018

Objective 1.2: Assess Capacity and Needs of Tribes, States, Private Sector Seed Producers, Nurseries, and Other Partners

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
1.2.1 Conduct a needs and capacity assessment of tribal, state, local, private, and non-profit seed storage and distribution facilities.	BIA, NRCS	ASTA, FANN, MARS-B	2015-2020
1.2.2 Work with partners to leverage strengths and address deficiencies in distribution and availability of genetically appropriate seed.	DOI, DOT, USDA	ASTA, FANN, IAE/Native Seed Network, MARS-B, NatureServe/ Natural Heritage Network	2015-2020
1.2.3 Analyze results of needs and capacity assessment.	DOI, DOT, USDA	IAE/Native Seed Network	2016-2017

Objective 1.3: Increase the Supply and Reliable Availability of Genetically Appropriate Seed

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
1.3.1 Expand and improve facilities and plant production capacity (based on capacity and needs assessments).	ARS, BIA, BLM, NPS, NRCS, USFS, USFWS	ASTA, CBG, FANN	2015-2020
1.3.2 Improve ability to plan for seed needs and use common seed zones.	BIA, BLM, NPS, ARS, NRCS, USFS, USFWS	CBG, FANN, MARS-B	2015-2020
1.3.3 Research and implement alternative seed production methods for 'workhorse' shrub/forb species.	BLM, NPS, USFS, USFWS	CBG	2015-2020
1.3.4 Expand collection, conservation, and assessment of native plant genetic resources through programs such as SOS.	ARS, BLM, NPS, NRCS, SI, USFS, USFWS	CBG	2015-2020
1.3.5 Engage federal procurement specialists to assess contracting regulations and practices; correct deficiencies.	BLM, NPS, NRCS, USFS, USFWS	ASTA, FANN, IAE/Native Seed Network, MARS-B	2015-2017

GOAL 2 TABLES

Identify Research Needs and Conduct Research to Provide Genetically Appropriate Seed and Improve Technology for Native Seed Production and Ecosystem Restoration

Objective 2.1: Characterize Genetic Variation for Restoration Species to Delineate Seed Zones and Provide Seed Transfer Guidelines for Current and Projected Environmental Conditions

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
2.1.1 Research to develop seed zones.	ARS, BLM, NIFA, NRCS/Plant Materials Centers, USFS, USGS	CBG, GBRC, IAE, MARS-B, NatureServe, Utah DNR, universities	2015-2020
2.1.2 Develop predictive models of climate change effects.	ARS, NIFA, USFS, USGS	CBG, IAE, NatureServe, universities	2016-2020

Objective 2.2: Conduct Species-specific Research to Provide Seed Technology, Storage and Seed Production Protocols for Restoration Species

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
2.2.1 Conduct seed germination studies and develop seed testing protocols for key restoration species.	ARS, BLM, NIFA, USFS, USGS	CBG, GBRC, IAE, private seed testing labs and seed companies, state seed laboratories, universities	2015-2020
2.2.2 Storage guidelines for key restoration species.	ARS, BLM, NIFA, USFS, USGS	CBG, GBRC, private seed testing labs and seed companies, state seed laboratories, universities, Utah DNR	2015-2020
2.2.3 Develop species-specific protocols for seed and seedling production.	ARS, BLM, NIFA, NRCS, USFS, USGS	CBG, GBRC, IAE, public and private seed producers and nurseries, state agencies, universities	2015-2020

Objective 2.3: Conduct Research on Plant Establishment, Species Interactions, and Ecological Restoration

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
2.3.1 Develop site preparation and seeding and transplanting strategies that improve plant establishment and community diversity.	ARS, BLM, NIFA, USFS, USGS	CBG, GBRC, IAE, universities	2015-2020
2.3.2 Within seed zones, examine capacity of native plants to establish and persist.	ARS, BLM, NIFA, USFS, USGS	CBG, GBRC, IAE, universities	2015-2020
2.3.3 Develop techniques to successfully replace exotic monocultures with a diversity of native species.	ARS, BLM, NIFA, NPS, USFS, USGS	CBG, GBRC, IAE, universities	2015-2020
2.3.4 Assess soil degradation and develop treatments, soil amendments and other site preparation techniques.	ARS, BLM, NIFA, NPS, USFS, USGS	CBG, GBRC, IAE, NatureServe, universities	2015-2018

Objective 2.4: Develop or Modify Monitoring Techniques and Investigate Long-term Restoration Impacts and Outcomes

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
2.4.1 Evaluate monitoring methodologies to evaluate restoration outcomes.	ARS, BLM, NIFA, NRCS, USFS, USGS	CBG, FANN, GBRC, IAE, universities	2015-2020
2.4.2 Quantify ecological and economic costs/benefits of native and non-native plants on public lands.	ARS, BLM, DOI, NIFA, NPS, NRCS, USFS, USGS	CBG, FANN, IAE, universities	2016-2017
2.4.3 Study selected native plant restoration projects to evaluate short-and-long term responses.	ARS, BLM, NIFA, NPS, NRCS, USFS, USGS	CBG, FANN, GBRC, IAE, universities	2015-2020

GOAL 3 TABLES

Develop Tools that Enable Managers to Make Timely, Informed Seeding Decisions for Ecological Restoration

Objective 3.1: Develop Training Programs to Educate Practitioners and Stakeholders on the Use of Genetically Appropriate Seed for Restoration

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
3.1.1 Develop a cadre of experts and work with partner(s) to establish a restoration certification program.	BIA, BLM, FHWA, NIFA, NPS, NRCS, USFS, USFWS	CBG, IAE/Native Seed Network, SER	2016-2020
3.1.2 Use and, where appropriate, expand network of restoration field sites and demonstration areas.	ARS, BIA, BLM, FHWA, NIFA, NPS, NRCS, USFS, USFWS, USGS	CBG	2015-2020
3.1.3 Develop resources for managers to highlight successful/unsuccessful programs, including site visits.	ARS, BIA, BLM, FHWA, NIFA, NPS, NRCS, USFS, USFWS, USGS	IAE/Native Seed Network, New York City Parks, SER	2015-2020

Objective 3.2: Develop Native Seed Source Availability Data and Tools for Accessing the Data for Use by All Agencies

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
3.2.1 Building on local knowledge and needs, support regional /non-governmental native seed networks that provide seed with seed zone origin.	BLM, NRCS	IAE/Native Seed Network, NatureServe	2016-2020
3.2.2 Maintain website with seed zone maps and publications, develop web-based, seed selection tool to match seed source/planting site.	ARS, USFS, USGS	IAE/Native Seed Network, NatureServe	2016-2020
3.2.3 Create a multi-agency and non-federal partner seed inventory system.	BLM, NRCS, USFS/RNGR	IAE/Native Seed Network, NatureServe	2016-2020
3.2.4 Develop/enhance federal agreement/procurement tools for multi-agency seed acquisition.	BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS	To be determined	2016-2018

Objective 3.3: Integrate and Develop Science Delivery Tools to Support Restoration Project Development and Implementation

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
3.3.1 Work with federal and state agencies, NGOs and other partners to identify available restoration guides and protocols by ecoregion.	ARS, BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS, USGS	CBG, IAE/Native Seed Network, LCC, MARS-B, NatureServe	2015-2020
3.3.2 Write and distribute ecoregional native plant project reports.	BLM, NPS, NRCS, USFS	CBG, NGO	2016 and after
3.3.3 Support field implementation of restoration tools.	ARS, BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS, USGS	CBG, contractors, land lessees	2016-2020

Objective 3.4: Build on Ecological Assessments and Disturbance Data and Provide Training that will Allow Managers to Anticipate Needs and Build Spatially-explicit Contingency Strategies

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
3.4.1 Identify/inventory climate-based geospatial tools to inform decisions on restoration site priority /methods.	ARS, BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS, USGS	IAE/Native Seed Network	2015

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
3.4.2 Develop cross-walk of agency habitat restoration priorities/tools by provisional seed zone and plant community type.	ARS, BIA, BLM, FHWA, NPS, NRCS, USFS, USFWS, USGS	IAE/Native Seed Network	2015
3.4.3 Assess soil-water and climate modeling to predict likelihood of seedling establishment and persistence.	NPS, NRCS, USGS	To be determined	2016 for testing; 2017 for version 1
3.4.4 Develop GIS based tools for prioritizing seed needs/projects that incorporates disturbance, climate change, etc. into decisions	ARS, BLM, USFS, USGS	CBG, NatureServe	2015-2020
3.4.5 Use risk-based assessment tools to prioritize treatment locations and refine strategies based on wildfire disturbance/severity.	ARS, BLM, USFS, USGS	To be determined	2015-2020
3.4.6 Develop a decision tool of belowground assessment and treatment.	NPS, NRCS, USFS, USGS	To be determined	2015-2018
Action 3.4.7 Develop informational tools and guidelines on use of appropriate cultivars, hybrids, and non-invasive non-native species.	BLM	To be determined	2016-2020

GOAL 4 TABLES

Develop strategies for internal and external communication

Objective 4.1: External Communications: Conduct Education and Outreach through the Plant Conservation Alliance Network

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
4.1.1 Develop a communications plan, including goals and key messages.	DOI, DOT, USDA, SI	PCA Cooperators	2015
4.1.2 Involve the Plant Conservation Alliance CA in communication of the National Seed Strategy.	DOI, USDA, DOT, SI	PCA Cooperators	Ongoing

Objective 4.2: Internal Communications: Distribute and Implement the National Seed Strategy Across Agencies and Provide Feedback Mechanisms

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
4.2.1 Develop internal communications plans.	DOI, DOT, USDA	To be determined	2015
4.2.2 Identify and use mechanisms for implementing the Strategy.	DOI, DOT, USDA	PCA Cooperators	Ongoing
4.2.3 Identify and provide existing agency native plant policies.	DOI, DOT, USDA	To be determined	2015
4.2.4 Incorporate the Strategy goals and key messages into landscape-scale restoration initiatives.	DOI, DOT, USDA	To be determined	2016

Objective 4.3: Report Progress, Recognize Achievements, and Revise Strategy

ACTION	COORDINATING AGENCY(IES)	OTHER PARTICIPANTS	TARGET DATE(S)
4.3.1 Establish mechanism to report progress, successful native plant projects and lessons learned. (See 3.3.2)	DOI, DOT, USDA	To be determined	2015
4.3.2 Recognize/promote achievements/needed improvements across all agencies and partners.	DOI, DOT, USDA	To be determined	2016 and beyond
4.3.3. Review and revise the Strategy every 5 years or as needed.	DOI, DOT, USDA	To be determined	Ongoing