
**TECHNICAL REPORT
UCED 2018/19-00**

**RECOMMENDATIONS FOR INCREASING THE SUPPLY AND
LOWERING THE COST OF NATIVE PLANT MATERIALS IN
NEVADA THROUGH STRATEGIC SUPPORT OF THE NATIVE
PLANT MATERIALS INDUSTRY**



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This report was funded by the U.S. Fish and Wildlife Service as part of the “Great Basin Cooperative Ecosystem Studies Unit (GBCESU): Research to Enhance Restoration of Greater Sage-Grouse Habitat through Improved Production and Establishment of Critical Native Plant Species” project at the University of Nevada, Reno.

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Executive Summary

This report provides policy recommendations for supporting the development of the native plant material (NPM) industry in Nevada with the goal of increasing the supply and lowering the cost of NPMs for use in rangeland restoration projects.

These recommendations—which are based on stakeholder interviews, analyses of available data, and a review of existing literature—fall into three categories:

1. ***Policies Influencing Demand*** – State and Federal agencies can help to stabilize the demand for NPM in Nevada by: 1. Developing seed menus to align land managers’ NPM purchases across jurisdictions; 2. Documenting the contribution of NPM to restoration project outcomes; 3. Increasing land manager outreach in the use of locally-adapted NPM and appropriate restoration technologies; and 4. Increasing partnerships with non-governmental organizations to fund NPM use in restoration projects on public land in Nevada.
2. ***Policies Supporting Supply*** – State and Federal agencies can support the supply of NPM in Nevada by 1. Empowering a single state agency to coordinate NPM procurement for all state projects, which should facilitate relationships between growers, land managers, and researchers; 2. Expanding the use of public-private risk-sharing contracts to increase the supply of NPM produced under cultivation; 3. Creating a foundation seed bank to provide growers with a reliable source of foundation seed for seed increases; and 4. Streamlining wildland collection permitting processes.
3. ***Policies Providing General Industry Support*** – State and Federal agencies and non-governmental organizations can support the NPM industry in Nevada by 1. Expanding State, Federal, and University of Nevada, Reno, plant materials development activities to increase the number of released NPM species that are locally adapted for Nevada; 2. Increasing grower outreach and technical assistance; 3. Standardizing data collection to develop forecasts of anticipated NPM needs; and 4. Expanding public warehouse capacity, including refrigerated storage.

This report also includes:

- A comprehensive list of NPM users in Nevada
- A description of the current capacity to produce NPM in Nevada
- A description of the network of Federal, State, and non-governmental entities that currently support the NPM industry in Nevada
- A detailed analysis of NPM use by the Bureau of Land Management in Nevada
- A comprehensive list of challenges to producing NPM under cultivation
- A framework to identify what additional policies are required to support a stable supply of specific NPMs given their risk profiles

Table of Contents

1	Introduction.....	5
1.1	Why Does Nevada Need a Native Plant Materials Industry?	6
1.2	Why Does the Native Plant Materials Industry Need Support?.....	6
1.3	Why Focus on Native Plant Materials Produce under Cultivation?	7
1.4	Limit to the Scope of this Report: National-Level Policy	8
2	Native Plant Materials Network in Nevada.....	9
2.1	Demand for Native Plant Materials in Nevada.....	10
2.2	Supply of Native Plant Materials in Nevada	12
2.3	Support for Native Plant Materials Industry in Nevada	14
3	BLM Native Plant Materials Use in Nevada.....	16
3.1	BLM Native Plant Material Data.....	16
3.2	BLM Native Plant Material Use by Year and Field Office	17
3.3	BLM Native Plant Material Use by Species.....	19
3.4	Native Plant Material Prices	24
4	Challenges to Growing Native Plant Materials.....	26
5	Native Plant Materials Risk Matrix.....	28
5.1	Selecting Policy Given Market and Production Risk.....	29
5.2	Pay-for-Performance Contracting	32
6	Policy Recommendations	33
6.1	Stabilize Demand for Native Plant Materials	36
6.2	Increase Supply of Native Plant Material	37
6.3	Support the Native Plant Materials Industry.....	38
	References.....	40
A.	Appendix: Acronyms	41
B.	Appendix: List of Interviews.....	42

1 Introduction

Native plants and seeds (hereafter referred to as Native Plant Materials, or NPMs) are favored by many Federal, State, and private land managers in Nevada. Selecting appropriate NPMs for restoration, rehabilitation, and/or reclamation (hereafter referred to as restoration) projects can improve the survival rates of plants and, in turn, improve the likelihood that projects will be successful at restoring desired ecological function. More and more, empirical research shows the superiority of applying locally-adapted or genetically-appropriate NPMs over non-native alternatives in restoration projects, especially in the harsh, semi-arid rangeland environments of Nevada (Kulpa et al. 2012; Leger and Baughman 2015). The availability and cost of locally-adapted NPMs, however, are persistent obstacles to their widespread use. This report provides policy recommendations for increasing the supply and lowering the cost of locally-adapted NPMs in Nevada and for supporting the growth of an NPM industry in Nevada.

The policy recommendations in this report are based on an analysis of the NPM industry in Nevada, as well as the experiences of NPM industries in other states in the intermountain West. Project researchers reviewed the available literature, conducted interviews with public and private participants in the NPM industry, and analyzed the available data on NPM use in Nevada. Appendix B includes a list of interviews conducted in the process of writing this report.

The body of this report provides context for the policy recommendations contained in the final section of the report (Section 6). Section 2 describes the existing network of Federal and State agencies, universities, private-sector producers, and non-governmental organizations that comprise the NPM industry in Nevada. The policy recommendations in Section 6 focus on how this network can be strengthened through a combination of policy changes and strategic hires in key positions.

Section 3 provides a detailed analysis of NPM use by the Bureau of Land Management (BLM) in restoration projects in Nevada from 2005 to 2013. Analysis of the BLM data reveals several insights: that BLM demand for NPM in Nevada varied significantly from year to year in the time period studied, that post-fire restoration projects account for the large majority of BLM's NPM use, and that, while the BLM primarily purchased species native to Nevada, ecotypes of these species that were locally-adapted for Nevada were rarely used.

Section 4 catalogues the production challenges facing NPM growers. These production challenges increase the costs and production risk (variability in yields) associated with producing a given species under cultivation, and are a major reason why the NPM industry needs public support to supply many desired species.

Building on the analysis in Section 4, Section 5 develops a framework to identify what additional policies are required to support a stable supply of specific NPMs on the commercial market given their production and market risk (variability in price). This framework informs our policy recommendations to enhance public-private risk-sharing in Section 6.

1.1 Why Does Nevada Need a Native Plant Materials Industry?

A reasonable starting point for this report is the question: Why does Nevada need a more robust NPM industry? After all, the majority of the NPMs currently used in restoration projects in Nevada are produced out-of-state. The answer to this question has to do with the nature of NPM supply-chain and the premium it puts on communication between producers and land managers. The demand for most varieties of NPMs for restoration projects in any year is small, and seed increases must be planned years in advance. As a consequence, NPM producers rely on their customers for guidance on their planting and wildland collection decisions. For land managers in Nevada to ensure a stable supply of desired species, they must coordinate with producers so that they can effectively communicate their NPM needs. The coordination cost between land managers and producers is minimized by repeat interactions facilitate by geographic proximity.

1.2 Why Does the Native Plant Materials Industry Need Support?

The premise of this report is that the commercial market for NPMs needs support from Federal, State, and non-governmental partners to provide the range of NPMs desired by land managers for restoration projects in Nevada. This premise, however, raises the question: If NPMs improve the likelihood of achieving restoration goals, why hasn't demand for NPMs from land managers oriented the private-market to supply desired species in sufficient quantities? There are, in fact, several reasons why the NPM industry needs support to supply many desired species:

1. *Budget Constraints for Public Land Manager* – The demand for NPMs for restoration projects in Nevada is primarily from the public sector land managers. However, public land managers face several constraints that prevent them from using desired NPMs in restoration projects and, therefore, from using their purchasing power to direct the commercial market towards producing desired NPMs. Foremost among these constraints is the mismatch between the budget for NPMs and the number of acres requiring restoration, particularly in large wildfire years.
2. *Uncertain Role of NPMs in Restoration Outcomes* – Information about the relative performance of different NPMs on restoration outcomes is difficult to obtain. There is a lack of systematic monitoring of restoration outcomes necessary to show correlations between land managers' choice of NPMs and restoration success. Given this information problem, land manager may not demand certain NPMs even if their use could significantly improve restoration outcomes. Or, they may demand NPM without the capacity to be specific enough about their needs to ensure probable success. For this reason, enhanced monitoring of restoration outcomes together with land manager outreach is needed to help land managers select NPMs that give their restoration projects the greatest chance of being successful at restoring desired ecological function.
3. *Variability in Agronomic Performance* – While the long-run incentives of the NPM industry as a whole is to provide NPMs that are successful in restoration projects, incentives for individual growers will lead them to prioritize the production of species with known agronomy that produce consistent yields under cultivation. For species of

unknown agronomic performance or highly variable yields, additional coordination between land managers and growers to mitigate production risk, often in the form of risk-sharing contracts, is required to make the species commercially available. Absent this coordination, growers will focus on NPMs with established agronomic best-practices and predictable yields, and many desired species will not be commercially available.

4. *Variability in Demand* – Relative to other agricultural products, NPMs are characterized by geographically-segmented markets and high inter-annual variation in demand. As is the case with agronomic performance, the uncertainty in the demand for many NPMs means that active coordination between the land managers and producers to mitigate market risk, often in the form of risk-sharing contracts, is required to make the species commercially available. Absent this coordination, growers will focus on NPMs with large and consistent market and many desired species will not be commercially available.

1.3 Why Focus on Native Plant Materials Produced under Cultivation?

The majority of the policy recommendations in this report focus on increasing the supply of NPM produced under cultivation for use in restoration projects in Nevada. We focus on NPMs produced under cultivation for three reasons:

1. *Wildfire* – The most significant NPMs challenge facing Nevada – and the western United States more broadly – is ensuring the supply of the large quantities of NPMs needed for restoration projects in big wildfire years. Supplying these large quantities of NPMs requires that most desired species be produced under cultivation. In California, State standards dictate that NPMs used in State restoration projects be local ecotypes from within a specified distance of the project site. A similar approach is often used by pipeline companies and utilities when restoring utility corridors. While this model works for proactive projects of modest size, it is not capable of providing the vast quantities of NPM necessary to rehabilitate hundreds of thousands of acres in large wildfire seasons.

2. *Lower Cost* – NPMs will only be produced under cultivation if doing so entails a lower average cost of production than obtaining the species through wildland collection. Lower average cost, however, is not a sufficient condition for a species to be produced under cultivation. It may be that risk associated with a particular species that makes wildland collection a more attractive option despite the cost advantages of cultivation. This means if policies to mitigate grower risk lead to additional species being produced under cultivation, they will also lower the average cost of production for these species.

3. *Policy Complexity* – The policy recommendations to support wildland collection apply broadly to all NPMs. In contrast, the policy required to support a particular species produced under cultivation depends on the risk profile associated with that species. The analysis in Section 5 provides a framework to identify the appropriate species-specific policy.

1.4 Limit to the Scope of this Report: National-Level Policy

This report provides policy recommendations for what can be accomplished in Nevada taking national-level policy as given. This is not to say that national-level policy is unimportant. Two BLM policies, in particular, are important to the development of the NPM industry in Nevada. First, the BLM's tri-annual consolidated seed buys reduce its NPMs procurement costs and provide stability to the NPMs market through regular, inventory purchases of frequently used species/ecotypes. However, minimizing procurement costs can reduce the incentives for new entrants due to lower profit opportunities, as well as reduce the need for local BLM offices to develop relationships with local growers necessary to bring new NPMs to market.

Second, the BLM uses Indefinite Delivery, Indefinite Quantity (IDIQ) contracts with growers to perform seed increases. IDIQs assure growers a pre-determined price for their product, as well as a minimum payment that is independent of quantity delivered. Increasing the number of growers entering into IDIQ contracts could be an important means of supporting the NPM industry in Nevada.

In addition to national-level BLM policy, this report does not discuss how the *Farm Bill* programs could potentially be used to support NPMs growers in Nevada. Programs of potential interest to NPM growers include the Farm Service Agency (FSA) administered *Farm Loan Program*, which could provide subsidized loans to NPM growers, and *Noninsured Crop Disaster Assistance Program*, which provides financial assistance to loss of non-insurable crops (a category that includes NPM) due to natural disasters. This report does discuss how three USDA agencies – the Natural Resources Conservation Service (NRCS), Agricultural Research Service (ARS), and United States Forest Service (USFS) – currently work to support the NPM industry in Nevada.

2 Native Plant Materials Network in Nevada

This section describes the existing network of Federal and State agencies, universities, private-sector producers, and non-governmental organizations (NGOs) that comprise the NPM industry in Nevada. The policy recommendations in Section 6 focus on how this network can be strengthened through a combination of policy changes and strategic hires to meet the interrelated goals of supporting the NPM industry in Nevada and increasing the supply and lowering the cost of NPM available for restoration projects in Nevada.

Figure 1 describes the public and private-sector entities that comprise the NPM network in Nevada in terms of three functions: 1. *Demand* – Public and private-sector purchasers of NPMs for use in restoration projects; 2. *Supply* – Public and private-sector entities involved in the supply of NPMs through wildland collection and seed increases; 3. *Support* – Public sector and non-governmental agencies that support the supply of NPMs and/or their appropriate use in restoration projects.

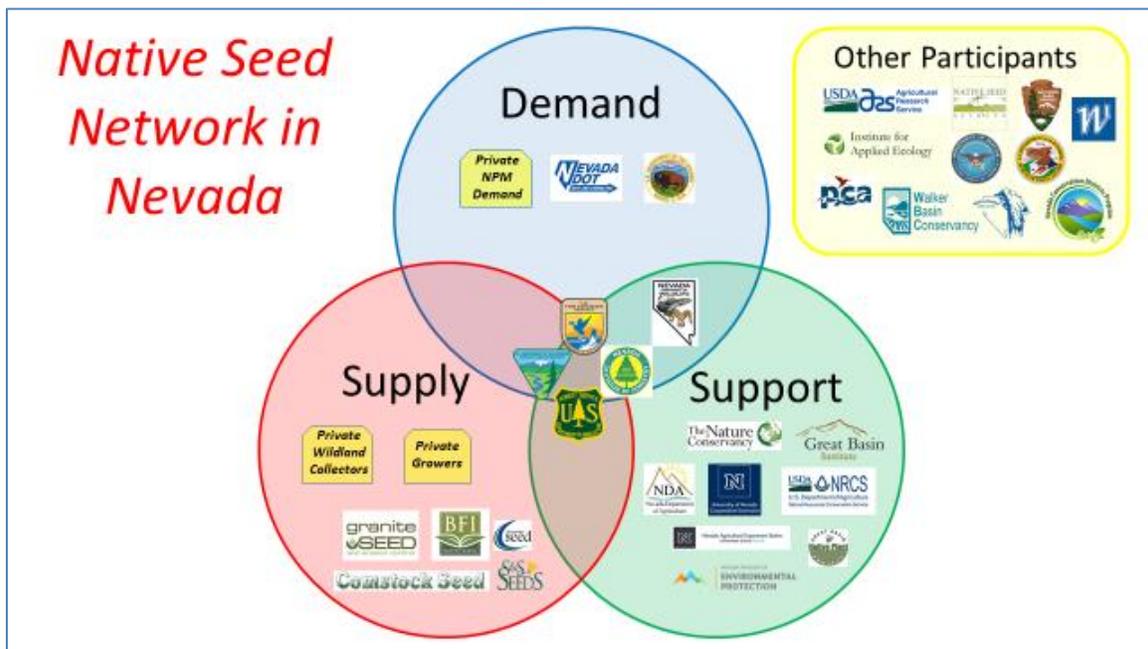


Figure 1. Native Seed Network in Nevada in terms of three functions: 1. *Demand* – Public and private-sector purchasers of NPMs for use in restoration projects (State: NDOT, NDOW, NDF; Federal: BLM, BIA, NPS, USFS, USFWS; Private Sector); 2. *Supply* – Public and private-sector entities involved in the supply of NPMs through wildland collection and/or seed increases (State: NDF; Federal: BLM, FWS, USFS; Private Sector); 3. *Support* – Public sector and non-governmental agencies that support the supply of NPMs and/or their appropriate use in restoration projects (State: NDF, NDA, NDEP; Federal: BLM, FWS, USFS, NRCS; NGO: TNC, UNR, GBI, GBNPP). See Appendix A for a list of acronyms used in this report.

2.1 Demand for Native Plant Materials in Nevada

This section describes the Federal, State, private sector, and NGOs currently using NPMs in restoration projects in Nevada, as well as Federal and State agencies in a position to set policy to influence the demand for NPM. In order to understand NPM use in restoration, project researchers met with all public agencies in Nevada that use NPMs in restoration projects. This effort included contacting the BLM (Patricia Roller), NRCS (Bill Elder), Nevada Department of Wildlife (Lee Turner), Nevada Department of Transportation (Seth Johnson), and the FWS - Sheldon Hart Antelope Refuge (John Kasbohm and Kevin Goldie).

1. *Federal Agencies Demand*

- a. Bureau of Land Management (BLM)
 - i. The BLM is the largest user of NPM for restoration projects in Nevada. Section 3 provides a detailed analysis of NPM use by the BLM in Nevada from 2005-2013.
- b. U.S. Fish and Wildlife Service (FWS)
 - i. FWS demand NPM for restoration projects on FWS managed land in Nevada. FWS projects requiring NPMs are concentrated at National Wildlife Refuges and on private lands, through the Partners for Fish and Wildlife Program.
 - ii. FWS has a formal, regulatory role in reviewing and approving seed mixes for restoration projects on public land in Nevada when an Environmental Impact Statement (EIS) is in effect. When an EIS is not in place, FWS role in reviewing seed mixes for restoration projects is advisory.
- c. U.S. Forest Service (USFS)
 - i. USFS uses NPM in restoration projects on USFS managed land in Nevada.
- d. Other Federal Agencies
 - i. Department of the Interior (DOI) both develops and purchases NPM for restoration projects in Great Basin National Park, through the National Parks Service (NPS), and on Bureau of Indian Affairs (BIA) managed land in Nevada.
 - ii. National Interagency Fire Center (NIFC) has the potential to play a significant role in setting NPM guidelines for Emergency Stabilization and Rehabilitation (ERS) seed specifications.
 - iii. U.S. Department of Defense (DOD) manages a considerable amount of the public land in Nevada and could potentially be an important source of demand for NPM.

2. *State Agencies Demand*

- a. Nevada Division of Wildlife (NDOW)
 - i. NDOW funds several proactive restoration projects requiring NPM every year in Nevada, as well as funds the inclusion of additional species in seed mixes used by BLM and USFS in their restoration projects.
- b. Nevada Department of Transportation (NDOT)

- i. NDOT is a significant user of NPM in Nevada. NDOT hires private contractors to perform restoration work. These contractors purchase NPMs from the commercial market. Information on purchased NPMs (weed free, purity, germination) is then sent to NDA to be examined and verified.
- c. Bureau of Mining Regulation and Reclamation (BMRR)
 - i. Nevada Division of Environmental Protection (NDEP), Bureau of Mining Regulation and Reclamation (BMRR) works with the BLM to develop seed mixes for bonded mining reclamation projects in Nevada.
- d. Nevada Division of Forestry (NDF)
 - i. NDF uses NPM in restoration projects throughout Nevada, as well as procures seed for NDOW and other State agencies.
- e. Nevada State Parks (NSP)
 - i. NSP use NPM in restoration projects in State Parks in Nevada.

3. *Private-sector Demand*

- a. Private with USDA Natural Resources Conservation Service (NRCS) Assistance
 - i. NRCS supports the use of NPM in restoration project on private land by providing cost-sharing through the Environmental Quality Incentives Program (EQIP). From 2005-2014, NRCS provided cost-sharing through EQIP for the purchase of NPM use on 98 projects in Nevada.
- b. Private without NRCS Assistance
 - i. Private land owners can either purchase NPMs on the commercial market or harvest wildland seed for use in restoration projects on their own property.
- c. Mining Reclamation/Mitigation
 - i. BLM is responsible for regulating reclamation activities on Federal lands that have been disturbed during the extraction and transport of energy and other mining resources. Prominent mining companies involved in these projects include Newmont Mining Corporation and Barrick Gold Corporation. See above for the BMRR's role in developing seed mixes for bonded mining reclamation projects.

4. *Non-Governmental Organizations Demand*

- a. The Nature Conservancy (TNC)
 - i. TNC funds restoration projects throughout Nevada. For example, from 2008-2017, TNC spent \$141,726 on wildland collected NPMs purchased through Comstock Seed for use on their Truckee River project.

2.2 Supply of Native Plant Materials in Nevada

This section describes the Federal, State, private sector, and NGOs currently involved in supplying NPMs for restoration projects in Nevada, as well as Federal and State agencies in a position to set policy to influence the supply of NPM in Nevada. In order to understand the current and potential supply of NPM in Nevada, project researchers met with personnel from the *Plant Industry* program at the Nevada Department of Agriculture (Meghan Brown and Russell Wilhelm), University of Nevada Cooperative Extension (Jay Davidson), and private-sector NPM suppliers (Ed Kliener, Comstock Seed; Rick McClintick, private grower in Oravada, Nevada; Josh Buck, Granite Seed), as well as prospective NPM producers through the Native Seed Forums in Winnemucca in March 2017 and Ely in May 2018.

1. Nevada Native Seed Partnership (NNSP)

- a. NNSP includes Federal (BLM, FWS, USFS, NRCS-PMC), State (NDA, NDOW, NDF, and Nevada Conservation Districts), and non-governmental partners (The Nature Conservancy, Great Basin Institute, UNR, Walker Basin Conservancy, Reno-Sparks Indian Colony,) who meet monthly to coordinate NPM activities. This coordination includes sharing information about wildland collection efforts, as well as well as working with private growers to perform seed increases.

2. Federal Agencies Supply

- a. Bureau of Land Management (BLM)
 - i. The BLM supports wildland collection through the *Seeds of Success* program and by issuing wildland collection permits through its five Great Basin field offices in Nevada (Battle Mountain, Carson City, Elko, Ely, and Winnemucca). The BLM also performs seed increases private growers, often through IDIQ contracts.
- b. U.S. Fish and Wildlife Service (FWS)
 - i. FWS supports wildland collection and seed increases through leadership and participation in the NNSP and support of the *Seeds of Success* program
- c. U.S. Forest Service (USFS)
 - i. USFS supports wildland collection and seed increases through participation in the NNSP and support of the *Seeds of Success* program. The USFS currently only issues wildland collection permits for research purposes in Nevada.

3. State Agencies Supply

- a. Nevada Division of Forestry (NDF)
 - i. NDF coordinates a large wildland collection effort and performs seed increases at its Washoe Nursery. NDF provides NPM on a cost-recovery basis for use in public and private restoration projects in Nevada. NDF stabilizes private-sector demand through contracting with private growers and inventory purchases stored either with growers or in a NDF managed warehouse facility. NDF coordinates wildland collection efforts with NNSP partners.

4. Private-sector Supply

- a. Wildland Collection
 - i. Wildland seed collection is done by a handful of private companies in Nevada, with Comstock Seed, based in Minden, Nevada and Granite Seed and Erosion Control, based in Lehi, Utah being the largest players.
- b. Private Growers: Out-of-State
 - i. The vast majority of NPM grown under cultivation that are used in restoration projects in Nevada are grown out-of-state. Major growers include Granite seed, Clearwater seed, and BFI natives.
- c. Private Growers: In-State
 - i. NDA has on-going relationships with several private growers in Nevada. Further, several growers talked with project researcher about their interest in entering (re-entering) native seed production included Rick McClintick (McClintick Farms, Inc.) and Dan Hettrick (Hettrick Bros. Inc.), both of Orovada, Nevada, Jerry Annis from Battle Mountain, Nevada (ranch located in Buffalo Valley), and Bevan Lister, from Pioche, Nevada.
 - ii. Jason “Jay” Davison, also with Nevada Cooperative Extension, was involved in recruiting growers of native seeds in the 2003-2004 time period. Jay indicated that he could easily find a number of growers who would be interested if the price fluctuations that caused the prior growers to drop out of native seed production were mitigated.
- d. Current Commercial Seed Industry
 - i. The most likely Nevada entrants to NPMs produced under cultivation are growers who have been in the grass seed industry. These growers have already made investments in much of the required equipment for planting, irrigating, harvesting and cleaning seed, and they understand the basics of growing and harvesting seed. The Nevada Department of Agriculture (NDA) documents certified alfalfa producers in the State. NDA currently has a list of 16 alfalfa seed producers in Nevada. The 2013 *USDA Census of Agriculture* reports that in 2013 there are 15 seed growers in Nevada, with 4,361 irrigated acres in production and 3,409,526 lbs produced. The 2007 *Census of Agriculture* reported 19 growers in Nevada, with 6,498 irrigated acres in production, and 4,237,101 lbs produced.

5. Non-Governmental Organization Supply

- a. Walker Basin Conservancy
 - i. Developing a plant materials production capability for plugs and seeds.
- b. Great Basin Institute
 - i. Supports *Seeds of Success* collections throughout Nevada.
- c. Native American Tribes
 - i. George “Buddy” Borden, with UNCE, indicated that the Duckwater Shoshone Tribe is interested in wildland collecting/growing NPM.
 - ii. Several representatives from the Yomba Shoshone Tribe attended the Native Seed Forum in Winnemucca, Nevada in March 2017.
 - iii. Reno-Sparks Indian Colony. Exploring the economic feasibility of developing a native plant nursery for Tribal members.

2.3 Support for Native Plant Materials Industry in Nevada

This section describes the Federal, State, and NGOs currently involved in supporting the supply of NPMs and/or their appropriate use in restoration projects

1. Federal Agencies Support

- a. Bureau of Land Management (BLM)
 - i. BLM support NPM research through the Great Basin Native Plant Project (GBNPP) and participation in the NNSP.
- b. U.S. Fish and Wildlife Service (FWS)
 - i. FWS supports NPM research through the GBNPP, strategic partnerships with the University of Nevada, Reno (UNR) through the Sagebrush Ecosystem Restoration Research Team (SERRT) project (which funded this report), and participation in the NNSP.
- c. U.S. Forest Service (USFS)
 - i. USFS support NPM research through the Great Basin Native Plant Project (GBNPP) and participation in the NNSP.
- d. USDA Natural Resource Conservation Service (NRCS)
 - i. NRCS supports the NPM industry by 1. Developing native plant material (NRCS Plant Materials Centers); 2. Cost-sharing NPM purchases for private restoration projects (NRCS approved seed mixes); and 3. Technical assistance to NPM growers (through district conservationists).
- e. USDA Agricultural Research Service (ARS)
 - i. ARS supports the NPM industry by conducting research into seed technology and cultural practices, as well as application strategies and technologies to improve seeding establishment.
- f. National Institute of Food and Agriculture (NIFA)
 - i. NIFA could make development of cultural practice for NPM required for rangeland restoration projects a national research priority.
- g. U.S. Geological Survey (USGS)
 - i. USGS supports research efforts to support the appropriate use of NPM in restoration projects in Nevada.

2. State Agencies Support

- a. Nevada Division of Wildlife (NDOW)
 - i. Collects data monitoring success of restoration projects. An NDOW employee works in the BLM seed warehouse in Ely, Nevada. Participates in NNSP.
- b. Nevada Department of Agriculture (NDA)
 - i. NDA supports growers and wildland collectors in the NPM industry by providing low-cost seed certification. Participates in NNSP.
- c. Nevada Division of Forestry (NDF)
 - i. NDF assists private landowners and public agencies to obtain NPM and perform restoration treatments. NDF provides preparation and seeding equipment for these restoration projects, mixing and bagging equipment

to Nevada growers, and public sector storage capacity. Participates in NNSP.

- d. University of Nevada, Reno (UNR)
 - i. Research into cultural practice for NPM and NPM use in restoration, as well as land manager and grower outreach.
- e. Western Nevada College – Specialty Crop Institute (SCI)
 - i. Workforce development through Specialty Crop Institute (SCI).
- f. Desert Research Institute
 - i. Research on NPM use in restoration.

3. *Non-Governmental Organization Support*

- a. The Nature Conservancy (TNC)
 - i. Research (seed-coating technology), outreach and communication.
- b. Institute for Applied Ecology—Native Seed Network
 - i. Communication, research, and increasing land manager knowledge and demand for NPM.
- c. Conservation Districts
 - i. Leveraging resources to cost-share seed purchases and providing rental equipment to private landowners.

3 BLM Native Plant Materials Use in Nevada

This section analyzes NPM use by the BLM in restoration projects in Nevada from 2005-2013 using a unique dataset assembled by project researchers. The analysis considers the BLM's demand for NPM by species, geographic area, and project type.

3.1 BLM Native Plant Material Data

We develop a data set on NPM by the BLM in Nevada using data from three sources:

1. Land Treatment Digital Library
 - a. We obtained data on BLM NPM use in Nevada from 2005-2013 from the Land Treatment Digital Library (LTDL). 2005-2013 are the only years where data is available for all five Great Basin field offices in Nevada (Battle Mountain, Carson City, Elko, Ely, and Winnemucca).
 - b. We did not include any observations from the Southern Nevada or Great Basin National Park. Data were only available for Southern Nevada in three years and included only post-fire rehabilitation treatments. Data were only available for two years from Great Basin National Park, but only included fuels management projects.
 - c. The LTDL data were cleaned to remove duplicate observations, standardize species names, and drop observations where data errors were suspected.
 - d. The final dataset includes 230 restoration projects. Most projects include several separate aerial and/or ground seeding treatments.
2. Leger and Baughman (2015)
 - a. We used data provided by Beth Leger to classify all species in the LTDL data by functional group (*e.g.*, Native Annual Grass, Exotic Perennial Forb, etc.). This is the same classifications used in Leger and Baughman (2015). We assigned functional group for species not included in the Leger and Baughman (2015) data set using USDA NRCS *Plant Guides*.
3. Utah Division of Wildlife Resources
 - a. We obtained contemporaneous price data from the Utah Division of Wildlife Resources (UDWR) seed buys. These data were made available by Kevin Gunnell, the Great Basin Research Center (GBRC) coordinator with the UDWR.
 - b. Many species in the LTDL data were not in the UDWR data at all, while other species only appear in the UDWR data in certain years. We used the following strategy to deal with missing data: 1. Selected 21 species that together comprise over 80% of the total pounds of NPMs in LTDL data. The top four species by number of projects in each of the five major functional groups ((*i.e.*, native grasses, native forbs, native shrubs, exotic grasses, and exotic forbs) are included in these 21 species. 2. If price data for a species is not available in a given year, then the average price from the prior and subsequent years was used; 3. For species other than the 21 included species, the average price of included species in their functional group is used. This final step allows us to include all species in the LTDL data in the analysis (*i.e.*, not assign them a price

of zero), but is likely to understate expenditure as less frequently used species generally have a higher price per pound than more commonly-used species.

3.2 BLM Native Plant Material Use by Year and Field Office

Figure 2 describes the number of BLM restoration projects and NPMs expenditure by year. Table 1 includes detailed information the number of BLM restoration projects and NPMs expenditure by BLM district office. Noteworthy results include:

- The BLM spent over \$18 million on NPM from 2005-2013. This spending is spread unevenly across field offices, with Elko and Ely accounting for 58% of total spending (Table 1), as well as across years, with spending in the big fire years of 2006 and 2007 reaching almost \$3.5 million, while falling below \$400,000 in 2008.
- The vast majority of the BLM’s NPM use in Nevada is for post-wildfire Emergency Stabilization and Rehabilitation (ESR) projects (Table 1). ESR projects comprise 200 out of 230 projects and 93% all NPMs spending.
- Non-wildfire (proactive restoration) spending is concentrated in the Battle Mountain and Ely field offices (Table 1).

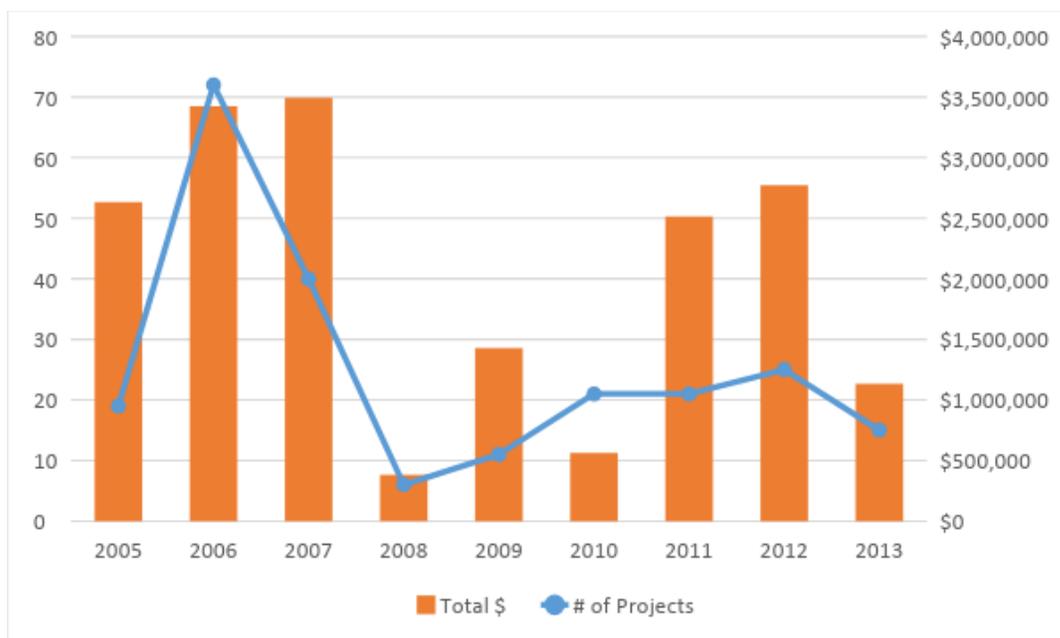


Figure 2. Number of BLM Restoration Projects and BLM NPM Expenditure by Year from 2005-2013 in the five Great Basin field offices in Nevada (Battle Mountain, Carson City, Elko, Ely, and Winnemucca).

Table 1. BLM NPM Use in Nevada

	All	Battle Mountain	Carson City	Elko	Ely	Winnemucca
All Projects						
# of Projects	230	19	31	66	76	38
Total lbs.	3,338,479	360,770	520,347	763,691	1,263,563	430,109
Total \$	\$18,339,574	\$2,230,127	\$2,930,919	\$4,674,624	\$6,010,154	\$2,493,750
\$ Per Project	\$79,737	\$117,375	\$94,546	\$70,828	\$79,081	\$65,625
Wildfire (ESR)						
# of Projects	200	16	24	58	65	37
Total lbs.	3,094,207	314,461	515,668	738,011	1,096,858	429,209
% Total lbs.	92.7%	87.2%	99.1%	96.6%	86.8%	99.8%
Total \$	\$17,081,199	\$1,793,080	\$2,911,017	\$4,536,734	\$5,350,243	\$2,490,125
% Total \$	93.1%	80.4%	99.3%	97.1%	89.0%	99.9%
\$ Per Project	\$85,406	\$112,068	\$121,292	\$78,220	\$82,311	\$67,301
Non-Wildfire (Proactive)						
# of Projects	30	3	7	8	11	1
Total lbs.	244,273	46,309	4,678	25,680	166,705	900
% Total lbs.	7.3%	12.8%	0.9%	3.4%	13.2%	0.2%
Total \$	\$1,258,375	\$437,047	\$19,902	\$137,890	\$659,911	\$3,625
% Total \$	6.9%	19.6%	0.7%	2.9%	11.0%	0.1%
\$ Per Project	\$41,946	\$145,682	\$2,843	\$17,236	\$59,992	\$3,625

3.3 BLM Native Plant Material Use by Species

Figure 3 reports expenditures by the five major functional groups for 2005-2013. Table 2 reports # of projects, total pounds, total expenditure by functional group. Figures 4 and 5 report expenditure by the top 25 species ranked by number of projects and total expenditure.

Noteworthy results include:

- From Figure 2, the largest category of expenditure is native grasses. The four most commonly used native perennial grasses (from Figure 3) – and the four largest by expenditure (from Figure 4) – are Indian ricegrass (*Achnatherum hymenoides*), squirreltail (*Elymus elymoides*), bluebunch wheatgrass (*Pseudoroegneria spicata*), and Sandburg’s bluegrass (*Poa secunda*). These four species are emphasized in the SERRT project, as well as by Nevada Native Seed Partnership wildland collection and seed increase efforts. Great Basin wildrye (*Leymus cinereus*), another SERRT species, was used by 42 projects and \$617,678 in expenditure.
- Figure 2 shows that the BLM spend over ten times more on native grasses than exotic grasses in the period 2005-2013. On the other hand, the BLM’s spent comparable amounts on native and exotic forbs. The BLM’s preference for native grasses is in conflict with the “Great Basin Wildfire Forum: The Search for Solutions”, which recommended the use of exotic grasses in post-fire restoration projects in the Great Basin (Miller and Naryanan 2008).
- The sixth grass included in the SERRT project, Thurber’s needlegrass (*Achnatherum thurberianum*) was not used in any BLM project in the study years. Neither was tapertip hawksbeard (*Crepis acuminata*), the one native forb included in the SERRT project.
- In addition to the seven species included in the SERRT project, the Nevada Native Seed Partnership has prioritized wildland collection of Douglas dustymaidens (*Chaenactis douglasii*), Hoary tansyaster (*Macranthera canescens*), yellow beeplant (*Cleome lutea*), tapertip hawksbeard, and four species of globemallow (*Sphaeralcea ambigua*, *coccinea*, *grossulariifolia*, *munroana*). Of these forb species, the BLM only used globemallow in restoration projects in our study period. The BLM used scarlet globemallow (*S. coccinea*) in 5 projects, desert globemallow (*S. ambigua*) in 8 projects, current-leaf globemallow (*S. grossulariifolia*) in 3 projects, and Munro’s globemallow (*S. munroana*) in 2 projects.
- The BLM spends more on Wyoming Big Sagebrush (*Artemisia tridentata* ssp. *wyomingensis*) than any other species. The BLM spent \$2,315,539 on Wyoming Big Sagebrush over the study period. This expenditure is significant because Wyoming Big Sagebrush is only available via wildland collection and, from our interviews, there is a consensus that wildland collection is likely to have a permanent cost advantage over cultivation for Wyoming Big Sagebrush. This highlights the importance of streamlining policies to support wildland collection to the goals of increasing the supply and lowering the cost of NPMs for use in restoration projects in Nevada.

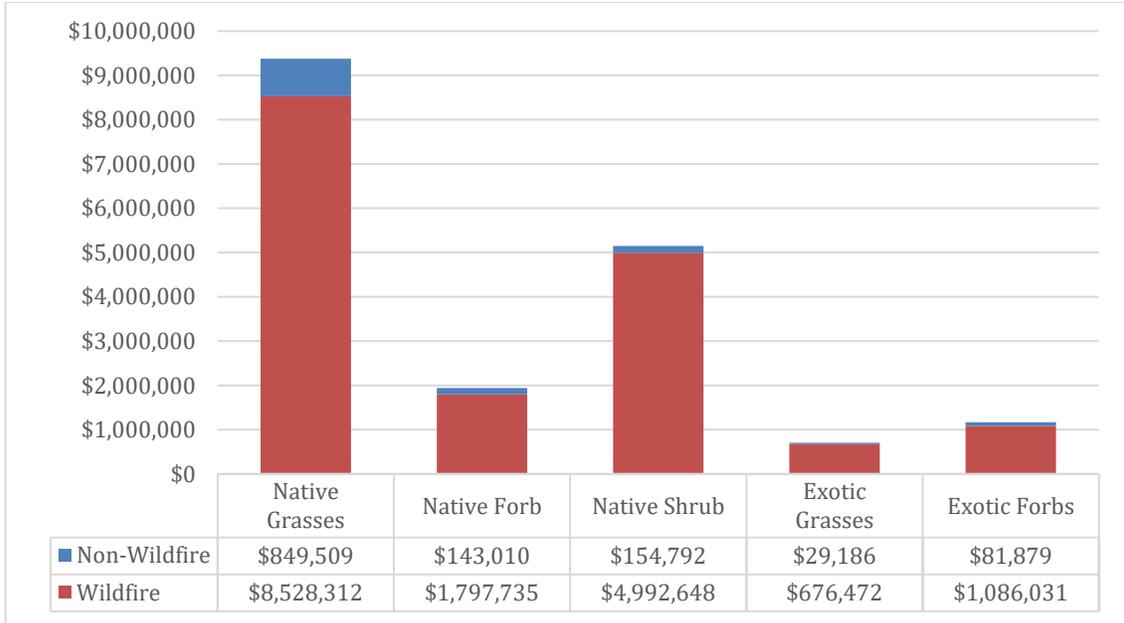


Figure 3. BLM NPM Expenditure by Functional Group: 2005-2013

Table 2. BLM NPM Use and Expenditure by Functional Group: 2005-2013

	All	Native Annual Grass	Native Perennial Grass	Native Annual Forb	Native Perennial Forb	Native Shrub	Exotic Perennial Grass	Exotic Annual Forb	Exotic Perennial Forb
All Projects									
# of Projects	230	2	174	7	140	139	79	3	135
% of Projects		0.9%	75.7%	3.0%	60.9%	60.4%	34.3%	1.3%	58.7%
Total Lbs.	3,338,479	846	1,882,873	3,548	145,960	412,120	508,300	2,004	382,828
% Total Lbs.		0.0%	56.4%	0.1%	4.4%	12.3%	15.2%	0.1%	11.5%
Total \$	\$18,339,574	\$6,905	\$9,370,916	\$40,701	\$1,900,044	\$5,147,440	\$705,659	\$12,442	\$1,155,466
% Total \$		0.0%	51.1%	0.2%	10.4%	28.1%	3.8%	0.1%	6.3%
Wildfire (ESR)									
# of Projects	200	2	157	7	122	131	65	3	109
% of Projects		1.0%	78.5%	3.5%	61.0%	65.5%	32.5%	1.5%	54.5%
Total Lbs.	3,094,207	846	1,739,604	3,548	132,964	393,313	490,034	2,004	331,894
% Total Lbs.		0.0%	56.2%	0.1%	4.3%	12.7%	15.8%	0.1%	10.7%
Total \$	\$17,081,199	\$6,905	\$8,521,407	\$40,701	\$1,757,034	\$4,992,648	\$676,472	\$12,442	\$1,073,589
% Total \$		0.0%	49.9%	0.2%	10.3%	29.2%	4.0%	0.1%	6.3%
Non-Wildfire (Proactive)									
# of Projects	30	0	17	0	18	8	14	0	26
% of Projects		0.0%	56.7%	0.0%	60.0%	26.7%	46.7%		86.7%
Total Lbs.	244,273	-	143,269	-	12,996	18,808	18,266	-	50,935
% Total Lbs.		0.0%	58.7%	0.0%	5.3%	7.7%	7.5%	0.0%	20.9%
Total \$	\$1,258,375	\$0	\$849,509	\$0	\$143,010	\$154,792	\$29,186	\$0	\$81,877
% Total \$		0.0%	67.5%	0.0%	11.4%	12.3%	2.3%	0.0%	6.5%

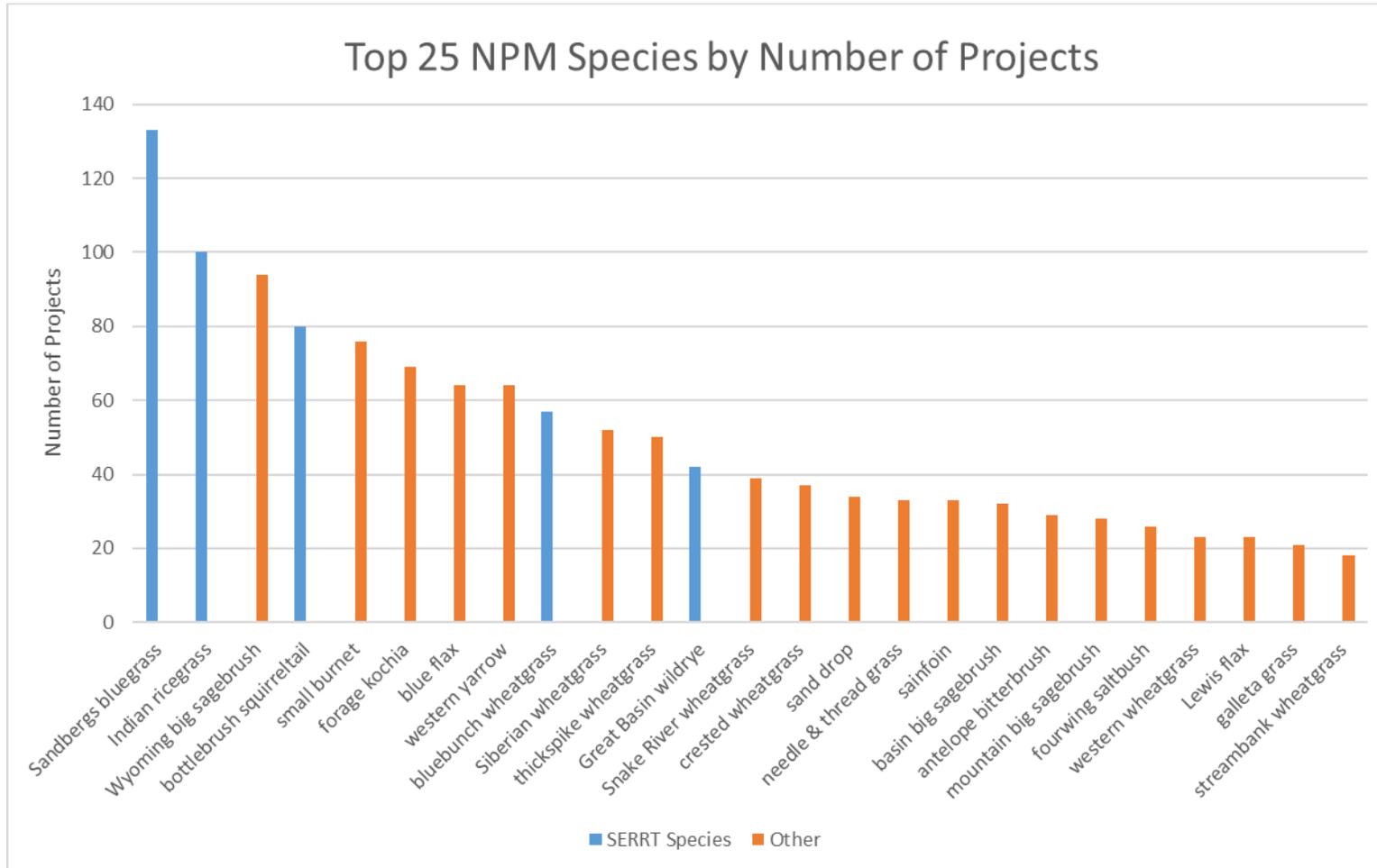


Figure 4. Top 25 NPMs Used by BLM in Restoration Projects: 2005-2013

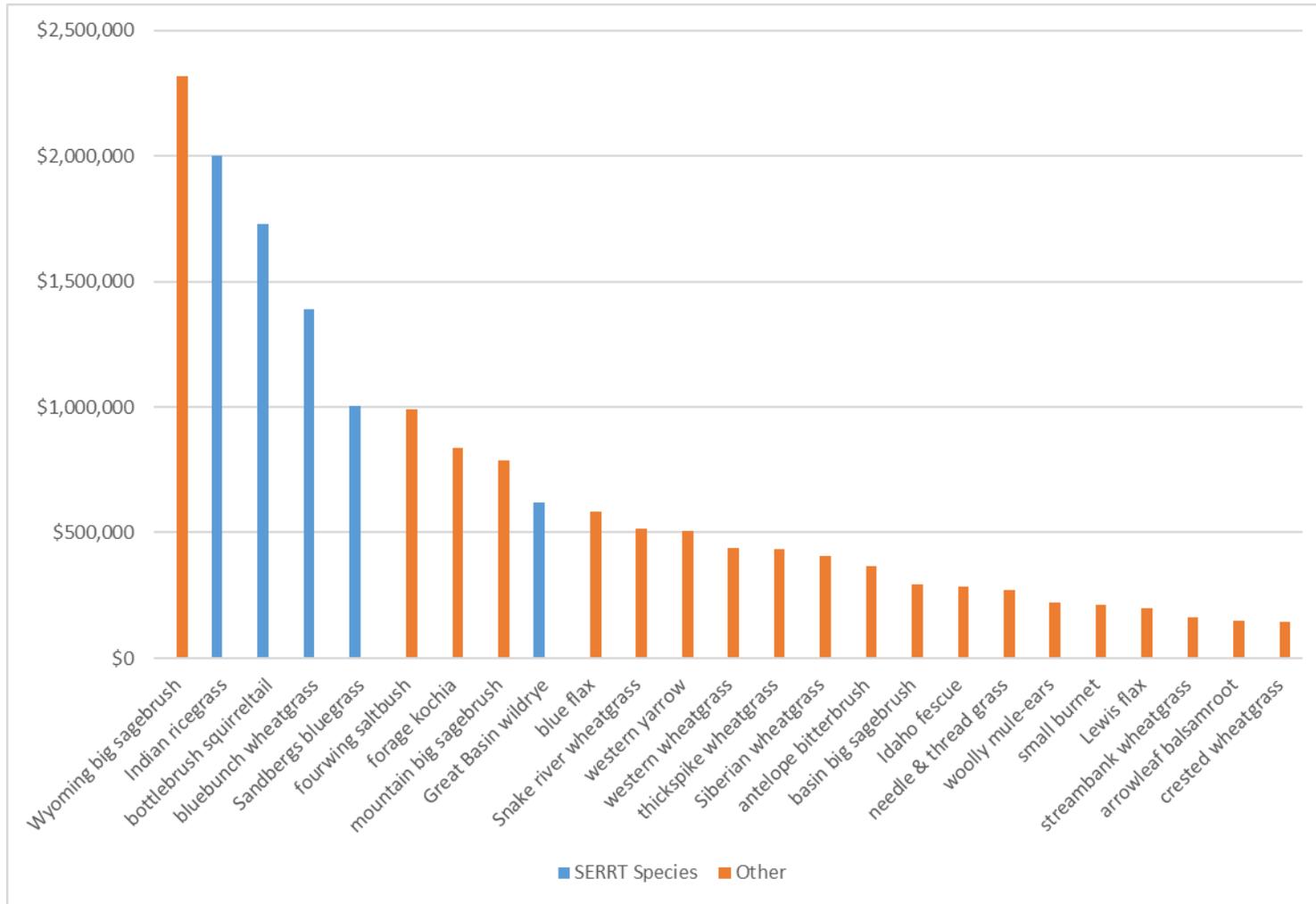


Figure 5. Top 25 BLM NPMs Expenditure by Species: 2005-2013

3.4 Native Plant Material Prices

Table 3 reports prices for the 19 NPM species that appear in the UDWR data four or more times (i.e., that UDWR purchased in four or more years between 2005-2013). Noteworthy results include:

- Table 3 documents that the price of all NPM species exhibit significant inter-annual variability. This suggests that market risk can be a barrier to expanding commercial cultivation for even the most commonly-used NPMs in Nevada.
- For example, Wyoming big sagebrush, which is the BLM's most important species by expenditure, has an extremely volatile price, ranging from a low of \$18 per pound to a high of \$75 in a nine-year period. The importance of Wyoming big sagebrush together with the high volatility in price is a powerful argument for expanding NDFs warehouse facility to include refrigerated storage to allow for annual inventory purchases of Wyoming big sagebrush.
- Of the five native perennial grasses emphasized by SERRT that appear in the UDWR data, squirreltail has the least volatile price (lowest coefficient of variation), Sandburg's bluegrass, Indian ricegrass, and bluebunch wheatgrass all have average coefficients of variation, while Great Basin wildrye has the most volatile price. This results suggests that of these five perennial grass species, Great Basin wildrye may require additional policy (e.g., forward contracts) to mitigate market risk for producers and increase its availability on the commercial market.

Table 3. UDWR Plant Materials Prices: 2005-2013

	Min	Max	Mean	S.D.	C of Var
Sandbergs bluegrass*	\$2.30	\$8.50	\$5.24	2.01	0.38
Indian ricegrass*	\$2.17	\$9.79	\$5.05	2.10	0.42
Wyoming big sagebrush	\$17.94	\$74.59	\$44.19	17.05	0.39
bottlebrush squirreltail*	\$13.04	\$22.29	\$17.61	3.38	0.19
small burnet	\$0.39	\$2.38	\$1.21	0.67	0.55
forage kochia	\$4.96	\$22.11	\$10.04	5.10	0.51
blue flax	\$8.95	\$15.12	\$12.04	1.54	0.13
western yarrow	\$5.87	\$28.00	\$15.89	6.99	0.44
bluebunch wheatgrass*	\$1.93	\$11.15	\$5.82	2.52	0.43
Siberian wheatgrass	\$0.54	\$3.65	\$1.89	0.84	0.44
thickspike wheatgrass	\$1.50	\$5.89	\$3.24	1.33	0.41
Great Basin wildrye*	\$1.53	\$11.43	\$5.14	3.00	0.58
Snake River wheatgrass	\$1.60	\$6.04	\$3.82	1.56	0.41
sainfoin	\$0.91	\$2.30	\$1.47	0.41	0.28
antelope bitterbrush	\$6.61	\$19.02	\$13.09	3.91	0.30
mountain big sagebrush	\$27.65	\$70.48	\$54.35	11.64	0.21
alfalfa	\$1.79	\$3.73	\$2.70	0.60	0.22
Lewis flax	\$4.58	\$23.48	\$11.55	5.78	0.50
Palmer's penstemon	\$7.50	\$22.49	\$15.59	5.75	0.37
* SERRT Species					

4 Challenges to Growing Native Plant Materials

This section describes the production challenges associated with producing NPM under cultivation. In order to understand the challenges faced by NPM growers, project researchers met with several private-sector NPM growers/suppliers, including Ed Kleiner (Comstock Seed) Rick McClintick (private grower in Orovada, Nevada), and Josh Buck (Granite Seed).

- Agronomic Challenges
 - *Site Preparation & Planting*: Planting methods vary by species and can require specialized equipment. The goal of site preparation is a clean field with minimal weed presence. Rotation with cover crops is often required to mitigate weed presence.
 - *Germination*: Native species have lower germination rates than conventional crops, and may not germinate at all depending on factors such as winter precipitation. In addition to germination, emergence, establishment, and competition from invasive weeds for nutrients and water can be significant barriers to plant persistence.
 - *Irrigation*: Guidance on timing and amount of irrigation is not available for many species.
 - *Purity*: Producing *Certified Seed* (see below for details on producing Certified Seed) requires maintaining a weed-free production field, as well as sufficient distance between production fields of the same species to avoid cross-contamination.
 - *Predation*: Seed predation from birds, rabbits, mice, etc. can reduce yields.
 - *Weather and Water*: There will be year-to-year variability in production costs and yields due to weather and water availability.
 - *Herbicide and insecticides*: Guidance on appropriate herbicides and pesticide use, including brand, application rates, and timing is not available for many species.¹
 - *Harvesting*: Harvesting native seed can be labor intensive, require specialized equipment, and harvest schedules can be unpredictable.²
 - *Time to Harvest*: For many species, there is often one to three years between establishment and when production can begin. Further, fields are often only productive for five years or less.
- Cleaning and Storage
 - *Cleaning*: Cleaning native seed requires specialized equipment. The cost of cleaning equipment can be a barrier for small growers.

¹ *Examples*: Ed Kleiner from Comstock Seed in Minden, Nevada, reports losing 2,500 plants provided to him from the ARS facility in Logan, Utah, as a result of application of a pre-emergent to control weeds. Norcini (2003) identifies testing of pre- and post-emergence herbicides as a necessary step to facilitate the successful establishment and seed production of native forbs.

² *Example*: Isidro-Mills (2006) documents an attempt to establish a field of *Penstemon speciosus* for seed production. Isidro-Mills recommend that the species undergo several agronomic improvements before growers attempt commercial cultivation, including selecting plants that have more upright growth habit in order to make mechanical seed harvesting possible, thereby reducing production costs.

- *Storage*: Storage is expensive, particularly if it requires refrigeration, and NPMs are perishable, so there is a risk of loss in seed viability from prolonged storage (inventory loss).
- Labor Costs
 - Labor costs associated with maintaining a certifiable product (*e.g.*, hand weeding and monitoring) can be substantial. For this reason, many out-of-state NPM growers use low-cost migrant labor.
- Certification: Foundation Seed & Certified Seed
 - *Foundation Seed*: Native seed is produced under a “limited generation” system that ensures genetic purity. Under the limited generation system, NPM producers are required to use foundation seed (for cultivars) or G1 seed (for pre-varietal germplasm or PVG) to establish a new production field. Foundation seed or G1 seed is generally distributed by public agencies and handled to ensure genetic purity and identity associated with breeder seed (for cultivars) or a specific seed source from uncultivated land (G0 seed for PVG).
 - *Certified Seed*: Federal and state agencies typically purchase “Certified Seed”. Certified Seed is the progeny of foundation seed/G1 seed that is grown under procedures accepted by NDA to ensure genetic purity and identify. Typically, NDA specifications are that after the foundation seed/G1 seed has established in a field, only the first three or four “generations” of seed (harvest years) can be considered “certified seed.”
 - Given the importance of producing Certified Seed for marketability, it is of critical importance that NPM growers have a reliable supply of foundation seed/G1 seed with consistent purity and viability.
- Testing
 - Native seed produced under cultivation must undergo third-party testing to ensure purity (of-species presence and weed presence) and viability (percentage of seed that has the potential to germinate).
 - Pure live seed (PLS) is the percentage of viable seed in one pound weight of bulk seed. There can be, however, considerable variability in tested PLS. Given that a growers payment for given quantity of bulk seed depend on tested PLS, variability in tested PLS is an important source of production risk.
- Economies-of-Scale
 - As in agricultural operation, the costs of fixed capital equipment related to sowing, harvesting, and cleaning implies that there will be increasing returns-to-scale associated with producing native seeds under cultivation. Increasing returns-to-scale means that the average cost of production is falling as the scale of production increases, and implies an advantage for larger growers.
- Economies-of-Scope
 - Given the shared equipment across species, as well as similar transaction costs associated with certification, testing, and marketing NPMs, there are economies-of-scope in producing NPMs under cultivation. Economies-of-scope imply that the average cost of cultivating more than one species is less than the cost of producing each species individually. Further, farm-level diversification is an important strategy to mitigate production and market risk by NPM growers. Working against economies-of-scope, however, is the need to isolate NPM fields in order to avoid cross-contamination.

5 Native Plant Materials Risk Matrix

Whether it is economically viable to produce a given species under cultivation is determined by four factors: 1. Production costs; 2. Production risk (variability in production yields); 3. Demand (and, hence, expected price); and 4. Market risk (variability in price). If the average cost of production for a species produced under cultivation is lower than its expected price (and lower than the cost of wildland collection), then production and market risk are the main obstacles to it being produced under cultivation. The *Native Plant Material Risk Matrix* in Figure 6 provides a framework to identify what additional policy is required to support a stable supply of a NPM produced under cultivation given its production and market risk.

Native Plant Materials Risk Matrix				
↑ M A R K E T R I S K ↓	H I G H	Policy 3A: Non-Wildfire Demand Projections, <i>and/or</i> Forward Contracts, <i>and/or</i> Tacit Contracts Status Quo: Wildland Collection, or Farm-level Risk Management	Policy 3B: Policy 3A <i>and</i> Minimum Revenue Commitments, or Cost-Plus Contracts Status Quo: Wildland Collection	Policy 3C: Agronomic Research <i>then</i> Policy 3B, or Cost-Plus Contracts Status Quo: Wildland Collection
	M E D I U M	Policy 2A: Annual Inventory Purchases with Public Storage <i>and/or</i> Seed Menus Status Quo: Private Growers <i>and</i> Private Storage	Policy 2B: Policy 2A <i>and</i> Minimum Revenue Commitments, or Cost-Plus Contracts Status Quo: Private Growers with Farm-level Risk Management <i>and</i> Private Storage	Policy 2C: Agronomic Research <i>then</i> Policy 2B, or Cost-Plus Contracts Status Quo: Wildland Collection
	L O W	Policy 1A: No Policy Needed Status Quo: Private Growers	Policy 1B: Minimum Revenue Commitments, or Cost-Plus Contracts Status Quo: Private Growers with Farm-level Risk Management	Policy 1C: Agronomic Research <i>then</i> Policy 1B, or Cost-Plus Contracts Status Quo: Wildland Collection
		L O W	K N O W N	U N K N O W N
		> - - - - - P R O D U C T I O N R I S K - - - - - >		

Figure 6. *Native Plant Material Risk Matrix*. The vertical axis displays three categories of market risk: 1. Low Market Risk – NPMs with consistent inter-annual demand; 2. Medium Market Risk – NPMs with variable inter-annual demand driven by ESR needs; 3. High Market Risk – NPMs with demand from niche markets. The horizontal axis on displays three categories of production risk: 1. Low Production Risk – NPMs with established agronomic best-practices and predictable yields; 2. Known Production Risk – NPMs with established agronomic best-practices but have significant and irreducible variability in yields (i.e., varieties that are difficult to grow); 3. Unknown Production Risk – NPMs with unknown agronomic performance.

5.1 Selecting Policy Given Market and Production Risk

1A. Low Market Risk/Low Production Risk

- **Description:** NPMs in this category include released species (cultivars and PVG) that have been selected to produce large and consistent yields at low cost and that can be used over a broad geographic area. The combination of low price and use over a broad geographic area means that these species are likely to be included in many restoration project specifications, thus ensuring growers a market for their product.
- **Status Quo:** NPMs with low market and production risk should already be available on the commercial market.
- **Policy Recommendation:** No policy is needed for NPMs in this category.

2A. Medium Market Risk, Low Production Risk

- **Description:** NPMs with medium market risk, but low production risk are varieties that produce consistent yields under cultivation, but have significant inter-annual variability in demand due to their use in ESR projects. NPMs in this category include locally-adapted ecotypes of common grass species such as those highlighted by the SERRT team (e.g., Great Basin wildrye, bluebunch wheatgrass, Indian ricegrass, Sandberg's bluegrass, squirreltail, and Thurbers' needlegrass).
- **Status Quo:** The fact that the commercial market is able to satisfy the quantity of NPMs demanded in large fire years (though not all desired species) suggests substantial private storage capacity. Private storage requires considerable working capital and is an advantage for large growers. Absent additional policy, varieties with high inter-annual variability in demand can be produced under cultivation by large growers and stored for sale in large wildfire years.
- **Policy Recommendations:** There are two policies that NDF and its State and Federal partners could pursue to mitigate market risk for NPMs to meet ESR needs:
 - **Annual Inventory Purchases and Public Storage:** The public sector can reduce demand volatility for NPMs used regularly in ESR seed mixes by having standing orders for these species (potentially with a price floor to further reduce market risk) and then storing the purchased seed for use (or re-sale) in large wildfire years. In addition to stabilizing the market, inventory purchases and storage will lower seed procurement costs for public agencies in large wildfire years.
 - **Seed Menus:** The primary objective of seed menus is to help to ensure that species that are often included in requested seed mixes by Federal and State agencies have been studied for their ability to establish in a wildland setting and are the right species for a given location. In addition to this goal, seed menus can help stabilize demand by limiting the species in seed mix specifications to those which are going to be in demand across a large number of restoration projects across a broad geographic area and that are economically viable to produce under cultivation.

3A. High Market Risk, Low Production Risk

- **Description:** NPMs with high market risk but low production risk are species that produce consistent yields under cultivation, but that are only demanded in geographically narrow, niche markets. These NPMs are likely to be included in proactive restoration projects, rather than ESR projects.
- **Status Quo:** The narrow nature of the demand for these species implies that a grower will not plant a field unless they know they have an agreement in place to sell the seed. Absent these agreements, these NPMs will only be available on the commercial market if they are collected opportunistically by wildland collectors.
- **Policy Recommendations:** There are three policies that NDF and its State and Federal partners could pursue to mitigate market risk to support the number of species in this category produced under cultivation.
 - **Non-Wildfire Demand Projections:** Have all public agencies post their NPM needs for proactive restoration projects at the start of the project to allow the private market sufficient lead time to supply desired species.
 - **Forward Contracts:** Forward contracts eliminate market risk for growers by providing them a guaranteed price for a specified quantity of a NPMs before the seed field is established. Indefinite Delivery, Indefinite Quantity (IDIQ) contracts favored by the BLM are structured as forward contracts in that they assure growers a predetermined price of a specified minimum quantity of a species.
 - **Tacit Contracts:** The Utah Department of Natural Resources (Utah DNR) uses tacit contracts with growers to perform seed increases. Rather than writing-down and signing a contract with multiple contingencies, Utah DNR simply provides the foundation seed to a grower along with a verbal commitment that they will include the species in their future seed buys. Tacit contracts reduce market risk for the grower, avoid the transaction costs related to formal contracting, and can shield the buyer from having to purchase the seed at a price far above production costs because if they distribute the foundation/G1 seed to multiple growers and purchase the variety via competitive bidding.

Policy 1B – 3B Low/Medium/High Market Risk with Known Production Risk

- **Description:** NPMs that can be profitably produced under cultivation, but are difficult to grow and, as a consequence, have highly variable yields.
- **Status Quo:** When these NPMs are produced under cultivation (*i.e.*, when the market risk is low or ESR demand can be met with private storage capacity), they are likely grown by large growers that can perform enterprise-level risk management through diversification. Diversification includes planting other NPMs, as well as agricultural seed varieties.
- **Policy Recommendation:** Regarding market-risk, the policies described above for low production risk species also applies to species with high, but known production risk. Regarding high, but known production risk, State and Federal partners in Nevada have several options:

- *Cultivate Relationships with Large Growers*: There are not many feasible, low-cost policy options available to State and Federal partners to mitigate known production risk for growers. For this reason, in addition to working with small growers, cultivating relationships with large growers (most likely out-of-state) that are able to assume the production risks associated with difficult to grow specie should also occur.
- *Cost-Plus Contracts*: A cost-plus contract pays the grower all expenses associated with planting, growing, harvesting, and cleaning a quantity of foundation seed *plus* some additional payment to allow for profit. Cost-plus contracts shield producers from both market and production risk. Cost-plus contracts are a commonly used in seed increase contracts when the species has highly variable yield or the agronomics are unknown and the purchaser (*e.g.*, private developer, California State Parks, pipeline companies and utilities for post-development restoration in utility corridors) is willing to assume the production risk.
- *Minimum Revenue Commitments*: One method to shield producers from the risk of low yields is to guarantee producers a minimum payment. IDIQ contracts used by the BLM often specify a minimum payment to producers, thereby reducing their marketing risk. While more innovative contracting types have not been used to promote NPMs produced under cultivation, the American Farmland Trust's *Best Management Practice Challenge* encourages farmers to experiment with lower fertilizer rates by providing side payments that ensure that their revenue would be the same as their expected revenue using conventional fertilizer rates. A similar approach for NPMs would guarantee producers some percentage of the revenue they would receive if they planted a low-production risk variety.

Policy 1C – 3C Low/Medium/High Market Risk with Unknown Production Risk

- **Description**: NPMs that have unknown agronomic performance and their commercial viability when produced under cultivation has not been established. Many native forb species that are desired in greater quantities by land managers for use in rangeland restoration projects fall in this category.
- **Status Quo**: If these species are available on the commercial market, it is through wildland collection.
- **Policy Recommendations**: NPMs in this category, where the current demand cannot be satisfied through wildland collection, should be prioritized for agronomic research. As mentioned above, we recommend that this research be performed in coordination with UNR, NDF, and the NRCS PMC. Agronomic best-practices can be distributed to growers for released varieties through the NRCS PMC publication, as well as through UNCE publications. Seed increases for NPMs with unknown agronomic performance could be performed by private growers through cost-plus contracts, but we would not recommend that NDF and its State and Federal partners assume this substantial risk before agronomic research has been performed.

5.2 Pay-for-Performance Contracting

If public land managers were able to enter into contracts with private-sector contractors where payments are contingent on restoration projects outcomes, then the incentives in the NPM industry would be aligned with public land management goals. Under pay-for-performance contracting, if NPMs improved the probability of achieving desired restoration project outcomes enough to justify its costs, then the private market could be left on its own to supply the species in desired quantities. There are several reasons, however, why pay-for-performance contracting is infeasible for rangeland restoration projects:

1. *Cash flow* – Having payments be contingent on restoration project outcomes means that it could be several years between when the firm performing the restoration project would assume the project costs and when they would receive payment. This would present a significant cash flow management challenge for firms.
2. *Metrics for Success* – The success of pay-for-performance contracting would require developing metrics that closely correspond to desired restoration projects outcomes. Developing these metrics is likely to be a challenge because restoration projects outcomes are most often multi-dimensional (e.g., soil stabilization AND forage for livestock AND wildlife habitat), and many important measures of restoration projects success are difficult to define (e.g., ecological resilience).
3. *Monitoring* – Pay-for-performance contracting would require third-party monitoring of agreed-upon metrics on which to condition payments. This monitoring would increase the cost of restoration projects, as well as open up the potential for litigation.
4. *Uncertainty* – The success of any restoration projects is uncertain and depends on factors that are either outside of the land managers' control, such as precipitation, or factors that are difficult for the land manager to perfectly observe, such as plant-community vigor, soil characteristics, and the composition of the existing seed bank. This uncertainty means that a restoration projects may fail to meet its objective even when were all best-practices are followed. This uncertainty poses a significant challenge for the design and implementation of pay-for-performance contracts.

Given that pay-for-performance contracts are likely not feasible for rangeland restoration projects, the policies prescribed by the Native Plant Material Risk Matrix in Figure 6 are necessary to ensure that desired species are available for restoration projects.

6 Policy Recommendations

The policy recommendations in this section focus on how the NPM network in Nevada described in Section 2 can be strengthened to more effectively meet the goals of increasing the supply and lowering the cost of NPM in Nevada. These recommendations are organized according to the three functions performed by public- and private-sector entities in the NPM network in Nevada: 1. *Demand* – How to stabilize the demand for NPM in Nevada; 2. *Supply* – How to increase the supply of desired NPM on the commercial market in Nevada; and 3. *Support* – How State, Federal, and non-governmental entities can better support the NPM industry in Nevada.

Figures 7 and 8 illustrate how the policy recommendations in this section will influence the commercial market for NPM in Nevada. Figure 7 depicts the current commercial market for NPM in Nevada. Figure 8 describes the commercial market if the policy recommendations in this report were implemented.

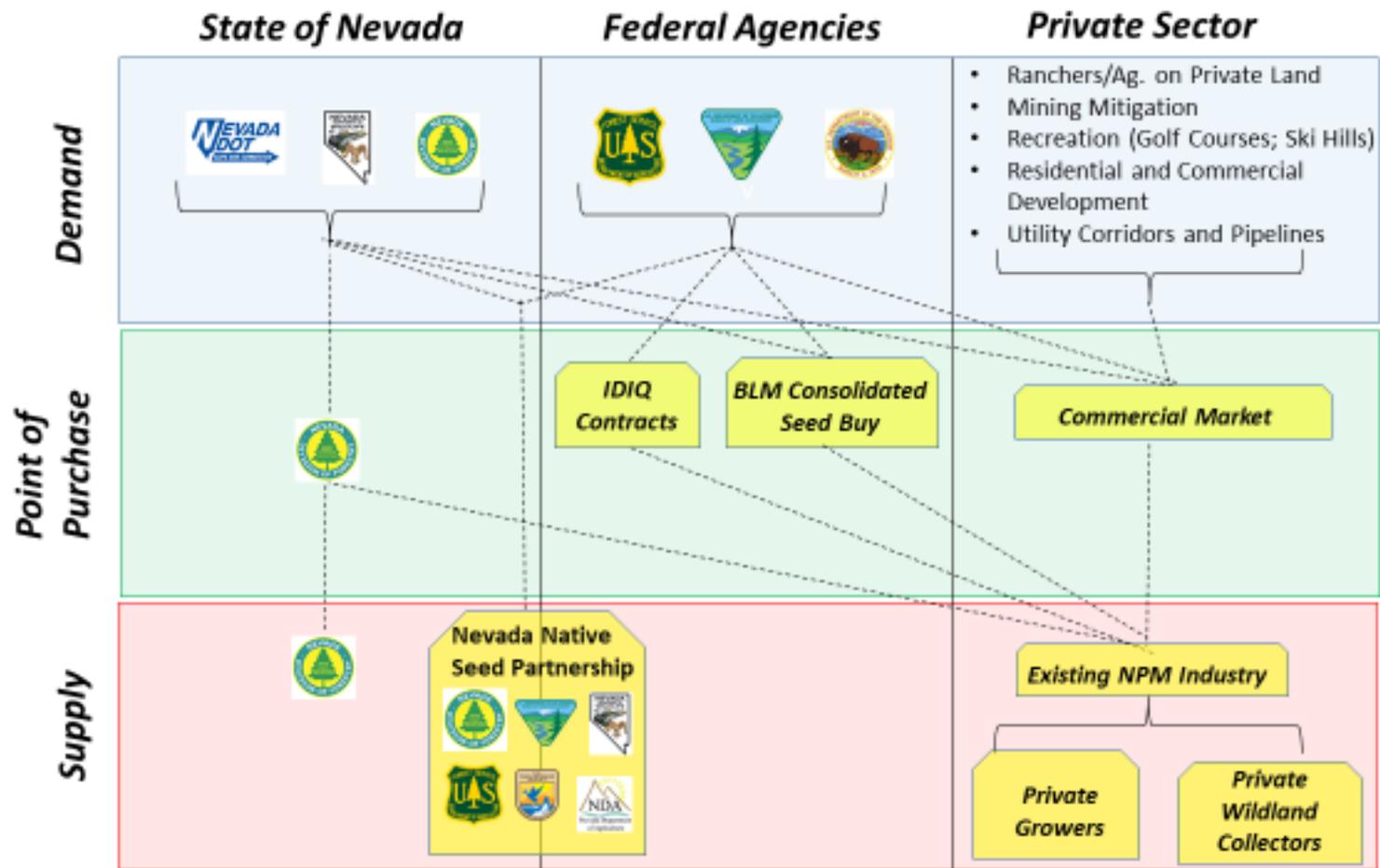


Figure 7. The current commercial market for NPMs in Nevada. Note: NDOW purchases NPMs directly through the BLM's tri-annual consolidated seed buys.

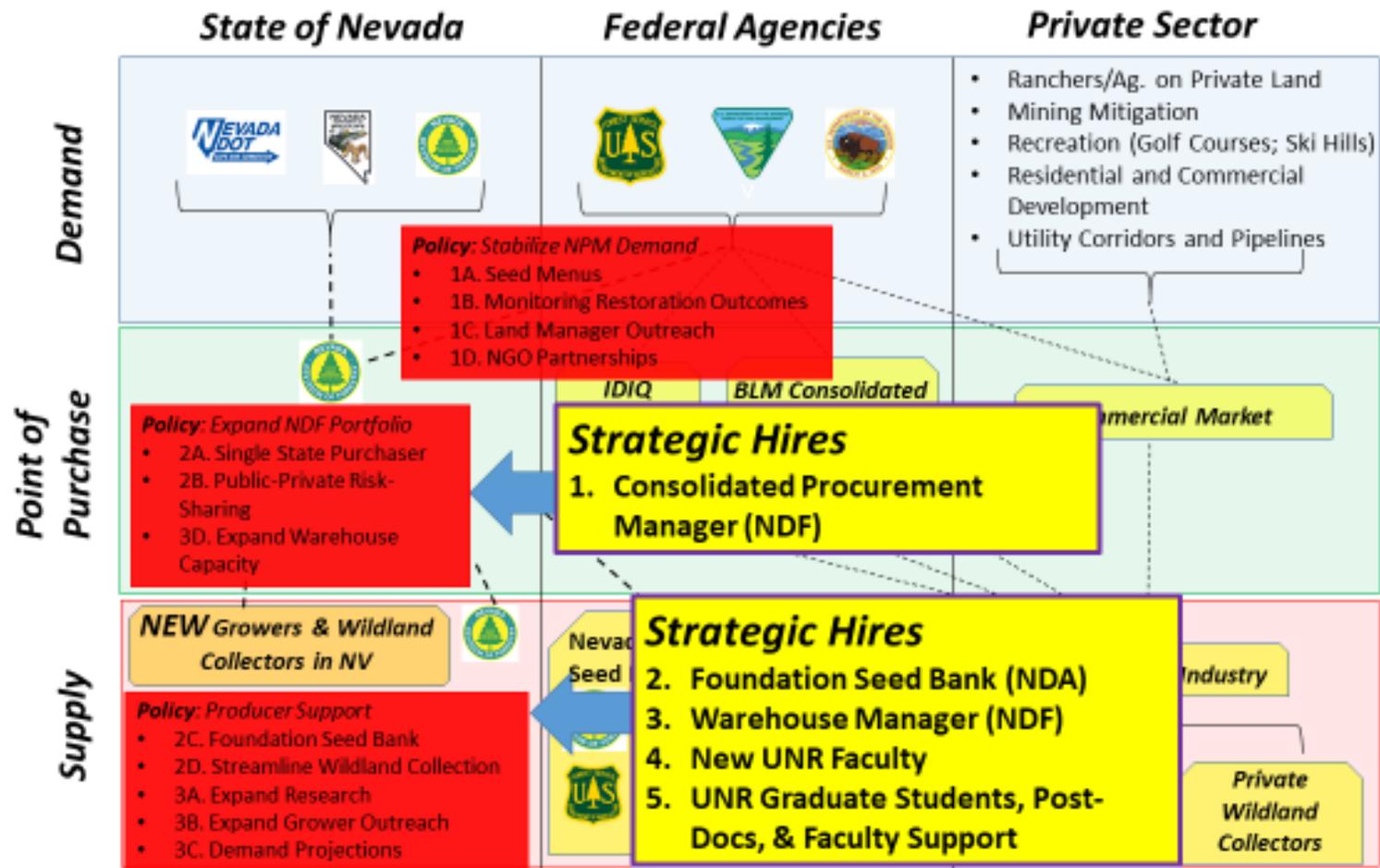


Figure 8. The commercial market for NPMs in Nevada if the policy recommendations in this report were implemented.

6.1 Stabilize Demand for Native Plant Materials

State and Federal agencies in Nevada can help stabilize the demand for NPM in Nevada and thereby support the development of the NPM industry by implementing the following recommendations:

1A. Seed Menus

Federal and State agencies should prioritize the development of seed menus with associated seed transfer guidelines. Seed menus can help ensure that only NPMs that have been studied for their ability to produce seed under cultivation and establish in a wildland setting are included in requested seed mixes. In addition, seed menus can be a powerful tool for stabilizing the market for NPMs by limiting the species in seed mix specifications to those that are going to be in demand across a large number of restoration projects across a broad geographic area. The formation of a seed menu working group that includes representative from BLM, USFS, FWS, NDOW, NDF, and NDA could help to ensure that seed menus are developed to reflect the range of stakeholder objectives, from those of botanists, ecologist, and wildlife biologists to those of public land managers, growers, and wildland collectors.

1B. Monitoring and Documenting Restoration Outcomes

Federal and State agencies should expand their long-run monitoring of restoration projects outcomes in Nevada. Documenting the success of locally-adapted NPMs at achieving restoration project objectives should be an integral component of a communication strategy to cultivate a preference for NPMs by public and private land managers. This topic is addressed in the Nevada Rangeland Monitoring Handbook (Swanson et al. 2018).

1C. Land Manager Outreach

Federal and State agencies should develop an outreach program directed towards public- and private-sector land managers focused on explaining the benefits of using appropriate NPMs in their restoration projects. These outreach efforts can include information on seed menus, purchasing NPM through NDF, and the success of previous restoration projects in Nevada that used NPMs.

1D. Partnerships with Non-Governmental Organizations

Building on NDOW's current activities, State and Federal agencies should increase partnerships with NGOs to help fund the use of genetically-appropriate NPM in restoration projects on public land in Nevada. The Utah Watershed Restoration Initiative (WRI) works with an extensive set of NGOs to fund NPM use in restoration projects on public land in Utah, including the Mule Deer Foundation, Sportsmen for Fish and Wildlife, the Rocky Mountain Elk Foundation, the National Wild Turkey Foundation, the Foundation for North American Wild Sheep, Utah's Bowman's Association, and Safari Club International.

Strategic Hires

No new personnel are needed to implement these recommendations. Seed menu development for seed zones in Nevada is already underway, led by BLM. Monitoring data are already collected for BLM ESR projects, USFS projects, and NDOW projects; however, creating knowledge from monitoring data will require dedicating additional staff time to analysis. Land manager outreach can be accomplished with existing resources, with assistance from University of Nevada Cooperative Extension.

6.2 Increase Supply of Native Plant Material

State and Federal agencies can increase the supply of desired NPMs for restoration projects in Nevada by implementing the following recommendations:

2A. Coordinated NPM Procurement for State Projects

Empower a single organization to oversee the procurement of NPMs for state restoration projects in Nevada. The consolidation of NPM procurement will facilitate the development of relationships between producers and land managers, help to coordinate seed mix specifications across State agencies (thereby reducing volatility in demand), and facilitate communication between growers and researchers developing released NPMs for seed increase. In addition to procuring NPMs for NDOW and NDF, the agency responsible for State procurement would also develop and supply seed mixes for NDOT projects, bonded mining reclamation projects, and Nevada State Parks projects. The agency best positioned to take on this procurement coordination role is NDF.

2B. Public-Private Risk-Sharing

Empowering a single organization (NDF) to oversee NPM procurement for State projects will allow it to cultivate relationships with growers and enter into long-term contracts (3-5 years minimum) that include provisions for public-private risk-sharing. Potentially attractive contractual arrangements include the expanded use of forward contracts and tacit contracts. See Section 5 for details. In addition, the single organization could implement standing orders (along with expanded public storage; see below) to stabilize the demand for frequently-used NPMs.

2C. Foundation Seed Bank

The creation of a foundation seed bank will provide a reliable source of foundation seed (for cultivars) or G1 seed (for pre-varietal germplasm, or PVG) to be used for propagation purposes by growers in Nevada and other states. This will minimize transaction costs associated with growers procuring foundation seed and support the supply of certified seed produced via seed increase for restoration projects in Nevada. The foundation seed bank could be run by either NDF or NDA, or jointly with NDA managing certification and NDF providing warehousing and logistics.

2D. Wildland Seed Collection Processes

There are three policy areas that can support wildland seed collection: 1. NDA can deputize more people in the state to approve source-identified tags; 2. BLM and USFS should conduct a programmatic National Environmental Policy Act (NEPA) review for NPM collection permits on BLM and USFS land in Nevada that designate seed collection areas, identify what species can be collected, and how they can be collected; 3. State and Federal permits should incorporate “contract flexibility” to allow for more substitutability between NPMs so that collectors are able to more optimally collect what is available on the landscape and needed for various purposes.

Strategic Hires

Consolidated Procurement

We propose a new hire to support consolidated procurement for State agencies, manage grower and wildland collector relationships, develop contracts to mitigate grower risk, and support inventory management activities at the expanded NDF warehouse. Given that the new hire would support and expand on many of NDF’s current activities, we recommend that this new hire be at NDF.

6.3 Support the Native Plant Materials Industry

State and Federal agencies can enhance their support of the NPM industry in Nevada by implementing the following recommendations:

3A. Expanded Research and Co-location of Native Plant Material Development Activities

To facilitate the coordination of NPM development, research, and grower outreach in Nevada, NPM personnel from NRCS Great Basin Plant Materials Center (PMC), UNR, NDF, NDA, and NDOW should co-locate. In addition to promoting collaboration and avoiding duplication of effort, co-location would facilitate the distribution of plant materials and agronomic best-practice information to Nevada growers. This research facility should be co-located with the foundation seed bank and the expanded NDF warehouse. This facility should be located in the Reno area in order to enhance employee recruitment and retention and to facilitate research participation by UNR undergraduate and graduate students. Potential locations include the University of Nevada, Reno’s Main Station ranch and the Nevada Division of Forestry Western Region Headquarters in the Washoe Valley.

3B. Grower Outreach and Technical Assistance

NDA, NDF, UNR, and Nevada’s Conservation Districts Program should coordinate a comprehensive producer outreach strategy to disseminate information on NDA seed certification, cultural best practices, seed testing requirements, how to obtain foundation seed, and NDF purchasing procedures.

3C. Data Collection & Demand Projections

Standardized data on native seed purchases (price, quantity, type) by Federal and State agencies in Nevada could be used to develop a publicly available list of commonly-used

NPMs, with the range of prices for each species. This data would also facilitate the development of demand projections for NPMs in Nevada for both proactive (e.g., mining reclamation, sage-grouse habitat restoration) and reactive (e.g., ESR) projects, thus helping NPM growers and wildland collectors gauge the potential market for their product.

3D. Expanded Warehouse Capacity

Expansion of existing NDF warehouse capacity and the addition of refrigerated storage is necessary for NDF to serve as the single NPM purchaser for state projects. This will allow NDF to effectively smooth inter-annual demand by purchasing NPMs commonly used in ESR projects on an annual basis (potentially via standing orders with a price floor) and storing them for use or sale in large-fire years. The NDF warehouse can also provide seed testing and mixing services for seed purchased for State-sponsored restoration projects. The NDF warehouse should coordinate with the BLM seed warehouse system, possibly through a memorandum of understanding (MOU).

Strategic Hires

Foundation Seed Bank

We propose a new hire to support the creation and operation of the foundation seed bank. This new hire could also assist with producer-focused communications, including information on the NPM certification process, cultural best practices, and NPM marketing. Given that this new hire would support and expand on many of NDA's current activities, we recommend that this new hire be at NDA.

Warehouse Manager

We propose hiring a full-time warehouse manager to support the expansion of the NDF seed warehouse. The warehouse manager would be responsible for shipping and receiving and inventory management, as well coordinating with NDA to manage inventory for the foundation seed bank.

New UNR Faculty

We propose hiring a new faculty member at UNR to support NPM research as well as land manager and grower outreach. This new hire would need both a restoration background to ensure that released NPMs can establish in a wildland setting, as well as a background in botany/agronomy to ensure that released NPMs can be reliably produced under cultivation.

University of Nevada, Reno

The University of Nevada, Reno, can support the NPM industry in Nevada and the use of NPM in restoration projects by expanding the number of graduate students, post-doctoral researchers, and faculty working on NPM topics.

References

- Davison, Jay. 2003. A Field Guide for Collecting Native Seeds in Nevada. University of Nevada Cooperative Extension Technical Report EB-03-03.
- Garner, E.R., Tucson Plant Material Center in co-operation with Coronado Resource Conservation and Development Area, Inc. 2004. Native Seed Production. Natural Resources Conservation Service, United States Department of Agriculture.
- Jones, T. A. 2005. Genetic principles and the use of native seeds – just the FAQs, please, just the FAQs. *Native Plants Journal*. 6 (1): 14-24.
- Jones, T. A. and S. A. Young. 2005. Native seeds in commerce: More frequently asked questions. *Native Plants Journal* 6 (3): 286–93.
- Kulpa, S.M., Leger, E.A., Espeland, E.K., Goergen, E.M. 2012. Postfire seeding and plant community recovery in the Great Basin. *Rangeland Ecology and Management*. 65:171-181.
- Isidro-Mills, Edith. 2016. Penstemon Seed Production and Stand Establishment. Sustainable Agriculture Research & Education, United States Department of Agriculture.
- Leger, Elizabeth A. and Owen W. Baughman. 2015. What Seeds to Plant in the Great Basin? Comparing Traits Prioritized in Native Plant Cultivars and Releases with those that Promote Survival in the Field. *Natural Areas Journal*. 35(1): 54-68.
- Miller, E. and R. Naryanan (Eds.). 2008. Great Basin Wildfire Forum: The Search for Solutions. Pages 28-29. Reno, NV: Nevada Agricultural Experiment Station.
- Mock, Betsy, Kristiana Hansen, Roger Coupal, and Dale Menkhaus. 2016. Policy Experiments for the U.S. Intermountain West Native Seed Industry. *Canadian Journal of Agricultural Economics*. 64(4): 685-716.
- Peppin, Donna L., Peter Z. Fule, Janet C. Lynn, Anne L. Mottek-Lucas, and Carolyn Hull Sieg. 2010. Market Perceptions and Opportunities for Native Plant Production on the Southern Colorado Plateau. *Restoration Ecology* Vol. 18, No. S1, pp. 113–124.
- Plant Conservation Alliance. 2015. National Seed Strategy for Rehabilitation and Restoration: 2015-2020. Bureau of Land Management, 56 pp.
- Presidential Memo Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators. 2014.
- Shaw, Nancy L., Scott M. Lambert, Ann M. DeBolt and Mike Pellant. 2005. Increasing native forb seed supplies for the Great Basin. *USDA Forest Service Proceedings RMRS-P-35*, pp. 94–102.
- Swanson, S. , B. Schultz, P. Novak-Echenique, K. Dyer, G. McCuin, J. Linebaugh, B. Perryman, P. Tueller, R. Jenkins, B. Scherrer, T. Vogel, D. Voth, M. Freese, R. Shane, and K. McGowan. 2018. Nevada Rangeland Monitoring Handbook, Third Edition. University of Nevada Cooperative Extension Special Publication SP-18-03. 122 pp.
- United States Department of Interior (DOI). 2015. Secretarial Order No. 3336: Rangeland Fire Prevention, Management and Restoration. 5 January 2015. Secretary of the Interior Sally Jewell.
- Wiese, J., F. Menalled, J. Jacobs, B. Maxwell and S. Winslow 2009. Establishment and Seed Production of Native Forbs Used in Restoration (Unpublished Master’s Thesis). Montana State University, Bozeman, Montana. 116 pp.

A. Appendix: Acronyms

- **Federal Agencies**
 - ARS – Agricultural Research Service (USDA)
 - BIA – Bureau of Indian Affairs (DOI)
 - BLM – Bureau of Land Management (DOI)
 - DOI – Department of the Interior
 - FWS – U.S. Fish and Wildlife Service (DOI)
 - FSA – Farm Service Agency
 - NIFC – National Interagency Fire Center
 - NIFA – National Institute of Food and Agriculture (USDA)
 - NRCS – Natural Resources Conservation Service (USDA)
 - NPS – National Parks Service (DOI)
 - PCRP – Plant Conservation and Restoration Program (DOI – BLM)
 - USDA – United States Department of Agriculture
 - USFS – U.S. Forest Service (USDA)
 - USGS – U.S. Geological Survey (DOI)_
- **State Agencies**
 - BMRR – Bureau of Mining Regulation and Reclamation
 - NDA – Nevada Department of Agriculture
 - NDOW – Nevada Division of Wildlife
 - NDF – Nevada Division of Forestry
 - NDEP – Nevada Division of Environmental Protection
- **Other**
 - AIM – Assessment, Inventory, and Monitoring Data from BLM
 - ASTA – American Seed Trade Association
 - BAER – Burned Area Emergency Response
 - CABNR – College of Agriculture, Biotechnology, and Natural Resources at UNR
 - ESR – Emergency Stabilization and Rehabilitation
 - GBNPP – The Great Basin Native Plant Project
 - GBRC – Great Basin Research Center
 - IAE – Institute for Applied Ecology
 - NAES – Nevada Agricultural Experiment Station
 - NACD – National Association of Conservation Districts
 - NGO – Non-Governmental Organization
 - NSHE – Nevada System of Higher Education
 - NNSP – Nevada Native Seed Partnership
 - PCA – Plant Conservation Alliance
 - PLS – Pure Live Seed
 - PVG – Pre-varietal Germplasm
 - SOS – Seeds of Success
 - UNR – University of Nevada, Reno
 - Utah DNR – Utah Department of Natural Resources

B. Appendix: List of Interviews

Formal Interviews (Semi-structured Interviews)

- 10 May 2016 – Francis Kilkenny (GBNPP)
- 8 September 2016 – Sherman Swanson (UNR) and Matt Church (UNR/Zephyr Seed)
- 14 September 2016 – Juan Solomon (UNR)
- 15 September 2016 – Elizabeth “Beth” Leger (UNR)
- 26 September 2016 – William “Bill” Elder (USDS NRCS – Reno)
- 16 October 2016 – Lee Turner (NDOW)
- 25 October 2016 – Russell Wilhelm and Meghan Brown (NDA)
- 11 November 2016 – Ed Kleiner (Comstock Seed)
- 21 November 2016 – Tyler Thompson and Alison Whittaker (WRI)
- 29 November 2016 – Seth Johnson (NDOT)

Informal Interviews/Discussions

- 10 January 2017 – Jay Davison (UNCE)
- 15 February 2017 – Peggy Olwell (BLM)
- 16 February 2017 – Rob Fiegenger (Native Seed Network, Institute of Applied Ecology)
- 28 March 2017 – Rick McClintick (Native seed grower near Orovada, NV),
- 28 March 2017 – Dan Hettrick (Alfalfa seed grower near Orovada, NV)
- 28 March 2017 – Jerry Annis (Rancher in Buffalo Valley, south of Battle Mountain, NV)
- 28 March 2017 – Bevan Lister (Rancher near Pioche, NV), and
- 27 September 2017 – John Griffiths (Nature Conservancy, Oregon)
- 1 February 2018 – Kevin Gunnell, Danny Summers, and Jason Vernon (Utah Division of Wildlife Resources)
- 22 May 2018 – Josh Buck (Granite Seed)

Reoccurring Interactions & Discussions

- Sarah Kulpa (FWS)
- Fred Edwards (BLM)
- Meghan Brown (NDA)
- Russell Wilhelm (NDA)
- Lee Turner (NDOW)
- Christopher Bernau (NRCS)
- Jessica Kindred (GBI)
- Eric Roussel (NDF)
- Ryan Sharrer (NDF)
- Kevin Badik (TNC)
- Elizabeth Munn (TNC)
- Dirk Netz (USFS)