



Diné Native Plants Program: Navajo Nation Native Plant Needs and Feasibility Assessment



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Navajo Nation Chapters

Birdsprings	Nenahnezad
Burnham	Oljato
Cameron	Rock Springs
Coppermine	Sheep Springs
Crownpoint	Standing Rock
Dilkon	Sweetwater
Ganado	Blue Gap/Tachee
Leupp	Teec Nos Pos
Many Farms	Teesto
Naschitti	Tolani lake
Navajo Mountain	Tselani/Cottonwood

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ABSTRACT

The Navajo Nation encompasses a vast, biologically diverse landscape and is home to over a thousand species of native plants, many of which are utilized by the Diné people for livestock fodder, food, ceremony, and medicine. Unfortunately, more than a century of over-exploitation and mismanagement of natural resources has led to the degradation of large areas of native ecosystems on Navajo land. Environmental issues such as overgrazing, oil/gas extraction, uranium mining, and invasive species threaten native ecosystems, natural resources, and the Diné people's way of life. Despite preliminary steps made by Navajo leaders and agencies to address some of these environmental concerns, there remains considerable need for ecological restoration of rangeland, forests, and riparian corridors on the Navajo Nation in order to conserve natural resources and preserve traditional knowledge. Revegetating degraded areas with locally-sourced, native species following site treatment or a disturbance is an increasingly useful tool for land managers. However, a common obstacle to revegetating with native species is lack of access to affordable, locally-sourced, native plant material. As a result, plant materials, including non-native species, are often obtained from commercial growers in other regions, a practice that can jeopardize the success of restoration. Although several national and regional organizations exist to increase the availability of native plant material in the Southwest, there are no locally-sourced, native plant material suppliers currently operating on the Navajo Nation.

We distributed two surveys to Navajo (and affiliated) agencies/organizations and Navajo community members to assess the need for native plant material and the feasibility of a Navajo-run program aimed at producing native plant material for restoration, conservation, and cultural preservation. The results of our study, from both agency and community surveys, were overwhelmingly in favor of the Diné Native Plants Program. A majority of agency/organization respondents (67%) said they utilized some form of plant material in their operations. The most common uses of plant material reported were "ecological restoration" (68%), "education" (61%), and "range rehabilitation" (35%). A majority of respondents said "Yes" they were concerned about the genetic or regional source of their plant material (68%) and probability of success was the most important factor deciding what plant material to purchase (71%). Finally, a vast majority (80%) of respondents reported "Yes" their organization anticipates needing local, native plant material in the next 5-10 years and "Yes" they would be willing to purchase from a local partnership of growers and buyers (74%).

The Navajo community responses to our surveys were similarly encouraging. A vast majority (95%) of Navajo community members responded "Yes" they use native plants. Respondents listed a total of 65 specific native plants when asked which plants they used, which plants were becoming scarce, and which plants were desired for propagation. Common responses were Navajo tea, juniper, and sagebrush. Food (68%), cultural/ceremonial (63%), and medicinal (58%) were the most common uses of native plants reported. A majority of respondents (69%) indicated they would be interested in participating in workshops involving traditional uses of native plants. Sixty-six percent (66%) of respondents were "Interested" or "Very interested" in partnering with our program to grow native plants.

These results clearly indicate the feasibility of the Diné Native Plants Program to provide cost effective, locally-sourced plant material for restoration while also providing Navajo community members access to culturally-important native plants. In order to address agency/organization needs we will focus seed collection on "workhorse" species intended for use in ecological restoration. To address Navajo community needs we will focus seed collection on culturally-important species, mainly traditional Diné foods. We will use the survey responses to prioritize specific species to target while also collecting opportunistically to amass a robust, diverse seedbank in anticipation of future restoration projects and native plant needs. Overall, we received valuable feedback that will allow us to develop the Diné Native Plants Program into an enduring and productive operation that will benefit Navajo land and its people.

INTRODUCTION

The Navajo Nation is the largest tribal reservation in the United States with a land base of approximately 27,000 square miles stretching across Arizona, Utah, and New Mexico. It encompasses a geologically, topographically, and biologically diverse landscape that ranges from arid deserts to montane conifer forests. The Navajo Nation is home to over a thousand species of plants (Mayes & Rominger 1994), many of which are endemic to the region. Portions of five major sub-regional watersheds of the Southwest are also part of this vast landscape; the Rio Grande, the Upper and Lower Colorado, the Little Colorado, and San Juan River basins (Seaber et al. 1987). For centuries the Navajo or Diné people, as they traditionally call themselves, have utilized the floristic resources within this diverse landscape for livestock fodder, heat, building materials, food, ceremony, and medicine. Unfortunately, more than a century of over-exploitation and mismanagement of natural resources has led to the degradation of large areas of native ecosystems on Navajo land. For example, as early as the beginning of the 20th century widespread overgrazing and erosion were already being observed on Navajo rangelands, and, despite mandatory reductions in the 1930s, livestock have regularly exceeded the carrying capacity of the land (Redsteer et al. 2010). Overgrazing and erosion have only increased on the Navajo Nation in recent decades due to the rapid growth of feral horse populations coupled with severe drought (Redsteer et al. 2010). These and additional environmental impacts such as oil and gas extraction, historic uranium mining (Necerfer et al. 2015), and invasive species (Brown et al. 2008) continue to negatively affect native ecosystems on the Navajo Nation and will likely intensify with an increasingly warmer climate (Nania et al. 2014, Redsteer et al. 2013). The compounded effects of these impacts not only threaten native ecosystems and natural resources on the Navajo Nation, but also the Diné people's cultural identity and way of life. Already Navajo elders have noticed important medicinal plants have disappeared from the landscape in recent years (Redsteer et al. 2010). As more and more culturally-important native species vanish from Navajo land, the traditional teachings and knowledge associated with those plants will likely disappear as well.

Despite its size, biological diversity, cultural significance, and prevalence of environmental issues, the Navajo Nation remains a gap in ecological research and restoration in the Southwest, which tends to be concentrated largely on surrounding federal lands. However, recently, there have been preliminary steps taken internally to address environmental issues and to restore important ecosystem functions of degraded rangelands, forests, and riparian corridors on the Navajo Nation. The Bureau of Indian Affairs (BIA) as well as Navajo agencies have developed official drought contingency (Navajo Nation Drought Contingency Plan, 2003), weed management (Navajo Nation Integrated Weed Management Plan [IWMP], 2016), and forest management plans (Navajo Forestlands Integrated Management Plan [IRMP], in draft); many of which call for restoration and conservation of native ecosystems. An increasingly important tool in this effort, and one that is referenced specifically in the IWMP and Navajo Forestlands IRMP, is revegetation of priority degraded and/or disturbed sites with native species. Revegetation with native species has been successfully utilized for post-fire rehabilitation, invasive species management, livestock grazing, wildlife habitat management, roadside rehabilitation, mine reclamation, and recreation (Peppin et al. 2010). Unfortunately, a common obstacle to revegetating with native species is lack of access to affordable native plant material (plant material refers to any portion of a plant that can be used for propagation, i.e. seed, rootstock, cuttings, and container plants). This has become a problem throughout the Southwest as more organizations have recognized the importance and benefits of using native plant material, especially locally-sourced plant material, for revegetation (Peppin et al. 2010). Local adaptation of native plants to specific site characteristics, such as precipitation, temperature, and substrate, is widely recognized (Leimu & Fischer 2008, Bucharova et al. 2017) and is likely a key factor in determining successful establishment and long-term survival of plants used in revegetation (McKay et al. 2005). Numerous executive guidelines, regulations, and policies have since been created to require the use of native plant material for restoration projects supported by federal funds (Richards et al. 1998). In response to these federal requirements, a host of native plant groups have established across the United

States in order to increase the supply of native plant material for restoration and to connect seed buyers with growers. For example, the Bureau of Land Management's Seeds of Success (SOS) program was introduced in 2001 as a nation-wide initiative to collect, conserve, and develop native plant material for restoration (Seeds of Success n.d.). Currently, there are SOS seed collecting teams operating in 13 western states (including Alaska), as well as in two Midwestern and three eastern states. Additionally, in 2015 the National Seed Strategy for Rehabilitation and Restoration was developed to coordinate restoration efforts of private, federal, state, local, and tribal entities and to establish a network of native seed collectors and growers to address the national shortage of native plant material (National Seed Strategy for Rehabilitation and Restoration 2015).

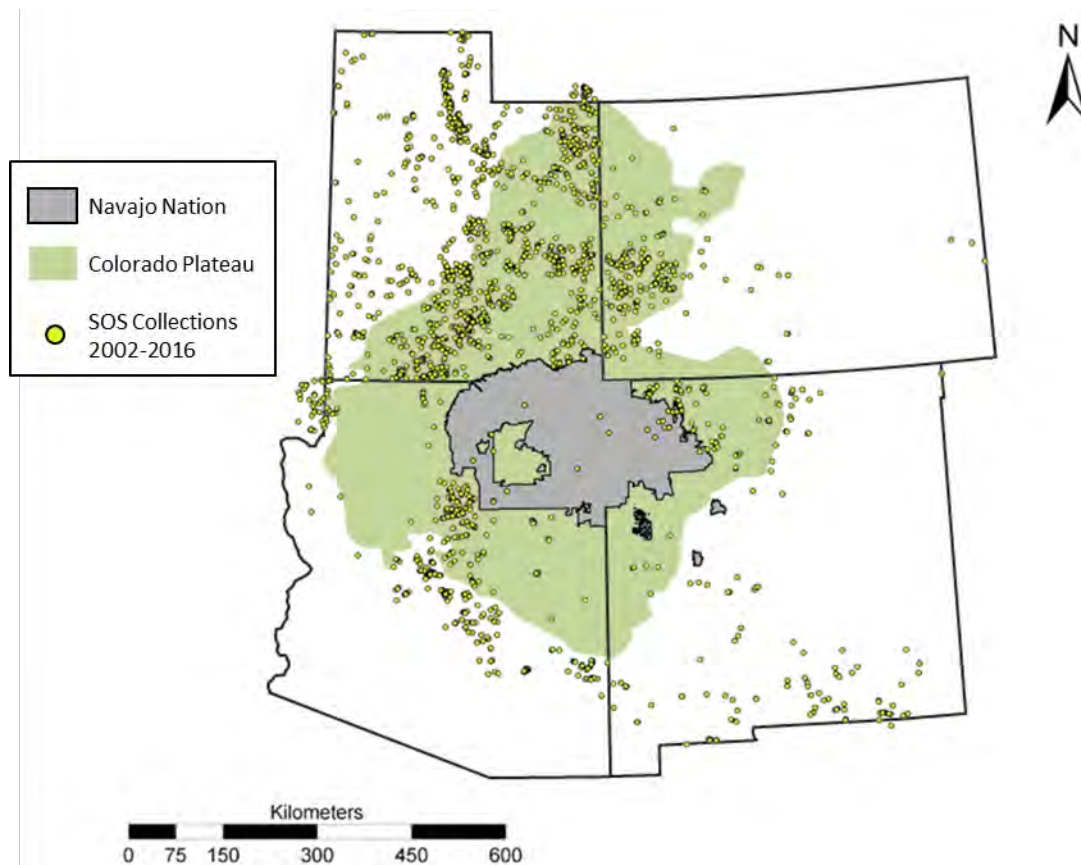


Figure 1. Seeds of Success (SOS) collections made in Utah, Colorado, Arizona, and New Mexico from 2002-2016 (Colorado Plateau Native Plant Program 2016).

Despite an increase in advocacy groups and federal initiatives in the Southwest to restore degraded land using native plants, there are no locally-sourced, native plant suppliers on the Navajo Nation. As a result, plant materials, including non-native species, are often obtained from commercial growers outside of the Nation (U.S. Department of the Interior Bureau of Indian Affairs, Navajo Region 2016), a practice which can jeopardize the success of restoration efforts and introduce non-native species (Brown et al. 2008). Furthermore, seed collection efforts, scientific research investigating factors contributing to restoration success, and native plant material development efforts largely cease at the border of the Navajo Nation. For example, only 43 SOS collections have been made on Navajo land from 2002-2016 (Figure 1, Colorado Plateau Native Plant Program 2016) In comparison, there have been over 600 SOS collections made in the rest of Arizona in the same timeframe.

Fortunately the Navajo Nation currently has the infrastructure to initiate native plant production and a seed banking program. The Navajo Forestry Department (NFD) operates four climate-controlled greenhouses, lab space, and two seed storage freezers in Fort Defiance, AZ. These facilities were originally established to grow primarily ponderosa seedlings and other conifer species for reforestation following logging operations. However, after Navajo Forest Products Industry's closure in 1994, nursery production of conifers intended for reforestation of Navajo land has sharply decreased. In a 2003 tribal nursery needs assessment report conducted by the U.S. Forest Service, nursery managers at NFD expressed interest in expanding their operations to include propagation of other native species (Luna et al. 2003). Although the nursery continues to successfully propagate conifer seedlings, to date the Navajo Forestry Department has not initiated a native plant market beyond conifer species.

Recognizing the opportunity to expand the NFD nursery and the need for locally-sourced native plant material, the Navajo Nation Department of Fish and Wildlife recently initiated the Diné Native Plants Program (DNPP) to develop native plant material production on the Navajo Nation. The DNPP's ultimate goal is to utilize the NFD existing nursery infrastructure (greenhouses, irrigation, seed cleaning equipment, seed storage, etc.) to expand plant material production to include other grass, forb, shrub, and tree species native to the region. The DNPP's goal is to focus seed collection and propagation efforts on widespread "workhorse" species that are important for restoration, rare species with limited distribution for conservation, and culturally-important species for the purpose of education and preservation of traditional knowledge. We intend to collaborate with both tribal and non-tribal stakeholders to promote biological diversity on the Colorado Plateau while also providing Navajo community members access to culturally-important native plants.

Before these long-term goals can be realized, planning and research must be conducted to assess the need and feasibility of operating a native plants program on the Navajo Nation. Feasibility assessments are commonly completed prior to substantial personnel and infrastructure investment in a native plants program in order to garner and gauge public interest and to assess public and agency native plant needs (Lynn et al. 2008, Luna et al. 2003). We conducted such a feasibility assessment in January and February of 2018 in order to gain insight into the uses and needs for native plant materials by potential benefactors of the DNPP. This included surveying professional, tribal, and non-tribal stakeholders, as well as Navajo community members from across the Navajo Nation. The results from this assessment are summarized in this report and will be used to guide the scope and mission of the DNPP, aid in developing a priority species list for seed collection and grow-out, and ensure that the DNPP is meeting stakeholder native plant demands on the Navajo Nation.

METHODS

Agency/Organization Survey

We developed a 22 question survey to assess the current and future native plant needs of various Navajo Nation agencies, federal stakeholders, and affiliated organizations. This information will help determine if the demand for native plant material is great enough to warrant a dedicated nursery and seedbank on the Navajo Nation. We borrowed many of our survey methods directly from Peppin et al. (2010), who conducted a similar assessment of native plant material market needs in Northern Arizona. We divided our survey into two sections; current plant material use, and anticipated native plant material use in the next 5-10 years. The two sections are similar with some redundancy for questions regarding the purpose of plant use, type of plant material needed, and annual expenditures. A complete example of our agency survey can be found in Appendix A. All questions in our survey had a "Don't know" and "Decline to answer" option. We asked three questions on the survey that required participants to rank the most desirable grass, forb, and shrub/tree species, for which we provided species lists to select from. The species lists we provided were adapted from BLM priority species lists for the Colorado Plateau, minus

common Colorado and Utah species that are not widespread on the Navajo Nation. We distributed the survey both via email using the web tool SurveyMonkey (www.surveymonkey.com), and in hardcopy. The online survey was prefaced with a brief description of our project and the purpose of the survey, while hardcopy surveys were distributed with a similar verbal preface. The online survey utilized “skip logic” which directs participants to specific question sets based on previous answers. For example, if the survey participant indicated “No” they did not current utilize plant material, they skipped other current use questions and were directed to questions pertaining to anticipated use.

We compiled a list of potential survey participants that work professionally in the field of natural resources and who might benefit from native plant material production on the Navajo Nation. We obtained contact information for potential survey participants (email addresses and phone numbers) through online staff directories and/or by contacting participant’s departments. Additionally, a small number of participants were suggested in the survey by other participants (question 21 asks for other relevant people/agencies/organizations to contact). Potential participants included Navajo government, federal, state, private, and non-profit agencies/organizations. We initially distributed the survey to target participants through a SurveyMonkey email invitation on December 11, 2017. We followed-up with additional email requests to participate in the survey on December 19, 2017 and February 27, 2018. In addition, Navajo agency individuals representing sub-departments under the Navajo Division of Natural Resources were solicited in-person to complete a hardcopy version of the survey during a Climate Change Adaptation Planning Session that took place at the Native America Cultural Center at Northern Arizona University from January 17-19, 2018.

Community Survey

We developed a 14 question survey to assess the native plant needs of Navajo community members across the Navajo Nation. Again, we developed questions based in part on similar feasibility assessments conducted in the region (Peppin et al. 2010, Watters & McCormick 2016); however, we adapted the questions for tribal members in order to gather information on personal and cultural uses of native plants. A complete copy of our community survey can be found in Appendix B. We administered both a hardcopy and online version of our survey to increase the return rate and diversify our demographic. We posted the online survey (using SurveyMonkey) on the Navajo Nation Department of Fish and Wildlife’s website and Facebook page. The online survey included a brief description of our project and the purpose of the survey. We administered hard-copy surveys in person at chapter meetings across the Navajo Nation in January and February, 2018. We selected 22 chapters to visit based on logistical considerations, while also attempting to adequately spread our sampling across all agencies and regions of the Navajo Nation. At each chapter meeting we delivered a 5-10 minute presentation describing our project and the purpose of the survey, emphasizing our interest in non-agricultural native plants, after which we distributed the survey. To increase our return rate we gave away small wildflower seed packets as an incentive prize for completing the survey.

Data Analysis

We compiled all data and calculated basic statistics using Microsoft Excel. We calculated survey sample sizes (n) and percentages separately for each question based on the number of respondents reporting legitimate answers. For example, we omitted all non-native and agricultural plants from the dataset before calculating the percentage; we refer to this as the valid percent. Non-specific answers such as “ceremonial plants” or “medicinal plants” were included in calculations, but not reported in figures. We did not include “decline to answer” and unanswered questions in our calculation of the valid percent (for a list of omitted responses refer to Appendix E). We rounded percentages to the nearest whole number, which may in some cases result in totals slightly greater or less than 100%. Also, for questions that allowed

multiple answers, we calculate percentages based on the number of respondents rather than number of specific responses; therefore in some cases the total percentages exceed 100%.

All questions on the community survey had a write-in option (as opposed to multiple-choice selection) either exclusively, such as question 2 “What native plants do you use?”, or as an “Other (please specify)” option. For these open response questions we summarized responses into broader categories before analysis. For example, we combined the responses Navajo tea, native tea, Indian tea, wild tea, and tea into the single response “Navajo tea” before analysis. Furthermore, some community members responded to the species specific questions (questions 2, 5, and 6) with Navajo plant names, in which case we referred to Matthews (1886), Wyman & Harris (1941), Elmore (1944), and Mayes et al. (1989) for English translations, though we were unable to translate every response. The responses we were unable to translate and determine corresponding plants were included in calculations as valid responses.

Finally, questions 14, 15, 16 on the agency/organization survey and question 6 on the community survey asked participants to rank species from most desirable to least. However, most participants simply listed or selected species in no particular order. Consequently we were only able to calculate the percentage of participants reporting each species.

Results

Agency/Organization Native Plant Needs

We solicited 139 individuals from relevant agencies/organizations and we received 46 completed surveys (33% response rate). The largest number of responses came from Navajo Nation agencies (39%), followed by federal (26%), and non-profit (17%) agencies/organizations (Table 1).

Table 1. Total number and percent of survey participants by agency/organization type.

<i>Agency/organization type</i>	<i>Participants</i>	<i>Percent</i>
Navajo Nation	18	39
Federal	12	26
Nonprofit	8	17
State	4	9
Private	3	7
Local	1	2
Total	46	100

Current Agency/Organization Plant Material Use

A majority of respondents (67%, n=46) answered “Yes” their agency/organization utilizes live, non-agricultural plant material (Figure 2a). Of those that utilize plant material 68% (n=31) said they use only native species, while 26% said they use both non-native and native species (Figure 2b). Less than half (43%) of these agencies/organizations reported having a specific policy regarding the use of non-native vs. native plant species. Forty percent said “No” they had no such policy and 17% did not know.

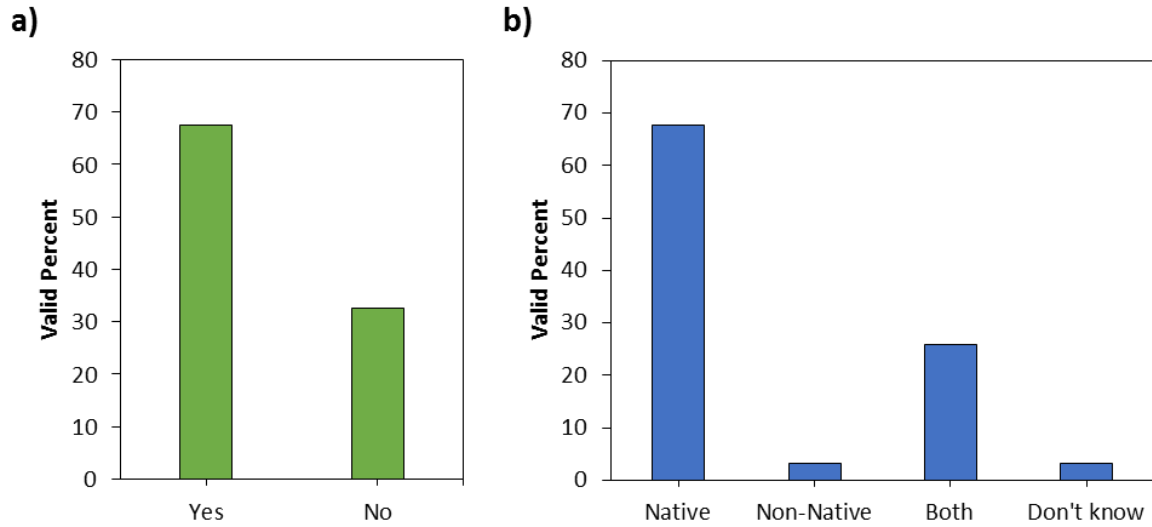


Figure 2. a) Percent of agencies/organizations that utilize (Yes) and do not utilize (No) live, non-agricultural plant material, and b) the type of species used by agencies/organizations that responded affirmatively.

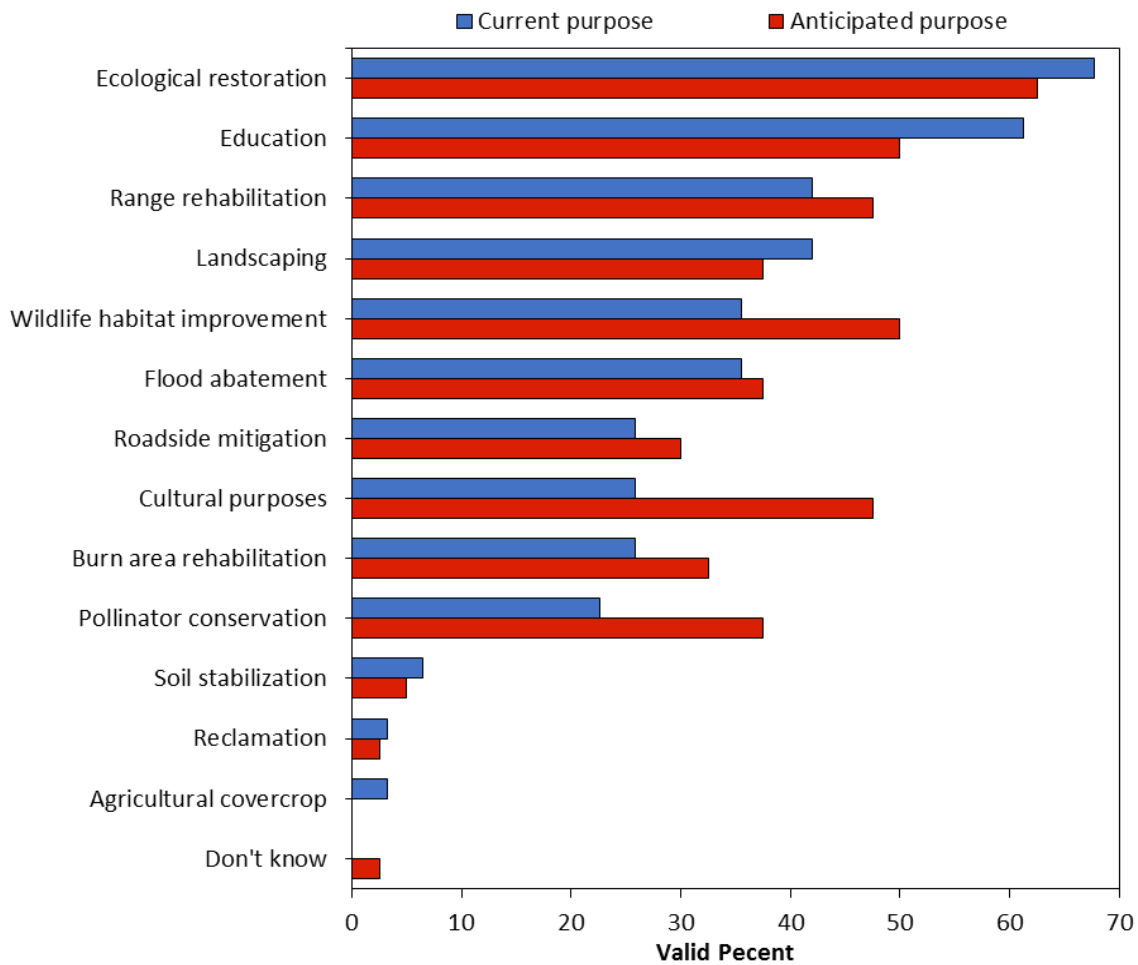


Figure 3. Current purpose of any plant material purchased and anticipated (next 5-10 years) purpose of native plant material purchased by agencies/organizations.

The majority of respondents reported using plant material for “ecological restoration” (68%) and “education” (61%, Figure 3). The next most common use was “range rehabilitation” (42%) and “landscaping” (42%), followed by “wildlife habitat improvement” (35%) and “flood abatement” (35%). Seed was the most common type of plant material utilized (81%) followed by cuttings (48%) and container seedlings (35%, Figure 4b). The majority of respondents did not know how much money their agency spent on plant material annually (55%, n=29). Of those who did respond, 46% (n=13) spent less than \$500, while 38% reported spending more than \$5,000 on plant material annually. Overall, dollar amounts reported ranged from \$0 to \$10,000. When asked their principle source of plant material, the most common provider listed was Granite Seed (13%, n=45), followed by local collection (7%), and Native Seed/SEARCH in Tucson, AZ (4%). Thirteen other specific providers were reported from Colorado, New Mexico, Arizona, and Utah.

A majority of respondents (68%, n=31) said “Yes” their agency/organization was concerned about the genetic or regional source of plant material purchased. Only 23% were not concerned. Probability of success (71%, n=31) was the most important factor when deciding what plant material to purchase, followed by cost (55%), wildlife/habitat objectives, maintaining diversity (45%), the size of the project (42%), and plant adaptability (3%). Several agencies/organizations (41%, n=29) reported not having any means to collect, store, or grow plant material, however, others reported having various capabilities. Thirty-one percent said they have land available, 21% have greenhouses, 17% have storage facilities, 17% have seed processing equipment, 17% have irrigation capabilities, and 10% have seed collecting equipment.

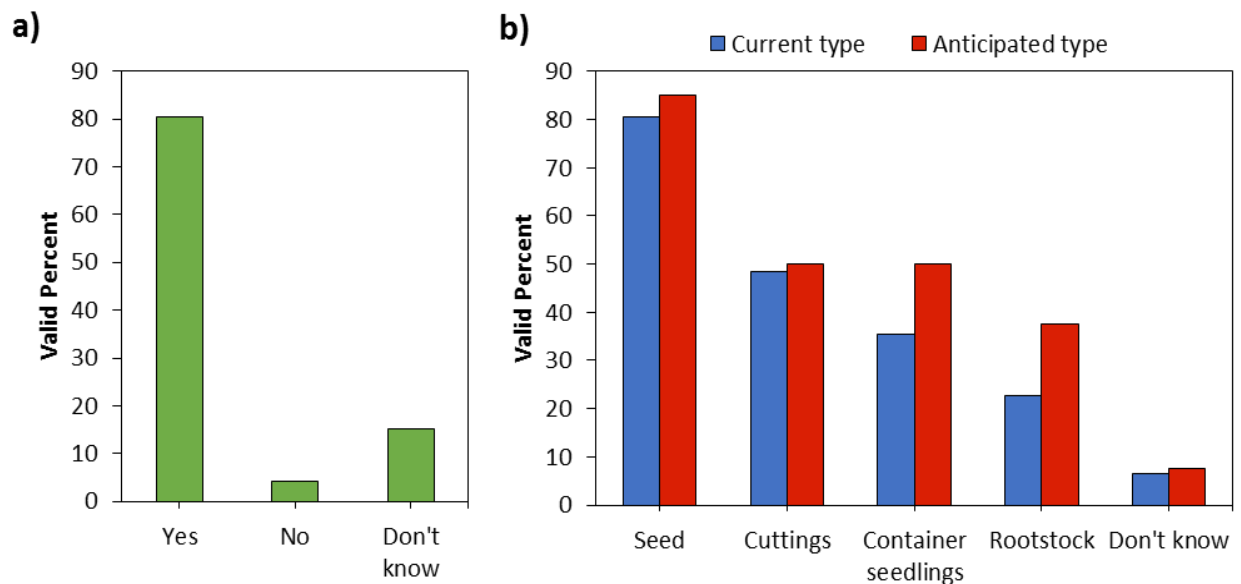


Figure 4. a) Percent of agencies/organizations that anticipate needing native plant material in the next 5-10 years. b) Current type of plant material utilized and anticipated type of native plant material needed.

Anticipated Agency/Organization Native Plant Material Use

When asked about their native plant needs in the next 5-10 years, a majority of agencies/organizations surveyed (80%, n=46) anticipate needing local, native plant material, only 4% said that they wouldn't (Figure 4a.). The most common use for native plants in the 5-10 years, again, is ecological restoration (63%, n=40) followed by education and wildlife habitat improvement (50% each, Figure 3). Cultural purposes (48%) and range rehabilitation (48%) were the next most common uses, followed by pollinator conservation, flood abatement, and landscaping (38% each).

For the native plant needs indicated, the majority of respondents (85%, n=40) answered that they would want native plant seed in the next 5-10 years (Figure 4b). Fifty percent said they would want cuttings and container plants and 38% responded rootstock. When asked which top five grass species their agency/organization anticipated needing, respondents (n=38) selected Indian ricegrass (*Achnatherum hymenoides*, 53%), blue grama (*Bouteloua gracilis*, 50%), alkali sacaton (*Sporobolus airoides*, 26%), western wheatgrass (*Pascopyrum smithii*, 26%), and galleta grass (*Pleuraphis jamesii*, 26%, Figure 5). When asked which top five forbs their agency/organization would likely need in the next 5-10 years, respondents (n=38) selected globe mallow (*Sphaeralcea spp.*, 24%), Rocky Mountain beeplant (*Cleome serrulata*, 21%), Rocky Mountain penstemon (*Penstemon strictus*, 18%), butterfly milkweed (*Asclepias tuberosa*, 16%), and Colorado four o'clock (*Mirabilis multiflora*, 16%). When asked which trees or

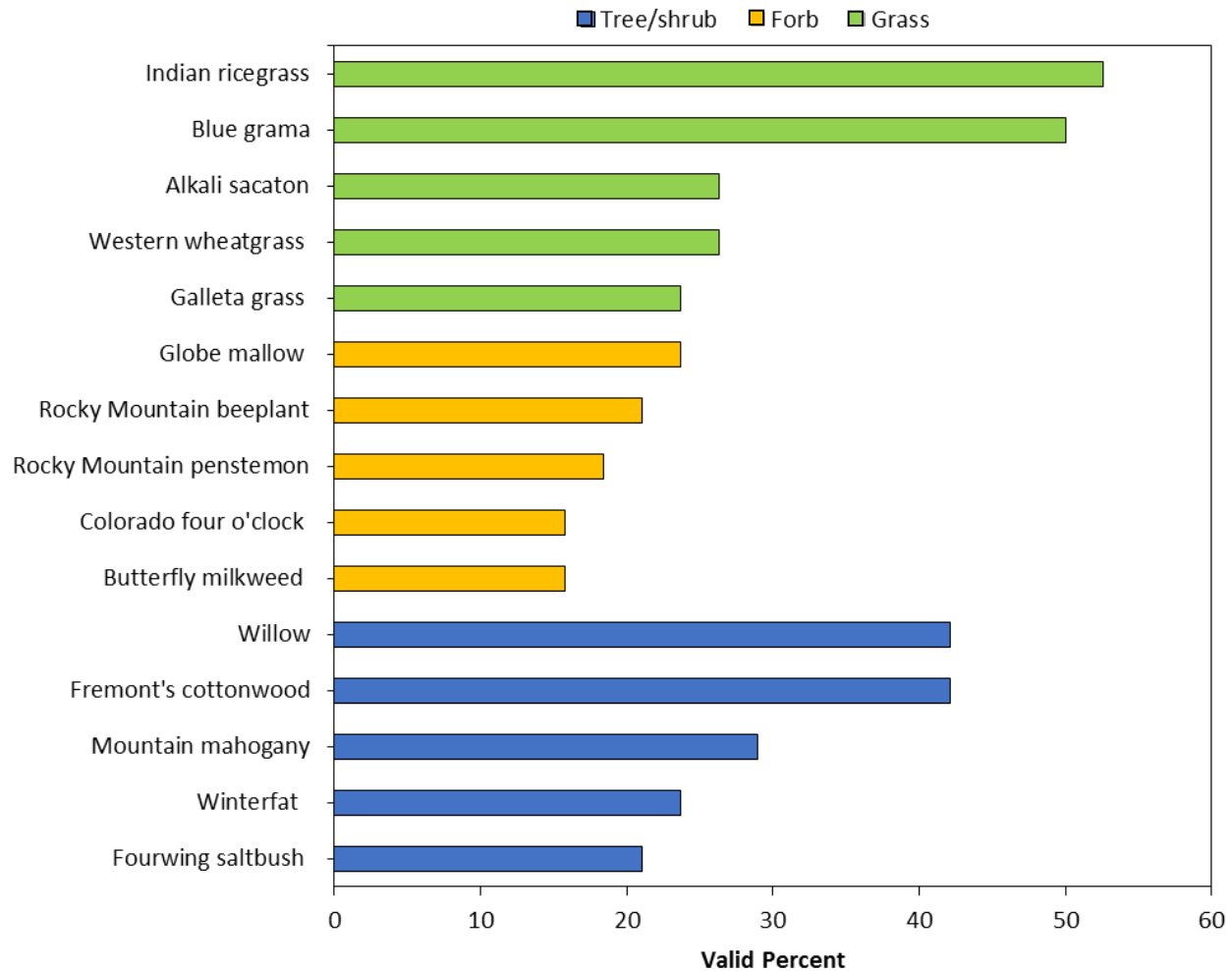


Figure 5. Top 5 native tree/shrub, forb, and grass species agencies/organizations would like to have brought into local production in the next 5-10 years.

shrubs were preferred, respondents (n=38) selected Fremont cottonwood (*Populus fremontii*, 42%), willow (*Salix spp.*, 42%), mountain mahogany (*Cercocarpus montanus*, 29%), winterfat (*Krascheninnikovia lanata*, 24%), and fourwing saltbush (*Atriplex canescens var. angustifolia*, 21%). For a complete list of species indicated by respondents see Appendix C. The most common habitat type indicated where native plant material would be utilized was riparian habitat (68%, n=38), pinon-juniper woodland (66%), desert scrub (58%), grassland (55%), and agricultural/urban mid to low water-use desert environments (55%).

The most common obstacle to successfully initiating a native plant material market on the Navajo Nation reported was the knowledge of the use of native plants (53%, n=40). Fostering partnerships with other agencies (45%), availability of seed (43%), cost of facilities (33%), and lack of funding from other agencies (33%) were also common answers. When asked if their agency/organization would be willing to purchase local, native plant material from a partnership of growers and buyers, 74% (n=39) said “yes” they would.

Community Native Plant Needs

Over the course of January and February 2018 we attended 22 chapter meetings across the Navajo Nation (Figure 6) and collected a total of 225 community native plant needs assessment surveys. Of these, 82 (36.4%) were from online submissions through the survey link posted on the Navajo Nation Department of Fish and Wildlife’s webpage and social media (Facebook) page.

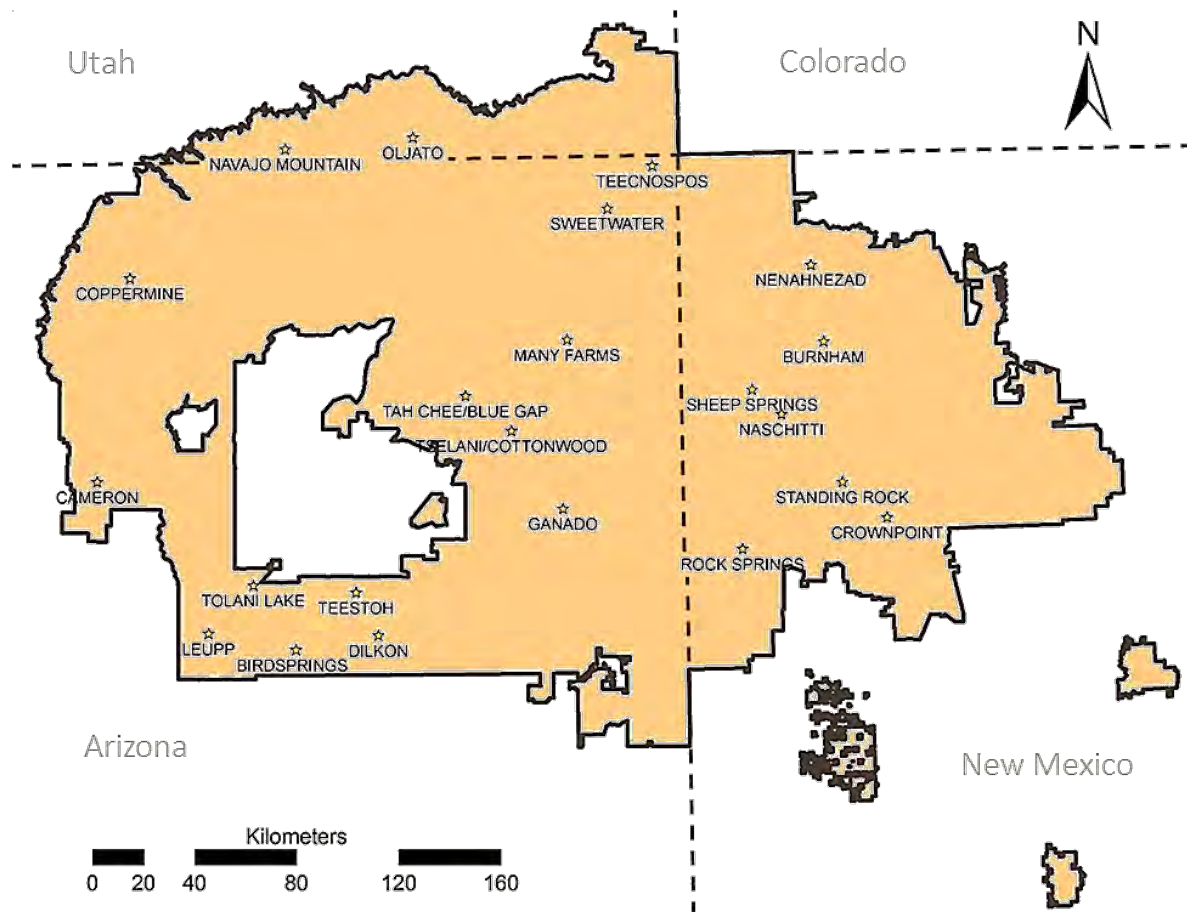


Figure 6. Twenty-two Navajo Nation chapters were visited in January and February, 2018 during each chapter’s monthly community meeting (indicated by stars). A short presentation was given and surveys were distributed to community members present.

Personal Native Plant Use

An overwhelming majority (95%, n=224) of people we surveyed responded “Yes” they use non-agricultural native plants for personal or cultural purposes (Figure 7a). Food (68%, n=210), cultural/ceremonial (63%), and medicinal (58%) were the most common uses of native plants reported

(Figure 7b). Respondents listed using 54 specific native plants. A majority of respondents (58%, n=179) reported using Navajo tea, followed by sagebrush (47%), juniper or cedar (32%), and yucca (23%, Figure 8). For a complete list of native plants reported see Appendix D. The most common means of obtaining native plants reported was to collect them from the wild (83%, n=206), while 47% purchase and 20% grow the native plants they use. Nearly half of respondents (48%, n=207) reported that “Yes” some native plants they use have become scarce or difficult to find, 28% said “No”, and 24% didn’t know. Navajo tea (24%, n=85) was the most common native plant reported as becoming scarce, followed by yucca (12%), sagebrush (8%), sumac (7%), and wild onion (6%, Figure 8). Fourteen percent of respondents did not specify which native plants were becoming scarce and 14% said they did not know the (English) names of the plants.

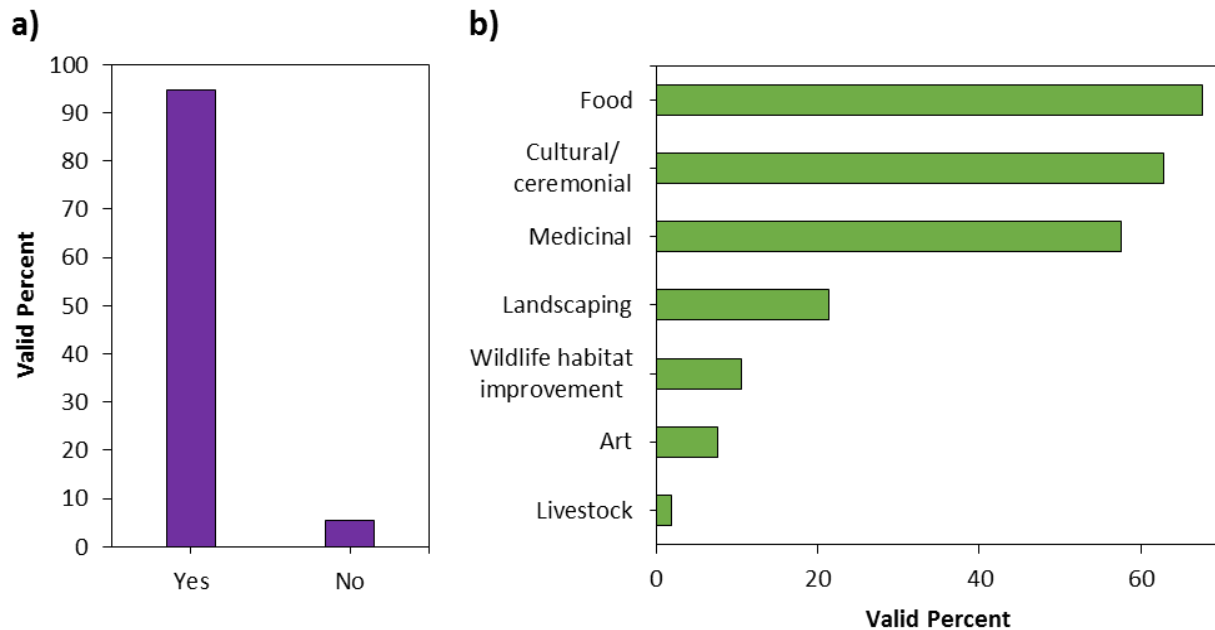


Figure 7. a) Percent of community members that use (Yes) and do not use (No) native plants, and b) their purposes. Other purposes (<1%) were education, nature, firewood, construction, restoration, and don't know.

Local Native Plant Production

When asked what native plants they would like to see grown locally, 39% (n=166) did not know which plants they wanted grown. The top five native plants listed, of those who did respond, were Navajo tea (24%), sumac (11%), sagebrush (11%), yucca (11%), and juniper (8%, Figure 8). Seventy three percent of respondents (n=218) indicated they would want native plants in the form of seed, 39 % wanted native rootstock, 34% wanted container plants, and 23% wanted cuttings.

Community Participation and Environmental Concerns

A majority of respondents (69%, n=217) indicated they would be interested in participating in workshops involving traditional uses of native plants and 28% were not interested (Figure 9a). Only 3% of respondents indicated they would be willing to lead such workshops, however, there were no comments on what type of workshops they would lead. Sixty-six percent (n=212) of respondents were “Interested” or “Very interested” in partnering with our program to grow native plants, 21% needed more information, and 13% were not interested (Figure 9b). Respondents who were interested in growing native plants indicated a wide range of available growing space. Responses ranged from qualitative, such as “Backyard”, “Some space”, and “Chapter house”, to more quantitative responses which ranged from 0.1-

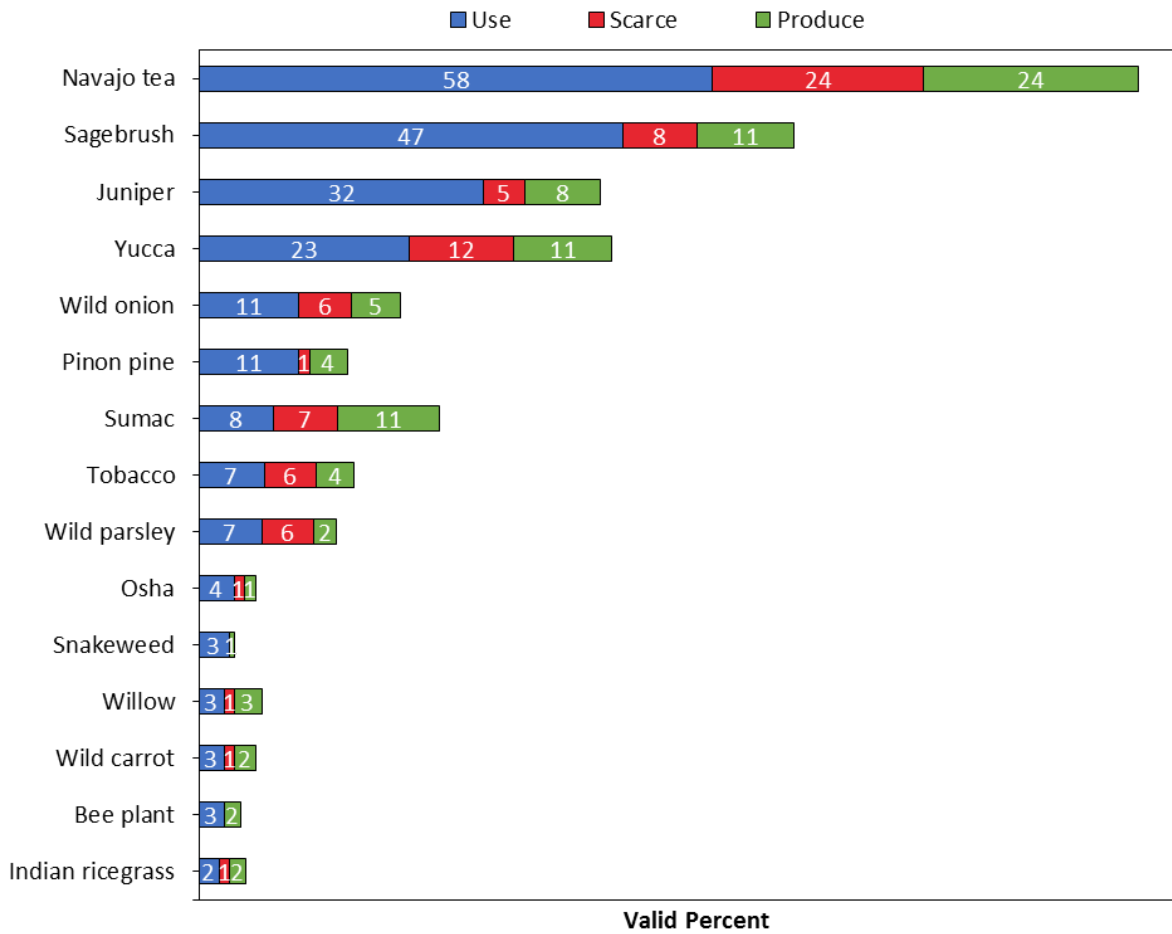


Figure 8. Top 15 native plants community members reported using (blue), plants becoming scarce (red), and plants they would like produced (green).

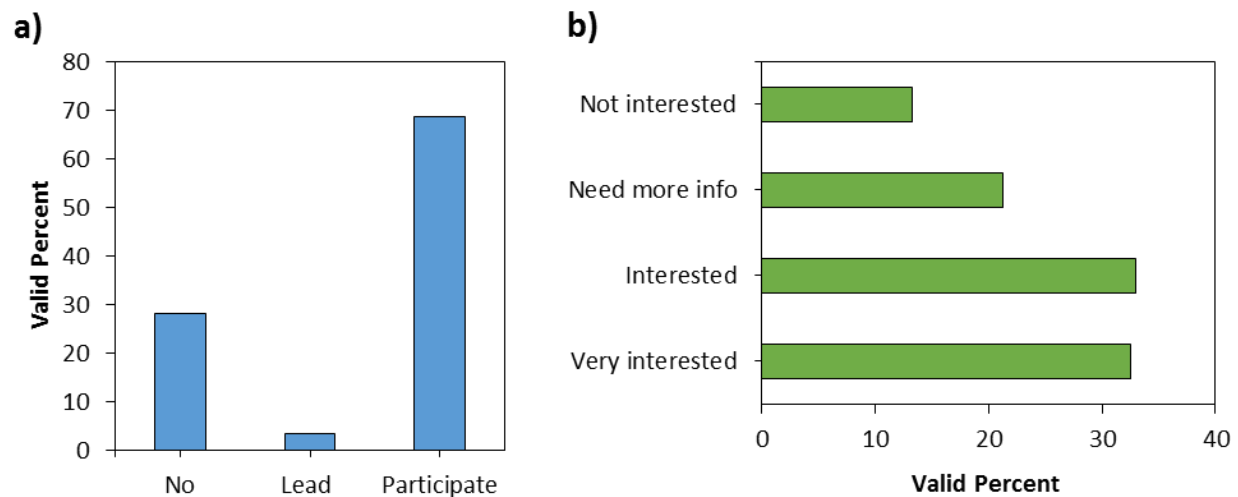


Figure 9. a) Percent of community members who were interested in participating in native plant workshops. b) Percent of community members interested in growing native plants on their personal farms.

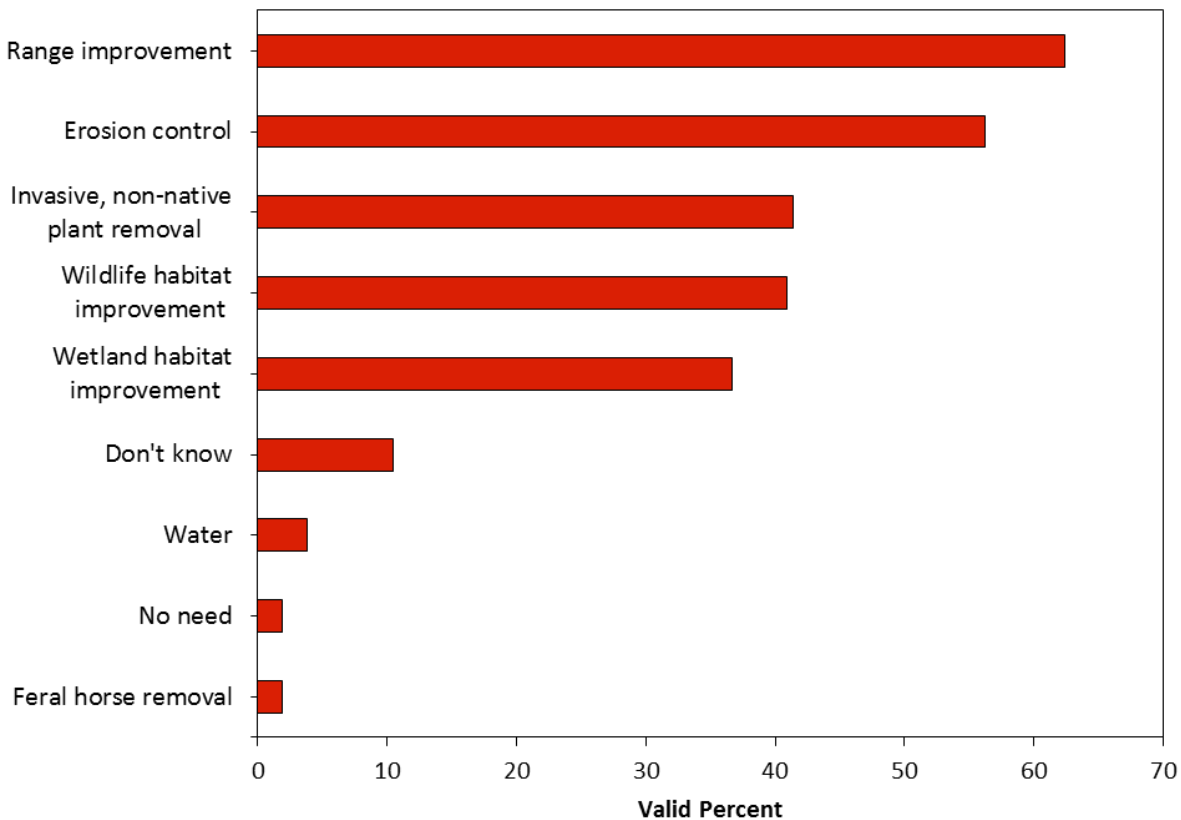


Figure 10. Environmental issues that need improvement in Navajo Communities. Other responses were bioremediation, illegal dumping, post-fire restoration, education, climate change, and off-road vehicle activity (all reported by <2% of respondents).

2,300 acres. Forty-seven percent (n=206) of respondents were interested in participating in our program as a committee member or an advisor and 9% needed more information. Forty-five percent were not interested.

When asked if there was a need to improve the health of the land in their community only 2% (n=210) of respondents said there was “No need” (Figure 10). The most common needs selected were “Range improvement” (62%) and “Erosion control” (56%), followed by “Invasive, Non-native plant removal” (41%), “Wildlife habitat improvement” (41%), and “Wetland habitat improvement” (37%). Ten percent of respondents indicated “Other” issues including various water issues (4%), Feral horse removal (2%), Bioremediation (1%), and Illegal dumping (1%).

DISCUSSION

The methods we utilized for this assessment were intended to generally gauge interest in our program and infer native plant species important to the Navajo people and Navajo agencies/organizations. We did not intend to conduct an exhaustive ethnobotanical assessment of the Navajo people or a definitive evaluation of agencies uses and needs on the Navajo Nation. We acknowledge that our sample size is limited and our sampling non-random; therefore our assessment lacks statistical power and any generalizations of our findings should be made with caution. However, this assessment offers unique insight into native plant uses and needs on the Navajo Nation.

With this in mind, we feel the results of our surveys clearly indicate the need for producing locally-sourced, native plant material on the Navajo Nation for use in restoration, conservation, and cultural preservation. The Navajo community members and Navajo agencies/organizations we surveyed expressed needs, both current and anticipated, that can be met by the Diné Native Plants Program. We will use the feedback we received through these surveys to tailor our seed collection and propagation efforts to meet the needs of both land managers and the Diné people. This assessment will serve as the foundation upon which we will continue to develop the Diné Native Plants Program into a lasting, successful operation for the Navajo Nation.

Agency/Organization Native Plant Needs

Federal, tribal, state, and non-profit needs and uses of native plants on the Navajo Nation are similar to those in surrounding regions (see Peppin et al. 2010, Shaw et al. 2012, Watters & McCormick 2016). In particular, Peppin et al. (2010) reported similar agency needs to our study in their native plant material market assessment of the Southern Colorado Plateau, despite surveying only one tribal department (the Navajo Natural Heritage Program). Ecological restoration was the most common current and anticipated use of native plant material for our survey and for the assessment by Peppin et al. (2010). Additionally, several of the most commonly desired species reported in their assessment, such as blue grama (*Bouteloua gracilis*), Indian ricegrass (*Achnatherum hymenoides*), globemallow (*Sphaeralcea spp.*), penstemon (*Penstemon spp.*), winterfat (*Krascheninnikovia lanata*), and fourwing saltbush (*Atriplex canescens*) were also among the top species reported in our survey. Watters & McCormick's (2016) needs assessment of the Verde Valley in Arizona also revealed similar needs to our findings. Again, restoration was the main use of native plant material purchased by those surveyed and many of the same species were reported as desired, including cottonwood (*Populus fremontii*) and willow (*Salix spp.*) (Watters & McCormick 2016). These similarities in results are not surprising, given the similarity in ecosystems and environmental issues within Arizona, regardless of tribal boundaries. Furthermore, this regional similarity of native plant material needs and uses indicates an opportunity for collaboration and information sharing between the Navajo Native Plants Program and other native plant programs within the Southwest (see the "collaboration" section for further discussion).

Another similarity in native plant needs between our assessment and others in the region was the high demand for seed over other types of plant material (Peppin et al. 2010, Watters & McCormick 2016). Direct seeding is often the most cost effective method of revegetation, particularly when large tracks of land are being restored (Richards et al. 1998, Beyers 2004). For this reason, it is commonly employed on federal lands, especially following wildfire, and there has been a change in recent decades within some federal agencies to prioritize the use of native seed over non-natives (Beyers 2004, Peppin et al. 2011). Unfortunately, high costs associated with purchasing certain highly desirable native species coupled with difficulties in finding genetically-appropriate native plant material commercially can limit the use of native seed for revegetation and restoration (Lynn et al. 2008). Despite a majority of agencies/organizations reporting being concerned about the genetic source of plant material purchased in our assessment, the most common supplier of plant material was the non-regional company Granite Seed, which has locations in Lehi, UT, Denver, CO, and Tempe, AZ. This was also true for Peppin et al. (2010) and Watters & McCormick's (2016) assessment where a large majority of participants indicated being concerned with the genetic source of plant material purchased, however, Granite Seed was also listed as the most common provider. This is likely a reflection of the lack of locally-sourced plant material within the commercial seed market, and/or a reflection of economic or logistical barriers to obtaining regionally-sourced plant material.

The Navajo Native Plants Program will focus the majority of our seed collection on native "workhorse" species that can be used in revegetation and restoration. We plan to use a portion of the seed we collect

for seed increase efforts to increase the availability of locally-sourced native seed on the Navajo Nation. Seed increase involves planting wild-collected, native seed stock in stringent agricultural and environmental conditions in order to produce high yields of quality native seed (Seeds of Success n.d.). Ideally, Navajo farmers with existing infrastructure (irrigation, crop land, equipment) could join a native seed increase cooperative to grow native plants aimed at providing stakeholders with native seed while simultaneously bringing income to rural communities. The Diné Native Plants Program would facilitate seed increase efforts by providing farmers with seed and training, coordinating harvesting efforts, and cleaning and storing increased seed. Several survey participants reported having various plant production capabilities (including land, irrigation capabilities, and greenhouses). We hope to cooperate with these individuals and other Navajo Nation, state, and federal entities to accomplish this goal.

Financial Feasibility of the Diné Native Plants Program

In order to assess the financial feasibility of the Diné Native Plants Program, we asked participants about their current and anticipated expenditures on plant material. However, very few respondents reported actual dollar amounts for annual purchases of native plant material. Therefore it's difficult to anticipate how much funding from stakeholders will be allocated for purchasing native plant materials in the future. Those that did report annual spending varied widely in how much their organization allocated to purchasing native plant materials to meet their natural resource objectives. Nevertheless, attitudes about the importance of using genetically-appropriate native plants for ecological restoration have been evolving, both on the Navajo Nation and in the United States in general (Richards et al. 1998, Beyers 2004). Recent federal policies requiring the use of native plant material for restoration activities such as post-fire rehabilitation, riparian restoration, and range rehabilitation have increased the availability of funding for native plant programs in order to meet the increased need for native plant material (Peppin et al. 2010). The Navajo Nation does not currently have a specific policy regarding the use of native plant material (see the Navajo Native Plant Policy section for further discussion); however, federal agencies operating on Navajo land have the potential to provide future funding for the DNPP.

The Bureau of Indian Affairs (BIA), which is responsible for several restoration projects on the Navajo Nation, will be an important funding source for the DNPP. In addition to funding this assessment, the BIA developed the Integrated Weed Management Plan for the Navajo Nation. This plan specifically calls for revegetation using locally-sourced native plants following invasive species removal (U.S. Department of the Interior Bureau of Indian Affairs, Navajo Region 2016). In this plan there are several projects outlined in which invasive species have already been mapped and are ready to be treated. The DNPP has the potential to provide native plants for this and many similar revegetation projects proposed by federal and tribal agencies occurring on Navajo land. For example, the BIA has employed tribal youth conservation crews to remove tamarisk and Russian olive from priority watersheds. For the majority of these projects, native vegetation is not being replanted or reseeded once invasive plants are removed, which could result in increased erosion, reestablishment of invasive plants, and decreased wildlife habitat quality within the watershed post-treatment (N. Talkington, NNHP Botanist, personal communication, September, 2018). Similarly, a watershed-wide riparian restoration project will occur within the Black Creek watershed (a tributary to the Puerco River) in a partnership between the Natural Resources Conservation Service (NRCS) and agencies within the Navajo Division of Natural Resources. However, it is currently unclear where plant material used for revegetation efforts for this project will be obtained. Based on a demonstrated immediate need for ecological restoration expressed by agencies working on the Navajo Nation, we're confident there are sufficient funding opportunities through state, federal, and tribal restoration projects to demonstrate the financial feasibility of the DNPP. Furthermore, we believe that establishing a tribally-run native plants program will encourage more ecological restoration and use of

native plants on the Navajo Nation, and has the potential to develop into a financially self-sustaining enterprise.

Navajo Community Native Plant Needs

The results of our survey indicate that the ecological health of Navajo land and access to native plants remain very relevant to the livelihood of the Diné people. There is subsequently considerable public interest in the Diné Native Plants Program's mission. An overwhelming majority of participants reported collecting and using native plants for personal or cultural purposes. Over 65 species of native plants were listed as either personally used, becoming scarce, or desired for production, which is an overt sign of the traditional plant knowledge still in existence among the Diné people. Unsurprisingly, there was also a high level of awareness of major environmental issues on the reservation, with a majority of people indicating the need for range improvement, erosion control, invasive species removal, and wildlife habitat improvement in their community. The DNPP will serve a dual purpose to the community by simultaneously providing native plants for restoration to address the environmental issues highlighted by community members, while also providing plants and hosting workshops to preserve Diné culture and traditional knowledge.

A majority of the responses we received from our survey indicated that native plants are still being used as traditional foods on the Navajo Nation. Food was the most common personal use of native plants and nine of the top 15 plants requested were traditionally consumed. Also, a majority of participants expressed interest in attending workshops involving native plants, including workshops focused on collecting and preparing traditional foods. These results appear to align with the current movement occurring within indigenous communities throughout North America and on the Navajo Nation focused on revitalizing cultural knowledge and the practice of wild-collecting native plants that were once traditional foods (Diné Policy Institute 2014, Kamal et al. 2015). The Diné Policy Institute [DPI] (2014), through their own survey of Navajo communities, also found an overwhelming interest in revitalizing traditional Navajo food. In response, DPI developed the Diné Food Sovereignty Initiative to combat the high rates of nutritionally-related illness and the lack of healthy food on the Navajo Nation. Through this initiative DPI has engaged in public education and outreach on topics such as rangeland management, wild food collection, and traditional food teachings to revitalize healthy, self-sufficient food systems for the Navajo people (Diné Policy Institute 2014). Once established, the Diné Native Plants Program will be poised to complement this and similar initiatives by providing plant material for educational workshops on traditional uses of native plants and by providing a space for these workshops to occur. Furthermore, DNPP staff would be able to provide expertise to community members on identification, proper harvesting, and propagation techniques of native plants. Cultural preservation is a major goal of the Diné Native Plants Program and it is apparent that there is considerable demand for this type of access and expertise.

In addition to native plant workshops, several community members expressed interest in partnering with the DNPP to help us meet some of our program objectives. A majority of people surveyed conveyed interest in growing native plants in collaboration with the DNPP, and several people indicated they had available farmland that could be used. Seed increase is a goal of the DNPP and partnering with local farmers to grow native plants would help us accomplish our mission while also providing economic opportunities for rural communities. Also, about half of those surveyed indicated that they would be interested in advising the DNPP as a member of a committee put in place to provide regular community input to NNHP program objectives. Having input from Navajo people would be invaluable to our program and would ensure we are meeting the needs of the people while also respecting the traditions and customs we're trying to preserve. A small portion of the people we surveyed expressed concern about growing ceremonial and culturally-important plants in a greenhouse setting. A committee of Navajo

herbalist and medicine people would provide guidance on such culturally sensitive plants and help us to identify which species need to be grown and which are off-limits for propagation.

Target Species Selection

The 101 specific native plants reported on the community and agency surveys will serve as the basis for our target species list. Because resources are limited we prioritized species for seed collection and propagation by reconciling the needs of the Navajo people, Navajo (and affiliated) agencies/ organizations, and specific goals of the DNPP. Species that were frequently reported and species that are important for both restoration and Navajo culture (those that were reported on both agency and community surveys) will be a high priority for collection.

In order to maximize revegetation success, ideally we will work to secure contracts to produce native plants for projects years in advance, which will allow us the time to collect seed from target species at specific project sites to preserve local adaptation and increase the chances of survival following out-planting. In their Nursery Manual for Native Plants: A Guide for Tribal Nurseries, Dumroese et al. (2009) recommends this method, referred to as the “target plant concept” to guide species selection and grow-out. This concept emphasizes starting with specific project objectives and out-planting site characteristics to determine the most appropriate species to propagate and type of plant material to produce. According to this concept we will propagate plants on a project-by-project basis to ensure that plant materials are genetically suited for a particular revegetation site. Prioritizing species on a per-project basis will allow us to meet the needs of the client and to ensure that the plant material we produce will have the best chance of survival at the restoration site.

Although the target species concept works well for projects for which there are several years of advance planning, we recognize that funding opportunities do not always allow for a multiple seasons of seed collection prior to project implementation. For this reason, initially, we will collect seed opportunistically in order to develop a robust seedbank of diverse culturally-important and common restoration species. This will allow us to have numerous accessions of priority species on-hand for propagation if projects arise on short notice or if certain species have “bad” years where there isn’t an adequate seed crop to collect from the wild. Because provenance and the genetic suitability of plant material is important to us, while being opportunistic, we will also be particular about collecting seed broadly from areas with ubiquitous environmental conditions. This will broaden the range of potential sites and projects for which we will be able to provide plant material.

An additional factor taken into account when determining our target species list is our ability to successfully propagate the species we collect. Native plants can be difficult to grow and some have complicated germination requirements. Fortunately, there have been significant innovations in native plant material development and propagation techniques. Organizations such as the Natural Resource Conservation Service (NRCS) and the Reforestation, Nurseries and Genetic Resources (RNNGR) program have online databases that supply growers with up-to-date technical information on the propagation of numerous native species. This valuable information will assist us in developing germination and propagation protocols for species selected for grow-out. Several species suggested by community members do not have existing propagation protocols and growing them will require resources and experimentation. In order to conserve resources and efficiently produce native plants we selected species with available propagation protocols for our target species list.

Seed Collection Strategy

Several decades of scientific research on the topic suggests that there are important guidelines to follow in order to produce high quality plant material that has the best chance of establishing and persisting at the restoration site. It is most important to balance the costs and benefits of maximizing genetic diversity and evolutionary potential by collecting broadly within a population, while also preserving local adaptation to specific site characteristics (McKay et al. 2005, Ward et al. 2008). In order to accomplish this, the DNPP will collect, accession, and store native seed and plant material according to the BLM Seeds of Success (SOS) protocol. This protocol is designed to maximize the genetic diversity of the species being collected on a population-level while also ensuring that the long-term viability of wild populations are not impacted by seed collection (Seeds of Success 2018). The SOS protocol outlines the requirements for the minimum number of plants to collect from within a population, the ideal number of seeds to collect, the maximum proportion of available seed to collect, etc. Furthermore, it provides a framework to organize and accession collections by establishing a collector identification code and collection number for each seed collection. Following this protocol will not only allow us to efficiently and systematically collect source-identified seed for DNPP purposes, but it will also allow us to collaborate with the SOS program in the future to collect and archive genetically distinct native seed from the Navajo Nation.

Seed Transfer Zones

It is often not feasible to collect and propagate plant material from every restoration site due to financial and time constraints or, for severely degraded sites, a lack of available seed to collect. In these cases seed transfer zones are commonly used to define where seeds or plant material can be deployed outside of the area they were collected, with low risk of maladaptation, loss of local adaptation, and mortality (Hufford and Mazer 2003, Miller et al. 2011). There are several ways in which seed transfer zones can be defined, but most involve grouping together areas with similar, topography, climate, or soils (Miller et al. 2011, Bower et al. 2014). The most accurate seed transfer zones are empirically determined through common garden studies; however, there are very few species that have been subjected to this type of research. Ecoregions are another more accessible method of defining seed transfer zones that utilize geology, landforms, soils, vegetation, climate, land use, and hydrology to delineate similar regions (Omernik 1987, Miller et al 2011). The Environmental Protection Agency (EPA) defines ecoregions of the United States in four levels, ranging from general regions to detailed ecological areas (United States Environmental Protection Agency: Ecoregions 2018). There are 21 level IV Ecoregions, the most detailed delineations, which occur within the Navajo Nation's boundaries (Figure 11, U.S. Environmental Protection Agency 2013). We will use these regions to determine where we obtain and deploy seed and plant material when collecting locally isn't possible. Bower et al. (2014) suggests using climate-based seed transfer zones combined with ecoregions to refine the movement of plant material. Likewise, we plan to utilize several different types of seed transfer zones to guide our seed collection in order to most accurately match our collection and restoration sites. The USGS and USFS each have newly available web-based applications that will be useful in accurately defining these transfer zones (for example, <https://www.fs.fed.us/wwetac/threat-map/TRMSeedZoneData.php>).

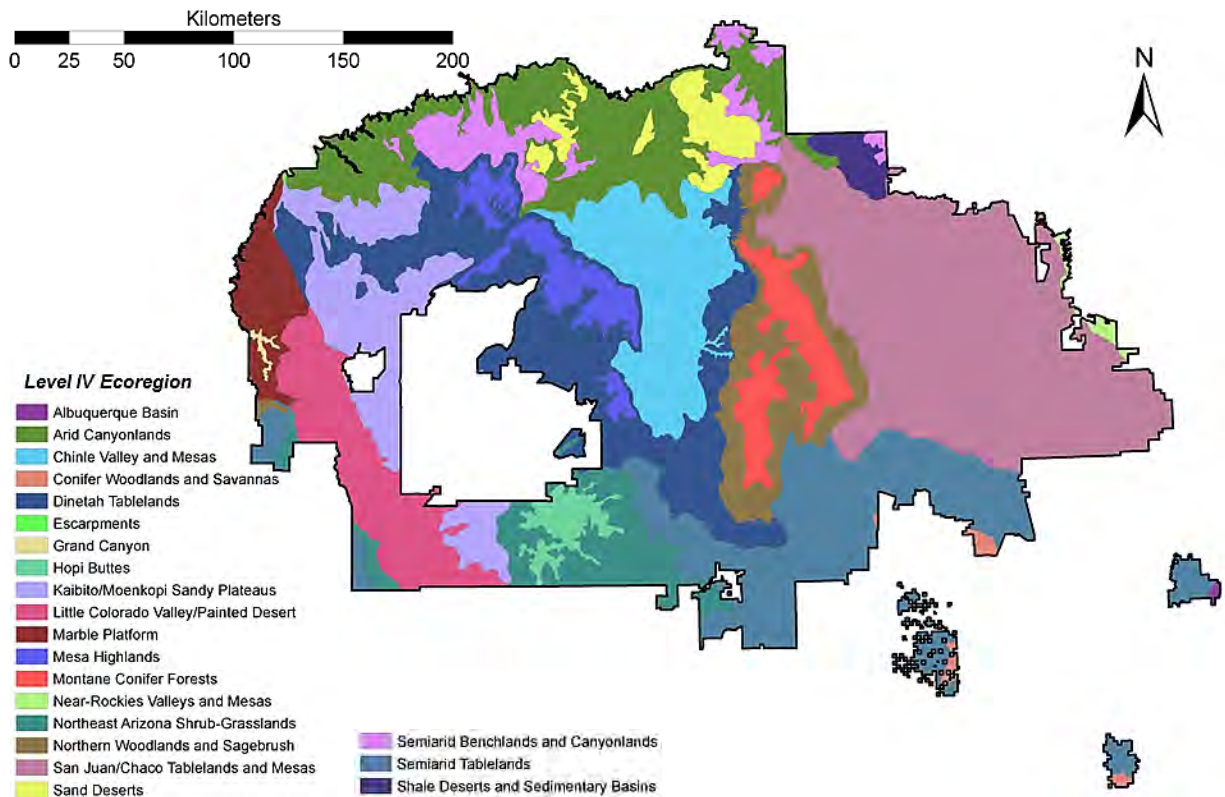


Figure 11. Level IV Ecoregions of the Navajo Nation (U.S. Environmental Protection Agency 2013).

Collaboration

The mission of the Diné Native Plants Program is to serve as a living library of native plants for restoration, conservation, and research and to provide the Diné people with access to locally-sourced high-quality plant material for the benefit of the community, culture, wildlife, and land. We recognize that we are not the only organization or tribe with this mission and that establishing partnerships allows for creative ideas and solutions to be exchanged. Collaborating with existing organizations and native plant programs will increase our collective ability to produce genetically-appropriate native plants and help us to develop a network of outreach and employment opportunities within the Southwest Region to encourage future generations of environmental stewards.

Several Navajo Nation departments will be important, not only as clients of the DNPP, but as collaborators helping us to achieve our mission. The Navajo Forestry Department (NFD) is a currently one such partner, providing access to their greenhouse facilities that will be the foundation of the DNPP nursery operations. The NFD has decades of experience with growing conifer seedlings for reforestation on the Navajo Nation and will be an excellent resource for technical assistance and guidance as we develop our program. Other Navajo Nation natural resource departments, such as the Navajo Nation Department of Agriculture, are involved in restoration efforts that will likely require native plants such as invasive removal and rangeland improvement projects. The Navajo Nation Department of Agriculture will also be instrumental in connecting the DNPP with Navajo farmers and ranchers interested in learning about or producing native plants.

Navajo and other tribal non-profit organization will also help with similar outreach projects aimed at educating community members about native plant identification, traditional uses, seed collection, and propagation. The DNPP is currently involved with Tolani Lake Enterprises, a local Navajo non-profit group interested in Navajo food sovereignty, and the U.S. Geological Survey on a project to promote restoration of degraded tribal rangelands through training and demonstration grow-out and restoration projects. We hope to continue to collaborate with local environmental/Navajo advocacy groups like Tolani Lake Enterprises to connect with land users and interested community members to increase the awareness of native plant issues on the Navajo Nation.

Collaborating with federal and tribal organizations, as exemplified by the Tolani Lake project, will also be a priority of the DNPP. The United States Forest Service (USFS) Reforestation, Nurseries, and Genetics (RNGR) program has a subdivision dedicated to providing technical assistance to Native American tribes interested in developing native plant programs for cultural, restoration, and educational purposes. Additionally, RNGR organizes an annual Intertribal Nursery Council meeting where tribal members and tribal native plant programs from across the United States can convene to discuss and hear presentations regarding native plants. Other federal agencies, such as the Natural Resource Conservation Service (NRCS) Plant Material Program (PMP), have missions aimed at providing technical assistance about seed collecting, propagation, and growing native plants to Native American tribes. These and other federal agencies will be important resources for the DNPP moving forward.

Existing regional native plant programs have made a great deal of progress towards collecting, producing, and deploying native plant material in the Southwest. There has also been a great deal of progress by these programs towards connecting plant growers and buyers, funding scientific research aimed at improving restoration practices and success, and disseminating these results to land managers. Organizations such as SOS, the Institute for Applied Ecology's Southwest Seed Partnership (SWSP), , and the BLM-run Colorado Plateau Native Plant Program (CPNPP) all currently have similar missions to the DNPP and operate in the Southwest. We hope to partner with these organizations and become a part of the network of native plant advocates in the Southwest with the goal of not only exchanging information but also contributing to and progressing the field of native plant production, education, and restoration. It is our intention that these partnerships will emphasize the value of native plant communities, healthy land management practices, and preservation of Diné traditions.

Native Plant Policy

In addition to growing native plant material for restoration projects, the Diné Native Plants Program will advocate internally for more awareness about the importance of native plants and native communities on the Navajo Nation. To accomplish this goal, we will encourage the Navajo Division of Natural Resources to establish a policy to mandate the use of native plants for all projects occurring with tribal funding or on tribal land which require the use of plant material. This includes all riparian restoration, reforestation, post-fire rehabilitation, mine reclamation, rangeland improvement, invasive removal, and wildlife habitat improvement projects, etc. occurring under the jurisdiction of departments within the Division. This policy will demonstrate the Navajo Division of Natural Resource's commitment to improving the health of Navajo land and preserving the natural heritage and traditions of the Diné people.

In 2014, the Seneca Nation of Indians, recognizing the ecological harm of continuing to plant non-native species, became the first tribe to pass a native plant policy requiring the use of native plants in tribal landscaping projects (Galeza 2014). Their policy provides guidance with a "No-plant list" containing highly invasive species to avoid and an "Encouraged plant list" of approved native and culturally-important plants. The policy also encourages land owners to remove non-native plants and replace them with native species. We will use the Seneca policy as a template for the Navajo Nation's native plant

policy, expanding beyond landscaping applications to include restoration and reclamation activities occurring on Navajo land. The DNPP will attempt to meet the demand for native plant material as a result of this policy, and if that demand exceeds our capacity, we will serve as a resource to provide guidance on appropriate plants and seed mixes to purchase from external sources.

CONCLUSION

The environmental issues facing the Navajo Nation will continue to reduce native plant cover and threaten native ecosystems in the region for the foreseeable future. Consequently, the Diné People's natural resources, traditional practices, and livelihood are also imperiled. It is clear that active ecological restoration through revegetation with regionally-sourced native plant material is necessary to improve the health of the land for the benefit of the wildlife, culture, and people. Our assessment shows that the Navajo community members and agencies we surveyed are aware of the need for restoration and support native plant material production on the Navajo Nation. Through this assessment we have adequately demonstrated the feasibility of the Diné Native Plants Program and its mission to produce native plant material for ecological restoration, conservation, and cultural preservation on the Navajo Nation.

Moving forward we will use the feedback we received in our surveys to prioritize species to collect and propagate in order to meet the needs of Navajo community members, land users, and land managers. Furthermore, we will pursue the connections we made through our surveys to collaborate and establish partnerships to more effectively accomplish the goals of the DNPP. Finally, we hope that the existence of the DNPP and this report will encourage more ecological restoration and awareness of native plants on the Navajo Nation.

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Appendix A: Agency/Organization Survey

Native Plant Needs Assessment Survey

Name: _____

Position: _____

Org./Agency/Chapter: _____

1. Does your organization or agency utilize any (live, non-agricultural) plant material?

- a. Yes
- b. Don't know
- c. No
- d. Decline to answer

2. What type of species do you use?

- a. Native
- b. Don't know
- c. Non-native
- d. Decline to answer
- e. Both

3. Does your organization or agency have a specific policy regarding the use of native vs. non-native species?

- a. Yes (specify policy below if possible)
- b. Don't know
- c. No
- d. Decline to answer

Please specify policy

4. For which of the following does your organization or agency currently utilize plant material? Circle all that apply.

- a. Ecological restoration
- b. Wildlife habitat improvement
- c. Flood abatement
- d. Burn area rehabilitation
- e. Cultural purposes
- f. Landscaping
- g. Education
- h. Roadside mitigation
- i. Don't know
- j. Pollinator conservation
- k. Range rehabilitation
- l. Decline to answer
- m. Other (please specify)

5. What type of plant material does your organization or agency currently utilize? Circle all that apply.

- a. Seed
- b. Cuttings
- c. Don't know
- d. Rootstock
- e. Container seedlings
- f. Decline to answer
- g. Other (please specify)

6. Approximately how much does your organization or agency spend on plant material annually? Please specify amount in DOLLARS.

- a. Don't know
- b. Decline to answer

7. Please name the principal sources, and their locations, from which you acquire plant material.

	<i>Provider</i>	<i>Location</i>
1		
2		
3		
4		
5		

- a. Don't know
- b. Decline to answer

8. Is your organization or agency concerned about the genetic or regional source of plant material purchased?

- a. Yes
- b. Don't know
- c. No
- d. Decline to answer

9. What factors ultimately decide what plant materials are needed for your organization or agencies practices? Circle all that apply.

- a. Maintaining diversity
- b. Wildlife foraging/habitat objectives
- c. Don't know
- d. Probability of success
- e. Cost
- f. Decline to answer
- g. Other (please specify)
- h. Size of project

10. Currently, what mechanisms does your organization or agency have to collect, store, and/or propagate plant material? Circle all that apply.

- a. Greenhouse
- b. Seed collecting equipment
- c. Land available
- d. Storage facilities
- e. Seed processing equipment
- f. Don't know
- g. Other (please specify)
- h. Irrigation capabilities
- i. Decline to answer

11. In the next 5-10 years, does your organization or agency foresee a need for local, native plant material?

- a. Yes
- b. Don't know
- c. No
- d. Decline to answer
- e. Other (please specify)

12. In the next 5-10 years, for which of the following does your organization or agency anticipate utilizing local, native plant material? Circle all that apply.

- a. Ecological restoration
- b. Wildlife habitat improvement
- c. Flood abatement
- d. Burn area rehabilitation
- e. Cultural purposes
- f. Landscaping
- g. Education
- h. Roadside mitigation
- i. Don't know
- j. Pollinator conservation
- k. Range rehabilitation
- l. Decline to answer
- m. Other (please specify)

13. In the next 5-10 years, what type of native plant material does your organization or agency anticipate needing? Circle all that apply.

- h. Seed
- i. Cuttings
- j. Don't know
- k. Rootstock
- l. Container seedlings
- m. Decline to answer
- n. Other (please specify)

14. In the next 5-10 years, what native GRASS species would your organization or agency like to have brought into local production? Please rank in order from your 1st choice to your 5th (1st being the most ideal).

Rank	Species	Rank	Species
	Indian ricegrass (<i>Achnatherum hymenoides</i>)		New Mexican feathergrass (<i>Hesperostipa neomexicana</i>)
	Purple threeawn (<i>Aristida purpurea</i>)		Junegrass (<i>Koeleria macrantha</i>)
	Sideoats grama (<i>Bouteloua curtipendula</i>)		Mountain muhly (<i>Muhlenbergia montana</i>)
	Blue grama (<i>Bouteloua gracilis</i>)		Galleta Grass (<i>Pleuraphis jamesii</i>)
	Mountain brome (<i>Bromus marginatus</i>)		Muttongrass (<i>Poa fendleriana</i>)
	Bottlebrush Squirreltail (<i>Elymus elymoides</i>)		Little bluestem (<i>Schizachyrium scoparium</i>)
	Slender wheatgrass (<i>Elmus trachycaulus</i>)		Alkali sacaton (<i>Sporobolus airoides</i>)
	Western wheatgrass (<i>Pascopyrum smithii</i>)		Sand Dropseed (<i>Sporobolus cryptandrus</i>)
	Arizona fescue (<i>Festuca arizonica</i>)		Sixweeks fescue (<i>Vulpia octoflora</i>)
	Needle and thread (<i>Hesperostipa comata</i>)	a.	Don't know
	Other (please specify)	b.	Decline to answer

15. In the next 5-10 years, what native FORB species would your organization or agency like to have brought into local production? Please rank in order from your 1st choice to your 5th (1st being the most ideal).

Rank	Species	Rank	Species
	Western Yarrow (<i>Achillea millefolium</i>)		Showy Goldeneye (<i>Heliomeris multiflora</i>)
	Butterfly Milkweed (<i>Asclepias tuberosa</i>)		Scarlet gilia (<i>Ipomopsis aggregata</i>)
	Showy Milkweed (<i>Asclepias speciosa</i>)		Lupine (<i>Lupinus argenteus</i>)
	Yellow spider flower (<i>Cleome lutea</i>)		Hoary tansyaster (<i>Machaeranthera canescens</i>)
	Rocky Mountain Beeplant (<i>Cleome serrulata</i>)		Colorado Four O'Clock (<i>Mirabilis multiflora</i>)
	Shaggy fleabane (<i>Erigeron pumilus</i>)		Beardlip penstemon (<i>Penstemon barbatus</i>)
	Redroot buckwheat (<i>Eriogonum racemosum</i>)		Rocky Mountain penstemon (<i>Penstemon strictus</i>)
	Hopi Blanket Flower (<i>Gaillardia pinnatifida</i>)		Globe Mallow (<i>Sphaeralcea spp.</i>)
	Blanket Flower (<i>Gaillardia pulchella</i>)		Greenthread (<i>Thelesperma megapotamicum</i>)
	Utah sweetvetch (<i>Hedysarum boreale</i>)	a. Don't know b. Decline to answer	
	Sunflower (<i>Helianthus annuus</i>)		
	Other (please specify)		

16. In the next 5-10 years, what native TREE/SHRUB species would your organization or agency like to have brought into local production? Please rank in order from your 1st choice to your 5th (1st being the most ideal).

Rank	Species	Rank	Species
	Boxelder (<i>Acer negundo</i>)		Cottonwoods (<i>Populus fremontii</i>)
	Serviceberry (<i>Amelanchier utahensis</i>)		Chokecherry (<i>Prunus virginiana</i>)
	Big sagebrush (<i>Artemisia tridentata</i>)		Antelope bitterbrush (<i>Purshia tridentata</i>)
	Fourwing Saltbush (<i>Atriplex canescens</i>)		Three-leaf sumac (<i>Rhus trilobata</i>)
	Water birch (<i>Betula occidentalis</i>)		Currant (<i>Ribes spp.</i>)
	Mountain mahogany (<i>Cercocarpus montanus</i>)		Wood's rose (<i>Rosa woodsii</i>)
	Green Mormon Tea (<i>Ephedra viridis</i>)		Willow (<i>Salix spp.</i>)
	Rubber rabbitbrush (<i>Ericameria nauseosa</i>)		Greasewood (<i>Sarcobatus vermiculatus</i>)
	Winterfat (<i>Krascheninnikovia lanata</i>)		Narrowleaf Yucca (<i>Yucca angustissima</i>)
	Pale desert-thorn (<i>Lycium pallidum</i>)	a. Don't know b. Decline to answer	
	Other (please specify)		

17. Please select the habitat types where your organization or agency would be most likely to utilize purchased native plant material. These would be areas where you most often work. Circle all that apply.

- a. Riparian
- b. Montane conifer forest
- c. Desert scrub
- d. Agriculture/urban mid to low water-use for desert environments
- e. Grasslands
- f. Agriculture/urban high water-use for high elevation environments
- g. Pinon-Juniper woodlands
- h. Don't know
- i. Other (please specify)
- j. Decline to answer

18. In the next 5-10 years, approximately how much would your organization or agency anticipate spending on native plant material annually?

Please specify amount in DOLLARS.

a. Don't know

b. Decline to answer

19. In order to initiate a successful native plant materials market on the Navajo Nation, what are the greatest obstacles to overcome? Circle all that apply.

a. Availability of qualified labor

b. Cost of facilities

c. Don't know

d. Cost of seed

e. Fostering partnership with other agencies

f. Decline to answer

g. Availability of seed

h. Funding from other agencies

i. Other (please specify)

j. Knowledge on the use of native plants

20. Would your organization or agency be willing to buy local, native plant materials from a partnership of growers and buyers?

f. Yes

g. Don't know

h. No

i. Decline to answer

j. Other (please specify)

21. Do you know any other people/agencies/organizations that need or grow plant, material that we should contact? Please provide contact information if available.

k. Yes, mention my name

l. No, I don't know any other contacts

m. Yes, do not mention my name

Contact info

22. Are there any general comments that you would like to add regarding the topics of this survey?

Appendix B: Community Survey

Community Native Plant Needs Assessment Survey

Name: _____

Date: _____

1. Do you use any native plants for personal or cultural purposes?

- a. Yes
- b. Don't know
- c. No
- d. Decline to answer

2. What native plants do you use?

3. For what purposes do you use native plants? Circle all that apply.

- a. Cultural/ceremonial
- b. Wildlife habitat improvement
- c. Art
- d. Landscaping
- e. Medicinal
- f. Don't know
- g. Other (please specify)
- h. Food
- i. Decline to answer

4. How do you obtain native plants? Circle all that apply.

- a. Collect
- b. Grow
- c. Purchase
- d. Don't know
- e. Other (please specify)
- f. Decline to answer

5. Have any native plants you use become scarce or difficult to find?

- a. No
- b. Don't know
- c. Yes, which ones?
- d. Decline to answer

6. Are there any native plants you would like to see grown locally and made available to you and your community? Please list in order from 1st choice to 5th (1st choice being most ideal).

1 st	
2 nd	
3 rd	
4 th	
5 th	

- a. Don't know
- b. Decline to answer

7. What type of native plant material would you want? Circle all that apply.

- a. Seed
- b. Container plants
- c. Don't know
- d. Rootstock
- e. Cuttings
- f. Decline to answer
- g. Other (please specify)

8. Would you be interested in leading or participating in a workshop involving native plants? For example, basket making, plant dyes, traditional foods, medicinal uses, etc.

- a. Yes, I want to participate
- b. No
- c. Yes, I want to lead a workshop on...

9. We would like to work with existing nurseries and farms on the Navajo Nation to grow native plants. How interested are you in growing native plants for this partnership?

- a. Very interested
- b. Not interested
- c. Interested
- d. Need more info

10. If interested, how much greenhouse space or farm acreage do you have?

11. Would you be interested in participating in the partnership as a committee member or advisor?

- a. Yes
- b. No
- c. Other (please specify)

12. Do you see a need to improve the health of the land within your community? If yes, how? Circle all that apply.

- a. No need
- b. Range improvement
- c. Wetland habitat improvement
- d. Invasive, non-native plant removal
- e. Wildlife habitat improvement
- f. Don't know
- g. Other (please specify)
- h. Erosion control
- i. Decline to answer

13. Do you know any other people who use native plants for personal or cultural purposes on the Navajo Nation we should contact? Can we mention your name? Please provide contact information if available.

- a. Yes, don't mention my name
- b. No, I don't know any other people
- c. Yes, mention my name

Contact info

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14. If interested in participating in the Navajo Native Plants Program as a grower, advisor, or workshop leader, please provide your contact info.

Name	
Address	
Phone #	

Appendix C: Agency/Organization Native Plant Response

<i>Scientific name</i>	<i>Common name</i>	<i>Percent</i> (n=38)	<i>Type</i>
<i>Achillea millefolium</i>	Western Yarrow	10.5	Forb
<i>Asclepias angustifolia</i>	Arizona milkweed	2.6	Forb
<i>Asclepias speciosa</i>	Showy Milkweed	2.6	Forb
<i>Asclepias tuberosa</i>	Butterfly Milkweed	15.8	Forb
<i>Cirsium spp.</i>	Cirsium	2.6	Forb
<i>Cleome lutea</i>	Yellow spider flower	2.6	Forb
<i>Cleome serrulata</i>	Rocky Mountain Beeplant	21.1	Forb
<i>Conoclinium greggii</i>	Palmleaf thoroughwort	2.6	Forb
<i>Erigeron pumilus</i>	Shaggy fleabane	7.9	Forb
<i>Eriogonum racemosum</i>	Redroot buckwheat	10.5	Forb
<i>Gaillardia pinnatifida</i>	Hopi Blanket Flower	5.3	Forb
<i>Gaillardia pulchella</i>	Blanket Flower	7.9	Forb
<i>Hedysarum boreale</i>	Utah sweetvetch	13.2	Forb
<i>Helianthus annuus</i>	Sunflower	10.5	Forb
<i>Ipomopsis aggregata</i>	Scarlet gilia	7.9	Forb
<i>Machaeranthera canescens</i>	Hoary tansyaster	5.3	Forb
<i>Mirabilis multiflora</i>	Colorado Four O'Clock	15.8	Forb
<i>Penstemon barbatus</i>	Beardlip penstemon	7.9	Forb
<i>Penstemon strictus</i>	Rocky Mountain penstemon	18.4	Forb
<i>Sphaeralcea spp.</i>	Globe Mallow	23.7	Forb
<i>Thelesperma megapotamicum</i>	Greenthread	2.6	Forb
<i>Achnatherum hymenoides</i>	Indian ricegrass	52.6	Grass
<i>Aristida purpurea</i>	Purple threeawn	5.3	Grass
<i>Bouteloua curtipendula</i>	Sideoats grama	15.8	Grass
<i>Bouteloua gracilis</i>	Blue grama	50.0	Grass
<i>Bromus marginatus</i>	Mountain brome	5.3	Grass
<i>Elymus elymoides</i>	Bottlebrush Squirreltail	5.3	Grass
<i>Festuca arizonica</i>	Arizona fescue	10.5	Grass
<i>Hesperostipa comata</i>	Needle and thread	5.3	Grass
<i>Hesperostipa neomexicana</i>	New Mexican feathergrass	10.5	Grass
<i>Hopia obtusa</i>	Vine mesquite	2.6	Grass
<i>Muhlenbergia montana</i>	Mountain muhly	15.8	Grass
<i>Pascopyrum smithii</i>	Western wheatgrass	26.3	Grass
<i>Pleuraphis jamesii</i>	Galleta Grass	23.7	Grass
<i>Poa fendleriana</i>	Muttongrass	10.5	Grass
<i>Sporobolus airoides</i>	Alkali sacaton	26.3	Grass
<i>Sporobolus cryptandrus</i>	Sand Dropseed	13.2	Grass

<i>Sporobolus wrightii</i>	Big sacaton	7.9	Grass
<i>Acer negundo</i>	Boxelder	5.3	Tree/shrub
<i>Amelanchier utahensis</i>	Serviceberry	10.5	Tree/shrub
<i>Artemisia bigelovii</i>	Bigelow Sagebrush	2.6	Tree/shrub
<i>Artemisia tridentata</i>	Big sagebrush	10.5	Tree/shrub
<i>Atriplex canescens var. angustifolia</i>	Fourwing Saltbush	21.1	Tree/shrub
<i>Cercocarpus montanus</i>	Mountain mahogany	28.9	Tree/shrub
<i>Ephedra viridis</i>	Green Mormon Tea	18.4	Tree/shrub
<i>Ericameria nauseosa</i>	Rubber rabbitbrush	10.5	Tree/shrub
<i>Krascheninnikovia lanata</i>	Winterfat	23.7	Tree/shrub
<i>Populus fremontii</i>	Cottonwood	42.1	Tree/shrub
<i>Prunus virginiana</i>	Chokecherry	7.9	Tree/shrub
<i>Purshia tridentata</i>	Antelope bitterbrush	15.8	Tree/shrub
<i>Rhus trilobata</i>	Three-leaf sumac	15.8	Tree/shrub
<i>Ribes spp.</i>	Currant	10.5	Tree/shrub
<i>Rosa woodsii</i>	Wood's rose	10.5	Tree/shrub
<i>Salix spp.</i>	Willow	42.1	Tree/shrub
<i>Sarcobatus vermiculatus</i>	Greasewood	10.5	Tree/shrub
<i>Tetradymia spp.</i>	Tetradymia	2.6	Tree/shrub
<i>Yucca angustissima</i>	Narrowleaf Yucca	7.9	Tree/shrub

Appendix D: Valid Community Native Plant Response

<i>Scientific name</i>	<i>Common name</i>	<i>Valid Percent (%)</i>		
		<i>Use</i> (n=179)	<i>Scarce</i> (n=85)	<i>Produce</i> (n=166)
<i>Achillea millefolium</i>	Yarrow	0.6	-	0.6
<i>Achnatherum hymenoides</i>	Indian ricegrass	2.2	1.2	1.8
<i>Allium spp.</i>	Wild onion	11.2	5.9	5.4
<i>Alnus spp.</i>	Alder	-	-	0.6
<i>Amaranthus spp.</i>	Amaranth	0.6	-	-
<i>Amelanchier alnifolia</i>	Saskatoon bush	0.6	-	-
<i>Artemisia frigida</i>	Prairie sagewort	0.6	-	-
<i>Artemisia tridentata</i>	Sagebrush	47.5	8.2	10.8
<i>Atriplex canescens</i>	Fourwing saltbush	1.7	-	0.6
<i>Berberis repens, B. fremontii</i>	Barberry	0.6	-	-
<i>Bouteloua dactyloides</i>	Buffalo grass	-	1.2	0.6
<i>Bouteloua gracilis</i>	Blue grama	1.7	1.2	1.2
<i>Calachortus nuttallii</i>	Sego lily	-	-	0.6
<i>Castilleja spp.</i>	Indian paintbrush	1.1	-	-
<i>Chenopodium album</i>	Lambs quarter	0.6	-	-

<i>Cirsium spp.</i>	Thistle	0.6	1.2	-
<i>Cleome serrulata</i>	Beeplant	2.8	-	1.8
<i>Conyza canadensis</i>	Horseweed	-	1.2	0.6
<i>Cymopterus glomeratus,</i> <i>Aulospermum purpureum</i>	Wild parsley	6.7	5.9	2.4
<i>Daucus pusillus</i>	Wild carrot	2.8	1.2	2.4
<i>Delphinium spp.</i>	Larkspur	0.6	-	-
<i>Ephedra viridis</i>	Mormon tea	2.2	-	0.6
<i>Equisetum spp.</i>	Horsetail reed	0.6	-	-
<i>Ericameria nauseosa</i>	Rabbitbrush	2.2	-	-
<i>Eriogonum alatum</i>	Winged buckwheat	0.6	-	-
<i>Gaillardia spp.</i>	Gaillardia	0.6	-	-
<i>Grindelia spp.</i>	Gumweed	0.6	-	-
<i>Gutierrezia sarothrae</i>	Snakeweed	3.4	-	0.6
<i>Helianthus annuus</i>	Sunflower	0.6	-	1.2
<i>Hesperostipa comata, H.</i> <i>neomexicana</i>	Needle and thread grass	-	-	0.6
<i>Hierochloe odorata</i>	Sweetgrass	0.6	-	-
<i>Hippus vulgaris</i>	Mares tail	0.6	-	-
<i>Juniperus spp.</i>	Juniper (cedar)	31.8	4.7	8.4
<i>Krascheninnikovia lanata</i>	Winterfat	0.6	1.2	0.6
<i>Ligusticum porteri</i>	Osha (naabii)	3.9	1.2	1.2
<i>Linum spp.</i>	Flax	0.6	-	-
<i>Lupinus spp.</i>	Lupine	0.6	-	-
<i>Lycium spp.</i>	Wolfberry	0.6	-	-
<i>Mentha arvensis</i>	Mint	1.7	-	-
<i>Muhlenberia pungens</i>	Sand Muhly (hair brush)	0.6	1.2	0.6
<i>Nicotiana attenuata, N. palmeri</i>	Tobacco (mountain/desert/smoke)	7.3	5.9	4.2
<i>Oenothera spp.</i>	Evening primrose	0.6	-	-
<i>Opuntia spp.</i>	Cactus (fruit)	0.6	1.2	0.6
<i>Pectis angustifolia</i>	Lemon flower	0.6	1.2	0.6
<i>Picea pungens</i>	Blue spruce	1.1	-	-
<i>Pinus edulis</i>	Pinon pine	11.2	1.2	4.2
<i>Plantago spp.</i>	Plantain	0.6	-	-
<i>Pleuraphis jamesii</i>	Galleta grass	-	1.2	-
<i>Poliomintha incana</i>	Purple sage	-	-	0.6
<i>Populus fremontii</i>	Cottonwood	1.1	1.2	1.8
<i>Prunus virginiana</i>	Choke cherry	-	-	1.2
<i>Pseudotsuga menziesii</i>	Douglas fir	0.6	-	-
<i>Purshia stansburiana, P. tridentata</i>	Cliffrose	0.6	-	0.6
<i>Quercus gambelii</i>	Oak	1.7	-	0.6
<i>Rhus trilobata</i>	Sumac	8.4	7.1	11.4
<i>Rosa woodsii</i>	Rose (hip)	0.6	-	-

<i>Rudbeckia spp.</i>	Brown eyed Susan	-	-	0.6
<i>Salix spp.</i>	Willow	2.8	1.2	3.0
<i>Sarcobatus vermiculatus</i>	Greasewood	2.2	-	0.6
<i>Schizachyrium scoparium</i>	Little bluestem	-	1.2	-
<i>Shepherdia rotundifolia</i>	Buffaloberry	-	-	0.6
<i>Solanum jamesii</i>	Wild potato	-	1.2	0.6
<i>Solanum spp.</i>	Poison nightshade	0.6	-	-
<i>Sphaeralcea spp.</i>	Globe mallow	2.2	-	-
<i>Sporobolus wrightii</i>	Big sacaton	0.6	-	-
<i>Thelesperma megapotamicum, T. subnudum</i>	Navajo tea	57.5	23.5	24.1
<i>Typha spp.</i>	Cattail	0.6	-	-
<i>Yucca baccata, Y. glauca</i>	Yucca	23.5	11.8	10.8
-	Bioremediation plants	-	-	0.6
-	Bitter plant (medicine/powder)	1.7	-	-
-	Blue sage	-	1.2	0.6
-	Ceremonial herbs	2.8	3.5	1.2
-	Ch'iin jila' ha	-	-	0.6
-	Ch'il Dich'ii	0.6	-	-
-	Cold season grass	-	1.2	0.6
-	Only know Navajo names	7.8	14.1	1.2
-	Don't know	-	-	38.6
-	Ghaahaazeejii	-	1.2	-
-	High elevation plants	-	1.2	-
-	I'ilkwoo	0.6	1.2	-
-	Iina ja azeed	0.6	1.2	-
-	Landscaping plants	-	-	4.2
-	Medicinal herbs	8.9	5.9	2.4
-	Native grass	3.4	2.4	4.2
-	Small blue grama	0.6	-	-
-	Various herbs	8.9	3.5	1.2
-	Vines	-	-	0.6
-	Warm season grass	-	-	0.6
-	Wild berries	-	-	1.8
-	Wildflowers	-	-	3.6
Brassicaceae (Family)	Wild mustard	0.6	-	-
-	Wool dyes	1.1	-	0.6

Appendix E: Omitted Community Native Plant Response

<i>Scientific name</i>	<i>Omitted Responses</i>	<i>Use</i>	<i>Count</i>	
			<i>Scarce</i>	<i>Produce</i>
-	Bee pollen	1	-	-
-	Bug-bite brush	1	-	-
-	Corn	15	-	10
<i>Taraxacum officinale</i>	Dandelion	1	-	-
-	Fruit trees	-	-	6
-	Hay	-	-	1
-	Lavender	1	-	-
-	Lettuce	1	-	-
-	Livestock plants	1	-	-
-	Melons	1	-	1
Convolvulaceae (Family)	Morning glory	1	-	-
<i>Verbascum thapsus</i>	Mullein	2	-	-
-	No comment/Decline to answer	28	14	54
-	Peat moss	1	-	-
-	Peyote	6	-	-
-	Potatoes	1	-	-
<i>Portulaca oleracea</i>	Purslane	1	-	-
<i>Rumex acetosella</i>	Sheep sorrel	1	-	-
<i>Capsella bursa-pastoris</i>	Shepherd's purse	1	-	-
-	Squash	-	-	5
<i>Tamarix chinensis</i>	Tamarisk	1	-	-
-	Tulip bulbs	1	-	-
<i>Salsola spp.</i>	Tumbleweed (for livestock)	1	-	-
-	Usnea (lichen)	1	-	-
-	Washbush	1	-	-
<i>Nasturtium officinale</i>	Watercress	1	-	-
-	Wild asparagus	1	-	1
-	Yellow top	-	-	1

Appendix F: Agency/Organization Survey Participants

<i>Name</i>	<i>Affiliation</i>	<i>Position</i>	<i>Email Address</i>
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-	Navajo Nation	-	-
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