United States Department of the Interior Bureau of Indian Affairs

Navajo Nation Integrated Weed Management Plan

Navajo Trust Land and Navajo Indian Allotments within Coconino, Navajo, and Apache Counties in Arizona; McKinley, San Juan, Sandoval, and Cibola Counties in New Mexico; and San Juan County in Utah

Photographed By: Rene Benally, Natural Resource Specialist

Navajo Nation Integrated Weed Management Plan

Prepared by:

Fred Phillips Consulting
401 South Leroux St.
Flagstaff, AZ 86001
Ph. (928) 773-1530

Prepared for:
U.S. Department of Interior
Bureau of Indian Affairs
Navajo Region

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1.0 Introduction

Controlling noxious/invasive weeds, or more appropriately, undesirable non-native vegetation, has long been a serious concern for land users. According to the Federal Noxious Law of 1974 (USC 2814), noxious or invasive weed species are plants "classified as undesirable, noxious, harmful, exotic, injurious, or poisonous" and "shall not include plants indigenous to an area where control measures are to be taken." Noxious weeds have little value in locations where they are not desired and often have negative impacts on desired native plants and wildlife. Noxious weeds also occupy space within the landscape and absorb sunlight and utilize soil moisture that otherwise would be available for native plants. Many noxious weeds can directly change a site, making it difficult to re-establish desired native plant species. In addition, noxious weeds can cause harm to livestock; thereby, resulting in economic and social impacts.

On the Navajo Nation, the number of noxious and invasive weed species has increased in recent years. Noxious plants were introduced to the landscape from various activities, including:

- Road construction & maintenance
- Use of non-weed-free hay and feed, resulting in livestock transporting weed seeds to remote locations
- Infrastructure development (i.e., waterline, gas lines, and powerlines)
- Flowing streams, wildlife and the wind which contribute to seed dispersal
- A lack of grazing limits, which can put additional pressure on native vegetation, allowing noxious weeds to outcompete native plants.

Disturbed habitats provide a platform for the establishment of noxious weeds. Due to high rates of disturbance, weeds are frequently introduced along roads and right-of-ways from vehicles carrying seed or plant material, construction material, or garbage. These linear corridors provide a thoroughfare for rapid weed expansion to adjacent wild, agricultural or range lands. Also, right-of-ways provide an access point for weed spread to riparian corridors from runoff or road crossings over waterways.

The expansion of noxious weeds on the Navajo Nation has contributed to the decline of livestock forage production, native grassland community quality, wildlife habitat quality, and overall ecological health of the region. Noxious weeds have impacted every habitat on the Navajo Nation, which has affected the economic, historic and cultural livelihood of the Navajo people. Control of these invasive plants will help improve rangeland and agricultural land quality by improving the growth of native forbs and grasses to benefit subsistence ranching and farming activities, increase the native diversity of riparian trees and understory species in riparian corridors, protect water resources and water quality, prevent the spread of additional weed infestations to unaffected land and property, and maintain and improve wildlife habitat.

1.1 Background

The Bureau of Indian Affairs (BIA) Noxious Weed program was initiated in December1988 in response to congressional directives for improved management on Indian lands. A task force and 10-Year Management Plan were developed and put into the BIA Range and Agriculture Handbook. The Acting Deputy Commissioner of Indian Affairs issued an Interim Policy in 1991 for the Noxious Weed Control Program. This policy directed on-the-ground accomplishments and allocated funds directly for weed control projects. Funding has been approximately $2 million Indian Country wide. Program standards and oversight are provided by designated BIA Regional Noxious Weed Coordinators in the Division of Natural Resources at the national level.

The BIA Navajo Region has initiated efforts to control specific target noxious weeds on the Navajo Nation using various methods. The target noxious weeds treated to date on the Navajo Nation include:

- Tamarisk (*Tamarix* spp.)
- Russian olive (*Elaeagnus angustifolia*)
- Russian knapweed (*Acroptilon repens*)
- Camelthorn (*Alhagi camelorum*)
- Halogeton (*Halogeton glomeratus*)
- Musk thistle (*Carduus nutans*)

While these efforts support the goals of the Noxious Weed Control Program, the Navajo Regional Office (NRO) determined the need for an integrated and coordinated management plan which utilized methodical, science-based strategies to actively monitor and control invasive weeds. In conjunction with developing a weed management plan, NRO determined that compliance with the National Environmental Policy Act (NEPA) was necessary to facilitate discussions with the public regarding potential impacts of a weed management plan. In addition, completing one wholesale environmental compliance effort for integrated weed control would allow the BIA Noxious Weed Coordinators to streamline processes and help to elicit large-scale cooperative projects.

In response to the identified need for a more balanced approach to weed management, NRO initiated the development of a weed management plan. This Integrated Weed Management Plan (IWMP) helps identify weed species of concern; details weed removal strategies; and consolidate the best management practices available for weed control. Best management practices that have been limited in the past are now an integral component of NRO's weed management efforts, such as early detection and eradication, prevention, and education. This plan will encompass a 10-year period but will incorporate a plan review after five years. It is estimated that during the first five years of the project approximately 250,000 acres will be treated. Repeated treatments will be necessary for most species since seeds can be viable in soil for 10 or more years.

Therefore, re-occurring weed treatments will be implemented until the desired control objective is reached.

1.2 Project Goals

1. Develop the best control techniques described for the target weed species in a planned, coordinated, and economically feasible program to limit the impact and spread of noxious and invasive weeds.
2. Identify and prevent the expansion of existing infestations of target weed species, and quickly prevent the spread of new high priority weed species in the project area.
3. Coordinate weed removal efforts with adjacent land owners or managers to prevent the further spread of weed populations (i.e. State roads and Bureau of Land Management).
4. Provide and promote economic opportunities to the Navajo people by improving rangeland productivity and potentially providing economic opportunities to remove invasive plant species.
5. Develop a public education program focusing on weed identification, prevention and removal techniques for the local communities and non-profit organizations.

2.0 Project Area

The Navajo Nation is located in northeastern Arizona, southeastern Utah, and northwestern New Mexico and encompasses approximately 17 million acres (**Figure 2-1**). The land base includes Navajo Indian Allotments, within Coconino, Navajo, and Apache Counties – Arizona, McKinley, San Juan, Sandoval, and Cibola, Counties - New Mexico, and San Juan County – Utah. The Navajo Nation is comprised of five BIA agencies including: Western Navajo Agency (5.2 million acres), Eastern Navajo Agency (2.3 million acres), Fort Defiance Agency (3.3 million acres), Northern (Shiprock) Agency (2.7 million acres), and Central (Chinle) Agency (1.4 million acres). Additionally, there are Navajo Partitioned Lands (910,000 acres) and other newly acquired lands (1.4 million acres). For this document, the project area refers to the entire Navajo Nation as defined above and the project site refers to individual weed removal project sites.

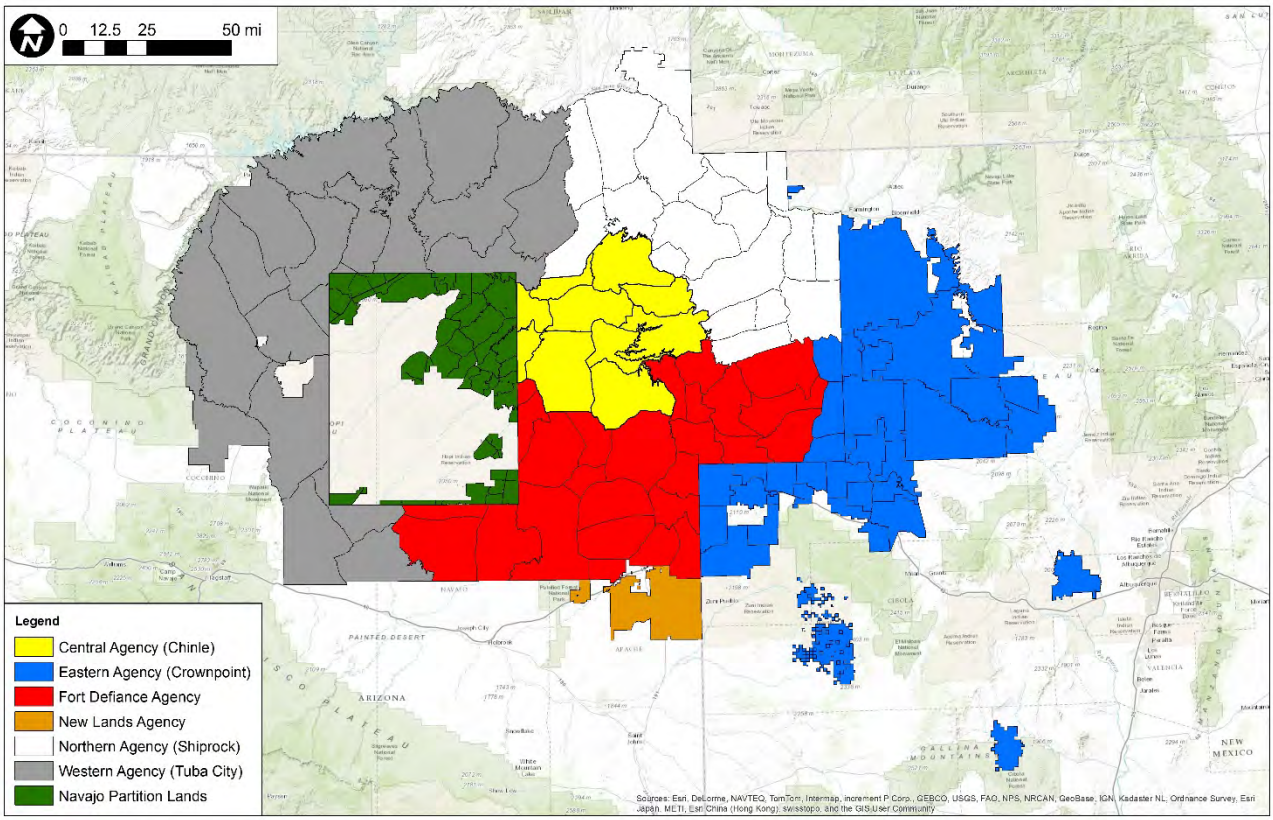

Figure 2-1. Project area of the Navajo Nation divided by BIA Navajo Regional Agencies.

This plan addresses lands that are under the direct administration of the NRO, which includes all Navajo Indian Allotments and Navajo trust land. Priority areas have been identified to help direct weed treatments to areas where noxious weeds have caused issues and concerns for land users and land managers (Appendix B). These areas were selected based on general land types where BIA Regional Weed Coordinators were planning or coordinating weed management projects. Priority areas include: Navajo Nation, BIA, state, and county roads; riparian areas; Navajo Agricultural Products Industry (NAPI) lands, Navajo Tribal Utility Authority (NTUA) right-of-ways; designated farm lands, designated rangeland, and Navajo Nation Designated Community Development Areas.

Although weed treatments in the priority areas are the focus of the BIA upon implementation of the plan, weed treatments may still take place in non-priority areas based on ecological and economic impacts and need. If a site matches the site prioritization criteria outlined in Section 4.0, and serious concern exists for the ecological and economic impacts of existing noxious weed populations, efforts should be made to treat and manage weeds in those areas.

Current weed inventory efforts have resulted in only 0.1% of the 17 million acres, or only 21,254 acres, inventoried for noxious weeds. Weed inventory and mapping will be conducted concurrently with the implementation of this plan to identify weed populations within the project

area and to aid in prioritizing control efforts. All areas with identified weed infestations should be ranked and prioritized based on criteria outlined in Section 4.0

Portions of five sub-regional watersheds which occur on the Navajo Nation include (acreages represent total acreages): Rio Grande (17.3 million acres), Upper Colorado (8.7 million), San Juan (16 million acres), Lower Colorado (19.4 million acres), and Little Colorado (17.6 million acres). Within these major watersheds, there 30 sub-watersheds that occur on the Navajo Nation and 14 sub-watersheds that are adjacent to the Navajo Nation (**Figure 2-2**, **Table 2-1**). Invasive weeds have been identified in all the sub-watersheds that occur on Navajo land.

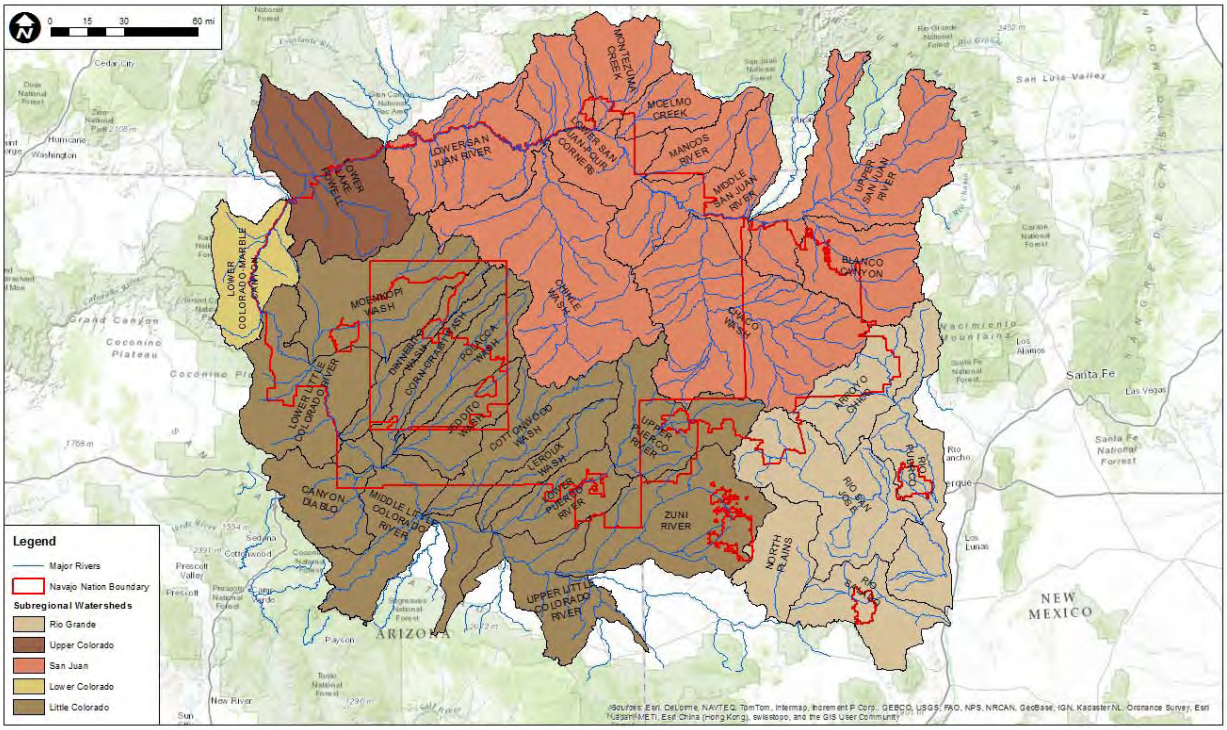

Figure 2-2. Map of sub-regional watersheds and surface drainage basins that occur on the Navajo Nation as defined by the U.S. Geological Survey (USGS, 2013).

Table 2-1. Watersheds and surface drainage basins that occur on the Navajo Nation, including the USGS Hydrologic Unit Code Number (HUC No.), total acreage of the sub-watersheds, and total acres of subwatersheds occuring on the Navajo Nation.

Surface Drainage Basin Name	HUC No.	Total Acres	Acres on Navajo Nation
LITTLE COLORADO WATERSHED			
Moenkopi Wash	15020018	1,685,552	1,199,190
Dinnebito Wash	15020017	475,416	207,895
Corn-Oraibi Wash	15020012	547,176	305,664
Lower Little Colorado River	15020016	1,535,259	783,649
Polacca Wash	15020013	692,851	324,573
Upper Puerco River	15020006	1,225,809	1,121,178

Surface Drainage Basin Name	HUC No.	Total Acres	Acres on Navajo Nation
Cottonwood Wash	15020011	1,028,501	896,982
Jeddito Wash	15020014	665,429	440,772
Leroux Wash	15020009	516,281	385,579
Middle Little Colorado River	15020008	1,580,529	326,363
Lower Puerco River	15020007	715,941	333,537
Canyon Diablo	15020015	770,708	68,597
Zuni River	15020004	1,764,468	327,718
Upper Little Colorado River	15020002	1,032,340	2,216
LOWER COLORADO WATERSHED			
Lower Colorado-Marble Canyon	15010001	927,155	272,588
RIO GRANDE WATERSHED			
Rio Puerco	13020204	1,356,949	82,749
Arroyo Chico	13020205	876,642	338,158
Rio San Jose	13020207	1,689,289	218,417
Rio Salado	13020209	900,010	60,563
North Plains	13020206	729,397	10,480
SAN JUAN WATERSHED			
Montezuma Creek	14080203	747,121	61,012
Lower San Juan -Four Corners	14080201	1,283,869	582,240
Upper San Juan River	14080101	2,206,444	262,308
Lower San Juan River	14080205	1,502,448	1,009,277
McElmo Creek	14080202	458,010	40,026
Mancos River	14080107	513,141	37,971
Middle San Juan River	14080105	1,241,815	685,612
Chaco Wash	14080106	2,927,155	2,917,013
Blanco Canyon	14080103	1,097,855	278,642
Chinle Wash	14080204	2,664,383	2,664,383
UPPER COLORADO WATERSHED			
Lower Lake Powell	14070006	1,910,567	980,449

Roads are a primary contributor to the introduction of noxious weed populations on the Navajo Nation, and serve as a priority area for weed treatment. The major interstates and U.S. Highways include: Interstate 40, U.S. Highways 64, 89, 89A, 191, 163, 160, 491, and State Routes 2, 40, 44, 53, 57, 64, 77, 87, 98, 99, 134, 197, 262, 264, 371, 506, 564, 566, 7900, and 7900. Additionally, there are numerous paved and unpaved roads managed by the Navajo Nation Department of Transportation and the BIA Department of Transportation. The Arizona, Utah, and New Mexico Departments of Transportation treatment area along interstates is approximately 300ft from the center of the road and on state highways is between 50-100ft from the center of the road or to the right-of-way fence. Right-of-way fences line all of the ADOT, UDOT, and NMDOT roads to delineate the easement. The agencies responsible for the roads include: Navajo Nation Department of Transportation (NNDOT, 16,900 miles); Bureau of Indian

Affairs Department of Transportation (BIADOT, 6,700 miles); County Roads (2,000 miles); Arizona Department of Transportation (ADOT, 840 miles), Utah Department of Transportation (UDOT, 103 miles), and New Mexico Department of Transportation (NMDOT, 821 miles).

Community Development Areas are defined in the Biological Resource Land Use Clearance Policies and Procedures (RCP) (RCS-44-08) by the Navajo Nation Department of Fish and Wildlife as "areas in and around towns with few or no restrictions on development." These are typically areas that have been deemed as unsupportive for Navajo species of concern, allowing for few restrictions on development. The Community Development Areas within the Navajo Nation include: Navajo, Sawmill, Lukachukai, Chinle, Many Farms, Ganado, Tohatchi, Crownpoint, Shiprock, Castle Butte, Tuba City, Pinon, Window Rock, Kayenta, Leupp, and Greasewood. No weed treatment activities will occur within Biological Preserves or other Sensitive Conservation Areas. If weed treatments are desired in these areas a separate consultation with U.S. Fish and Wildlife Service and Navajo Nation Department of Fish and Wildlife will be initiated.

Utility right of ways that will be a focus of this plan include those managed by the Navajo Tribal Utility Authority (NTUA) and Indian Health Services (IHS). Utility lines include those for electricity, telecommunications, water and wastewater, and natural gas. The utility companies establish and manage utility lines across the Navajo Nation; including: electric (19,000 miles), waterline (6,500 miles), natural gas (550 miles), and sewer (350 miles). Right of ways (ROWs) for these utility features extend 40-60 feet depending on the size and type of line being used. IHS has several ROWs to their facilities; however total mileage is not available. In 25 CFR 169.5 requires that right-of-way applicants "take soil and resource conservation protection measures, including weed control, on the land covered by the right-of-way." All utility companies are responsible for clearing and managing weeds within right of ways for utilities on the Navajo Nation. Land disturbance for installation or repair of utility lines has encouraged the growth and introduction of many of invasive weed species.

Designated rangeland in the Navajo Nation is defined as either Range Units or Range Management Units (RMU). Range Units are defined by the BIA as rangelands consolidated to form a unit of land for the management and administration of grazing under a permit. Navajo Nation Ranches (Range Management Units) are defined by Navajo Nation per 3 N.N.C. 3 as Fee Patent Lands, Trust Lands, Allotted Lands, BLM Leased Lands, State Leased Lands, and other forms of land in the States of New Mexico and Arizona. The Navajo Nation Ranch Program fulfills the following purposes: 1) provide for productive and optimum use of lands under the direct control of the Navajo Nation designated as Ranch Lands; 2) Ensure that sufficient revenues are realized to pay taxes, land use fees, and cost of administration; and 3) to carry out select purposes form land acquisition. All range permits and units are managed by the BIA per 25 CFR 167. These lands encompass approximately 2.6 million acres. The highly disturbed nature of designated range lands has promoted the growth of many invasive weeds due to overgrazing.

Farm land includes lands that have been officially designated for agricultural purposes either through land lease agreements or permits by the Navajo Nation per 3 N.N.C. 1 or by the BIA per 26 CFR 162. It also includes lands that are part of the NAPI and Navajo Indian Irrigation Project (NIIP) lands, which provide irrigation and agricultural products for the Navajo Nation. The BIA is responsible for NAPI and NIIP project oversight and making sure the project remains in compliance with environmental concerns. The Navajo Nation is responsible for overall management and operations. NAPI lands comprise approximately 110,000 acres along the border between Northern Navajo Agency and Eastern Navajo Agency east of Farmington, NM. In 2014, 60,000 to 70,000 acres are in active production. Remaining 40,000 to 50,000 acres are not currently in active management due to delays in the construction of the NIIP irrigation delivery system to the site. Designated or permitted farmlands comprise approximately 40,000 acres of the Navajo Nation.

3.0 Priority Weed Species

There are 46 noxious weed species identified in this plan as a priority for control. These species have been documented in the Navajo Nation from data collected from the Southwest Exotic Plant Mapping Program (SWEMP) and weed mapping projects conducted by the BIA Regional Weed Coordinators (**Table 3-1**). The extent of individual weed species infestations is unknown due to limited efforts to map weed infestations. To address this knowledge gap, the BIA proposes to implement a weed mapping program as part of this IWMP to help Agency Weed Coordinators and other land managers assess the extent of weeds on the Navajo Nation. Weed inventory and mapping is discussed in further detail in Section 5.0.

These 46 weed species were prioritized by first categorizing them into Category A, B, or C with the help of the San Francisco Peaks Weed Management Area Working Group (**Table 3-1**). Category A weeds are those species that are currently not present in Navajo Nation but may occur in neighboring areas, or have limited distribution. The management goal for Category A weeds is to prevent new infestations and eradicate existing infestations. For Category A species, emphasis will be placed on eradication, prevention, education, awareness, identification, monitoring, and treatment. Category B invasive weed species are limited in range to portions of the Navajo Nation and the management goal is to contain the infestation and stop any further spread. For Category B species, emphasis will be placed on immediate control, prevention of seed spread and eradication. Category C invasive weed species are wide-spread and well established in the Navajo Nation, and the management goal is to locally contain the infestation and monitor the population. Management of Category C species is determined at the local level, and is based on feasibility of control and level of infestation. For Category C species emphasis is placed on management, education, awareness, and identification/monitoring.

Within the context of this plan:

- **Prevention** means minimizing introductions of a weed species in the project area and is usually combined with eradication to allow for elimination of spot populations as they arise.

- **Eradication** means attempting to totally eliminate a species from the project area (Navajo Nation).

- **Contain** means preventing seed production throughout a target patch and reducing the area covered by a species.

- **Long-term eradication** means that there will be an attempt to totally eliminate a species from the project area over the several years. The "contain" and "long-term eradication" strategies are combined as different sized populations may be found in different areas.

  Some populations may be controlled in a manner to eventually achieve eradication within the project area.

- **Local contain** means that local weed management teams will identify the species to contain in localized sites and implement monitoring.

- **Monitoring** is defined as implementing observations to detect changes in a plant's population using either qualitative or quantitative techniques. Monitoring can be used to help prioritize invasive plant removal activities by identifying expansions in existing invasive plant populations, presence of new infestations, and invasion from new exotic species.
    - Qualitative techniques involve monitoring methods that do not involve measurements or statistics (i.e. photo monitoring and general ocular observations).
    - Quantitative techniques involve using a systematic empirical investigation of plant community characteristics via statistical, mathematical or computational methods.

Table 3-1. Invasive weeds of concern and proposed management strategy objectives.

CATEGORY A		
COMMON NAME	**SPECIES**	**MANAGEMENT GOAL**
Leafy spurge	*Euphorbia esula*	Prevent
African rue	*Peganum harmala*	Prevent
Tree of Heaven	*Ailantus altissima*	Prevent
Fountaingrass	*Pennisetum setaceum*	Prevent
Squarrose knapweed	*Centaurea virgate*	Prevent
Blue mustard	*Chorispora tenella* (Pall.) DC.	Eradicate
Ravenna grass	*Saccharum ravennae*	Eradicate
Yellow starthistle	*Centaurea solstitialis*	Eradicate
Bull thistle	*Cirsium vulgare*	Eradicate
Canada thistle	*Cirsium arvense*	Eradicate
Dalmatian toadflax	*Linaria dalmatica*	Eradicate
Musk thistle	*Carduus nutans*	Eradicate
Perennial pepperweed	*Lepidum latifolium*	Eradicate
Scotch thistle	*Onopordum acanthium*	Eradicate
Spotted knapweed	*Centaurea maculosa*	Eradicate
Tall Whitetop	*Cardaria draba*	Eradicate
Sahara mustard	*Brassica tournefortii*	Eradicate
Uruguyan pampas grass	*Cortaderia sellonana*	Eradicate
Yellow nutsedge	*Cyperus esculentus*	Eradicate
Sulphur cinquefoil	*Potentilla rect L.*	Eradicate
Common Mediterranean grass	*Schismus barbatus*	Eradicate
Tamarisk, Saltcedar	*Tamarix* spp., including hybrids	Eradicate
Camelthorn	*Alhagi camelorum*	Eradicate
CATEGORY B		
COMMON NAME	**SPECIES**	**MANAGEMENT GOAL**
Halogeton	*Halogeton glomeratus*	Contain & Long term eradicate
Siberian elm	*Ulmus pumila*	Contain & Long term eradicate
Tamarisk, Saltcedar	*Tamarix ramosissima*	Contain & Long term eradicate
Diffuse knapweed	*Centaurea diffusa*	Contain & Long term eradicate
Russian knapweed	*Acroptilon repens*	Contain & Long term eradicate
Russian Olive	*Elaeagnus angustifolia*	Contain & Long term eradicate
Johnsongrass	*Sorghum halepense*	Contain & Long term eradicate
CATEGORY C		
COMMON NAME	**SPECIES**	**MANAGEMENT GOAL**
Cheatgrass	*Bromus tectorum*	Local Contain & Monitor
Field bindweed	*Convolvulus arvensis*	Local Contain & Monitor
Jointed goatgrass	*Aegilops cylindrica*	Local Contain & Monitor
Puncturevine	*Tribulus terrestris*	Local Contain & Monitor
Rescuegrass	*Bromus catharticus*	Local Contain & Monitor
Ripgut brome	*Bromus diandrus*	Local Contain & Monitor
Smooth brome	*Bromus inermis*	Local Contain & Monitor
Bald brome	*Bromus racemosus*	Local Contain & Monitor
Red brome	*Bromus rubens*	Local Contain & Monitor
Spreading wallflower	*Erysimum repandum*	Local Contain & Monitor
Horehound	*Marrubium vulgare*	Local Contain & Monitor
California burclover	*Medicago polymorpha*	Local Contain & Monitor
Russian thistle	*Salsola kali*	Local Contain & Monitor
Field brome	*Bromus arvensis*	Local Contain & Monitor
Kochia	*Bassia scoparia*	Local Contain & Monitor

4.0 Implementation Strategy

The tasks outlined below provide the initial steps to implementing a successful weed removal effort. For the long-term sustainability of weed removal efforts, a Weed-Free Policy should be developed and enforced by the Navajo Nation to prevent further spread of invasive species. The Weed-Free Policy should require the use of only certified-weed free hay, seed, ballast, and road material for use on the Navajo Nation to prevent further spread and establishment of noxious weed species. A checklist is provided in Appendix C. which outlines all steps necessary for weed projects.

Task 1. **Apply the site and species approaches.** Actions are prioritized using the site and species approaches to select the best sites to initiate weed management.

Task 2. Map and inventory invasive species. A workshop will be conducted by the BIA Weed Coordinators to establish an approach for how and where to initiate this work to consolidate and coordinate weed mapping efforts. Mapping provides information on the species present, the size of the infestation, and its location.

Task 3. Develop a site specific plan to implement weed removal efforts for projects. The plan will provide information on the weed species present; a map of the treatment area; the removal efforts selected, including detailed information on equipment necessary; native plant restoration; and proposed project costs.

Task 4. Obtain required permits, clearances, and funding. Acquire permits, obtain support from the tribe, develop landowner access agreements, obtain funding, and build capacity.

Task 5. Initiate demonstration projects near a community. These projects provide public outreach and educational opportunities, obtain public support for the broader goals of the Plan, and engages the local community in weed removal efforts. The demonstration projects provide information about the distribution of invasive species, effective removal methods, project costs, and effectiveness of monitoring and maintenance.

5.0 Approach for Prioritizing Actions and Sites

In order to successfully work toward the goals outlined in this plan, an organized approach to prioritize weed removal actions and sites is essential. While the Navajo Nation is a large land base, focused weed removal efforts in target areas will help prevent the spread of invasive species. A two pronged approach was developed to prioritize invasive species removal actions, including 1) Site Approach (**Table 5-1**) and 2) Species Approach (**Figure 5-1**).

The Site and Species Approaches for prioritizing actions are tools that can be used to first prioritize sites and then prioritize the species for removal within a given site. In some cases, all

invasive species occurring at a site could be removed. This should be determined on a case-by-case basis.

There are five fundamental requirements that dictate the feasibility of a successful weed removal project at any given site. The characteristics listed below must be met at any of the sites prioritized by the Site or Species Approach for weed removal to proceed:

1. Funding is available to complete the project, including monitoring and maintenance, to obtain success.

2. The land owner/manager is interested and willing. Commitment, cooperation, and common goals with the land owner or land manager are required to achieve weed removal actions and goals, monitoring and long-term maintenance.

3. Permits are obtained. Invasive plant removal work cannot commence without the required permits. Any projects implemented under this plan will have National Environmental Policy Act (NEPA) compliance, Section 106 of the National Historic Preservation Act (NHPA), and Section 7 of the Endangered Species Act (ESA) coverage. Additional permits and clearance may be necessary to comply with regulations set forth by the Navajo Nation Environmental Protection Agency (NNEPA), the Navajo Nation Department of Fish and Wildlife (NNDFW), the Navajo Nation Historic Preservation Office (NNHPO), the U.S. Army Corps of Engineers, and the U.S. Fish and Wildlife Service (USFWS). Permits and additional compliance are explained further in Section 7.0

4. The capacity to conduct work at prioritized sites. A trained work force and logistic plan is necessary to implement a successful and timely invasive species removal effort.

5. The site is accessible. Site accessibility will affect the cost of the invasive plant species removal efforts. Difficulty of employing certain removal techniques, monitoring and long-term maintenance will have to be considered based on the accessibility of the site.

5.1 Site Approach

The site prioritization criteria listed below should be evaluated in order to select sites that will help prevent the spread of invasive species infestation.

Table 5-1. Criteria for site prioritization

Criteria	***Criteria Objective***
A. Sites upwind of prevailing wind direction or higher in elevation	Prevent seed or vegetative source from infesting sites downwind of the prevailing wind direction
B. Sites higher up in the watershed	Prevent seed or vegetative source from infesting downstream sites.
C. Sites with high economic value	Removal efforts can be focused in areas of economic value (i.e. range and farm land) if invasive plant species compromise their functionality.
D. Sites with potential for high mobility (i.e. roads, right-of-ways)	Prevent the spread of invasive species along roads or other disturbed linear corridors that have high mobility potential.
E. Presence of Category A species.	These species occupy minimal habitat and are feasible to remove. These species should be prevented from further infestation.
F. Coordinated project efforts	Removal efforts can be focused in areas where adjacent land (e.g. Bureau of Land Management, Forest Service, Hopi Tribe, National Park Service, etc.) have complimentary invasive weed removal projects.
G. Greater than 10% total canopy cover of woody invasive plants	Maintain woody invasive plant cover below 10 percent.
H. Greater than 20% total canopy cover of herbaceous and grass invasive species.	Maintain herbaceous and grass invasive plant cover below 20 percent.

Criteria	*Criteria Objective*
I. Presence of isolated small populations of Class A or B species.	Isolated populations of Class A or B weeds are feasible to remove to prevent further infestation. Priority Class A or B weeds should be identified using the Species Prioritization Flow Chart (Figure 5-1).
J. Potential for wildfire	Reduce wildfire risk for potential damage to property, human safety and wildlife habitat.
K. Herbaceous weed control where these plants interfere with passive or active revegetation.	Control invasive herbaceous species if they have the potential to serve as secondary weeds when woody invasive species have been removed.
L. Sites with high wildlife value	Removal efforts can be focused in areas of high wildlife value if invasive plant species are compromising their habitat.

5.2 Species Approach

The species prioritization approach is adapted from the U.S. Forest Service (USFS) Region 3 Invasive Weed Classification System and the Coconino National Forest. A species prioritization approach provides a plan for treating and managing different target weed species on a site based by species categorization, infestation size, risk or potential of spread, and available resources.

5.2.1 Risk Assessment

An essential aspect to consider when prioritizing species is to determine the risk or potential of an invasive weed spreading to other areas due to the site characteristics and the location of the species within the site. For example, roads, fences or other disturbed linear corridors can readily promote the spread of noxious weeds to new areas. This includes considering the mechanism of establishment or colonization (seed, vegetatively, spread via flood events, wind, water, etc.) of the invasive species with respect to its location at a site. Species that may be considered Category A (**Table 3-1**) weeds because they are highly aggressive may be a lower priority than a Category B species because the site factors are not conducive to spreading, whereas the Category B species may have the appropriate site conditions to promote spread. For example, a patch of saltcedar located on flat or isolated area off the river corridor may be less of a priority than camelthorn located on the river bank. While saltcedar is a highly aggressive species, the

camelthorn has a higher risk of spreading through flood events. Risk assessments should be conducted in the field by qualified professionals.

5.2.2 Pre-Field Review

The prioritizing species process should begin with a review of existing weed data for a particular area of interest. Areas of interest should include those that may serve as an invasive plant seed source to downstream or downwind resources, disturbed linear corridors (roads, fences, utility easements), areas that have high quality range, agricultural or riparian habitat (dominated by >90% native species), and areas that are at high risk for fire. Following are a list of considerations when preparing the existing data.

1. Review geographic information system (GIS) maps of all existing information about an area, including existing weed mapping data, hydrology, roads and travel corridors, vegetation type, and primary use of the land.

2. Check with local BIA weed coordinators, county/state weed specialist, and Southwest Exotic Mapping program with Northern Arizona University to determine if invasive weed species have been detected on or adjacent to the area. Also, for invasive weeds along roads contact ADOT, NMDOT, and UDOT. Develop a list of species considered for possible appearance.

3. Compare the habitat requirements of invasive plant species with habitat known to occur in the area of interest to determine if potential habitat for invasive weed species exists.

4. Determine the accessibility of the site and complete a habitat evaluation if necessary.

5. A field reconnaissance should be conducted if the presence of invasive weed species or their habitats within the area is indicated by the pre-field review.

6. Summarize results, including a list of the species considered and any sources of area habitat information.

5.2.3 Field Reconnaissance

A field reconnaissance should be conducted to determine the presence and distribution of invasive plant infestations and to evaluate the risk of spread. In order to accomplish this, a reliable sampling design should be conducted, such as using a systematic search using grid lines or transects to cover as much of the area as possible. If the area is large, a sub-sample of the area using grids or transects can be used. The surveyor should walk the distance of the grid line or transect and map all invasive plant species observed using a Global Positioning System (GPS) handheld unit (e.g. Trimble, Garmin, etc.). Infestations should be identified by the name of the species encountered, a number designating the order of occurrence, and the species risk of spreading. Surveys should be conducted during the growing season for proper identification. When conducting the field reconnaissance, the weather conditions occurring during that year

should be considered to determine if other invasive species may be present at the site when different weather conditions occur. Some invasive species are not obvious or do not occur when the ideal weather conditions are not present (i.e. monsoon season, early spring emergence).

The following weed management actions should be taken according to the class of invasive weed encountered and the risk of spread:

Category A or B weeds are present:

1. Develop and implement management measures to eliminate weeds, with the following considerations.
    a. Removal techniques: chemical, mechanical, and bio-control
    b. Approved herbicides for that area
    c. Legal requirements for using herbicides
    d. Re-planting in areas >50% invasive species
    e. Follow U.S. Environmental Protection Agency (USEPA) and NNEPA Guidelines and obtain appropriate state environmental quality permits and approvals for Arizona, Utah, and/or New Mexico.
    f. Develop fire and safety plan
2. Monitor management measures (qualitative and quantitative) for 5 years

Category C weeds are present:

1. Develop and implement management measures to prevent spread or eliminate invasive weeds.
2. Monitoring management measures for 3 years.

No weeds are present

1. Document results.
2. Monitor every 5- 10 years.

The results from the field reconnaissance should be documented and be used to develop a removal strategy, establishing the actions that will be taken including: control methods, re-planting of native species, and monitoring. These inventories will also provide baseline information on the species present and size and location of the infestation.

Figure 5-1. Flow Chart Species Prioritization

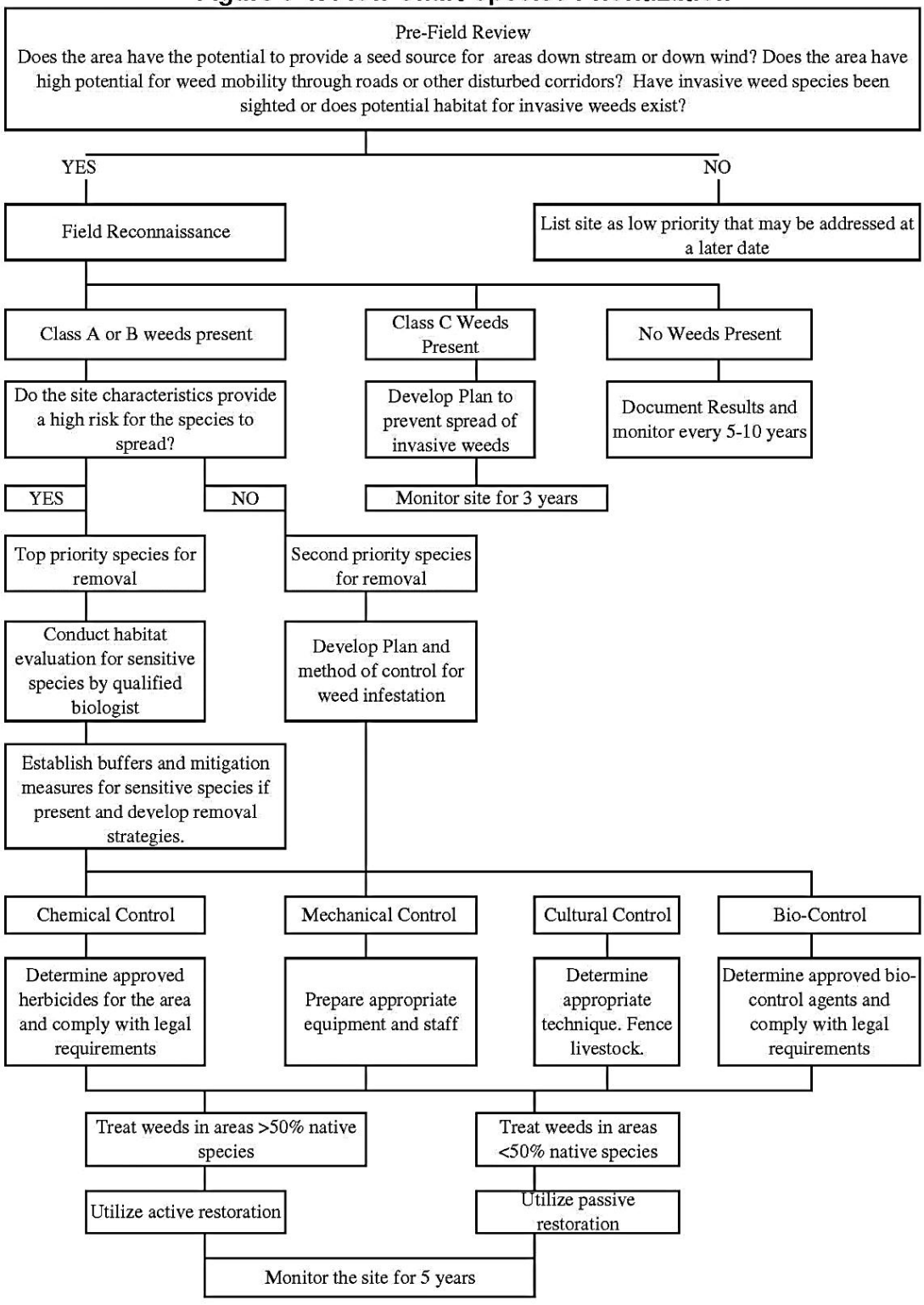

Figure 5-1. Flow chart for prioritizing invasive weed species identified at a project area.

6.0 Weed Inventory and Mapping

Figure 6-1. A field infested with Musk thistle on the Navajo Nation. Photo courtesy of R. Benally.

Of the 16 million acres across the Navajo Nation, only 21,254 acres (or less than 0.1% of the land area) have been inventoried for invasive weeds. Weed inventory and mapping should be conducted concurrently with the implementation of this plan to identify and monitor weed populations within project areas. Once site and/or species prioritizations have been completed, weeds within the prioritized project site should be mapped to assess the size and scale of existing infestations, provide valuable information for developing weed control projects, and monitor the efficacy of weed control efforts. Weed mapping should be conducted annually to help with project planning and to document changes to previously treated areas.

Weed mapping is an important tool for land managers to effectively manage weeds on the Navajo Nation. While it is impossible to map every single weed, mapping is a critical tool for identifying and monitoring problem populations. Annual weed mapping should be done on areas identified for treatment and management and should provide information on the cover of weeds found within those project areas. Site-specific mapping, as described above in Field Reconnaissance, should be conducted throughout the year to assess new infestations that may be identified by weed coordinators, range managers, or members of the community. In addition to in-field mapping, data processing of collected data is also necessary to provide agency and region-wide assessments of recurring and emerging weed issues on the Navajo Nation. While there are several different methods and tools that can be used to field map weeds, the following information provides necessary components that should be integrated into basic weed inventory protocols for the BIA Navajo Region and Navajo Agencies to assist in prioritizing weed control projects and assessing the effectiveness of control measures. A basic weed mapping protocol is provided in Appendix D.

For an in-depth review of weed mapping, the California Department of Food and Agriculture has developed a useful handbook which evaluates weed mapping tools, techniques, and analysis methods. Many of the techniques outlined below have been adopted from their California Weed Mapping Handbook (DiPietro et al., 2002). The handbook is available at: http://www.cdfa.ca.gov/weedhome/pdfs/handbook_sept.pdf.

6.1 Field Mapping

Mapping of weeds requires field surveys of new and on-going weed infestations. Field surveys should be conducted annually to determine the presence and distribution of invasive plant infestations and to evaluate the risk of spread. In order to accomplish this, a reliable sampling design should be developed, such as using a systematic search using a grid or transects to cover as much of the area as possible. If the area is large, a sub-sample of the area can be used to estimate coverage and extent of observed weed populations. The surveyor should walk the area of the grid cell or the distance of the transect and map all invasive plant species observed. Information on identified infestations should record the geographic location of the spread, any invasive species present, and the extent and the density of the population. Weed map data can use point, line, or polygon data depending on the techniques being used and the size of infestations being investigated. The preferred method documents infestations as polygons to make it easier to estimate acres of a given infestation and to assist in project planning. However, if a method records infestations using point or line data, it is recommended that acreage and coverage estimates be included in the survey data to assist in estimating the overall size of the population.

When conducting field mapping, surveyors should be briefed on the following:

- The extent of the property being surveyed including property or areas to avoid (i.e. private property).
- How to clean off equipment and clothing after a survey is completed to avoid inadvertently spreading weeds to other mapping locations.
- How to identify and avoid sensitive plant species (i.e. federally and tribally listed species).
- How to identify priority weed species.
- The best routes for accessing mapping locations and where to park to avoid damage to sensitive areas.

Different techniques that can be used to record weed infestations in the field are listed below.

6.1.1 GPS Units

The use of Global Positioning System (GPS) units has become a common way for most land managers to collect geographic data on weeds. GPS units provide real-time location data and navigation, allowing users to collect data points as they survey a project area. GPS units can provide accurate geographic location data by receiving signals from networks of satellites. They can also provide an easy platform to transfer the collected data to a computer where it can be used to create detailed maps and perform a variety of spatial analyses. The use of GPS units, however, may be an impediment as they do require some technical training on how to use them accurately and efficiently. For surveying, it is important that users know how to set up the

projection system, navigate to specific locations, and input relevant information and unique identifiers for individual data points or polygons.

Some GPS units may also save geographic data in a variety of different file formats, which may not be directly converted for use with GIS mapping software or between different GPS models. To help with these data issues, the State of Minnesota Department of Natural Resources has developed open source software called DNRGPS, which can convert several popular GPS file formats for use on different GPS models and on GIS software (Available online here: http://www.dnr.state.mn.us/mis/gis/DNRGPS/DNRGPS.html).

GPS units can also be limited access to satellite reception. While the widespread use of GPS units has allowed for units to increase their accuracy, some locations may still be hard to obtain accurate location data, such as slot canyons where topography or dense canopy cover may block the unit from communicating with the satellite network. It may be necessary to note data points where accuracy was limited or questionable.

6.1.2 Smart Phone Mapping Apps

The emergence of the smart phone technology has also encouraged the development of a number of apps that allow surveyors to use their personal phones as GPS devices. Such apps make sue of the GPS technology incorporated into new smart phone systems to provide real-time location information and data collection. Use of smart phone GPS apps may help cut down on the costs for purchasing survey equipment and can help volunteer groups assist in documenting weed infestations. Apps such as Strider and MapItFast from AgTerra can be used on Android phones to provide a mobile method for collecting data and creating custom reports on-the-go for mapping projects. Organizations, such as Bugwood, also create specific apps for natural resource managers all over the United States to help managers, volunteers, and community members identify, map, and track invasive plant infestations. This method however will depend on whether field surveyors have access to smart phones or if the cost for a weed mapping app is prohibitive (prices range from free to $20 for each user). There may also be complications in transferring data from an app into an ArcGIS format.

6.1.3 GIS Remote Mapping

GIS, or a Geographic Information System, is a powerful tool for creating geographic data that can be used for mapping and project planning purposes. GIS software can be used to compile and analyze data collected in the field. GIS software may be used to map areas away from the field either by using remote sensing or by documenting visible problem areas on aerial imagery. This method works well for invasive tree species, such as tamarisk or Russian olive, which can grow in dense stands. For example, dense stands of tamarisk can often be delineated when using high resolution aerial imagery. Use of remote sensing or delineation is recommended where field mapping is not feasible, such as in canyons or rivers. Do not use remote sensing for smaller, less dense weed species such as thistles, grasses, or other herbaceous or annual weeds.

6.2 Data Collection

In addition to collecting location data for identified weed infestations, it is also important that datasheets be used to collect information that describe other attributes of the site. Whether in digital or paper form, the information outlined below provides additional characteristics of the infestation that is necessary along with the geographic data. The information outlined below represents the basic required information that should be collected during all weed mapping surveys and will allow the BIA to share weed data with other agencies and weed management groups. This list can be updated as weed mapping efforts develop and evolve. A sample data sheet is provided in Appendix D.

- Agency- As weed mapping efforts will be done on an agency basis, field surveys should identify the BIA Agency collecting the survey data and the weed coordinator who is managing the weed mapping effort.
- Date- Mapping surveys should document the month, day, and year the survey was conducted. This information can be helpful in determining if certain species of weeds may have been missed due to the time period the survey was conducted. For example, species that emerge in the early spring may not be documented if surveys are conducted in the fall.
- Surveyor Information- Individuals conducting the survey should provide their name and potential contact information in case questions arise when processing the data. There is always the possibility that follow-up may be needed on the documented infestation.
- Unique ID Code- Each infestation or area should have a unique identifier developed for it. It can be a unique combination of letters and numbers that correspond to specific geographic features, or sequential numbers. However, they should be unique to the infestation being documented within an area on a specific field date to avoid confusion. The identifiers can be used to track project areas over time.
- Source- Source information identifies where knowledge of the infestation originated or who notified the BIA of the infestation. It could identify previous survey dates, weed coordinators, specific land owners, other federal, state, or tribal agencies, community groups, or other BIA Navajo Regional agencies. During the first few years implementing the Integrated Weed Management Plan, knowledge of who helped identify the location of known weed infestations may be incomplete, but collection of this information in subsequent years can help identify community members who can assist with weed management issues.
- Location- All weed inventories should identify where infestations are located. Location information should include geographic coordinates that can be used to pin point the exact location of the infestation. Location data should be recorded for each infestation being documented during the survey. An infestation represents a collection of invasive plants

within a given area. While infestations composed of solitary plants may be collected, mapping efforts should focus on sites where infestations represent sizeable clusters of invasive plants in a given area. Often this information is automatically collected by GPS or Smart Phone apps as data points are taken.

If using GPS units or programs to map weed populations, **the geographic projection system on the unit should be set to either NAD1983 UTM Zone 12N (Arizona) or 13N (New Mexico)**, depending on where the survey is being conducted to provide accurate northing and easting coordinates. If this projection is not available on the handheld device in use, it is advised that coordinates be recorded in Latitude and Longitude (Degrees, Minutes, Seconds, or Decimal Degrees), which can be converted into UTM coordinates later. To convert coordinates, the following website from the University of Montana provides coordinate conversion to a variety of different coordinate systems: http://www.rcn.montana.edu/resources/tools/ coordinates.aspx.

Other location data that can be recorded includes the USGS quad map identifier (if being used), the state, the county, watershed HUC codes, and range, township, and section information. However, such data is not required for basic weed mapping inventories.

- Weed Species- Weed species should be identified during field surveys per the U.S. Department of Agriculture (USDA) PLANTS database symbol (http://plants.usda.gov). Individuals conducting field surveys should be given training and guidebooks to help them identify priority weed species and local vegetation in the field. This training should also help field surveyors identify potentially sensitive species to help them avoid collection or damage to sensitive plant species. If a species is not easily identifiable in the field, a sample may be collected for identification. A collected plant specimen should include the entire plant, if possible, including: flower, roots, stems, and leaves. Collected samples should note the date, location, a unique ID, and any other pertinent information about where the sample was taken. A data point should also be recorded on the GPS unit to denote where the plant was collected.

  USDA PLANTs database symbols for are target weed species are provided in Appendix D. The table and symbols should be updated annually to ensure that the proper symbols are being used in the field to identify problem weeds.

- Size and Extent- The size of the infestations should be documented in either square feet (for small sites) or an estimated acreage (for large sites). An estimate of the size and extent of the documented infestation will be used to assess the severity and spread of identified weed species. Some GPS units and programs may allow users to collect polygon data by either drawing the shape of the area in or by walking around the perimeter of the infestation. This is the most accurate way to document infestations as the polygon data can be used to easily estimate the size of the infestation. If point data for each infestation is collected, surveyors can record a rough estimate of the size (e.g. >0.1

acres, 5-10 acres, etc.). If line data is collected, surveyors may want to provide a buffer distance for how wide the infestation is.

Size and extent should record the size of the infestation for **each species identified** at a recorded site. The size estimate should be an estimate of each population of weeds found in an area, not an estimate of the size of individual plants. This information can be helpful in determining which control method to use, setting up post-treatment monitoring, and assessing the overall cover of priority weed species within the Navajo Nation.

- Vegetation Cover- Vegetation cover will be estimated as a percentage of the ground covered by the specified species. Cover is a measure of how dense the plants are growing within a given area. Some weeds may be growing in a large area, but they may be widely spaced, allowing other vegetation to grow in the same area. Other weeds, such as tamarisk, can grow in dense stands or patches, which crowd out other plant species. Cover is best estimated by looking at how much of the foliage or canopy crown is covering the ground. For more detailed information on how to estimate vegetation cover reference Elzinga et al. 1998 (http://www.blm.gov/nstc/library/pdf/MeasAndMon.pdf; pp. 178-186).

- Other Information

  Additional information that can also be recorded, but is not required while conducting weed surveys includes:

  - Where samples were collected if an identification could not be made in field
  - If there are nearby water sources or barriers that may provide a boundary for the infestation
  - Other dominant vegetation
  - If unique or listed plants were encountered
  - Problems encountered while collecting the data
  - If information on the infestation is recorded on other documents (e.g. maps, notes, etc.)
  - Photos of infestations along with photo file information and numbers

6.3 Data Processing

Once data has been collected and recorded in the field, it will be necessary to compile and analyze the data using GIS software. The software allows users to organize inventory data and use it on a variety of scales to assess weed mapping efforts. Most analyses can be performed using Esri Licensed ArcGIS software, which integrates attribute and spatial data for analyses. Some data may also be compiled and analyzed using online mapping tools such as Google Earth or ArcGIS Online. Each weed coordinator should manage a spatial dataset of weed information. The BIA and Navajo Nation can provide training and access to Esri licensed software. Contact your local BIA Navajo Region IT representative for more information.

Spatial data in the form of vector data should also be used to assess and summarize mapping efforts. All field surveys should be compiled into an annual shapefile to provide a landscape view of weed infestations. Spatial data should include a table of attributes which will document the information recorded on data collection sheets, if infestations are new for that year or if they are part of ongoing monitoring efforts, if they are part of a specific weed management project, and if they represent an expansion or reduction of weed coverage from previous years (if applicable).

Weed mapping data should be assessed at the agency and regional level on an annual basis. Such analyses should look at the size and extent of infestations for all priority weed species, the ability of treatment methods to reduce the size and cover of target species, and locations where weed management projects can make the best use of limited funds. Implementation of a basic weed mapping program will help with planning and long-term management of priority weed species on the Navajo Nation.

7.0 Permitting

The Environmental Impact Statement (EIS), Biological Assessment and Biological Opinion associated with this plan will provide federal coverage to implement weed management activities on the Navajo Nation. However, some permitting will have to be completed on a project-by-project basis. Prior to implementing a project, the following agencies should be contacted to insure project compliance and obtain necessary permits and approvals. Additional information on how to apply or fulfill additional permitting and compliance requirements are outlined in the Weed Project Checklist (Appendix C.). Contact information for the agencies is available in Appendix H. .

Navajo Nation Department of Fish and Wildlife (NNDFW)

A project site should be evaluated by a qualified biologist to determine if habitat for Federal or Navajo Listed Endangered, Threatened, or Proposed species or migratory birds exists on the site. If habitat exists a qualified biologist should then conduct species specific surveys during the appropriate season to determine if the species is present on site. In order to conduct species surveys on Navajo Nation land a biological research permit must be acquired from the NNDFW. If species are detected on the site, avoidance measures outlined in the Biological Assessment, Biological Opinion and Environmental Impact Statement should be followed. Any positive results from the habitat evaluation and the species surveys (i.e. occurrences of listed species) should be reported to the NNDFW. If any projects affect wetland or riparian habitats, review and approval of the project by NNDFW will be required.

Navajo Nation Historic Preservation Department (NNHPD)

Surveys should be conducted by a qualified historic preservation officer or archaeologist to determine if any historic or cultural artifacts are present on the site. If artifacts are detected on the site, avoidance measures outlined in the Section 106 Programmatic Agreement and EIS should be followed. Any findings should be reported to the NNHPD per the Programmatic Agreement associated with this project.

Navajo Nation Environmental Protection Agency (NNEPA)

Projects must comply with the Navajo Nation Clean Water Act, Navajo Nation Safe Drinking Water Act, Navajo Clean Air Act, Navajo Environmental Policy Act, and the Navajo Nation Pesticide Act. The following reports may be required to meet the Navajo Nation EPA regulations:

- Due to the size of the Navajo Nation, all projects using herbicides should submit an eNOI to the U.S. EPA to document and track herbicide use on the Navajo Nation. Each BIA Navajo Agency will serve as the Decision-Maker and Operator for the eNOI for the U.S. EPA's Region 9 Pesticide General Permit. This annual eNOI will provide the U.S. EPA with the project details (herbicides proposed, size of area, weeds managed, potential endangered species and watershed impacted, etc.). Copies of the Notice of Intent will need to be sent to the NNEPA Surface & Ground Water Protection Department and the NNEPA Pesticide Enforcement and Development Program. Information on the Pesticide General Permit requirements and eNOI submission requirements can be found in Appendix C.
- Any projects using restricted pesticides must have certified pesticide applicators who also hold certification with the Navajo Nation through NNEPA. Project records must also be kept detailing where, when, amount applied, and for whom herbicide was applied. These records will be subject to review by NNEPA in adherence to the Navajo Nation Pesticide Act.
- Any projects which implement prescribed or controlled burns should be planned in coordination with NNEPA to address air quality concerns when developing the project Burn Plan. An air quality report may also be necessary to document the effects of burning on regional air quality for specific communities on the Navajo Nation.
- Any actions that require a federal permit, license or approval to discharge into 'waters of the U.S. will require a Section 401 permit from the NNEPA Water Quality Program. Application for the Section 401 permit should be done at the same time the Section 404 permit (see below) is completed as these permits are done in conjunction with each other for all projects conducted in riparian or wetland areas.

- If any projects are proposed within wetland or riparian areas, a wetland study and delineation will be required. NNEPA will need to review and approve all projects that may impact the waters of the Navajo Nation along with the NNDFW.
- Projects should survey for potential wellhead protection areas and coordinate activities with NNEPA Public Water Systems Supervision Program (PWSSP) to incorporate pollution prevention measures.

United States Army Corps of Engineers (Corps)

The Corps regulates activities on the nation's waters and is charged with protecting our nation's harbors and navigation channels from destruction and encroachment, and with restoring and maintaining environmental quality. Pursuant to Section 404 of the Clean Water Act, projects that occur along the riparian and wetland areas that impact jurisdictional waters require Corps permits. The Corps also has an obligation to ensure that permitted projects comply with NEPA, the Endangered Species Act (ESA), and the National Historic Preservation Act (NHPA). Weed projects that require mechanized removal of vegetation along riparian corridors or wetlands will require a Section 404 permit. The application for the permit should be submitted to the representative State Corps office (i.e. Arizona, New Mexico, or Utah).

8.0 Mitigation Measures

The following measures should be taken when implementing or performing survey work related to weed management projects.

8.1 General Measures

Project Planning

- Surveys and clearance for cultural resources are required by a qualified historic preservation officer or archeologist before all surface disturbing activities, mechanical treatments or chemical treatments.
- Surveys and clearance for paleontological resources are required before all surface disturbing activities, mechanical treatments or chemical treatments in coordination with the Navajo Nation Minerals Department.
- Complete all necessary permits and authorizations prior to implementing a project (see Chapter 7 and Appendix C.).
- All project participants will receive training use of Personal Protection Equipment (PPE), equipment handling, and safety protocols. Participants will be required to use PPE during herbicide and mechanical (chainsaw, control burn, etc.) applications.
- If potential habitat for endangered species is present, conduct a habitat assessment by a qualified biologist. If potential habitat is found, the protection measures, including buffers

established for that species will be applied or additional surveys for the presence of the species will be conducted by a qualified biologist. If the species is present at the site the appropriate species based protection measures will be employed (Appendix F.)

Prior to Project Implementation

- Designate staging areas and/or equipment wash stations for projects for cleaning and prep work before and after treatments. These sites will be used for mixing herbicides, refueling equipment and vehicles, and storage for the duration of the treatment. Equipment wash stations may be temporary and will have a filter system, for example at least 6 inches of large cinder or gravel spread over an area 10ft x 30ft. Filter cloth may be used for temporary stations. The area will be a perched drainage to allow excess moisture to drain after being filtered and will be located at least 300ft away from surface water, natural drainages or wellheads.
- Before treatments adjacent landowners, authorized land users, local authorities, and/or the general public will be notified of treatments, treatment duration, and post-treatment measures to prevent exposure and limit re-infestations. This will be done through posted public notices, radio announcements, and/or chapter meeting announcements.
- To reduce the risk of spreading and creating weed infestations, planning operating areas and access routes will be identified to avoid heavy infestation areas. Plan closures of access routes at the finish of the project.
- Clearly mark boundaries of treatment sites (such as posting visible flags or signage) before and during treatments.
- Sites will be inspected and potential hazards will be removed to insure safety prior to treatments.

During Project Implementation

- Vehicles will use only established roads for accessing project sites. Vehicles will be parked at designed parking areas during treatments. Parking areas will be near established roadways.
- If camping at a site is necessary, project participants will use only identified designated and established campsites, where NNHPD or qualified archeologist has reviewed and approved.
- On-site safety briefings will be given prior to any treatments to review required PPE, safety and emergency response measures, and what to do in the case of an injury or emergency.

- Equipment, heavy machinery, and clothing will be inspected and cleaned after treatments for mud, dirt, and plant parts to prevent spread to and from other project sites by the field crew.
- Minimize soil disturbance to the extent practical.
- No mechanical treatments or use of heavy mechanized equipment will be conducted within archeological or traditional cultural property boundaries.

Post Project Implementation

- Post-treatment monitoring of project sites will be done to evaluate treatment effectiveness, potential re-infestations or new introductions, and potential impacts to resources (Appendix D.)
- Limit the number of people and trips to sensitive areas for follow-up treatments and/or monitoring.

8.2 Chemical Treatments

Project Planning

- The on-site Pesticide Applicator will develop a Spill Contingency Plan that meets the minimum requirements specified by the BIA to eliminate contamination of water or soil resources in the case of accidental spills.

Prior to Project Implementation

- All herbicides must be USEPA approved and must be mixed and applied according to label instructions.
- Treatment sites will be closed for a duration of time according to label specifications when herbicide labeling recommends limiting exposure to humans, livestock, and pets.

During Project Implementation

- All herbicides will be used according to the USEPA approved label.
- Certified Pesticide Applicators must be on site to supervise projects during herbicide treatments. Pesticide Applicators must be certified by the Navajo Nation.
- Use dye markers with herbicides to raise awareness of the physical spray location on weeds.
- An emergency spill kit must be present at project sites where herbicide is used to allow for containment, absorption, and disposal of spill materials.
- Material Safety Data Sheets (MSDS) for herbicides and adjuvants must be accessible at project sites in the event of accidental exposure or spill.

- Avoid applying chemicals during times of high wind speeds, high temperature, and low humidity to prevent chemical drift to areas off site. Read the herbicide label for exact conditions.
- Use Water Quality Protection Zones (WQPZ) set by the NNEPA for mechanical treatments and aerial and vehicle-based herbicide applications within riparian and wetland areas. The buffer distance for the WQPZ is 200ft, unless a greater buffer is needed for a sensitive species or if indicated on the herbicide label.
- *Near riparian areas, o*nly aquatic formulations of 2,4-D, glyphosate, triclopyr and imazapyr would exclusively be used within 25 ft of the daily high water mark.
- Herbicides that are practically non-toxic to fish and mollusks (White 2007) require a 25 ft (7.6 m) buffer from the daily high water mark, including: aminopyralid, chlorsulfuron methyl, clopyralid, diflufenzopyr, imazapic, and thifensulfuron-methyl.
- Non-aquatic approved and moderate to high aquatic toxicity herbicides (White 2007) require a 300 ft (91 m) buffer from the daily high water mark.
- Only aquatic approved herbicides would be used for aerial applications by either fixed wing or rotary aircraft within riparian areas.
- Water for mixing herbicide and cleaning herbicide equipment will be potable water obtained off-site or through a Water Use Permit. For remote sites, there is a possibility of a Water Use Permit with the local water code. An anti-siphon and back flow preventer device is required to prevent contamination of the water source.
- Store equipment and materials away from riparian areas in safe and secure upland sites during project implementation and within close proximity of the project site. Herbicide containers and equipment must be stabilized with straw bales, filter cloth, or other appropriate means to prevent reentry into the waterway or wetlands.
- Herbicide will be stored in a secondary containment storage unit with impermeable materials such as concrete or metal so leaks and spills do not reach soils. Storage containers will be coordinated with BIA Safety Officer and Environmental Services

Post Project Implementation

- Herbicide containers and application equipment will be triple rinsed at designated washing stations to minimize chemical residues left as per the MSDS and herbicide labels. If possible, use the triple rinsate from the sprayer cleaning as dilution for the next herbicide batch. Do not pour rinsate from empty containers or sprayer cleaning onto ground or any drainage system. Dispose as a hazardous waste.
- Properly dispose of pesticide waste and containers according to federal, state, and tribal regulations.

8.3 Mechanical

Prior to Project Implementation

- If mechanical treatments may increase the risk of erosion near waterways, erosion control measures will be implemented to stabilize and limit erosion along bank lines.
- Establish a burn plan if planning to use burning as a control method and follow it during implementation.
- Prescribed burning will not be conducted during migratory bird breeding season.

During Project Implementation

- Keep areas devoid of vegetation wet to prevent fugitive dust. This can be accomplished with a sprayer mounted to a water truck.
- Use of the lightest/smallest ORV, UV or tractors will be prioritized for treatments. No such equipment will be used on wet soils or cryptobiotic soil crusts.

8.4 Cultural

During Project Implementation

- Areas being treated with target weed grazing must have fencing installed around the perimeter of the treatment area to contain the livestock.
- If using target weed grazing, use only in sites where weeds are palatable and non-toxic and where desired native species will not be damaged.
- After target weed grazing is implemented, livestock will be placed in a fenced location for 48 hours. All animal waste will be collected and burned to destroy defecated plant parts and seeds.
- Target weed grazing will not exceed more than 10 days on a range and/or wildland project site or 365 days on a cropland site.
- Passive restoration is preferred when native vegetation comprises >75% of the treated area. If natural re-vegetation fails, then active restoration is necessary. Active restoration includes planting of native species poles, root stocks, and seeds.
- Reseeding will be timed with anticipated precipitation events and at least 7 days after herbicide treatments have been completed. Reseed disturbed areas within native vegetation to minimize opportunities for weed establishment and soil erosion.
- Only native vegetation, certified weed-free and preferably locally sourced, will be used for restoration activities.

Post Project Implementation

- If possible, implement livestock grazing deferment during growing seasons or until seeding has had an opportunity to establish itself.

9.0 Weed Management Techniques

An integrated combination of treatment methods will be necessary to control aggressive and adaptable weed species. No single control method or any 1-year treatment program will ever achieve effective control of an area infested with invasive weeds. The fast growth, extensive root system and high reproductive capacity of these plants requires long-term cooperative and integrated management programs and planning to contain and reduce weed populations on the Navajo Nation. Weed removal efforts should coordinate resources with neighboring agencies (e.g., NTUA, ADOT, BLM) who conduct nearby weed treatments to maximize cost and effectiveness of weed treatments. Mechanical and/or manual treatments followed by a chemical treatment will be more effective than implementing any one treatment alone. Chemical treatment followed by seeding or planting native understory species, such as grasses, will help achieve additional project success. Prior to invasive plant seed set, hand pulling or grubbing is effective for small infestations in addition to follow up with a mechanical or chemical treatment to insure no target species set seed that year. Appropriate timing of a weed control technique is the most important factor to improve/ensure effectiveness. Most annual and biennial plants should be treated early in the season before the plants bolt and flowering occurs. In contrast, many perennials are most effectively treated with systemic herbicides in the fall when the plant is actively transporting nutrients to its root system. The methods described below are recommendations for treating invasive weeds based on effective techniques used in other areas outside the Navajo Nation. Appendix E. has a table of the best option for control of the priority weed species.

Biological control agents will not eliminate an infestation; however, they will enhance control and reduce the rate of expansion of large existing infestations. Biological control is most effective on large populations where other control methods are limited due to the size and scale of the infestation. The use of herbicides in combination with biological control is successful on large populations of several weed species. A more detailed discussion of the proposed weed treatments for the Navajo Nation is discussed below. Comprehensive weed management methodology for each target weed species can be found in USDA Forest Service Southwest Region Weed Field Guides (2012, http://www.fs.usda.gov/detail/r3/forest-grasslandhealth/invasivespecies/?cid= stelprdb5228481) and in the Montana, Utah, Wyoming Cooperative Extension Services 2006-2007 Weed Management Handbook (http://www.uwyo.edu/ces/programs/weed_management_handbook_files/weed_management_handbook.pdf).

9.1 Prevention

Prevention is the most effective and least expensive method of control. Establishing a "weed-free" policy to include, but not limited to hay, grain, seed, and ballast, will be crucial to reducing current weed expansion and the introduction of new weed species. A "weed-free" policy will require the enactment of a law from the Navajo Nation Tribal Council. Maintenance of a vigorous, competitive native plant community will help to reduce invasive plant establishment.

Cleaning tires, boots, hooves and equipment when leaving infested areas will also prevent the introduction of new infestations and limit the spread of existing infestations. Extensive disturbances often give invasive weed species another advantage over native plants as most weeds are highly adaptable to disturbed areas. Revegetation of large disturbed sites with vigorous, hardy native grass and perennial plants will also prevent establishment of new invasive weed populations.

9.2 Early Detection/Rapid Response

The key to dealing with the introduction of new invasive weed species involves early detection and rapid response. The longer a species goes undetected during the early, non-invasive stage, the less opportunity there is to intervene. This often leads to more expensive and limited options for control or eradication of newly establishing non-native weed species. Information and education programs to inform people how to recognize invasive species of concern are helpful in detecting infestations when they are still small. Repeated surveys will be needed to detect new weed infestations in high priority areas. After detecting a new invasive species on the Navajo Nation, a treatment plan will be developed based on the growth characteristics of each species, size of the infestation, and the personnel and equipment capacity of the BIA. Early detection and rapid response will be most successful if new infestations are detected when they are less than 1 acre in size. Early detection and rapid response to new invasive weed infestations on the Navajo Nation will be a high priority.

Since roads and right-of-way corridors are primary vectors for the introduction and spread of noxious weed species, early detection and rapid response will be particularly important. Surveys along roads and right-of-ways and adjacent land will help identify new weed populations that have the potential to spread. Once these populations are identified, early treatment to maintain these linear corridors will prevent or reduce the potential for large scale infestations on adjacent land.

Early detection and rapid response techniques will follow those established by the U.S. Forest Service in 2005 and the Arizona Invasive Species Advisory Council in the Arizona Invasive Species Management Plan in 2008. Scattered plants and spot infestations around the perimeter of the infestation need to be treated first to contain the spread of the infestation. To limit seed dispersal, treatment of infestations along roads should be done at the same time as treatment

around the infestation perimeter. Treatments should then move inward toward the core of the infestation. Treatments will need to be repeated until the seed bank is depleted. Treatments along linear corridors (roads and right-of ways) will be treated in a linear fashion within easements. Linear corridors serve as both the core and/or the perimeter of the infestation and weed removal activities on adjacent infested areas should be coordinated during the same time period.

9.3 Manual Control

Photo courtesy of Fred Phillips Consulting.

Manual control will be the primary control method for weed populations on the Navajo Nation, if feasible. These techniques include the use of hand tools to cut, clear, or prune herbaceous or woody species. A maximum of 30 people (typically between 7-20 people) will be present within a project site to conduct manual treatments. Manual treatments involve cutting undesirable plants above the ground level; pulling, grubbing, or digging out root systems to prevent sprouting and regrowth; removing competing plants around desired species. Manual control is conducted with hand tools, including handsaws, loppers, axes, shovels, rakes, machetes, grubbing hoes, mattocks (combination of cutting edge and grubbing hoe), Pulaskis (combination of axe and grubbing hoe), brush hooks, weed whackers, and hand clippers. Manual treatments, such as hand pulling and hoeing, are most effective where the weed infestation is limited and soil types allow for complete removal of the plant material, including, in most cases, the root system (Rees et al. 1996).

Annual and biennial plants with shallow root systems that do not re-sprout from residual roots, and plants growing in sandy or gravelly soils will be hand pulled. Vegetation removed by manual methods will be bagged and sent to a certified incinerator to prevent seeds or other plant materials from re-infesting areas. Repeated treatments will be necessary due to soil disturbance and residual seeds that remain in the soil. Manual techniques will be implemented in smaller areas, but are not effective in larger weed infestations. Manual techniques will be implemented in sensitive areas such as riparian areas, areas where burning or herbicide treatments are not appropriate, areas that may be inaccessible to ground vehicles, and in areas where species of concern exist. For the most effective control, manual techniques will be used in combination with chemical techniques.

9.4 Mechanical Control

Mechanical control involves the use of power tools and heavy machinery to remove noxious weed species. The techniques described below were adapted from the Bureau of Land Management (BLM)'s Vegetation Treatments for 17 Western States (BLM 2007). These techniques are utilized when clearing large areas where weeds are widespread and provide dense

coverage, often limiting the growth of native vegetation to very confined areas (**Figure 9-1**). Mechanical equipment will be cleaned before treatment and before leaving the treatment area in designated facilities or equipment wash stations. Equipment wash stations may be temporary and will have a filter system, for example at least 6 inches of large cinder or gravel spread over an area 10ft x 30ft. Filter cloth may be used for temporary stations. The area will be a perched drainage to allow excess moisture to drain after being filtered and must be at least 300 ft from a natural drainage to avoid contamination. A wash system or water trucks with potable water will be used for equipment cleaning. The equipment wash area and staging area will be inspected for weed seed and plant material and will be properly disposed by bagging and incinerating.

Figure 9-1. Examples of mechanical treatments. (Left) Tractors grubbing root systems for large tamarisk stands. (Right) A site cleared of invasive tamarisk using mechanical treatments. Photos courtesy of Fred Phillips Consulting, LLC.

- **Grubbing** - Grubbing refers to removing a plant by digging out its root system. If a species has a shallow root system, a shovel is used to remove the plant. Invasive species with deeper root systems require the use of a crawler-type tractor and a brush or root rake attachment to remove plants with deep root systems. One method that is used includes using the rake attachment (a standard dozer blade adapted with a row of curved teeth projecting forward at the blade base) on a tractor. Brush is uprooted and roots are combed from the soil by placing the base of the blade below the soil surface. Grubbing greatly disturbs perennial grasses, so grubbed areas will be reseeded to prevent extensive runoff and erosion, if possible. This removal technique requires a maximum of 5 people to drive the heavy machinery and prepare the site. Grubbing has high ground disturbing impacts, and will not be used in active prairie dog colonies or in habitats with other burrowing animals.

- **Tillage** - Tilling involves the use of angled disks (disk tilling) or pointed metal-toothed implements (chisel plowing) to uproot, chop, and mulch vegetation. Tilling is done with either a brushland plow, a single axle with an arrangement of angle disks that covers about 10-foot swaths, or an offset disk plow, which consists of multiple rows of disk sets at different angles to each other. These plows are pulled by a crawler-type tractor or a large rubber tire tractor. This technique is best used in situations where complete

removal of vegetation or thinning is desired and will be performed in conjunction with seeding operations. Tilling leaves mulched vegetation near the soil surface, which encourages the growth of newly planted native seeds. This method is also used for removal of sagebrush and similar shrubs and works best on areas with smooth terrain, and deep, rock-free soils. Chisel plowing is used to break up soils such as hardpan soils. This removal technique requires a maximum of 5 people to drive the heavy machinery and prepare the site. Tillage has high ground disturbing impacts, and will not be used in active prairie dog colonies or in habitats with other burrowing animals.

- **Mowing -** Mowing tools such as rotary mowers or straight-edged cutter bar mowers are used to cut herbaceous and woody vegetation above the ground surface. Power tools such as chainsaws and power brush saws are also used for particularly thick-stemmed plants. Mowing is often done along highway ROWs to reduce fire hazards, improve visibility, prevent snow buildup, or improve the appearance of an area. Mowing is most effective on annual and biennial plants (Rees et al. 1996). Weeds are rarely killed by mowing, and an area often needs to be mowed repeatedly for the treatment to be effective (Colorado Natural Area Programs 2000). However, the use of a "wet blade," in which an herbicide flows along the mower blade and is applied directly to the cut surface of the treated plant, has greatly improved the control of some species. In addition, chipping equipment is used to cut and chip vegetation. This removal technique requires a maximum of 5 people to operate the chainsaws, power brush saws or Bobcat and prepare the site. Mowing is a surface treatment and the ground disturbance is low, however it may noisy. Heavy machinery (Bobcats) with a mowing attachment may require off-road use and have medium ground disturbance (**Figure 9-2**).

Figure 9-2. A Bobcat with a brush hog mower attachment removing invasive weed. Photo courtesy of Fred Phillips Consulting, LLC.

- **Prescribed Fire** - The use of controlled burns, or prescribed fire, for the control of undesired weed species is the intentional application of fire under specified conditions. Controlled burns can provide many benefits to an area by controlling vegetation, enhancing the growth, reproduction, and vigor of desired vegetation, reducing fuel loads, and maintaining certain vegetation community types. A Burn Plan will be developed on a project specific basis prior to implementing this technique. The Burn Plan may include, but will not be limited to: 1) project objectives; 2) prescription; 3) scheduling; 4) pre-burn considerations and weather; 5) site assessment and topography considerations; 6) organization and equipment; 7) communication; 8) public and personnel safety, medical, 9) smoke management plan; 10) ignition and holding plans; 11) contingency plan; 12) mop up plan, and 13) restoration plan. Prescribed fire will be followed by habitat restoration.

  

  Photo courtesy of Fred Phillips Consult LLC

  Also, pile burning is effective method to reduce fuel loads after mechanical treatments have been conducted. Prescribed fires will only be used in areas where there is no threat to human life or property to help maintain ecosystems that are functioning within a normal fire regime. Application of fire as a treatment method is evaluated thoroughly for potential risks and is carried out in areas where there is adequate fire management personnel and equipment available. Fire treatments will follow the guidelines outlined in the BIA NRO Programmatic Pile Burn Agreement with the Navajo Nation and all permits and authorizations obtained prior to implementing this technique. Prescribed fires will be conducted to minimize soil disturbance. Prescribed burning will not be conducted during the migratory bird breeding season.

- **Heavy Machinery**- The use of heavy machinery is often used in conjunction with other mechanical treatments and includes the use of large chipping equipment, roller chopping tools, and feller-bunchers which have not been covered in other mechanical treatment techniques. Heavy machinery also includes using bulldozers and extracting equipment to uproot dense invasive woody vegetation or tree species. Use of such equipment requires special training for their operation. Large chippers, or "tub-grinders," are used to chip the limbs, barks, and woods of trees to generate mulch or biomass. Feller-bunchers are used to cut trees at the base, pick them up, and move them into a pile or onto the bed of a truck (Bonneville Power Administration [BPA] 2000). Feller-bunchers are used to thin stands of trees to remove hazardous fuels. Rolling chopping tools are heavy bladed drums that cut and crush vegetation up to 5 inches in diameter with a rolling action. The drums are pulled by crawler-type tractors, farm tractors, or a special type of self-propelled vehicle designated for forested areas or range improvement projects. Blading

is another method that utilizes a crawler-type tractor with a blade shear attachment to cut small brush at ground level. The topsoil is then scraped with the brush and piled into windrows. Blading is only employed in areas where the degradation of the soil is acceptable, such as along ROW or in borrow ditches. Heavy machinery highly disturbs the soil and machinery can contribute a lot of noise. This removal technique requires a maximum of 5 people to operate the heavy machinery and prepare the site.

9.5 Cultural Control

Cultural treatments include grazing by livestock, re-seeding and planting native species (see Chapter 10), cultivation and crop rotation, weed free hay, and mulching around desired vegetation to limit competitive growth of undesired plants. In some cases, deferment will be used as a cultural control treatment. Target livestock grazing will only be used around Community Development Areas and in agricultural fields, and will be prohibited for use in waterways, Highly Sensitive Areas, and where sensitive species are known to occur. To make grazing effective as a method for weed control and not as a vector for their continued spread, it is imperative to contain livestock with fencing in an isolated area for up to 24 hours after grazing treatments to isolate and collect defecated seed. Feces will be gathered, bagged and destroyed by incineration.

Many noxious weeds can be toxic or harmful to livestock and grazing, therefore grazing occurs when most weeds species are young before harmful toxins or features have developed. This method is most effective when used in combination with bio-control or chemical methods. Grazing by livestock has shown to have limited effect on leafy spurge, yellow starthistle, Japanese brome, knapweeds, thistles, common Mediterranean grass, camelthorn, Russian olive, brome grasses, and jointed goatgrass and is not recommended for control of these species. Livestock grazing can result in a high degree of ground disturbance.

9.6 Biological Control

Biological control agents will utilize U.S. Department of Agriculture (USDA)-approved insects and pathogens that undergo a rigorous testing procedure prior to being available for release. Initial testing occurs in quarantined laboratories abroad and in the United States. The agents are tested for their effectiveness in controlling the target organism and for their host specificity. Testing includes potential effects on economic crops, rare plants, and similar species found in North America. An agent is approved for release only after it has been determined that it is unlikely that the agent will feed or cause injury to any native or agronomic species. It generally takes between 15-20 years for an agent to be cleared for release. Prior to the release of a new agent an environmental analysis is prepared by USDA APHIS (Agricultural Plant Health Inspection Service). The analysis assumes that agents will spread throughout North America to wherever the target species exists following release. The BIA is using the approved list of biological agents provided by APHIS (**Table 9-1**).

The BIA will not consider the release of the tamarisk leaf beetle (*Diorhabda carniulata*). This species was released in Delta and near Moab, UT in 2004 along the Colorado River with the expectation that it would not migrate below the 38º North latitude. However, beetles have moved and been introduced to sites south of the 38º North latitude, migrating down the Colorado River past Lake Mead. This unexpected migration has decimated the nesting habitat of the endangered Southwestern Willow Flycatcher, which has consequently affected the reproductive rate of this species. In response to the widespread damage caused by the tamarisk leaf beetle across the southwestern United States, the BIA NRO started monitoring programs for the leaf beetle to document its extent and impact within the Navajo Nation.

Table 9-1. Invasive weeds and proposed biological control agents.

Target Weed Common Name	Proposed Control Agents	Type
Leafy Spurge	*Aphthona abdominalis*	Minute flea beetle
	Aphthona cyparissiae	Brown dot flea beetle
	Aphthona czwalinae	Black flea beetle
	Aphthona flava	Copper flea beetle
	Aphthona lacertosa	Brown-legged flea beetle
	Aphthona nigriscutis	Black dot flea beetle
Dalmatian toadflax	*Brachypterolus pulicarius*	Flower feeding beetle
	Calophasia lunula	Toadflax moth
	Eteobalea intermediella	Root-boring moth
	Eteobalea serratella	Root-boring moth
	Mecinus janthinus	Stem-mining weevil
	Gymnetron antirrhini	Seed capsule weevil
	Gymnetron linariae	Root-galling weevil
Spotted knapweed	*Bangasternus fausti*	Seed head feeding weevil
	Bangasternus orientalis	Seed head feeding weevil
	Cyphocleonus achates	Root feeding weevil
	Larinus minutus	Seed head feeding weevil
	Larinus obtusus	Seed head feeding weevil
Diffuse knapweed	*Bangasternus fausti*	Seed head feeding weevil
	Bangasternus orientalis	Seed head feeding weevil
	Cyphocleonus achates	Root feeding weevil
	Larinus minutus	Seed head feeding weevil
Russian knapweed	*Subanguina picridis*	Nematode
	Jaapiella ivannikovi	Diptera: Cecidomyiidae
	Urophora kasachstanica	Flower gall fly
	Urophora xanthippe	Flower gall fly

Yellow starthistle	*Eustenopus villosus* *Bangasternus orientalis* *Chaetorellia australis* *Urophora sirunaseva*	Starthistle hairy weevil Starthistle bud weevil Starthistle peacock fly Starthistle gall fly
Field bindweed	*Aceria malherbae* *Tyta luctuosa*	Bindweed gall mite Bindweed moth
Puncturevine	*Microlarinus lypriformis*	Puncturevine seed feeding weevil

The BIA will consult with Navajo Nation Department of Fish and Wildlife (NNDFW) on a project-by-project basis when considering the use of bio-control agents. Project sponsors proposing the release of a biological control agent onto Navajo Nation lands must first obtain approval from NNDFW. Also, prior to the release of any biological control agent, the BIA will obtain a permit from APHIS. The Coconino, Kaibab, and Prescott National Forests and the City of Flagstaff have conducted bio-control treatments in sites near the Navajo Nation for Dalmatian toadflax, diffuse and spotted knapweed, yellow starthistle, and leafy spurge (Dewey Murray, personal communication 2013). The greatest success has occurred in the region with bio-controls released to control diffuse knapweed.

9.7 Chemical Control

Chemical methods include the use of herbicides to control exotic plant species. Herbicides are categorized as selective or non-selective. Selective herbicides kill only a specific type of plant. For example, an herbicide that is selective for broad-leaved plants will not affect the grasses that surround the treated area. Non-selective herbicides will kill all vegetation that it contacts. Therefore, it is important to be careful not to spray desirable vegetation when using non-selective herbicides. The herbicides that will be used on the Navajo Nation are listed in **Table 9-2**.

Photo courtesy of Fred Phillips Consulting.

There are several herbicide application methods that are used. The method that is chosen for a particular project site may depend on the size of the infestation, the species present, accessibility to the site, topography, resources and equipment available, and finances. All herbicides will be used according to their labels and a Navajo Nation Certified Pesticide Applicator will be on site. Water for mixing herbicide and cleaning herbicide equipment will be potable water obtained off-site or through a Water Use Permit. For remote sites, a Water Use Permit may be obtained with the local water code. An anti-siphon and back flow preventer device is required to prevent contamination of the water source. Up to 30 people will be used to implement chemical treatments. Some of the herbicide application methods are described below.

- **Cut Stump**- This method is effective on tree species that sparsely populate an area or in areas where heavy machinery is not an option. Through this method, the plant is cut as close to the ground as possible using a chainsaw or loppers. The cut stump is then immediately (within 15 minutes) sprayed or painted on with a systemic herbicide to prevent vigorous re-sprouting. It is important to cover the entire cut stump with herbicide. For the most effective and safe treatment, skilled sawyers should be used to fell trees.
- **Basal Bark**- Basal bark spraying is most effective on dormant and leafless woody plants with less than a 6-inch stem diameter. This method involves spraying the bottom 12-18 inches of a stem with herbicide. Care is taken to apply herbicide around the entire stem. The herbicide is mixed with a penetrating oil that allows it to pass through the bark. This method results in a dead standing snag.
- **Frill or "Hack and Squirt"**- This method involves making spaced cuts around the entire tree trunk with an ax, machete or hatchet. It is important to make sure the cut penetrates to the cambium layer. Herbicide is then applied to the cuts using a spray bottle or similar tool.
- **Foliar spray** – Foliar sprays are most effective when plants are in full leaf. Foliar spray is applied using a backpack sprayer, spray bottle, a boom or boomless sprayer mounted on an ATV or truck, fixed-wing airplane or helicopter to distribute over a large area.
- **Pelletized Treatment**- Herbicides that are made into a pellet can be buried around the plant's base.
- **Pre-Emergent Treatment**- This treatment method involves applying herbicide to the soil before the target invasive species germinates or emerges.

Herbicide application requires certain precautions and protocols. It is important to be familiar with the legal requirements and approved herbicides for the area where work is being conducted. USEPA categorizes every use of every pesticide as either "unclassified" or "restricted use". Near riparian areas, only aquatic formulations of 2,4-D, glyphosate, triclopyr and imazapyr would exclusively be used within 25 ft of the daily high water mark. Herbicides that are practically non-toxic to fish and mollusks (White 2007) require a 25 ft (7.6 m) buffer from the daily high water mark, including: aminopyralid, chlorsulfuron methyl, clopyralid, diflufenzopyr, imazapic, and thifensulfuron-methyl. Chlorsulfuron, imazapic, imazapyr, and herbicides have shown no risk to aquatic invertebrates and fish even if there is an accidental direct spray or spill to the aquatic habitat (BLM 2007). Non-aquatic approved and moderate to high aquatic toxicity herbicides (White 2007) require a 300 ft (91 m) buffer from the daily high water mark. Only aquatic approved herbicides would be used for aerial applications by either fixed wing or rotary aircraft within riparian areas.

A pesticide, or some of its uses, is classified as restricted if it could cause harm to humans (pesticide handlers or other persons) or to the environment. Herbicides must be applied by

applicators that possess a state applicators license and a U.S. EPA Certified Pesticide applicator card for the Navajo Indian Country. The U.S. EPA Certified Pesticide applicator card can be obtained through the Navajo Nation EPA. When applying herbicides, meteorological factors such as wind speed, wind direction, inversions, humidity, and precipitation should be taken into consideration. Herbicides should always be used as directed on the labels. Caution is taken to prevent overspray on non-target species. Application rates for each herbicide are located in **Table 9-3**.

Extreme caution is used when mixing herbicides. Dermal exposure to a small amount of a concentrated herbicide is equivalent to the exposure received after a full day of working in a treated field. Herbicides are applied using the proper equipment and applicators are required to use personal protective equipment. Herbicide treatments will comply with the USEPA label directions and meet or exceed states' label standards. Also, herbicide application will comply with the Navajo Nation Pesticide Act as enforced by the Navajo Nation Environmental Protection Agency, which includes annual reporting on projects that use herbicide treatments and disposal of unused herbicide.

Table 9-2. Herbicides considered for use on the Navajo Nation.

Herbicide	Herbicide Characteristics and Target Vegetation	Riparian	Rangeland	Agricultural Lands	Right-of-Ways	Roadsides	Residence/ Communities
2,4-D	Selective herbicide that is used to control broadleaf weeds by interfering with the metabolism of the plant. It is moderately to highly mobile in the soil, which restricts its use in and around high ground water tables or open water. Key species include biennial thistles, Canada thistle, diffuse knapweed, leafy spurge, blue mustard, perennial pepperweed, Russian knapweed, squarrose knapweed, sulfur cinquefoil, Dalmatian toadflax, whitetop, halogeton, puncturvine, spreading wallflower, horehound, California burclover, Russian thistle, and yellow starthistles.	X	X	X	X	X	X
Aminopyralid	Selective herbicide used for control of broadleaf weeds. It is relatively immobile in the soil, and remains in upper 12" of soil profile. Target weeds include: yellow starthistle, squarrose knapweed, bull thistle, Canada thistle, musk thistle, scotch thistle, spotted knapweed, whitetop, sulfur cinquefoil, diffuse knapweed, Russian knapweed, and Russian olive.	X	X	X	X	X	X
Atrazine	Selective herbicide that controls pre- and post- emergence broadleaf and grassy weeds. It is mostly absorbed through the roots inhibiting photosynthesis. Atrazine degrades in soil primarily by action of microbes. It is common chemical contaminant in ground and surface water. Key species include: red brome and kochia.		X	X			
Chlorsulfuron	Registered for general use and is used to control many broadleaf weeds and some annual grasses. This herbicide inhibits enzyme activity. Chlorsulfuron tends to leach into soils with a textural range from sand to silt loam and degrades more rapidly at higher temperatures with adequate moisture contents. It is broken down to smaller compounds by soil microorganisms. Chlorsulfuron may be used to treat blue mustard, Dalmatian toadflax, perennial pepperweed, puncturevine, Russian thistle, kochia and thistles.		X	X	X	X	X
Clopyralid	Selective post-emergence herbicide controlling broadleaf species. This herbicide affects the target weed by mimicking the plant hormone auxin and causes uncontrolled plant growth and eventual death. Once applied to the ground, it rapidly disassociates and does not bind strongly with soil particles, which results in having a high potential to contaminate ground or surface water. It may be used to treat biennial thistles, Canada thistle, perennial pepperweed, diffuse knapweed, Russian knapweed, squarrose knapweed, and yellow starthistle.		X	X	X	X	
Dichlobenil	Selective weed control of annual grassy and broad-leafed weeds and certain perennial weeds. It is water soluable and it moves slowly in the soil. Can be used to treat leafy spurge, biennial thistles, Canada thistle, perennial pepperweed, Russian knapweed, field bindweed and kochia.			X	X	X	X
Fluroxypyr	A pyridinoxy acid herbicide used to control annual and perennial broadleaf weeds and woody brush. Potential to leach to groundwater is high and potential for loss on eroded soil is low. Plants take up through leaves and roots and translocated to other plant parts. Target weeds include kochia and knapweeds.		X		X	X	

Herbicide	Herbicide Characteristics and Target Vegetation	Riparian	Rangeland	Agricultural Lands	Right-of-Ways	Roadsides	Residence/ Communities
Fluazifop-p butyl	Selective herbicide for post-emergence control of annual and perennial grass weeds. Breaks down rapidly in moist soils. It is actively taken up by plants and translocated throughout the plant where it interferes with plant cell's ability to produce energy. Target weeds include: fountaingrass, common Mediterranean grass, and red brome.			X	X	X	
Glyphosate	Broad-spectrum, nonselective herbicide used for control of annual and perennial plants including grasses, sedges, broadleaf weeds, and woody plants. Method of action is to inhibit amino acid and protein synthesis. It is moderately persistent in the soil and has an estimated half-life of 30 to 50 days. Glyphosate is strongly absorbed in most soils and normally does not leach out of the profile. Glyphosate has been successful in controlling annual, biennial, and perennial grasses, broadleaf weeds, and woody shrubs and trees.	X	X	X	X	X	X
Imazapic	Selective herbicide for both pre- and post-emergent control of some annual and perennial grasses and broadleaf weeds. It affects plants by inhibiting the production of amino acids that ultimately reduces cell growth. Its half-life in the soil is 120 days, and it is considered moderately persistent. Effective in control of biennial thistles, Canada thistle, leafy spurge, Dalmatian toadflax, perennial pepperweed, whitetop, halogeton, jointed goatgrass, red brome, and cheatgrass.		X	X	X	X	X
Imazapyr	Broad-spectrum herbicide that can be applied pre- or post-emergence. Is absorbed by the leaves and roots, and moves rapidly through the plant. It has a strong affinity to bind to soils and rarely moves beyond the top few inches of the soil. Low potential for leaching to ground water, but may reach surface water during storm events over recently treated land. Imazapyr is known to be effective on African rue, Tree of Heaven, Fountaingrass, yellow starthistle, perennial pepperweed, whitetop, Uruguayan pampas grass, common Mediterranean grass, saltcedar, Siberian elm, camelthorn, Russian knapweed, and Russian olive.		X		X	X	
Isoxaben	Used for pre-emergence control of broadleaf weeds. It is absorbed through the roots and inhibits cellulose biosynthesis in the cell walls. It is moderately persistent in soil and potential for ground and surface water contamination is low. Target weed species include: kochia, mustards, Russian thistle, and leafy spurge.			X	X	X	
Metsulfuron methyl	Control brush and certain unwanted woody plants, annual and perennial broadleaf weeds, and annual grassy plants. Affects plants by inhibiting cell division in the roots and shoots, thereby stopping growth. It dissolves easily in water and can leach through the soil to contaminate ground water, but confined to soils that are either sandy or porous. This herbicide has been proven successful in control of biennial thistles, Canada thistle, Russian knapweed, African rue, yellow starthistle, blue mustard, perennial pepperweed, halogeton, camelthorn, horehound and whitetop.		X	X	X	X	
Metribuzin	Selective herbicide that inhibits photosynthesis. It is used for control of annual grasses and broadleaf weeds. Highly soluble in water and low tendency to adsorb to most soils. Target weeds include Japanese brome, field sandbur, Johnson grass, puncturevine, bromes, Russian thistle, and kochia.			X			

Herbicide	Herbicide Characteristics and Target Vegetation	Riparian	Rangeland	Agricultural Lands	Right-of-Ways	Roadsides	Residence/ Communities
Paraquat	Non-selective herbicide that destroys green plant tissue on contact and by translocation within the plant. It is a "Restricted Use" herbicide. Quickly adsorbed by soil particles and is long-lived in soil. Target species include field sandbur.		X	X	X	X	X
Picloram	A “Restricted Use” herbicide due to its mobility in water combined with the sensitivity of many crops that can be damaged with the use. It interferes with the weed’s ability to make proteins and nucleic acids. It dissolves easily in water. This herbicide works well in control of biennial thistles, Canada thistle, knapweeds, Dalmatian toadflax, camelthorn, Russian thistle, leafy spurge, Russian knapweed, Scotch thistle, whitetop, and yellow starthistle.		X	X	X	X	
Thifensulfuron-methyl	This is a broad spectrum, post-emergent herbicide for control of broadleaf weeds. Absorbed through foliage of plants to inhibit growth. This herbicide controls spreading wallflower, kochia, and Russian thistle.		X	X	X	X	
Triclopyr	Works by disrupting plant growth. It is absorbed by green bark, leaves, and roots and moves to the meristem of the plant. It has a moderate to low solubility in water and normally binds to clay and organic matter, so it’s potential to contaminate ground water is slight. Triclopyr is effective in the treatment of yellow starthistle, squarrose knapweed, perennial pepperweed, spotted knapweed, diffuse knapweed, horehound, tamarisk, tree of Heaven, Russian olive, and Siberian elm.	X	X	X	X	X	X
Pendimethalin	Selective herbicide used to control most annual grasses and certain broadleaf weeds. It can be used on both pre- and post-emergence weeds. Adsorbs strongly to soil organic matter and clay and does not leach through soil to contaminate ground water. It is used to control puncturevine and kochia.			X	X	X	
Prodiamine	A selective, pre-emergent herbicide for the control of broadleaf weeds and grasses by inhibiting plant growth. Used for control of kochia, rescuegrass, and Johnsongrass				X	X	X

Table 9-3. Herbicides and recommended application concentrations per acre for priority weed species. Rates listed are general according to label instructions, the USFS Field Guide for Managing Weed Species in the Southwest; Montana, Utah and Wyoming Cooperative Extension Service Weed Management Handbook; and Lake Mead Exotic Plant Management Plan. Herbicides should be applied according to the label instructions by certified pesticide applicators.

Invasive Weeds		2,4-D						Aminopyralid			Atrazine	Chlorsulfuron methyl		Clopyralid			Dichlobenil
Common Name	Scientific Name	Various	Grazon P+D (+picloram)	Weedmaster (+dicamba)	Curtail: (+clopyralid)	GrazonNext (+aminopyralid)	Crossbow (+triclopyr)	Milestone	Chaparral (+metsulfuron)	Milestone + Garlon 4	Aatrex	Telar XP	Cimmaron Plus (+metasulfuron)	Transline	Reclaim	Redeem (+triclopyr)	Casoron
Category A																	
Leafy spurge[1]	*Euphorbia esula*		2 qts	2-4 qt													0.92 - 3.84 qt
African rue[1]	*Peganum harmala*																
Tree-of-Heaven[1]	*Ailantus altissima*																
Ravenna grass[2]	*Saccharum ravennae*																
Fountain grass[1]	*Pennisetum setaceum*																
Yellow starthistle[1]	*Centaurea solstitialis*	1 qt	2 qt (1:4 mixture)		0.25 - 1 pt			3-5 oz						0.25-0.67 pt	0.25-0.67 pt		
Blue mustard[3]	*Chorispora tenella* (Pall.) DC.	½ - ¾ pt for 4 lb/gal product										0.125 oz					
Squarrose knapweed[1]	*Centaurea virgata*	1-2 qt	2-3 qt	2 pt to 1 qt	4 pt			5-7 oz						⅔- 1 pt	⅓- 1 ⅓ pt	2 pt	
Bull thistle[1]	*Cirsium vulgare*		1 - 2 pt	1.5 - 2 pt	1 - 2 qt	2 pt		3-5 oz						0.33-1.3 pt	0.33-1.3 pt	1.5 - 2 pt	0.92 - 3.84 qt
Canada thistle[1]	*Cirsium arvense*	2 qt (based on 1 qt of 4 lb per gal)			6 pints			5-7 oz						0.67-1.3 pt	0.67-1.3 pt	2.5-4 pt	0.92 - 3.84 qt
Dalmatian toadflax[1]	*Linaria dalmatica*											2-2.6 oz					
Musk thistle[1]	*Carduus nutans*		2 - 4 pt	1.5 - 2 pt	1 - qt	1.5 - 2 pt		3-5 oz						0.33-1.3 pt	0.33-1.3 pt	1.5 - 2 pt	0.92 - 3.84 qt
Perennial pepperweed[1]	*Lepidum latifolium*	1-2 lbs/ac										1-2 oz					0.92 - 3.84 qt
Scotch thistle[1]	*Onopordum acanthium*		2 - 4 pt	1.5 - 2 pt	1 - 2 qt	2 - 2.6 pt		5-7 oz						0.33-1.3 pt	0.33-1.3 pt	1.5 - 2 pt	0.92 - 3.84 qt
Spotted knapweed[1]	*Centaurea maculosa*	1 - 2 qt	2 - 3 qt	2 pt to 1 qt	4 pt			5-7 oz						⅔- 1 pt	⅓- 1 ⅓ pt	2 pt	
Tall Whitetop[1]	*Cardaria draba*			2 qt					2.5 - 3.33 oz			1 oz	1.25 oz				
Sahara mustard[4]	*Brassica tournefortii*	3-6 pt						¼ to 1/3 pint	2.5-3.3 oz					2-3 qts			
Uruguyan pampas grass[6]	*Cortaderia sellonana*																
Yellow nutsedge[3]	*Cyperus esculentus*																
Sulphur cinquefoil[3]	*Potentilla rect L.*		2-4 pt					4-6 oz									
Common Mediterranean grass	*Schismus barbatus*																
Tamarisk, Saltcedar[1]	*Tamarix* spp., including hybrids																
Camelthorn[1]	*Alhagi camelorum*			1-4 qt										1- 1/3 pt	1- 1/3 pt		
Category B																	
Halogeton[3]	*Halogeton glomeratus*	2 - 2.7 qt															
Siberian elm[1]	*Ulmus pumila*																
Tamarisk, Saltcedar[1]	*Tamarix ramosissima*																

Invasive Weeds		2,4-D						Aminopyralid			Atrazine	Chlorsulfuron methyl		Clopyralid			Dichlobenil
Common Name	Scientific Name	Various	Grazon P+D (+picloram)	Weedmaster (+dicamba)	Curtail: (+clopyralid)	GrazonNext (+aminopyralid)	Crossbow (+triclopyr)	Milestone	Chaparral (+metsulfuron)	Milestone + Garlon 4	Aatrex	Telar XP	Cimmaron Plus (+metasulfuron)	Transline	Reclaim	Redeem (+triclopyr)	Casoron
Diffuse knapweed[1]	*Centaurea diffusa*	1 - 2 qt	2 - 3 qt	2 pt to 1 qt	4 pt			5-7 oz						⅔- 1 pt	⅓- 1 ⅓ pt	2 pt	
Russian knapweed[1]	*Acroptilon repens*				1-2 qt			4-6 oz						1- 1 ⅓ pt	1- 1 ⅓ pt		0.92 - 3.84 qt
Russian Olive[1]	*Elaeagnus angustifolia*						2 gal			7 oz + 2 qt							
Johnsongrass[3]	*Sorghum halepense*																
Category C																	
Cheatgrass[1]	*Bromus tectorum*																
Field bindweed[3]	*Convolvulus arvensis*		2-4 pt														0.92 - 3.84 qt
Jointed goatgrass[1]	*Aegilops cylindrica*																
Puncturevine[3]	*Tribulus terrestris*	2 qt															
Rescuegrass[3]	*Bromus catharticus*																
Ripgut brome[3]	*Bromus diandrus*																
Smooth brome[3]	*Bromus inermis*																
Bald brome[3]	*Bromus racemosus*																
Red brome[4]	*Bromus rubens*										1-2 pt						
Spreading wallflower	*Erysimum repandum*	1/4-3/8 lb															
Horehound[5]	*Marrubium vulgare*	1-4 pt															
California burclover[4]	*Medicago polymorpha*	0.67-4 pt															
Russian thistle[3]	*Salsola kali*	0.75-4 pt		0.5-4 pt										2-4 pt	2-4 pt		
Field brome	*Bromus arvensis*																
Kochia[3]	*Bassia scoparia*			0.5-4 pt							3.2-4 pt						0.92 - 3.84 qt

Invasive Weeds		Fluroxpyr	Fluazifop-p butyl	Glyphosate		Imazapic		Imazapyr			Isoxaben	Metsulfuron methyl	Metribuzon	Paraquat	Picloram	Thifensulfuron-methyl	Triclopyr	Pendimethalin	Prodiamine
Common Name	Scientific Name	Vista	Fusilade 2000, Fusilade DX	Rodeo	Round Up	Plateau	Journey (+ Glyphosate)	Arsenal	Arsenal + Rodeo	Chopper	Gallery	Ally, Allie, Gropper, Escort	Sencor	Gramoxone	Tordon 22K	Volta	Garlon	Pendulum	Evade
Category A																			
Leafy spurge[1]	*Euphorbia esula*			1 qt	1 qt	8-12 oz + 1.5-2 pt MSO									1-2 qt				
African rue[1]	*Peganum harmala*							3 pt				3.2 - 6.4 oz							
Tree-of-Heaven[1]	*Ailantus altissima*			2 -5 qt				1-1.5 pt		2-3 pt							3-6 qts		
Ravenna grass[2]	*Saccharum ravennae*			5% soln															
Fountain grass[1]	*Pennisetum setaceum*		1-1.5 pt	0.5-1 pt						2-3 pt									
Yellow starthistle[1]	*Centaurea solstitialis*			4.5-7.5 pt	1.5-4 qt			1 pt				1 oz			1-1.5 pt		3 pts		
Blue mustard[3]	*Chorispora tenella* (Pall.) DC.			1.5 pt	11-12 oz							0.125 oz							
Squarrose knapweed[1]	*Centaurea virgata*	8 oz													1-2 pt				
Bull thistle[1]	*Cirsium vulgare*					8-12 oz									0.5-2 pt				
Canada thistle[1]	*Cirsium arvense*														1 qt				
Dalmatian toadflax[1]	*Linaria dalmatica*					8-12 oz + 1 qt MSO									1-2 qt				
Musk thistle[1]	*Carduus nutans*					8-12 oz									0.5-2 pt				
Perennial pepperweed[1]	*Lepidum latifolium*			3 qt	1 gal	12 oz				2-3 pt		0.75-1 oz					3 qts		
Scotch thistle[1]	*Onopordum acanthium*					8-12 oz									0.5-2 pt				
Spotted knapweed[1]	*Centaurea maculosa*	8 oz													1-2 pt				
Tall Whitetop[1]	*Cardaria draba*			3 qt	4 qt	12 oz				2-3 pt		0.75-1 oz							
Sahara mustard[4]	*Brassica tournefortii*											0.5-1.0 oz					3 qts		
Uruguyan pampas grass[6]	*Cortaderia sellonana*			0.5-1 pt						2-3 pt									
Yellow nutsedge[3]	*Cyperus esculentus*			1-5 qt															
Sulphur cinquefoil[3]	*Potentilla rect L.*														1 pt				
Common Mediterranean grass	*Schismus barbatus*		1-1.5 pt plants; 8 oz for seedlings	1-3 pt						2-3 pt									
Tamarisk, Saltcedar[1]	*Tamarix* spp., including hybrids							2 qts	1.5 qt + 1.5 qt										
Camelthorn[1]	*Alhagi camelorum*							0.75-1.5 qt				1-3 oz			2 qt				
Category B																			
Halogeton[3]	*Halogeton glomeratus*					4-12 oz						0.5-1 oz							
Siberian elm[1]	*Ulmus pumila*			3-7.5 pt	1.5-3.3 qt			1-1.5 pt		2-3 pt							3-6 qt		
Tamarisk, Saltcedar[1]	*Tamarix ramosissima*							2 qt	1.5 qt + 1.5 qt										
Diffuse knapweed[1]	*Centaurea diffusa*	8 oz													1-2 pt				
Russian knapweed[1]	*Acroptilon repens*			3-7.5 pt	4-4.8 qt			2 pt							1-2 qt				

Invasive Weeds		Fluroxpyr	Fluazifop-p butyl	Glyphosate		Imazapic		Imazapyr			Isoxaben	Metsulfuron methyl	Metribuzon	Paraquat	Picloram	Thifensulfuron-methyl	Triclopyr	Pendimethalin	Prodiamine
Common Name	Scientific Name	Vista	Fusilade 2000, Fusilade DX	Rodeo	Round Up	Plateau	Journey (+ Glyphosate)	Arsenal	Arsenal + Rodeo	Chopper	Gallery	Ally, Allie, Gropper, Escort	Sencor	Gramoxone	Tordon 22K	Volta	Garlon	Pendulum	Evade
Russian Olive[1]	*Elaeagnus angustifolia*			1-5 qt	1.5-3.3 qt			2.4 pt	1.5 qt + 1.5 qt								1-3 qt		
Johnsongrass[3]	*Sorghum halepense*												0.5 lb						1 lb
Category C																			
Cheatgrass[1]	*Bromus tectorum*			0.5-1 pt		2-12 oz + 1 qt MSO	16-21 oz + 1 qt MSO												
Field bindweed[3]	*Convolvulus arvensis*				0.25-5 qt										0.5 pt- 2 qt				
Jointed goatgrass[1]	*Aegilops cylindrica*			2.5-3 pt		0.063-0.188 lbs													
Puncturevine[3]	*Tribulus terrestris*			0.75-4 pt														1.2-4.8 qt	
Rescuegrass[3]	*Bromus catharticus*			0.5-3 qt									0.5-0.6 lb						1 lb
Ripgut brome[3]	*Bromus diandrus*			0.5-3 qt									0.5-1 pt						
Smooth brome[3]	*Bromus inermis*			0.5-3 qt									0.5-1 pt						
Bald brome[3]	*Bromus racemosus*			0.5-3 qt									0.5-1 pt						
Red brome[4]	*Bromus rubens*		1-1.5 pt	0.5-1 pt		2-12 oz + 1 qt MSO	1⅓- 2 pt													
Spreading wallflower	*Erysimum repandum*															0.3-0.6 oz			
Horehound[5]	*Marrubium vulgare*											0.2-1 oz			2-4 pt		2.5- 3.33 pt		
California burclover[4]	*Medicago polymorpha*				24-32 oz														
Russian thistle[3]	*Salsola kali*				8 oz- 5 qt						16 oz		0.25-0.75 pt		1-1.5 oz				
Field brome	*Bromus arvensis*			0.5-3 qt									0.5-1 pt						
Kochia[3]	*Bassia scoparia*	8 oz			0.5-5 qt						16 oz		0.5 lb					1.8-4.8 pt	1 lb

MSO=Methylated seed oil

[1]USFS. 2012. Field guide for managing Weed Species in the Southwest. United States Department of Agriculture. Forest Service. Southwestern Region. http://www.fs.usda.gov/main/r3/forest-grasslandhealth/invasivespecies.
[2]McMaster, M.A., L.J. MaKarick, J. Spence, C. Deuser, and T. Dow. 2012. Beware the ravenous ravenna: management of the highly invasive exotic Ravenna grass (Saccharum ravennae) in Colorado River Parks. 2011 Tamarisk Research Conference - Tamarisk Coalition. Tucson, AZ.
[3]Montana, Utah, Wyoming Cooperative Extension Services. 2006-2007. Weed Management Handbook. Pp 288.
[4]National Park Service. 2010. Exotic Plant Management Plan -Lake Mead National Recreation Area. Clark County, Nevada. Mohave County, Arizona
[5] U.S.G.S Southwest Biological Science Center. 2003. USGS Weeds in the West Project: Status of Introduced Plants in Southern Arizona State Parks. Fact Sheet for : *Marrubium vulgare* L.
[6] USDA Forest Service, Forest Health Staff, Newtown Square, PA. Invasive Plants website: http://www.na.fs.fed.us/fhp/invasive_plants

9.8 Road and Right-of-Way Treatments

While noxious weed treatments on roads and right-of-ways (linear corridors) utilize many of the techniques described above, treatments occur on a regular basis, and because treatment areas are long and linear, the treatments are aimed at moving quickly to disrupt as little traffic as possible. The techniques that are primarily used to treat noxious weeds in linear corridors include (most are described above):

- Chemical spraying using trucks or All-Terrain Vehicles (ATV) for efficient application,
- Mechanical mowing timed to occur prior to seed-head maturation,
- Boom axe or chainsaw used to cut vegetation within 15-30ft of pavement edge,
- Cut-stump treatments,
- Pile burning of collected plan material,
- Controlled burns, and
- Maintenance of fire guards along road shoulder or fence line.

Other measures that are utilized to prevent weed introduction and retain native vegetation along linear corridors include using techniques that reduce erosion and other disturbances to retain native vegetation, re-seed areas with native species in areas where weeds were removed, use of weed free materials (straw, wattles, fill, and seed), cleaning of vehicles and equipment before beginning treatment and before leaving a treatment area, and coordination with landowners to treat weeds on the roads and adjacent areas.

10.0 Native Vegetation Re-Planting

To successfully restore areas invaded by weeds, it is highly recommended that native species revegetation occurs after invasive species have been removed from areas where invasive species comprised 50% or more of the vegetation community. Areas dominated by invasive species for long periods of time likely do not have the native seed bank necessary to allow for passive native species recolonization. Also, revegetating areas with native species helps prevent re-colonizing invasive species, restores native pastures, and provides habitat for wildlife. Below are listed some recommendations for native species revegetation scenarios for different native to invasive plant ratios prior to clearing.

10.1 Passive Restoration

Passive restoration can occur in habitats dominated by native vegetation. Invasive species can be removed by hand and the native seed bank and surrounding vegetation is left to recolonize the cleared areas.

10.2 Active Restoration

In order to prevent invasive species recolonization, particularly in habitats that have >50% invasive species presence, native species planting techniques are utilized after invasive species clearing occurs. If a ground water source is not available to the planted vegetation supplemental irrigation is necessary.

10.2.1 Planting Seeds

Direct seeding offers many advantages over other techniques. When conditions are optimal, it produces large numbers of plants over an extensive area in a relatively short period. Through sheer volume, seeded plants out-compete other invasive species and survive harsh environmental conditions that would decimate a small population. Seeding is also less expensive, especially for large tracts of land. Grasses and herbaceous vegetation establish best from seed. Seeds from regional genetic stock have the most success germinating and surviving in the conditions found within the Navajo Nation. However, many seeds can only be obtained from commercial growers in other regions. USDA Natural Resource Conservation Service (NRCS) can provide information on the most appropriate seeds or seed mix for the desired area (www.az.nrcs.usda.gov). Additional native plant seed resources also include the NNDFW Botanist, State University Cooperative Extension programs, local BIA Branch of Natural Resource Office, and the Navajo Nation Department of Agriculture Window Rock Office. Planting locally gathered seeds is more successful, but requires more time and effort than purchasing seed from a commercial source.

Just prior to planting, some seeds with hard seed coats should be scarified mechanically or chemically. Scarification, a pre-germination process, opens the seed coat so water and gas can penetrate. When seeds naturally pass through the digestive tracts of animals, they undergo both chemical and mechanical scarification as part of the digestion process. As a substitute, seeds are mechanically scarified by grinding them in a blender for about 10 seconds or by scraping a hole in the coat using sandpaper. Chemical scarification uses strong acids or other chemicals to partially open the seed coat; however, it is more dangerous and less effective than mechanical methods.

Photo courtesy of Fred Phillips Consulting.

10.2.2 Propagating Cuttings

Propagating stem and root cuttings is the best way to grow many plants. Vegetative propagation is more predictable and often quicker than starting with seeds. Desirable traits can be selected—for example, a superior flower color or thornless branch. However, plants propagated from the same stock over a long period may become susceptible to sudden environmental changes, insect attacks, and diseases. Harvesting cuttings from a variety of populations or from different areas ensures greater diversity and resistance to such problems. Cottonwood and sandbar and Goodding willows have shown the highest survival rates from

planting as vegetative cuttings.

Cutting Guidelines. Check recommendations for individual species to identify the optimal season to take cuttings. In general, the best time to cut is when the plants are dormant—usually from December to early February. Ideally, cuttings are planted within a week of harvesting, after they are submerged in water for at least 7 days. If cuttings are not going to be planted for a few months refrigerate them at 35ºF to maintain dormancy. Try to select juvenile plants (1-2 years or younger if big enough) for cuttings, especially for woody species like cottonwood and willow. Younger plants are less likely to have growth inhibitors. If you must cut from older plants, target the newest, most flexible growth near the base. When possible, prune older plants to generate new growth.

Preparing Cuttings. Before planting (either on site or in pots), you will need to re-cut and, for some species, apply rooting hormone. First, make a new cut just above the original one but below a leaf node or bud, where concentrations of growth-influencing hormones or auxins are highest. This cut can be diagonal or straight. The diagonal method makes the cutting easier to plant and creates more surface area for water uptake. A straight cut lessens water loss and makes it easier to recognize the top and bottom ends. Then, if rooting hormone is necessary, dip the cut end into an IBA (Indole-3-butyric acid) rooting hormone, such as Rootone, and gently tap the cutting to remove excess powder. This hormone speeds up root development. To prevent contamination of the whole container of root hormone, remove the amount of hormone you plan to use and discard extra after use. Cuttings from some species, like willow, are soaked for at least 7 days, but no longer than 12-14 days because the roots will begin to grow and will risk breaking off during planting, which will limit successful establishment. Once poles are removed from water they should not spend more than 12 hours out of water before planting.

Planting Techniques. Techniques for planting cuttings vary considerably; virtually all are effective for fast-rooting species such as cottonwood and willow. Rooting times vary by species from under a week to several months. Planting areas with a 6-inch – 4-foot depth to water table are recommended for planting cottonwood and willow tree species. Willows can be planted in clusters with 3 poles at least 7 feet in length with a minimum diameter of ½ inch. Holes should be augured to a 6-inch diameter and at least 4 feet deep or just below the water table. All poles are planted at least 4 feet deep in the augured holes at the lowest water table of the year. Be sure to insert the correct end of the cutting into the soil, with the nodes pointing upward. The above ground portion of the pole is cut at a maximum height of 2 feet high and a minimum height of 18 inches. When planted all poles are slurred in with a water auger leaving no air gaps between pole and soil to maintain maximum soil to stem contact. The tops of all poles are coated with latex paint to seal in moisture. The willow planting areas should not require supplemental irrigation because of the close proximity to the water table.

10.2.3 Deep Pot Upland Plants

Many upland trees, including mesquite, catclaw acacia, and hackberry benefit from being grown in deep pots. Deep potted plants are planted in a hand augured planting holes that are 4-in wide. These potted plants are planted deep enough to reach the capillary fringe of the lowest water table of the year. One to three ft. of the plant with budding sites remains above the ground. Root balls must be planted into moist soils with the bottom of the root ball adjacent to the groundwater at the lowest water level of the year. The plant root ball is not planted in saturated soil, but just right above the saturated soil zone.

10.2.4 Containerized Plants

Containerized plants can establish quickly on a site if they have well-established root systems. Containerized plants are typically available all year round, which allows cleared sites to be rapidly planted. However, this method is expensive, time consuming and difficult to transport, and is not practical for sites that are hard to access. Tree species are often planted in five-gallon containers while shrubs and other low vegetation are planted as one-gallon containers. Herbaceous plants that naturally grow with multiple stems or rhizomatous roots are grown in flats of various sizes. If upland and riparian plants are not planted down to the water table, drip irrigation may be necessary.

Augured planting holes are dug to the lowest water table of the year with a 3-18-inch diameter depending on the size of the container. The native soil from the augured holes is utilized to secure the plantings and typically no amendments are added. When the plants are removed from the container, the root ball is pulled apart and loosened prior to planting. Once planted, a water well ring is formed on the surface soil around all tree plantings to enhance water retention. If invasive weeds are present in the native tree containers they are removed prior to planting.

10.2.5 Bioengineering and Erosion Control

Figure 10-1. Harvested willow poles are planted along a bankline to provide additional erosion protection. *Left*: Work crews prep the bundles of willow poles after they have soaked in the Colorado River. *Right*: the same location one year after planting. Photos courtesy of Fred Phillips Consulting.

Bioengineering is a methodology for bank lines that are in danger of eroding and invasive species recolonization after initial invasive species clearing (**Figure 10-1**). This technique utilizes native vegetation poles and plugs cut or harvested from local native stock. Poles are collected using the methods discussed above under Propagating Cuttings. Poles are planted individually or as bundles (approximately 3 poles per bundle). Individual pole plantings are planted using a power auger or punch bar. The power auger or punch bar is used to create a narrow hole that extends down to the water table. When the water table is reached using the power auger or punch bar, a pole is immediately placed in the hole down to the water table. It is critical to ensure that the soil is packed around the cutting to prevent air pockets. Two rows of poles are planted along the bank line, one at the average low water mark and one at the average high water mark.

Bundle plantings are good for areas with fluctuating water levels (**Figure 10-2**). Willow species work best as bundle plantings. To make the bundles, poles are tied into bundles of approximately 3 to 18 inches in diameter with the growing tips oriented up. The terminal bud is removed so the energy is re-routed to the lateral buds for more efficient root and stem sprouting. Vertical trenches are excavated with a slope of 2:1 or more in the bank line. Care is taken to ensure that the bottom of the trench is still under water during low flows. Trenches are excavated approximately on 3 foot centers to ensure adequate protections of the bank line and to encourage rapid growth. Once the trenches are excavated, the bundles are placed in them with the cut ends in the water. Bundles are secured with a wooden stake and the bundle is back filled with soil.

Figure 10-2. Bundles of fast growing plants planted along the bankline can help provide erosion control when steep banks cannot be re-graded. *Left*: grass bundles installed along a steep bank with willow bundles planted in between to stabilize and capture soils on the bankline. *Right*: The same bankline one year later. Photos courtesy of Fred Phillips Consulting.

The toe of the slope is highly erodible, and is planted with fast growing native wetland vegetation plugs if perennial water is present. Wetland plugs are planted during the lowest water flow of the year to ensure that plants are submerged in the water table. A hole is dug at the toe of the slope, in the water table and the wetland plug's roots are planted submerged in the water.

Other erosion control techniques include the following:

- **Erosion blankets** help hold soil and seed in place during inundation and create a microclimate conducive to germination of native grass and forb seeds. They come in a variety of styles and thicknesses appropriate to the shear expected at each project area. Blankets consisting of all natural materials will break down between one to 2 years after the vegetation is established and are wildlife friendly. The blanket is installed over the prepared seed bed and staked into place with wooden stakes and metal staples. The edges of the blanket are buried in a shallow trench. Installation is accomplished by hand crews.
- **Fiberschines**: This technique uses a coconut-fiber roll product to protect the streambank by stabilizing the toe of the slope and by trapping sediment from the sloughing streambank. Cuttings and herbaceous riparian plants are planted into the fiberschine and behind it. By the time the fiberschine decomposes, riparian vegetation will have stabilized the streambank.
- **Brush Layer.** This technique uses bundles of willow cuttings (*Salix* spp.) buried in trenches along the slope of an eroding streambank. This willow "terrace" is used to reduce the length of the slope of the streambank. The willow cuttings will sprout and take root, thus stabilizing the streambank with a dense matrix of roots. Some toe protection such as a wattle, fiberschine, or rock may be necessary with this technique.
- **Mulch Over Reseeding**. Straw mulch consists of wheat, barley, oat or rye straw, hay, and grass cut from native grasses that are “weed free”. Straw mulch could be applied at a rate of 2 tons per acre to designated seeding areas to provide a protective environment for seed germination. Mulching will occur in the upper overbank zone and portions of the transition zone.
- **Brush revetment** is utilized to protect and build the toe of eroding banks. This practice consists of a series of evergreen or other brushy trees tied end to end, placed along the toe of the stream bank, and anchored by bolster rock, earth anchors, or fence posts. The trees are secured to a combination of T-posts and/or earth anchors. The revetment provides temporary structural protection to the toe while vegetation becomes established by slowing velocities and diverting the current away from the bank edges. Over time, fine sediments accumulate, partially burying the degrading material. The mass of tree limbs also has the added benefit of creating the aquatic habitat as the revetment material generally does not sprout. Once bank vegetation is established, T-posts are removed. Installation of brush revetment can be accomplished by hand crews.

11.0 Project Maintenance and Monitoring

Monitoring and maintenance are essential to successful weed management projects. Monitoring a site after it has been treated can help determine the effectiveness of the project activities.

Monitoring aids in the adaptive management of a site, and the potential need for different treatments. Maintenance, including follow-up weed treatments and native species planting, is an integral part of an integrated weed management plan. Most weed species require multiple treatments before complete eradication occurs. Often times after one species weed is removed from a site, secondary weed infestations can take their place. Planting native vegetation, as discussed above, helps reduce re-colonizing weed species by out-competing them. Follow-up maintenance is critical for reducing the re-colonization of primary and secondary weed species of concern.

11.1 Project Monitoring

Establishing and implementing a monitoring program is essential to determine the success of the project activities and to implement a long-term adaptive management strategy. Monitoring is necessary to determine the efficacy of proposed treatments on priority weed species, to identify infestations of new and emerging weed species that have not yet been prioritized, and to better understand the factors that influence weed spread within the Navajo Nation. In order to determine the effectiveness of the treatment activities, monitoring reports will be required by field staff implementing treatments. Items that will be included in the monitoring report include: species controlled, method of treatment(s) used, a map of the treated area, issues encountered, and overall control achieved at the site. If using chemical treatments, the name and amount of herbicide used, dates sprayed, time of day sprayed, wind speed, and temperature at time of herbicide application is also required (Appendix G.). This information will help determine the effectiveness of the treatment and whether alternative methods should be employed.

11.1.1 Treatment Effectiveness Monitoring

Monitoring weed spread and/or suppression from the treatment techniques will be collected. This can be conducted through annual weed mapping of treatment sites (see Chapter 6). During the project planning phase, the perimeter of the affected area will be mapped (using methods outlined in Chapter 6) and the infested acreages will be calculated by multiplying total acres by average density to estimate percent cover. If the treatment area is a long linear corridor (road or right-of-way) the infested areas will be mapped by vehicle along the corridor. This baseline measurement will be used to compare acreage of infestation against future acreage calculations following treatments to determine the effectiveness of the projects. Yearly weed treatment monitoring reports and infestation mapping efforts will be used to assess the weed spread. By tracking the size of the weed infestation, BIA can determine if the methods are successful and the objectives are being met. If necessary, treatments will be adjusted through the adaptive management process to ensure that the project objectives are achieved.

If the treated weed populations are large, monitoring plots located on transects will be established to sub-sample smaller areas. Plots will be established by stretching a 100m tape measure across the treatment area. The start and end points of the transect will be recorded with

the GPS and the bearing of the transect recorded to aid in relocating transects in future surveys. Plots (1x0.5m) will be established every 10m along the transect, and cover will be estimated using the methods outlined in Elzinga et al. 1998. Cover will be done for the treated weed species or all vegetation species occurring in the monitoring plot. Multiple transects will be necessary if the treatment site is large. Data collected from the plots is measured over time and is compared from year-to-year. For long linear corridors (roads and right-of-ways) vehicles will stop at established intervals to estimate vegetation cover within an established larger plot area. An example monitoring plot data sheet is located in Appendix G.

11.1.2 Photo Monitoring

Photo monitoring is a qualitative way to show change over time in an area of interest. This is the most effective method for visualizing and capturing the habitat characteristics in a given point in time. Photo points are established immediately after treatment occurs. Photo points are marked with permanent markers and GPS coordinates are recorded. Care is taken to ensure that the photo point location is described in detail when the points are established in order to find the location in subsequent visits. Also, photos taken from the previous photo monitoring session are taken out to the field in subsequent visits to aid in re-location of points and to replicate the photo. Photos are immediately transferred to a database after returning from the field so that information does not get lost with time. Panoramic pictures are taken and photos are placed in an electronic file with descriptions clearly labeling each photo. An example Photo Monitoring Datasheet is located in Appendix D.

11.2 Project Maintenance

As discussed above, follow-up maintenance is required to effectively eradicate many weed species. For example, successful long-term management programs for tamarisk require more than five years of treatments using multiple control methods, including: mechanical, fire, and chemical treatments (USFS 2012). Secondary weeds (i.e. camelthorn) may colonize a treatment site once it is cleared. Planting native vegetation at treatment sites helps reduce re-colonizing native and invasive weed species. Periodic weeding using hand pulling or spraying or small mechanical tools is necessary until native vegetation matures and creates a mature canopy. Treatment sites, especially those planted with native vegetation, should be fenced or have a barrier to prevent livestock from entering the site to enable native vegetation to establish and mature. Barriers and/or fencing will require maintenance to ensure that it is an effective means to prevent livestock intrusion.

Project maintenance should occur every other month during the growing season (April-September) to treat re-sprouting and secondary weed infestations before they become established. Weed eradication methods and timing are reviewed to determine the most effective methods for weed removal. Consistent maintenance after the first treatment is the most cost effective way to ensure eradication or control of weeds. Less time and materials are required to treat young weeds than a mature, establish stand of weeds.

12.0 Demonstration Projects

A number of demonstration projects have been identified to test the invasive species removal process and to serve as a model for future projects (**Table 12-1**). These projects were identified by BIA Navajo Region Agencies for implementation. Selected projects are areas where weed mapping has been conducted, required compliance, permitting, and reporting have been completed, and departmental funding has previously been used to initiate invasive weed management. Monitoring and maintenance of these sites will provide valuable information that can be used to improve and enhance proposed weed treatment methods for future projects.

Table 12-1. Demonstration Projects as identified by the five BIA Navajo Region Agencies including Western (Tuba City), Northern (Shiprock), Central (Chinle), Eastern (Crownpoint), and Fort Defiance Agencies. The table outlines the weed species mapped at the site, habitat and land use, proposed methods, and funding years for project implementation.

Agency	Project Name	Acres	Habitat Type	Methods	Herbicide	Weed Mapping (ac)	Species Mapped	FY
Western	Moenkopi Wash	140	Stream Corridor	Mechanical, Chemical, Biological	Polaris	340.6	TAMAR2 HAGL	2010 & 2011
Western	Drylake Kayenta	200	Reservoir/Rangeland	Chemical, Biological	N/A	193.2	TAMAR2	2010 to 2012
Western	Ts'ahBiiKiin/Inscription House	38	Stream Corridor	Mechanical, Chemical, Biological	Polaris	25.5	ELAN ONAC TAMAR2	2010 & 2011
Western	Tsegi Canyon/Upper Laguna Creek	20	Stream Corridor	Mechanical, Chemical, Biological	Polaris	32	ELAN	2010 to 2012
Western	Betatakin Canyon	9	Stream Corridor	Mechanical, Chemical, Biological	N/A	149.9	ELAN TAMAR2	2011 & 2012
Western	Tonalea Lake	416	Reservoir	Mechanical, Chemical	N/A	9.8	ACRE3 ALMA TAMAR2	2011 & 2012
Western	Dennehotso	200	Cropland/Stream Corridor	Mechanical, Chemical, Cultural, Biological	N/A	548	ACRE3 ALMA13 TAMAR2	2010 to 2012
Western	Cowspring Wash	1083	Reservoir	Mechanical, Chemical	N/A	19	ELAN ELAN TAMAR2	2011 & 2012
Western	Chinchilbeto (RMU 814)	190	Stream Corridor/Rangeland	Mechanical, Chemical, Biological	Garlon 4, Tahoe, Element 4	41.9	TAMAR2	2010 to 2012
Western	Strong Rock	117	Stream Corridor	Mechanical, Chemical, Biological	N/A	122.4	TAMAR2 IPJA	2011 &2012
Fort Defiance	Black Creek Wash	708	Stream Corridor	Mechanical, Chemical	Habitat	707.5	ELAN TAMAR2	2010 to 2013
Fort Defiance	Little Colorado Pueblo Wash/Ganado Lake	1828	Stream Corridor	Mechanical, Chemical	Habitat	1821.2	ELAN TAMAR2	2010 to 2013
Fort Defiance	Oak Springs/Black Creek	106	Stream Corridor	Chemical	Habitat	420.1	ELAN TAMAR2	2010 & 2011
Northern	San Juan River	40	Stream Corridor	Mechanical, Chemical, Biological	Polaris	1780.2	TAMAR ELAN ACRE3 CANU	2012 & 2013
Central	Many Farms	2940	Stream Corridor	Mechanical, Chemical, Cultural, Biological	N/A	1991.4	Not specified	2013 & 2014

13.0 Estimated Project Costs

Estimating project costs can be difficult when the conditions of and access to the site are unknown. These variables should be considered when developing costs for individual budgets to conduct weed control. The table below breaks down costs based on the density of invasive plant infestation (**Table 13-1**). The costs assume that the site is easily accessible by vehicle, and includes: travel to sites, equipment, transportation, a project foreman or supervisor, hiring crews, and field time to conduct the removal efforts. These costs were developed from invasive plant removal efforts being conducted in the Verde and Colorado River watersheds (Laura Moser, Curt Deuser, Chip Norton, Fred Phillips Consulting, personal communication, 2013). Other costs that should be considered for project implementation, but are not included in the following estimates, include compliance and permitting; site-specific plan and design; grant writing; mapping and inventory; project manager; long-term maintenance; and monitoring.

Table 13-1. Estimated per Acre Project Costs.

Invasive Plant Removal Type	Cost per acre for accessible sites	Cost per acre with follow-up treatment
Hand clear stands dominated by native plants (>80% native)	$400	$480
Hand clear stands with 50% invasive and 50% native plants	$3,000	$3,600
Hand clear monotypic stands of invasive plants	$5,000	$6,000
Mechanically clear monotypic stands of invasive plants	$1,000- $2,500	NA
Hand weeding herbaceous wetland areas (30-60% invasive plants)	$500	NA
Broadcast spraying of herbaceous vegetation using Gator/ATV (>70% invasive plants)	$80- $160	NA

In areas where invasive species occupy >80% coverage, it is highly recommended that mechanical clearing be used. Mechanical clearing of invasive species-dominated sites will cost in the range of $1,000-$2,500/acre including one follow-up herbicide treatment. Costs can vary depending on existing site conditions and the type of mechanical clearing needed. Additional funds will be needed on sites where helicopter transport is necessary.

Active restoration should occur after invasive weed species are removed in areas that do not have sufficient native vegetation for successful passive restoration. Where active restoration is needed

(in areas that are comprised of >50% invasive species) revegetation work should be implemented to create native habitat and a seed bank that will outcompete invasive species. This work will include the following restoration methods that will require minimal, if no irrigation. These numbers are provided by information gathered by the Tamarisk Coalition, the Bosque Del Apache Wildlife Refuge, and Arizona Department of Transportation (**Table 13-2**).

Table 13-2. Estimated costs for native planting restoration methods. Estimates based on information provided by the Tamarisk Coalition, Bosque del Apache Wildlife Refuge, and the Arizona Dept. of Transportation.

Restoration Method	**Cost**
Pole and plug plantings	$900/acre
Tall pot plantings	$2,700/acre
Seeding	$119/acre
Roadside seeding (including seed, tilling, amendments and mulch)	$1,000- $3,000

Areas completely dominated by invasive species will require active restoration that in some cases will require supplemental irrigation. Costs for active restoration may include design, grading, plantings, irrigation and follow up maintenance and monitoring can range from $5,000-$20,000 per acre.

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Appendix A. Acronyms

Acronym	Meaning
ADOT	Arizona Department of Transportation
APHIS	Animal and Plant Health Inspection Service (USDA)
BA	Biological Assessment
BE	Biological Evaluation
BIA	Bureau of Indian Affairs
BIADOT	Bureau of Indian Affairs Department of Transportation
BLM	Bureau of Land Management
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
CFR	Code of Federal Regulations
Corps	U.S. Army Corps of Engineers
DNRGPS	Minnesota Department of Natural Resources – Global Position System Convertor
EIS	Environmental Impact States
ESA	Endangered Species Act
GIS	Geographic Information System
GPS	Global Positioning System
HUC	Hydrologic Unit Code
IHS	Indian Health Services
IWMP	Integrated Weed Management Plan
NAD	North American Datum
NAPI	Navajo Agricultural Products Industry
NEPA	National Environmental Policy Act
NIIP	Navajo Indian Irrigation Program (BOR)
NMDOT	New Mexico Department of Transportation
NNC	Navajo Nation Tribal Code
NNDFW	Navajo Nation Department of Fish and Wildlife
NNDOT	Navajo Nation Department of Transportation
NNEPA	Navajo Nation Environmental Protection Agency
NNHPD	Navajo Nation Historic Preservation Department
NHPA	National Historic Preservation Act
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service (USDA)
NRO	Navajo Regional Office
NTUA	Navajo Tribal Utility Authority
PPE	Personal Protection Equipment
RCP	Biological Resource Use Clearance Policy and Procedures

RMU	Range management unit
ROW	right of way
SWEMP	Southwest Exotic Mapping Program
UDOT	Utah Department of Transportation
USC	U.S. Code
USDA	U.S. Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
WQPZ	Water Quality Protection Zone

Appendix B. Priority Area Maps

Legend

- NNDFW Community Development Areas
- Central (Chinle) Agency
- Eastern (Crownpoint) Agency
- Fort Defiance Agency
- Northern (Shiprock) Agency
- Western (Tuba City) Agency
- Navajo Partitioned Lands Agency

Kayenta
Tuba City
Cameron
Leupp
Many Farms
Lukachukai
Pinon
Chinle
Sawmill
Navajo
Tohatchi
Window Rock
Ganado
Crownpoint
Greasewood
Castle Butte
Shiprock

N
1 inch = 25 miles
0 12.5 25 50 Miles

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

BIA NAVAJO REGION INTEGRATED WEED MANAGEMENT PLAN

Prepared by: FPC

Community Development Areas

Date: 6/4/2014

Legend

- Major Navajo Cities
- Permitted Farmland
- Central (Chinle) Agency
- Eastern (Crownpoint) Agency
- Fort Defiance Agency
- Northern (Shiprock) Agency
- Western (Tuba City) Agency
- Navajo Partitioned Lands Agency

NAPI/NIIP Land

Shiprock

Tuba City

Chinle

Fort Defiance

Window Rock

Crownpoint

Twin Arrows

N

1 inch = 25 miles

0 12.5 25 50 Miles

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, and the GIS User Community

BIA NAVAJO REGION INTEGRATED WEED MANAGEMENT PLAN

Prepared by: FPC

Designated Farmland and NAPI/NIIP Land

Date: 6/4/2014

Legend

- Major Navajo Cities
- Designated Rangeland
- Central (Chinle) Agency
- Eastern (Crownpoint) Agency
- Fort Defiance Agency
- Northern (Shiprock) Agency
- Western (Tuba City) Agency
- Navajo Partitioned Lands Agency

Tuba City
Chinle
Shiprock
Fort Defiance
Window Rock
Crownpoint
Twin Arrows

N
1 inch = 25 miles
0 12.5 25 50 Miles

BIA NAVAJO REGION INTEGRATED WEED MANAGEMENT PLAN

Prepared by: FPC

Designated Rangeland (RMUs)

Date: 6/4/2014

Legend

- BIA_Roads (6,705 mi)
- County_Roads (2,015 mi)
- State_Roads (1,060 mi)
- Interstate Hwy (100mi)
- US_Hwys (690 mi)
- NNDOT (16,905 mi)
- Central (Chinle) Agency
- Eastern (Crownpoint) Agency
- Fort Defiance Agency
- Northern (Shiprock) Agency
- Western (Tuba City) Agency
- Navajo Partitioned Lands Agency

N

1 inch = 25 miles

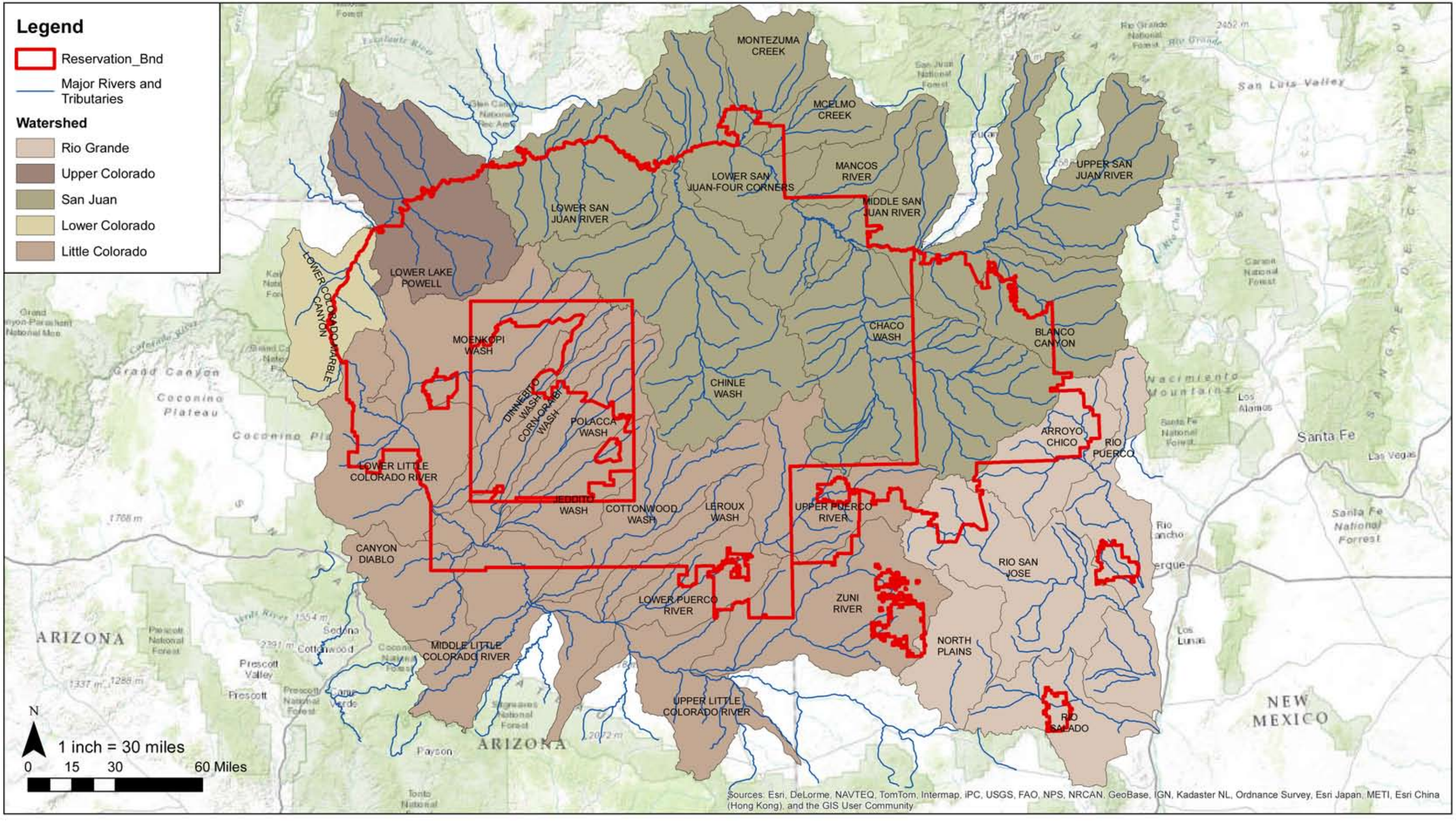
0 12.5 25 50 Miles

BIA NAVAJO REGION INTEGRATED WEED MANAGEMENT PLAN

Prepared by: FPC

Managed Roads on Navajo Nation

Date: 6/4/2014



BIA NAVAJO REGION INTEGRATED WEED MANAGEMENT PLAN

Prepared by: FPC

Watersheds

Date: 10/30/2013

Appendix C. Weed Project Checklist

For Each Weed Project:

Do Initial Project Planning

☐ Conduct annual weed mapping to identify potential projects and problem populations for the Navajo Region and each Navajo Agency.

☐ Meet with local land users, grazing officials, and/or neighboring agencies to determine cost-sharing for proposed projects. Determine resource concerns for stakeholders and review grazing permit history

☐ Identify Project Location and project area (preferably GIS). Create a map of the area or identify weed locations.

☐ Write up a description of the area (i.e. vegetation, nearby water sources, land use, terrain, potential conflicts) and project need. Plan should include goals and objectives for the area of interest for the next 3-5 years.

☐ Identify target weed species and infestation size for each species present

☐ Develop a work plan (timeframe for treatment, methods proposed, number of treatments, contracted portions, etc.)

☐ Describe monitoring and maintenance needs.

☐ Describe restoration needs for native plant communities.

Complete Project Permitting and Compliance:

☐ Obtain Tribal Resolution supporting the project. Can be approval from a Chapter meeting or from a Grazing meeting

☐ Have a qualified biologist conduct initial habitat surveys for federal and tribal sensitive species. Coordinate surveys with Navajo Nation Department of Fish and Wildlife.

IF suitable habitat is observed:

☐ Obtain a biological permit from Navajo Nation Department Fish & Wildlife (NNDFW)

☐ Conduct surveys to determine if endangered species are present.

☐ Report survey findings to NNDFW.

☐ Set up buffer zones and species avoidance measures per the Endangered Species mitigation measures for different treatments (Appendix E).

IF Treatments need to occur within suitable/occupied habitat:

☐ Open formal consultations with USFWS and NNDFW.

☐ Prepare a separate project BA or BE

☐ Initial do a consultation with Navajo Nation Historic Preservation Department (NNHPD) to see if the Agency needs to do a cultural resource survey or not. If a survey is required then perform cultural resource surveys. Report and coordinate findings with the NNHPD

If using pesticide:

☐ Submit an eNotice of Intent (eNOI) to the U.S. EPA for all projects using chemical treatments for coverage under the EPA's Region 9 Pesticide General Permit[1]. Upon reporting the project to the U.S. EPA, additional copies should be sent to the Navajo Nation EPA Surface & Ground Water Pollution Program and the Navajo Nation EPA Pesticide Program. Submission of the eNOI must be done 10-30 days prior to the start of the project. The eNOI will require:

- Permit Contact Information (BIA Navajo Agency designated Weed Coordinator)
- Description of the project location with a map
- List of weeds to be controlled
- List of pesticides proposed for use, including application method, application concentration, and number of proposed treatments.
- Rationale for the treatment methods proposed.
- Applicator Contact Information (If, applicator is a contractor, provide their information, if the applicator is BIA personnel, provide the Agency's Weed Coordinator information).

Each BIA Navajo Agency Weed Coordinator should consult with the Navajo Nation EPA Surface Water Quality Program to determine if projects have the potential to affect impaired or Outstanding (Tier 3). Such waters would be outside of the scope of the Pesticide General Permit.

The website for the EPA's PGP eNOI is available here: https://cdx.epa.gov/

[1]Each BIA Navajo Agency will be responsible as the Operator for all Pesticide General Permit eNOI submissions. To be eligible to apply under the EPA's General Permit, each BIA Navajo Agency will need to submit a Pesticide Discharge Management Plan. A template for the plan is available here: http://www.epa.gov/npdes/pubs/pgp_pdmp_template.doc.

IF work is to take place within a waterway (i.e. total clearing of vegetation along a river or stream):

☐ Write a letter with location, map and action to US ACOE via email or normal mail. Contact respective state U.S. Army Corps of Engineers' Office and prepare a Section 404 permit

☐ Submit an application for a Section 401 permit through Navajo Nation EPA.

☐ Permit approval is required before starting projects.

Obtain Weed Project Funding:

☐ Submit project proposal to BIA Regional Weed Coordinator for funding. BIA Weed Project funding proposal are due annually by December 10th.

☐ Coordinate project cost-share with landowner or organization.

☐ Seek additional grant funding through other resources (Appendix F).

Before Implementing Treatments:

☐ Do an initial site survey to look for and mark potential hazards (i.e. electricity lines, fences).

☐ Put up signs and notifications of when and where treatments are occurring at nearby Chapter House(s) at least a week prior.

☐ Mark the site for treatment boundaries for sensitive species, buffers for waterways, etc. (see Chapter 8 and Appendix E)

☐ Conduct a safety briefing for all personnel conducting weed treatments. Review all required Personal Protection Equipment for methods proposed.

☐ Review all mitigation measures with contractors and volunteers.

Implement Treatments:

☐ Purchase materials and equipment necessary for the treatment type.

☐ Implement necessary mitigation measures (see Chapter 8 and Appendix E)

☐ Update pesticide logs for BIA and U.S. EPA including GPS/GIS data. Information will be included in annual reporting for the U.S. EPA, NNEPA, and the BIA.

☐ Complete daily record treatment logs for herbicide treatments

Prepare Post-Treatment Report

☐ BIA Final Noxious weed report submitted to BIA Navajo Region Noxious Weed Coordinator. Due at the end of the Calendar year.

☐ Navajo Agency must complete U.S. EPA and Navajo EPA Annual Report for NPDES Pesticide General Permit outlining herbicide use for the year. Reports must be submitting using the Permit Tracking Number provided by the U.S. EPA when the original project eNOI was submitted.

☐ Annual Army Corps of Engineer Reporting for Section 404 permits (*if applicable)*

☐ Submit treatment report to the Grazing Official and/or Chapter.

Conduct/Manage Post-Treatment Monitoring and Maintenance

- ☐ Map changes in infestations size. Note expansions, reductions, migrations, and new species present at the site.
- ☐ Conduct photo or plant monitoring at the site to determine project success
- ☐ Prepare annual monitoring and maintenance reports.
- ☐ Re-treat areas that have noxious weed re-growth in coordination with local land users.
- ☐ Prepare final completion reports for non-BIA funding sources.

Appendix D. Sample Weed Mapping Protocol

Bureau of Indian Affairs – Navajo Region

Weed Mapping Protocol

The following protocol is adapted from Heibert & Hudson 2010.

Pre-Field Evaluation

1. Identify where priority areas are located for each Agency. Priority areas include: roadways, utility right-of-ways, designated cropland, designated range management units, riparian areas and wetlands, and NNDFW Community Development Areas. Prioritize areas based on the Site Prioritization criteria. This should result in a series of locations where mapping and inventory should take place.

2. Identify survey transects for each location. This can be done by taking the priority areas identified in the previous step and dividing the area into a set grid (e.g. 100mx100m, 150mx150m, 1mi x 1mi, etc). Eliminate grid cells where surveys will be dangerous (steep slopes), not permitted (private property or other land owners), or not feasible (far from access routes). Randomly select around 30% of the remaining grid cells for surveying. From the center of each selected grid cell, establish a standard length transect from the center of each grid cell (e.g. 50m, 100m, etc.). Orient transects in either a North-South or East-West orientation.

3. Upload transect locations to GPS units. Make sure that each transect is given a unique location to make it easy to identify the locations in the field using the unit. This unique transect ID should also be recorded on associated data sheets.

4. If using volunteers or work crews, provide training on how to conduct a weed survey which covers the following topics.

    a. Proper use of GPS units and navigation techniques
    b. Review of Data Collection Sheets
    c. Review of Priority Weed Species
    d. How to estimate the size and coverage of identified infestations
    e. Safety precautions for field work (i.e. water and food, sun protection)
    f. Review schedule of areas to be surveyed

Field Surveys

Field Equipment Checklist:

- GPS units (enough for one for every two people)
- Jump drives with a backup shapefile/GPS file of the survey transects
- Clipboards
- Data Collection Sheets (one for each transect plus extra)

- Priority Weed list (with PLANT codes)
- Plant field guides with photos
- Pens/pencils
- Compass
- 100ft measuring tape
- Plastic Bags
- Sharpies
- Calibration templates (for estimating coverage)
- Box for collecting plant samples
- Water
- Snacks
- Weather Appropriate clothing

1. Drive to survey location using existing roads and routes. Establish a meeting location for the day. It is advised to perform a safety briefing for the day and to establish a protocol in case of injuries or illness.
2. Have surveyors work in pairs and assign each pair a set of transects to survey for the day.
3. Surveyors will walk the distance of the line and look for priority weed species along the transect line. Surveyors should use a compass to maintain the correct orientation of the transect line during the survey. Use of the measuring tape will help determine the distance to walk. Distances will be set during the Pre-Field Evaluation when setting the project grid.
4. For each survey transect, record the transect ID, land use description (i.e. rangeland, cropland, right of way, road, riparian area, or community development area), the date and year of the survey, and the surveyor name and contact information.
5. For each infestation (which can be a single species or a group of different species) encountered along the transect, record the location of the infestation by either (a) walking around the perimeter of the infestation or (b)recording a GPS point in the approximate center of the infestation.
6. Record each species found in the infestation and the approximate area covered by each species in acres or square feet. Species will be recorded based on the USDA PLANTs database code (see the attached Priority Weed Plant List).
7. If a species cannot be identified, a sample may be taken for identification later. When taking a sample, try to take as much of a single plant as possible (flowers, leaves, seeds, roots, etc). Place in a plastic bag and record the transect grid ID, date, recorded GPS point or location, and a unique ID for the plant. Record the plant ID on the datasheet.

8. Record estimated foliar cover for each species along the transect (Fig. 1). This can be done by measuring and adding together the total distance a species intercepts the transect line, divided by the total distance of the line. Calculate the percent cover and use the following scale:

    a. <0.1%
    b. 0.1-1%
    c. 1-5%
    d. 5-10%
    e. 10-25%
    f. 25-50%
    g. >50%

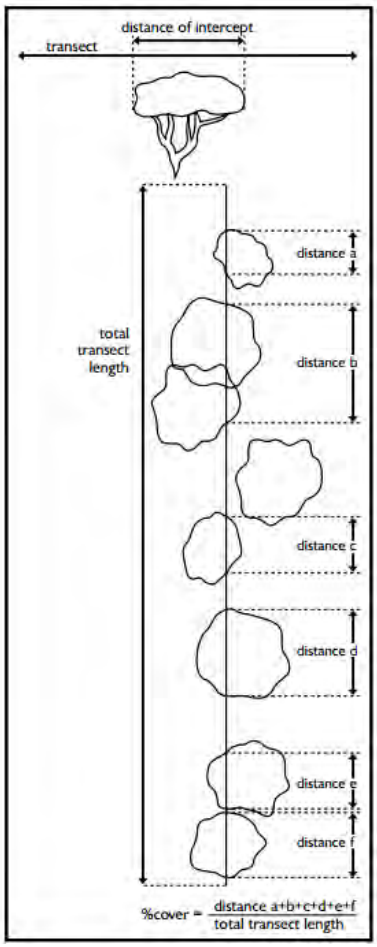


Figure 1 - Line intercept method of measuring cover for a single species. From C.L. Elzinga, D.W. Salzer, and J.W. Willoughby.

Data Entry and Analysis

1. GPS files and datasheets should be entered soon after field surveys have been completed. Using ArcGIS, create a GIS shapefile from the collected GPS data. This can be done a variety of ways:

    a. Create an Excel file of the GPS data points with Northing and Easting locations
    b. Convert the GPS file directly into a GIS file from either the GPS computer software or from the unit
    c. Create the GIS shapefile directly on the GPS unit.

2. Once a shapefile is created for each GPS survey, merge or append the GPS data together into one shapefile for each agency. Weed survey data should be combined for each year.

3. Add the following information to the attribute table for each species infestation identified:

    a. Agency
    b. Navajo Nation Chapter
    c. Date of the Survey
    d. Transect grid ID
    e. Infestation ID
    f. Species identified in the infestation
    g. Approximate size of each species infestation (make the units here uniform, either all in square feet or all in acres)
    h. Approximate % cover of each species' infestation.
    i. Associated weed management project

j. New infestation or old infestation (based on previous survey data)
k. Expansion or decrease in weed population size (based on previous survey data)

4. The following analyses should also be completed on an annual basis for each agency:
    a. Size and cover for each Priority Weed Species (recording approximate acres and average cover density).
    b. Location of Priority Weed Species found and associations with priority treatment areas.
    c. Location and identification of new invasive weed species found. This should be done by referencing state, county, and federal noxious weed lists for species that are not currently on the BIA Navajo Region Weed List.

Reference

Hiebert, R.D., and H. Hudson. 2010. Inventory of exotic plant species occurring in the Resource Preservation Zone of Walnut Canyon National Monument, Arizona. Natural Resource Technical Report NPS/SCPN/NRTR—2010/314. National Park Service, Fort Collins, Colorado.

Elzinga, C.L., D.W. Salzer, and J.W. Willoughby. 1998. Measuring and Monitoring Plant PopulationsU.S. Department of the Interior, Bureau of Land Management, National Applied Resource Sciences Center, Denver, CO. . BLM Technical Reference. BLM/RS/ST-98/005+1730.

Bureau of Indian Affairs- Navajo Region

Survey Information

Agency:
Surveyor:
Contact Info:
State:
Land Use:
Weed Coordinator:
Year:
Date:
County:
Transect/Grid #

Optional Area Information

USGS Quad
HUC Code:

ID	Source	Northing (x)	Easting (y)	Species Code	Estimated Intercept (ft)	% Cover	Notes:

%cover = (total length of intercept/total transect)x100

Date: May 13, 2013

Bureau of Indian Affairs - Navajo Region Noxious/Invasive Weed List

WEED MAPPING AND PROJECT PLANNING

Category A			
Common Name	**Species**	**PLANTS Symbol**	**Management Strategy**
Leafy spurge	*Euphorbia esula*	EUES	Prevent/Eradicate
African rue	*Peganum harmala*	PEHA	Prevent/Eradicate
Tree of Heaven	*Ailantus altissima*	AIAL	Prevent/Eradicate
Ravenna grass	*Saccharum ravennae*	SARA3	Prevent/Eradicate
Fountaingrass	*Pennisetum setaceum*	PESE3	Prevent/Eradicate
Yellow starthistle	*Centaurea solstitialis*	CESO3	Prevent/Eradicate
Japanese brome	*Bromus japonicus*	BRAR5	Prevent/Eradicate
Blue mustard	*Chorispora tenella* (Pall.) DC.	CHTE2	Prevent/Eradicate
Squarrose knapweed	*Centaurea virgata*	CEVI	Prevent/Eradicate
Bull thistle	*Cirsium vulgare*	CIVU	Eradicate
Canada thistle	*Cirsium arvense*	CIAR4	Eradicate
Dalmatian toadflax	*Linaria dalmatica*	LIDA	Eradicate
Musk thistle	*Carduus nutans*	CANU4	Eradicate
Perennial pepperweed	*Lepidum latifolium*	LELA2	Eradicate
Scotch thistle	*Onopordum acanthium*	ONAC	Eradicate
Spotted knapweed	*Centaurea maculosa*	CEMA4	Eradicate
Tall Whitetop	*Cardaria draba*	CADR	Eradicate
Sahara mustard	*Brassica tournefortii*	BRTO	Eradicate
Uruguyan pampas grass	*Cortaderia sellonana*	COSE4	Eradicate
Yellow nutsedge	*Cyperus esculentus*	CYES	Eradicate
Sulphur cinquefoil	*Potentilla rect L.*	PORE5	Eradicate
Common Mediterranean grass	*Schismus barbatus*	SCBA	Eradicate
Tamarisk, Saltcedar	*Tamarix* spp., including hybrids	TAMAR2	Eradicate
Category B			
Field Sandbur	*Cenchrus incertus*	CEIN4	Control & Long term eradication feasible
Halogeton	*Halogeton glomeratus*	HAGL	Control & Long term eradication feasible
Siberian elm	*Ulmus pumila*	ULPU	Control & Long term eradication feasible
Camelthorn	*Alhagi camelorum*	ALMA12	Control & Long term eradication feasible
Tamarisk, Saltcedar	*Tamarix ramosissima*	TARA	Control & Long term eradication feasible
Diffuse knapweed	*Centaurea diffusa*	CEDI3	Control & Long term eradication feasible
Russian knapweed	*Acroptilon repens*	ACRE3	Control & Long term eradication feasible
Russian Olive	*Elaeagnus angustifolia*	ELAN	Control & Long term eradication feasible
Johnsongrass	*Sorghum halepense*	SOHA	Control & Long term eradication feasible
Category C			
Cheatgrass	*Bromus tectorum*	BRTE	Local Control & Monitor
Field bindweed	*Convolvulus arvensis*	COAR4	Local Control & Monitor
Jointed goatgrass	*Aegilops cylindrica*	AECY	Local Control & Monitor
Puncturevine	*Tribulus terrestris*	TRTE	Local Control & Monitor
Rescuegrass	*Bromus catharticus*	BRCA6	Local Control & Monitor
Ripgut brome	*Bromus diandrus*	BRDI3	Local Control & Monitor
Smooth brome	*Bromus inermis*	BRIN2	Local Control & Monitor
Bald brome	*Bromus racemosus*	BRRA2	Local Control & Monitor
Red brome	*Bromus rubens*	BRRU2	Local Control & Monitor
Spreading wallflower	*Erysimum repandum*	ERRE4	Local Control & Monitor
Horehound	*Marrubium vulgare*	MAVU	Local Control & Monitor
California burclover	*Medicago polymorpha*	MEPO3	Local Control & Monitor
Russian thistle	*Salsola kali*	SAKA	Local Control & Monitor
Field brome	*Bromus arvensis*	BRAR5	Local Control & Monitor
Kochia	*Bassia scoparia*	BASC5	Local Control & Monitor

Appendix E. Best Weed Control Methods for Invasive Weeds of Concern

Invasive Weeds	Best Option for Control
"A Rating"	
Leafy spurge	Hand-pulling and grubbing are not effective. Tillage should be combined with re-seeding effort. Long-term grazing with sheep and goats can be effective to control (>5 years). Bio-control most effective when used with chemical control and grazing. Herbicide Treatments are effective when done repeatedly.
African Rue	Hand pulling, grubbing, tilling, and prescribed burn is not recommended because the roots are too deep and will promote the spread. Grazing is not an option because of the bad smell and taste, livestock will not eat. Treatment should occur when the plant is healthy and robust in the late summer (September-October) when using foliar spray. Using imazapyr alone or in combination with other herbicides provides the best control.
Tree of Heaven	Hand pull very young seedlings. Grub saplings or young trees if you can remove the root system. Plant not palatable for grazers. Tree will come back after a control burning. Basal spray or girdling with herbicide application with follow up foliar spraying for spot spraying new seedlings, sprouts and root suckers is a good option. Re-vegetating with native species should occur.
Ravenna Grass	Seed heads can be cut, bagged and incinerated. Remove whole plant by their root and place in a high and dry area. Spray glyphosate on foiage for control of larger populations.
Fountain Grass	Small populations can be hand pulled if roots are extracted. Hand pulling should occur every 1-2 months. Mow or till if infestations are accessible. Prescribe burn is not recommended. Fountain grass not palatable to livestock, except when really young. Best method is to apply herbicide (glyphosate) spot treatments to actively growing plants annually for good control.
Yellow starthistle	Reproduces solely by seed so mechanical control should focus on that-hand removal for small populations, tillage can be effective. Mowing can be effective over a 3 year period. Burning can be effective from January-May. Goat and sheep grazing can be effective. Limited experience with biocontrol in AZ. Herbicide spraying is effective.
Japonese brome	Control burn can be effective if done every 5 years and wil not achieve complete control. Cutting or mowing may be effective if conducted while the flowering head is still enclosed within sheath of the plant. Mecahnical methods may favor population growth. Herbicide is an effective method.
Blue Mustard	Changing crop rotation for heavily infested fields is effecting. Till before plants produce flowers will reduce amount of seed in seed bank. Herbicide most effective when applied before stems elongate.
Squarrose knapweed	Hand pulling can be effective for small populations-repeated pulling is necessary. Do not till. Mow young plants. Do not burn. Sheep and goat grazing can be grazed during spring. Biocontrol is highly effective when using other control methods. Herbicide treatment with follow-up treatments will be effective.
Bull thistle	Use integrated treatments. Cut-off seed heads and pull up roots repeatedly. Tillage, mowing and pulling at proper time will be effective. No burning. Livestock will graze young thistle. Biocontrol suitable for remote locations where other methods are not practical. Use biocontrol for large populations. Chemical treatment is effective
Canada thistle	Repeated mecahnical control should focus on destroying seed heads and root systems. Tillage provides limited control. Do not burn. Goats and sheep can be used to graze young thistle. Best controlled by a selective post-emergent broadleaf herbicide.
Dalmation toadflax	Mechanical removal should focus on root systems. Hand and digging can be effected for small populations. Mowing, chopping and cutting are not recommended. Burning is not recommended. Do not graze, it can be toxic to livestock. Long-term biocontrol effectiveness is unknown. Chemical treatment can be effective with re-seeding efforts if native grasses are not present.
Musk thistle	Use integrated treatments. Cut-off seed heads and pull up roots repeatedly. Tillage, mowing and pulling at proper time will be effective. No burning. Livestock will graze young thistle. Biocontrol suitable for remote locations where other methods are not practical. Use biocontrol for large populations. Chemical treatment is effective

Invasive Weeds	Best Option for Control
"A Rating"	
Perennial pepperweed	Hand-pulling, hoeing or grubbing are effecive for seedlings. Do not mow or till unless used in combination with herbicide. Do not burn. Use grazing with other tools. Goats, sheep and cattle graze new foliage growth. Herbicides are effective especially when using with other integrated approaches.
Scotch thistle	Use integrated treatments. Cut-off seed heads and pull up roots repeatedly. Tillage, mowing and pulling at proper time will be effective. No burning. Livestock will graze young thistle. Biocontrol suitable for remote locations where other methods are not practical. Use biocontrol for large populations. Chemical treatment is effective.
Spotted knapweed	Hand pulling can be effective for small populations-repeated pulling is necessary. Do not till. Mow young plants. Do not burn. Sheep and goat grazing can be grazed during spring. Control burning is effective, but hard to keep ignited through a dense monoculture. Biocontrol is highly effective when using other control methods. Herbicide treatment with follow-up treatments will be effective.
Tall Whitetop	Hand digging and grubbing may be feasible for small populations. Mowing is not recommended unless combined with herbicide applications. Tilling is effective if done repeatedly. Do not burn. Not recommended for livestock grazing. Bio-control agents are still not approved. Herbicides will provide effective control, but need to be cautious about herbicide selection when spraying near crops.
Sahara mustard	Hand pull, particularly seed heads, bag, and incinerate.
Uruguyan pampas grass	Pulling or hand grubbing seedlings is effective. A pulaski, pickaxe, or shovel can be used to remove clumps. Can use chainsaw or weed-whacker to remove the crown, to expose the base of the plant making it easier to remove the root system. It can be controlled with glyphosate in the fall. Top foliage can be removed or burned and the re-growth treated with glyphosate.#
Yellow nutsedge	Controlling the tubers of this plant is important. Remove plants before they have 5-6 leaves by hand or hand hoe. Make sure to remove entire plant. Till only small areas before plants have 6 leaves. Can till and then dry tubers (do not provide irrigation). Can cover an area with polypropylene polymer fabric to suppress nutsedge growth. Few herbicides are effective. Use repeated applications of glyphosate to young and mature plants to kill tubers. Apply halosulfuron to nutsedge prior to the fifth-leaf stage. Dichlobenil will reduce number of plants, but need repeated treatments.*
Sulpher Cinquefoil	Best method is prevention. If infestation is small shovels and tillers can be used to reach below the root crown to destroy plant. Till before the plant goes to seed. Mowing is not suggested. Plant with native seed and plants to reduce population. Chemical control is most effective. ###
Common Mediterranean Grass	Growth inhibited by shade. Plant dense shrubs. Hand removal is impractical. Plowing, disking or scraping reduces biomass initially then further encourages growth. Can be grazed, although disturbance will encourage growth. Herbicide use can be effective. ##
Tamarisk, saltcedar	Hand removal methods are effective for sprout/young plants. Mechanical clearing requires repeated applications. A Grubbing tool mounted on a tractor will works well to pull root ball out. Mulching and excavating can be used for individual trees. Prescribed fire is not recommended for long term management, but can be used to burn brush pile or dead saltcedar. Biological control not adminstered. Herbicide control can be effective: aircraft, helicopter, tractor, truck, atv, backpack, etc.
"B Rating"	
Halogeton	Can be controlled by mechanical tillage but should be followed up by re-seeding. Can be controlled using repeated herbicide treatments. ***
Siberian Elm	Basal spray or cut-surface treatment initially and follow-up with foliar spot spray to control new seedlings, sprouts and root suckers. Can use heavy machinery to grub trees (uproot from ground). Plant dense native shrubs and trees to prevent re-growth.

Invasive Weeds	Best Option for Control
"B Rating"	
Camelthorn	Do not till, mow or burn. Can pull small populations. Grazing may be effective for young growth. Chemical is the most effective treatment over multiple years.
Diffuse knapweed	Hand pulling can be effective for small populations-repeated pulling is necessary. Do not till. Mow young plants. Do not burn. Sheep and goat grazing can be grazed during spring. Biocontrol is highly effective when using other control methods. Herbicide treatment with follow-up treatments will be effective.
Russian knapweed	Hand-pulling or hoeing can be effective for small populations if repeated over multiple years. Tillage should not be used w/out herbicide application. Burning should not occur, except for debris disposal. Cattle, sheep and goats can graze during early growth. Toxic to horses. Biocotrol agents can be effective. Best controlled with selective, post-emergent herbicide.
Russian Olive	Hand removal of small trees (shovel, hoe) Can mow sapling stems <1 inch diamter. Repeated tillage is effective in ag situations and should be coordinated with reseeding. Excavator can be used to remove trees. Burning is a suppression technique can modestly control saplings and reduce top growth of more mature trees. Mature goats will graze on seedlings and young trees. No biocontrols. Herbicide treatment is effective especially when used with other methods.
Johnsongrass	Can remove individual plants by hand if you can remove all the roots. Herbicide is the most effective method.##
"C Rating"	
Cheat grass	Hand-pulling or hoeing will work for small infestations. Disking or tilling repeatedly may be effective if seed is buried at least 4-6 inches. Mowing every 2-3 weeks may be effective. Burning is effective when used with other methods. Grazing is effective during 6-8 weeks early in the season. No biocontrols present. Herbicides are effective, however may affect native species.
Field bindweed	Deep tillage of root system and hand removal of top growth can be effective if done repeatedly. Hoeing is partially effective when treated every 2-3 weeks. Herbicides are effective.*
Jointed goatgrass	Hand pulling effective for small populations. Deep tillage can be effective. Mowing can be effective during late winter. Control burn can be effective in agricultrual settings, but limited for range or non-crop lands. Grazing can be effective in combination with glyphosate spraying. No biocontrol. Effective control with non-selective herbicide.
Puncturevine	Best controlled by hand-removal or hoeing to cut plant off taproot. Mulch can be used around ornamentals to prevent this species. Biocontrol may be effective. Herbicides are an effective control.*
Rescuegrass	Hand removal effective if removed before seed heads are produced-remove roots. May require several return visits. Mowing can occur in winter or early spring before seeds are developed can reduce plant size, but may cause plant to increase in number of stems produced. Burning can be used with other control methods. Can use grazing, but will not provide complete control. Apply herbicide in the fall when the grass has uniform germination and establishment. Once treated the area should be seeded or planted with native species to out-compete recolonizing weeds.
Ripgut Brome	Small populations can be hand pulled if roots are extracted. Hand pulling will need to occur repeatedly. Mowing or cutting should occur regularly. Deep tillage can be effective. Herbicide application can be successful.@@
Smooth brome	Can hand pull small populations. Spray herbicide in fall after a killing freeze for best results. Can use control burn in a field during the dormant period and followed by cattle grazing of re-growth. @
Bald Brome	Hand removal effective if removed before seed heads are produced-remove roots. May require several return visits. Mowing can occur in winter or early spring before seeds are developed can reduce plant size, but may cause plant to increase in number of stems produced. Burning can be used with other control methods. Can use grazing, but will not provide complete control. Apply herbicide in the fall when the grass has uniform germination and establishment. Once treated the area should be seeded or planted with native species to out-compete recolonizing brome.

Invasive Weeds	Best Option for Control
"C Rating"	
Red brome	Hand removal effective if removed before seed heads are produced-remove roots. May require several return visits. Mowing can occur in winter or early spring before seeds are developed can reduce plant size, but may cause plant to increase in number of stems produced. Burning can be used with other control methods. Can use grazing, but will not provide complete control. Apply herbicide in the fall when the grass has uniform germination and establishment. Once treated the area should be seeded or planted with native species to out-compete recolonizing red brome.
Spreading Wallflower	2,4-D provides good control.
Horehound	Hand pulling before seeding occurs will work for small populations. Plants do not persist in areas of clean cultivation. Plants can be mowed to the ground as they begin to grow in spring, will need to be repeated. Deep plowing in ag fields with rotation of crops will improve control. Sheep will graze if other feed is scarce, but may open up new areas for infestation. Can control brun with follow-up treatments of germinating plants. Herbicides will work with follow-up treatments.!!!
California Burclover	Hand pulling plants may control small populations if roots are removed. Maintain or plant native vegetation for competition. Glyphosate may be effective.
Russian thistle	Mowing or hand-pulling young plants can prevent seed production, but will need to be done repeatedly. Do not burn. Planting competetive native species can prevent establishment. Can use preemergent and post emergent herbicides. Repeated use of a single herbicide should be avoided due to herbicide resistance.*
Field Brome	Hand removal effective if removed before seed heads are produced-remove roots. May require several return visits. Mowing can occur in winter or early spring before seeds are developed can reduce plant size, but may cause plant to increase in number of stems produced. Burning can be used with other control methods. Can use grazing, but will not provide complete control. Apply herbicide in the fall when the grass has uniform germination and establishment. Once treated the area should be seeded or planted with native species to out-compete recolonizing brome.
Kochia	Samll infestations can be hand-pulled to remove whole root. Mowing reduces seed production, but needs to be done repeatedly. Deep tillage may prevent seed germination. Can be grazed in small amounts, but is toxic in large amounts. Will re-grow after grazing. Competitive native vegetation, such as perennial grass plantings, can inhibit establishment. Chemical treatment will work, however there are chemical resistant populations.!

Weed management strategies for above-mentioned weeds were extracted from USDA Forest Southwestern Region Field Guides for Managing Species (http://www.fs.usda.gov/detail/r3/forest-grasslandhealth/invasivespecies/?cid=stelprdb5228481)

*	Statewide Integrated Pest Management Program at the University of California at Davis (http://ucipm.ucdavis.edu/PMG/PESTNOTES/pn74139.html)
***	USDA NRCS Plant Guide (http://plants.usda.gov/java/)
****	BugwoodWiki- High Plains Integrated Pest Management (http://wiki.bugwood.org/HPIPM)
#	Produced by the USDA Forest Service, Forest Health Staff, Newtown Square, PA. Invasive Plants website: http://www.na.fs.fed.us/fhp/invasive_plants
##	Lake Mead Exotic Plant Management Plan
###	University of Nevada, Cooperative Extension Fact sheet
!	DiTomaso, J.M., G.B. Kyser et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California. 544 pp.
@	http://www.ks.nrcs.usda.gov/news/coneds12/brome_grass.html and Restoring Native Grassland Species
!!!	http://sdrsnet.srnr.arizona.edu/data/sdrs/ww/docs/marrvulg.pdf
@@	Montana Utah Wyoming Cooperative Extension Weed Management Handbook

Appendix F. Federally and Tribally Listed Species Protection Measures

Species Conservation Measures

The species conservation measures listed below are intended to be implemented as part of the proposed action to reduce the effects of the proposed action on listed species. These measures are general measures that will be followed for each project. The species specific mitigation measures will be listed under the species of concern described below.

Species Conservation Measures (Project Design Features)

RPMPA refers to the Recommended Protection Measures for Pesticide Applications in Region 2 of the U.S. Fish and Wildlife Service authored by J. Allen White, April 2007. Both the RPMPA and the Avoidance Measures listed in the Navajo Nation Endangered Species List, Species Accounts created by the Navajo Natural Heritage Program Department of Fish and Wildlife, August 2008 were used as a starting point for the conservation measures. In general, the most conservative avoidance measures of the two documents were used for the conservation measures. Several informal discussions with the USFWS and the Navajo Natural Heritage Program, Navajo Nation Department of Fish and Wildlife (NNDFW) were conducted to help refine the conservation measures.

Federally Listed Species

General Project BMPs

1. If preliminary analysis based on maps, aerial photos, and other knowledge of the project site indicates that potential habitat for listed species may be present, conduct an on-the-ground habitat assessment by a qualified biologist.

2. Species permits would be obtained from USFWS and Biological Investigations Permits would be obtained from NNDFW prior to conducting species surveys for species where surveying methods may result in take of the species or for other activities that require Section 9 coverage on Navajo Nation land.

3. If potential habitat is found, the protection measures, including buffers established for that species would be applied or additional surveys for species presence would be conducted by a qualified biologist.

4. If the species is present at the site the appropriate species based protection measures would be employed. If the species is not present after species surveys are conducted no buffers need to be employed.

All Species

1. Where specified, species breeding season timing restrictions and buffers are applicable to all treatment methods.

2. Where two or more species' habitats overlap, the more restrictive measures will take priority.

3. Specific chemical treatment buffers for each chemical treatment type for the listed species is detailed in Appendix B.

Black-footed ferret (*Mustela nigripes)*

1. Breeding season for black-footed ferret is from mid-March to August, with most sensitive period from mid-March to June. Only occur in medium to large active prairie dog towns (>198 acres (80 hectare (ha), and ≥20 burrows/ha).

2. Notify USFWS and NNDFW of any project that would impact prairie dog towns greater than 200 acres (80 ha).

3. Weed treatments will be scheduled outside of breeding season.

4. No disking, plowing or prescribed burns around habitat during the breeding season (March to September).

5. No herbicide limitations for this project per the RPMPA, pg. 109.

Mexican Gray Wolf (*Canis lupus*)

1. No current populations occur or official sightings reported on the Navajo Nation.

2. No herbicide limitations for this project per the RPMPA (page 109).

Brady pincushion cactus (*Pediocactus bradyi*), Fickeisen plains cactus (*Pediocactus peeblesianus* ssp. *Fickeiseniae*), Welsh's milkweed (*Asclepias welshii*), Zuni fleabane (*Erigeron rhizomatus*), Goodings onion (*Allium gooddingii*), Mancos milk-vetch (*Astragalus humillimus*), Navajo sedge (*Carex specuicola*)

1. Vehicles would use only established roads for accessing project sites in listed plant habitat.
2. Vehicles would be parked at previously disturbed parking areas located 20feet (ft) (60 meter (m)) from suitable habitat for federally listed species when treating. Parking areas would be near established roadways.
3. Mechanical, cultural, chemical, and prescribed burn requires a 200 ft (60 m) buffer from identified listed species locations.

4. Manual treatments (low impact treatments) require a 20ft (6 m) buffer from identified listed species locations.

5. When doing treatments, flagging and fencing will be placed around listed plant populations.
6. The NNDFW botanist will be notified of any positive results of rare plant surveys. BIA would also notify the NNDFW botanist as to whether they are proceeding with the proposed weed treatment near the listed plant, and if so, the buffers and other avoidance measures that will be implemented.
7. The field crew administering weed treatments will be educated on the listed plants and how to avoid them.

Mesa Verde cactus (*Sclerocactus mesae-verdae*)

1. Vehicles would use only established roads for accessing project sites in listed plant habitat.
2. Vehicles would be parked at previously disturbed parking areas located 20ft from suitable habitat for federally listed species when treating. Parking areas would be near established roadways.
3. No treatments would occur in the Mesa Verde Biological Preserves.
4. Mechanical, cultural, and prescribed burn require a 200 ft (60 m) buffer from identified listed species locations.
5. Manual treatments (low impact treatments) require a 50 ft (15 m) buffer from identified listed species locations.
6. When doing treatments, flagging and fencing would be placed around listed plant populations.
7. The NNDFW botanist will be notified of any positive results of rare plant surveys. BIA would also notify the NNDFW botanist as to whether they are proceeding with the proposed weed treatment near the listed plant, and if so, the buffers and other avoidance measures that will be implemented.
8. The field crew administering weed treatments will be educated on the listed plants and how to avoid them.

California condor (*Gymnogyps californianus*)

1. Mechanical, prescribed fire and ground application of herbicide treatments require a one mile buffer from release sites, suitable nesting sites, or known communal roosting sites in species habitat of canyon lands and mountain ridges.

2. Aerial applications of herbicides require a 1.5 mile (2.4 km) buffer from release sites, suitable nesting sites, or known communal roosting sites in species habitat of canyon lands and mountain ridges.

3. If a condor is present all weed treatment activities would cease and NNDFW would be contacted. Field crews would avoid interacting with condors if present on site.

4. All trash and debris would be disposed of properly on site.

Colorado pikeminnow (*Ptychocheilus Lucius*), Razorback sucker (*Xyrauchen texanus*), Roundtail chub (*Gila robusta*)

1. Weed removal projects would require restoration of native vegetation to prevent erosion. Weed removal activities in the riparian zone would be conducted in patches in order to prevent erosion.

2. Best Management Practices would be used to reduce sedimentation and chemical run-off from mechanical and chemical weed treatments along bank lines within the 100-year floodplain.

3. Pile burning and prescribed burning would be conducted 300 ft outside of the floodplain.

4. Approved herbicides (aquatic formulations only): 2,4-D, Glyphosate, Triclopyr and Imazapyr would exclusively be used within 25-feet of the daily high water mark.

5. Herbicides that have relatively low aquatic toxicity to fish and mollusks require a 25 ft (7.6 m) buffer from the daily high water mark in the riparian zone, including: Aminopyralid, Chlorsulfuron methyl, Clopyralid, Diflufenzopyr, Imazapic, and Thifensulfuron-methyl.

6. Non-aquatic approved and moderate to high aquatic toxicity herbicides require a 300 ft (90 m) buffer from the daily high water mark.

Zuni bluehead sucker (*Catostomus discobolus*)

1. All bluehead suckers would be treated the same.

2. Ground disturbance would be minimized in habitat.

3. Approved herbicides (aquatic formulations only): 2,4-D, Glyphosate, Triclopyr and Imazapyr would exclusively be used within 25-feet of the daily high water mark.

4. Herbicides that have relatively low aquatic toxicity to fish and mollusks are permitted in the riparian zone, including: Aminopyralid, Chlorsulfuron methyl, Clopyralid, Diflufenzopyr, Imazapic, and Thifensulfuron-methyl require a 25 ft (8 m) buffer from the daily high water mark.

5. Non-aquatic approved and moderate to high aquatic toxicity herbicides require a 300 ft (90 m) buffer from the daily high water mark.

6. Only the cut-stump method would be used to remove large trees or shrubs in the floodplain. Debris would be piled outside of the floodplain.

7. Heavy machinery (bulldozers/root plows) mechanical treatments require a 300 ft (90 m) buffer from edge of the waterway.

8. Prescribed and pile burning would be conducted outside of floodplain.

9. Weed removal would occur in patches along the bank line and floodplain to prevent increased sedimentation. If more weed species removal is required the Best Management Practices to reduce sedimentation and chemical run-off would be used (see Integrated Weed Management Plan).

10. Weed removal projects would require restoration of native vegetation to prevent erosion.

Kanab ambersnail (*Oxyloma kanabense*)

1. Mechanized, manual and chemical spot treatments require a 200 ft (60 m) buffer from suitable habitat.

2. Low aerial spraying requires a 150 ft (50 m) buffer and high aerial spraying requires a 1/8 mile (200 m) buffer from suitable habitat.

Mexican spotted owl (*Strix occidentalis lucida*)

1. Breeding season is March 1 through August 30.

2. All treatments require a ¼ mile (0.4 km) buffer from the protected activity center (PAC) and suitable nesting habitat. A PAC is approximately 600 acres (240 ha) around an owl activity center (nest, roost or best roost habitat).

3. Specified herbicides may be applied along road and utility right-of-ways in MSO PACS during the breeding season, but applicators should make sure that pesticide spray drift does not occur beyond right-of-way.

Southwestern willow flycatcher (*Empidonax traillii extimus*)

<u>Definitions</u>

Currently suitable habitat is defined as a riparian area with all the components needed to provide conditions suitable for breeding flycatchers. These conditions are generally dense, mesic riparian shrub and tree communities 0.25 acre (0.1 ha) or greater in size within floodplains large

enough to accommodate riparian patches at least 33 ft (10m) wide. Suitable habitat may be occupied or unoccupied ("Southwestern Willow Flycatcher ("SWFL Recovery Plan").

Potentially suitable habitat is defined as a riparian system that does not currently have all the components needed to provide conditions suitable for nesting flycatchers, but which could – if managed appropriately – develop these components over time. Potential habitat occurs where the flood plain conditions, sediment characteristics, and hydrological setting provide potential for development of dense riparian vegetation ("SWFL Recovery Plan").

Breeding Patch is the area used by breeding flycatchers. Breeding patches include all flycatcher territories and most flycatcher breeding patches are larger than the sum total of the flycatcher territory sizes at that site ("SWFL Recovery Plan").

Conservation Measures

1. There would be no biological control for saltcedar on the Navajo Nation.
2. A qualified biologist would confirm occupancy during the breeding season (May through August, "SWFL Recovery Plan") within a year prior to conducting treatments to determine suitable habitat, breeding habitat, migration habitat, or potential territory for occupied habitat.
3. A qualified SWFL biologist would determine breeding patch size for nesting areas per the "SWFL Recovery Plan" and identify sites on the ground prior to treatments.
4. In occupied breeding areas, mechanical and mechanized and low and high aerial chemical treatments require a ¼ mile (0.4 km) buffer from the breeding patch boundary or suitable habitat.
5. Prescribed fires outside of a breeding patch would be conducted outside of the migrating and breeding season. Small pile burns would be conducted outside of the floodplain or 300ft (90 m) buffer from edge of waterway.
6. Manual treatments would be used up to the breeding patch boundary or suitable habitat.
7. Important migratory corridors for SWFL would be buffered as listed above from May to June.
8. All projects within the riparian zone near occupied SWFL habitat would require native riparian/wetland vegetation restoration following invasive species removal.

Western yellow-billed cuckoo (*Coccyzus americanus*)

1. A qualified biologist would confirm occupancy during the breeding season (May through August) within a year prior to conducting treatments.

2. A qualified biologist would determine breeding patch size for nesting areas and identify sites on the ground prior to treatments.

3. In occupied breeding areas, mechanical and mechanized and low and high aerial chemical treatments require a ¼ mile (0.4 km) buffer from the breeding patch boundary or suitable habitat.

4. Prescribed fires outside of a breeding patch would be conducted outside of the migrating and breeding season. Small pile burns would be conducted outside of the floodplain or 300ft (91 m) buffer from edge of waterway.

5. Manual treatments would be used up to the breeding patch boundary or suitable habitat.

6. All projects within the riparian zone near occupied YBCU habitat would require native riparian/wetland vegetation restoration following invasive species removal.

Bald and golden eagles (*Haliaeetus leucocephalus* and *Aquila chrysaetos*)

1. The breeding season for bald and golden eagles is January 15- July 15 ('Navajo Nation Golden and Bald Eagle Nest Protection Regulations').

2. Brief activities that occur for up to one hour per day and involve only personnel and passenger or maintenance vehicles (one hour of spot spraying, mechanical, or manual treatments) require a 0.4 mi (600 m) buffer from an active nest.

3. Light activities that occur for up to one day in the same general area and involve up to five vehicles and up to ten personnel (mechanical treatments and mechanized ground chemical treatments) require a 0.5 mi (800 m) buffer from an active nest.

4. Heavy activities that exceed at least one of the criteria for Light Activities that involve human activity of up to one visit per week (prescribed fire, low and high aerial chemical treatments) would be conducted outside of the breeding season and ¾ mi (1 km) from a nesting site.

Migratory birds

1. Mechanical treatments within the buffer zone would be conducted outside of the breeding season (March through August).

2. Non-endangered raptors- All treatments require a 490 ft (0.15 km) buffer from the active nest from March-August or until juveniles have left the nest.

3. Predatory birds- Spot and mechanized ground herbicide treatments with Class 2 or Class 3 liquid formulation herbicides require a 300 ft (90 m) buffer from the active nest from

March- August or until juveniles have left the nest. Low and high aerial treatments requires a 1/8 mi (200 m) buffer from the active nest.

4. Small migratory birds- Class 2 or Class 3 herbicides require 30 ft (9 m) buffer for spot and mechanized ground application of herbicide, 150 ft (50 m) with low aerial chemical treatments, and 1/8 mi (200 m) for high aerial chemical treatments near the species habitat.

5. Waterfowl- avoid using Class 2 or 3 herbicides in areas where waterfowl are concentrated, and wait until birds have migrated for the season. Applications of liquid formulations of Class 2 and 3 herbicides require a 30 ft (9m) buffer for spot applications, 60 ft (20 m) for mechanized ground, 200 ft (60 m) for low aerial spraying, and 1/8 mi (200 m) for high aerial spraying.

6. Prescribed fires outside of a breeding patch would be conducted outside of the migrating and breeding season.

Navajo Nation Endangered Species List

General Project BMPs

1. No species surveys are required for Group 1 species.

2. Species surveys by a qualified biologist are required for Group 2 and 3.

3. Species surveys are preferred for Group 4 species, but are not required. Surveys for these species would be conducted when conducting other species surveys.

4. If potential habitat for listed species is present, conduct a habitat assessment by a qualified biologist. See Table 2 for habitat descriptions for all the Navajo Nation listed species.

5. Biological Investigation Permits would be obtained from NNDFW prior to conducting species surveys.

6. If potential habitat is found, the protection measures, including buffers established for that species would be applied or additional surveys for species presence would be conducted by a qualified biologist.

7. If the species is present at the site the appropriate species based protection measures would be employed. If the species is not present after species surveys are conducted no buffers need to be employed.

All Species

1. Where specified, species breeding season timing restrictions and buffers are applicable to all treatment methods.

Group 1- No longer occur on Navajo Nation

Northern river otter (*Lontra canadensis*)

1. This species may be moved to Group 2 due to a new population along the San Juan River.
2. There is no need to conduct surveys, however if species is spotted contact the Navajo Nation Department of Fish and Wildlife.
3. No mitigation measures required.

Group 2- Critically Endangered Species

Northern leopard frog (*Lithobates pipiens*)

1. Mechanical and manual treatments require a 200 ft (60 m) buffer zone from open water habitats.
2. Prescribed fire requires a 200 ft (60 m) buffer zone from the edge of the wetland vegetation.
3. No applications of herbicides would be used inside occupied or potentially occupied aquatic habitat.
4. Mitigation measures would be applied in dispersal and migration corridors after rain events.
5. All projects in riparian/wetland habitats near occupied habitat would require native riparian/wetland vegetation restoration following invasive species removal.
6. Only herbicides labeled for aquatic use and the cut-stump method on tree species would be used in potential habitat.
7. No target grazing would be used in the habitat.
8. All equipment and boots be cleaned with bleach before and after treatments within 200 ft (60 m) of occupied habitat to prevent the spread of chytrid fungus.

Cutler's milk-vetch (*Astragalus cutleri*)

1. Low and high aerial spraying of herbicides requires a one mile buffer from identified listed species locations.

2. Mechanical, cultural, prescribed burn, and chemical ground treatments require a 200 ft (60 m) buffer from identified listed species locations.

3. Manual treatments (low impact treatments) require a 20 ft (6 m) buffer from identified listed species locations.

4. When doing treatments, flagging and fencing would be placed around listed plant populations.

5. The field crew administering weed treatments would be educated on the listed plants and how to avoid them.

Group 3- Endangered Species

Pronghorn (*Antilocapra americana*) and Bighorn sheep (*Ovis Canadensis*)

1. Pronghorn- All treatments require a 1 mile (1.6 km) buffer from potential lambing areas from May 1 through June 15.

2. Bighorn sheep- All treatments require a 1 mile (1.6 km) buffer from potential lambing areas from April 1 through September 15.

3. Disturbance to individuals would be minimized year-round.

Ferruginous hawk (*Buteo regalis*)

1. Breeding season occurs March 1- July 31 (Navajo Nation Endangered Species List: species accounts).

2. Protected under the Federal Migratory Bird Treaty Act.

3. Brief activities that occur for up to one hour per day and involve only personnel and passenger or maintenance vehicles (one hour of spot spraying, mechanical, or manual treatments) require a 1/2mile (0.8 km) buffer from an occupied nest.

4. Light activities that occur for up to one day in the same general area and involve up to five vehicles and up to ten personnel (mechanical treatments and mechanized ground chemical treatments) require a 5/8 mile (1 km) buffer from an occupied nest.

5. Heavy activities that exceed at least one of the criteria for Light Activities that involve human activity of up to one visit per week (prescribed fire, low and high aerial chemical treatments) require a ¾ mile (1.2 km) from an occupied nest.

American dipper (*Cinclus mexicanus*)

1. Protected under the Federal Migratory Bird Treaty Act.

2. Mechanical treatments require a 50–200 ft (15-60 m) buffer from occupied nesting habitat outside of breeding season.

3. No mechanical, mechanized ground, low or high aerial chemical treatments within 1/8 mile (0.2 km) from the active nest during March 15- August 15.

4. Spot chemical spraying or manual treatments require a buffer of 330 ft (0.1 km) from the active nest during March 15- August 15.

5. Small migratory birds- Class 2 or Class 3 herbicides require 30 ft (9 m) buffer for spot and mechanized ground application of herbicide, 150 ft (50 m) with low aerial chemical treatments, and 1/8 mi (200 m) for high aerial chemical treatments near the species habitat.

Western seep fritillary (*Speyeria Nokomis*)

1. Surveys would be conducted from August 1- September 1.

2. Avoidance measures would be applied to the host plant, violet.

3. No chemical or mechanical treatments permitted within 200 ft (60 m) of occupied habitat year-round.

4. No target livestock grazing within wet areas containing host plants during the mating season.

5. No broadcast or aerial herbicide applications would be permitted within western seep fritillary habitat or in areas containing host plants.

Marble Canyon milk-vetch (*Astragulus cremnophylax* var. *hevroni*), Cronquist milk-vetch (*Astragalus cronquistii*), Naturita milk-vetch (*Astragalus naturitensis*), Acoma fleabane (*Erigeron acomanus*), Round dunebroom (*Errazurizia rotundata*), Navajo bladderpod (Lesquerella navajoensis), Navajo Penstemon (*Penstemon navajoa*), Alcove rock daisy (*Perityle specuicola*), Alcove bog-orchid (*Platanthera zothecina*), Alcove death camas (*Zigadenus vaginatus*)

1. Low and high aerial spraying of herbicides requires a one mile (1.6 km) buffer from identified listed species locations.

2. Mechanical, cultural, prescribed burn, and chemical ground treatments require a 200ft (60 m) buffer from identified listed species locations.

3. Manual treatments (low impact treatments) require a 20 ft (6 m) buffer from identified listed species locations.

4. When doing treatments, flagging and fencing would be placed around listed plant populations.

5. The field crew administering weed treatments would be educated on the listed plants and how to avoid them.

Group 4- Sensitive Species

Townsend's big-eared bat (*Corynorhinus townsendii*)

1. All treatments require a 200 ft (60 m) buffer from occupied roost site during April 15-August 31.

Chisel-toothed kangaroo rat (*Dipodomys microps*), Banner-tailed kangaroo rat (*Dipodomys spectabilis*), Navajo Mountain vole (*Microtus mogollonensis*), Arizona (Wupatki) pocket mouse (*Perognathus amplus cineris*)

1. Mechanical and target grazing treatments require a 200 ft (60m) buffer from occupied habitats year-round.

Kit fox (*Vulpes macrotis*)

1. Mechanical and target grazing treatments require a 200 ft (60 m) buffer from occupied habitats year-round.

2. All treatments require a 1/8 mi (0.2 km) buffer from active den during December 1-August 31

Northern goshawk (*Accipiter gentilis*)

1. All treatments require a ¼ mi (0.4 km) buffer from nest site during March 1- August 15 and within 0.20 mi (0.2 km) of nest site year-round.
2. Protected under the Federal Migratory Bird Treaty Act.

Clark's grebe (*Aechmophorus clarkia*)

1. Mechanical treatments require 200 ft (60 m) buffer from lake-side vegetation or within the 100-yr floodplain, whichever is greater.

2. Prescribed fire, target livestock grazing, and mechanized ground, low and high aerial chemical spraying require a 1/8 mile (0.2km) buffer from the active nest during May 1-July 31.

3. Chemical spot and manual treatments require a 330 ft (0.1 km) buffer from active nest during May 1-July 31.

4. Class 2 and 3 liquid formulations require 1/8 mi buffer for high aerial applications. ULV or dust formulations require 500 ft (150 m) for low aerial spraying and ¼ mi (400 m) for high aerial applications from a nest site.

Northern saw-whet owl (*Aegolius acadicus*)

1. All treatments require a 1/8 mile (0.2 km) buffer from the nest site year-round.
2. Pesticides that rate as Class 2 or Class 3 in the Predatory Avian, Small Mammal, or Terrestrial Arthropod toxicity groups should have a ½ mile (0.8 km) buffer from occupied nests.

Burrowing owl (*Athene cunicularia*)

1. All treatments require a ¼ mile (0.4 km) buffer from the active nest burrow during March 1- August 15.

2. Pesticides that rate as Class 2 or Class 3 in the Predatory Avian, Small Mammal, or Terrestrial Arthropod toxicity groups should have a ½ mile (0.8 km) buffer from occupied nests.

3. Mechanical treatments require a 1/8 mile (0.2 km) buffer from inactive nest site year-round.

Belted kingfisher (*Ceryle alcyon*) and Mountain plover (*Charadrius montanus*)

1. No treatments within nesting habitats year-round.

2. Prescribed fire, target livestock grazing, and mechanized ground, low and high aerial chemical spraying require a 1/8 mile (0.2 km) buffer from the active nest during April 15-August 15.

3. Chemical spot and manual treatments require a 330 ft (0.1km) buffer from active nest during April 15- August 15.

Dusky grouse (*Dendragapus obscurus*)

1. Mechanical treatments require 1/8 mile (0.2 km) buffer from nest site year-round.

2. Prescribed fire, target livestock grazing, and mechanized ground, low and high aerial chemical spraying require a 1/8 mile (0.2 km) buffer from the active nest during April 1-July 15.

3. Chemical spot and manual treatments require a 330 ft (0.1 km) buffer from active nest during April 1-July 15.

Yellow warbler (*Dendroica petechial*)

1. All treatments require a 1/8 mile (0.2 km) buffer from the active nest from April 15- July 31.

2. Mechanical, mechanized ground and low and high aerial chemical treatments require a 1/8 mile (0.2 km) buffer from habitat patches used for breeding or potential habitat year-round.

Hammond's flycatcher (*Empidonax hammondii*)

1. Mechanical, prescribed fire and mechanized ground, low and high aerial chemical spraying require a 1/8 mile (0.2km) buffer from the active nest year-round.

2. Chemical spot and manual treatments require a 330 ft (0.1 km) buffer from active nest during May 15- August 15.

American Peregrine falcon (*Falco peregrinus*)

1. All treatments require a ½ mile (0.8 km) buffer from the nest during March 1- July 31.

Northern pygmy-owl (*Glaucidium gnoma*)

1. Chemical spot and manual treatments require a 1/8 mile (0.2 km) buffer from the nest site during April 1- August 15.

2. Mechanical, prescribed fire and mechanized ground, low and high aerial chemical spraying require a 1/8 mile (0.2 km) buffer from the nest site year-round.

3. Pesticides that rate as Class 2 or Class 3 in the Predatory Avian, Small Mammal, or Terrestrial Arthropod toxicity groups should have a ½ mile (0.8 km) buffer from occupied nests.

Flammulated owl (*Otus flammeolus*)

1. Chemical spot and manual treatments require a 1/8 mile (0.2 km) buffer from the nest site during May 1- August 15.

2. Mechanical, prescribed fire and mechanized ground, low and high aerial chemical spraying require a 1/8 mile (0.2 km) buffer from the nest site year-round.

3. Pesticides that rate as Class 2 or Class 3 in the Predatory Avian, Small Mammal, or Terrestrial Arthropod toxicity groups should have a ½ mile (0.8 km) buffer from occupied nests.

Band-tailed pigeon (*Patagioenas fasciata*), American three-toed woodpecker (*Picoides dorsalis*), and Tree swallow (*Tachycineta bicolor*)

1. Chemical spot and manual treatments require a 330 ft (0.1 km) buffer from the nest site during May 1- August 1.

2. Mechanical, prescribed fire and mechanized ground, low and high aerial chemical spraying require a 1/8 mile (0.2 km) buffer from the nest site year-round.

Sora (*Porzana Carolina*)

1. Mechanical treatments require 200 ft (60 m) buffer from lakes and Category I wetlands and 150 ft (45 m) of Category II wetlands, per Navajo Natural Heritage Program 1994.

2. Prescribed fire, target livestock grazing, and mechanized ground, low and high aerial chemical spraying require a 1/8 mi (0.2 km) buffer from the active nest during May 1-August 1.

3. Chemical spot and manual treatments require a 330 ft (0.1 km) buffer from active nest during May 1-August 1.

Gray vireo (*Vireo vicinior*)

1. Chemical spot and manual treatments require a 330 ft (0.1 km) buffer from the nest site during May 1- August 31.

2. Mechanical, prescribed fire and mechanized ground, low and high aerial chemical spraying require a 1/8 mile (0.2 km) buffer from the nest site year-round.

Milk snake (*Lampropeltis triangulum*) and chuckwalla (*Sauromalus ater*)

1. No mechanical treatments (surface disturbance) within occupied habitats.

Mottled sculpin (*Cottus bairdi*)

1. Approved aquatic labeled herbicides would be used adjacent to the stream bank.

2. Mechanical treatments require a 100-200 ft (30-60 m) buffer from the top of the stream bank (depending on stream category, per Navajo Natural Heritage Program).

Rocky mountainsnail (*Oreohelix strigosa*) and Yavapai mountainsnail (*Oreohelix yavapai*)

1. Mechanical and manual treatments require a 200 ft (60 m) buffer from occupied habitat year-round.

Aztec gilia (*Aliciella Formosa*), Peebles blue-star (*Amsonia peeblesii*), San Juan milkweed (*Asclepias sanjuanensis*), Beath milk-vetch (*Astragalus beathii*), Heil's milk-vetch (*Astragalus heilii*), Navajo saltbush (*Atriplex garrettii* var. *navajoensis*), Atwood's camissonia (*Camissonia atwoodii*), Rydberg's thistle (*Cirsium rydbergii*), Yellow lady's slipper (*Cypripedium parviflorum* var. *pubescens*), Utah bladder-fern (*Cystopteris utahensis*), Grand Canyon goldenweed (*Ericameria arizonica*), Sivinski's fleabane (*Erigeron sivinskii*), Sarah's buckwheat (*Eriogonum lachnogynum* var. *sarahiae*), Bluff phacelia (*Phacelia indecora*) , Cave primrose (*Primula specuicola*), Marble Canyon dalea (*Psorothamnus arborescens* var. *pubescens*), Parish's alkali grass (*Puccinella parishii*), Arizona rose sage (*Salvia pachyphylla* ssp. *eremopictus*), Brack hardwall cactus (*Sclerocactus cloverae brackii*), Welch's American-aster (*Symphyotrichum welshii*)

1. Low and high aerial spraying of herbicides requires a one mile buffer from identified listed species locations.
2. Mechanical, cultural, prescribed burn, and chemical ground treatments require a 200 ft (60 m) buffer from identified listed species locations.
3. Manual treatments (low impact treatments) require a 20 ft (6 m) buffer from identified listed species locations.
4. When doing treatments, flagging and fencing would be placed around listed plant populations.
5. The field crew administering weed treatments would be educated on the listed plants and how to avoid them.

Appendix G. Monitoring Protocols

Bureau of Indian Affairs- Navajo Region

Treatment Monitoring Report

Site Name:		Applicator Name:	
Date:		Company/Agency:	
State:		Contact Info:	
County:		USGS Quad:	
Land Use:			
Treatment Location:	Start:	Northing:	Easting:
	End:	Northing:	Easting:

Method of Treatment*	Tools used	Herbicide Name	Amount of Herbicide	Acres/Miles Treated	Time	Wind Speed	Temperature during Application

* Chemical, Mechanical, Manual, Cultural, Biological

Bureau of Indian Affairs- Navajo Region

Weed Spread/Supression Monitoring

Site Name:		Surveyor Name:	
Date:		Company/Agency:	
State:		Contact Info:	
County:		USGS Quad:	
Land Use:		Treatment Method:	
Transect Bearing:		Weed Species Treated:	

Transect Location:	Start:	Northing:	Easting:
	End:	Northing:	Easting:

Plot #	Plant species	Cover Estimate	Plot #	Plant species	Cover Estimate

Cover Classes: 1) <1% **2**) 1-10% **3**) 11-25% **4**) 26-50% **5**) 51-75% **6**) 76-90% **7**) >90%

Photo Monitoring Data Collection Sheet					
	Photo # 1	Photo #2	Photo #3	Photo #4	Photo #5
Date					
Time					
Weather					
Location					
Subject and Purpose of photo					
Camera					
Frame #'s					
Photo Label					
Tripod/Camera Height					
Marker					
Compass Bearing					
Latitude					
Longitude					
Error					
Photographer					
Note Taker					
Description of Location (How to find the spot)					
Reference Photos					

Appendix H. Federal, State and Navajo Contact Information

Arizona Invasive Species Advisory Council (AISAC)
http://az.gov/invasivespecies/
invasivespecies@azgfd.gov

Arizona Department of Environmental Quality
2625 N. King St. Second Floor
P.O. Box 639
Flagstaff, AZ 86001
(928)679-7307
Community Liaison: Sybil Smith

Arizona Department of Transportation

Justin White
Roadside Resource Manager
1611 W. Jackson Street, EM02
Phoenix, AZ 85007
jwhite@azdot.gov
(602) 399-3233

Robert Guevara
Natural Resources Regional Supervisor
1801 S. Milton Ave.
MD F864
Flagstaff, AZ 86004
928.532.2370 Office
928.527.8617 Fax

Bureau of Land Management – Farmington Field Office
http://www.blm.gov/nm/st/en/fo/Farmington_Field_Office.html
6251 College Blvd. Suite A
Farmington, NM 87402
(505)564-7600
(800)842-3127

National Park Service

Flagstaff Area Parks (Wupatki NM, Walnut Canyon NM, Sunset Crater NM)
6400 N. Hwy. 89
Flagstaff, AZ 8600
(928)526-0502

Superintendent: Kayci Cook Collins

Glen Canyon National Recreation Area
P.O. Box 1507
Page, AZ 86040-1507
(928)608-6205
Superintendent: Todd Brindle

Grand Canyon National Park
P.O. Box 129
Grand Cayon, AZ 86023
(928)638-7888
Superintendent: Dave Uberuaga

Canyon de Chelly National Monument
P.O. Box 588
Chinle, AZ 86503
(928)674-5500
Superintendent: Lloyd Masayumptewa

El Morro National Monument
HC 61 Box 43
Ramah, NM 87321-9603
Superintendent: Mitzi Frank

Hovenweep National Monument
McElmo Route
Cortez, CO 81321
Superintendent: Jim Dougan

Hubbell Trading Post National Historic Site
P.O. Box 150
Ganado, AZ 86505
(928)755-3475
Superintendent: Lyn Carranza

Navajo National Monument
HC 71, Box 3
Tonalea, AZ 86044-9704
(928)672-2700
Superintendent: Alden Miller

Petrified Forest National Park
P.O. Box 2217
Petrified Forest, AZ

(928)524-6228 ext. 225
Superintendent: Brad Traver

Rainbow Bridge National Monument
P.O. Box 1507
Page, AZ 86040-1507
Superintendent: Todd Brindle

Navajo Nation Environmental Protection Agency
http://www.navajonationepa.org
BIA 100
Window Rock, AZ 86515
Administration: (928)871-7692
Air and Toxics Department:
Air Quality Control Program (928) 729-4246
Pesticide Enforcement and Development Program (928) 729-4246
Surface and Groundwater Protection Department:
Water Quality/NPDES Program (928) 871-7690
Public Water System Supervision Program (928) 871-7755

Navajo Nation Historic Preservation Department
http://www.hpd.navajo-nsn.gov/
P.O. Box 4950
Window Rock, AZ 86515
(928)871-7198

Navajo Nation Department of Fish and Wildlife
http://www.nndfw.org/
P.O. Box 1480
(928)871-6450
Botanist – Andrea Hazelton ahazelton@nndfw.org
Zoologist – Chad Smith csmith@nndfw.org
Fish Biologist – Chris Cheek ccheek@nndfw.org
Environmental Reviewer – Pam Kyselka pkyselka@nndfw.org

Navajo Nation Parks and Recreation Department
http://www.navajonationparks.org
P.O. Box 2520
Window Rock, AZ 86515
(928)871-6647
Department Manager: Martin L. Begaye
Parks Program: Murray Lee
Planning/Technical Support: Nathanial Boyd

Navajo Tribal Utility Authority
P.O. Box 170
Fort Defiance, AZ 86504
(800)528-5011

New Mexico Department of Transportation
Nancy Romero, nancy.romero1@state.nm.us
1120 Cerrillos Road
Santa Fe, NM 87504
(505) 827-5161

New Mexico Environment Department

Gallup District Office
905 Metro Avenue
Gallup, NM 87301
(505)722-4160

Farmington District Office
3400 Messina Drive, Suite 5000
Farmington, NM 87402
(505)566-9741

New Mexico State University Cooperative Extension

Cibola County Extension Office
551 Washington Ave.
Grants, NM 87020
(505)287-9266

McKinley County Extension Office
2418 E Hwy 66
PMB 470
Gallup, NM 87301
(505)863-3432

San Juan County Extension office
213-A S. Oliver Drive
Aztec, NM 87410
(505)334-9496

University of Arizona – Cooperative Extension

Shiprock Office
East NM Highway 64
NNAPA Building
Shiprock, NM 87420

(505)368-1028
Assistant Agent: Jeannie Benally jbenally@cals.arizona.edu

Tuba City Office
The Navajo Nation
P.O. Box 126
Tuba City, 86045-0126
(928)401-0925
Extension Program Coordinator: Grey Farrell gfarrell@cals.arizona.edu

Window Rock Office
Window Rock Fairgrounds
Dept. of Agriculture 121D
Window Rock, AZ 86515
(928)871-7686
Coordinating Extension Agent" Gerald Moore gmoore@cals.arizona.edu

U.S. Army Corps of Engineers – Albuquerque District (New Mexico)
http://www.spa.usace.army.mil/
4101 Jefferson Plaza NE
Albuquerque, NM 87109
(505) 342-3171 – Main Office
(505) 342-3355 – Tribal Liaison
Email: cespa-pa@usace.army.mil

U.S. Army Corps of Engineers – Los Angeles District (Arizona)
http://www.spl.usace.army.mil/
925 Wilshire Blvd.
Los Angeles, CA 90017
(213)452-3333 – Main Office
(602)230-6949 – Regulatory Arizona Branch

U.S. Army Corps of Engineers – Sacramento District (Utah)
http://www.spk.usace.army.mil/
1325 J Street – Room 1513
Sacramento, CA 95814
(916)557-5100 – Main Office
(970)243-1199 ext. 15 – Tribal Programs

U.S. Environmental Protection Agency
eNOI website: http://cfpub.epa.gov/npdes/pesticides/enoi.cfm
EPA Tribal Program Portal: http://www.epa.gov/tp/trprograms/env-programs.htm
U.S. EPA Navajo Certified Applicators:
http://www.epa.gov/oppfead1/safety/applicators/2007/navajo.htm

U.S. EPA Region 9 Tribal Consultant – Laura Ebbert
Tribal Program Office (CMD-3)
75 Hawthorne St.
San Francisco, CA 94105
(415) 947-3561

USDA Natural Resource Conservation Service

Chinle Field Office
P.O. Box 490
Chinle, AZ 86503-0490
(928) 647-3612

Crownpoint Field Office
Code Talker/Chaco St.
Bldg 222, Rm 213
Crownpoint, NM 87313-2048
(505) 786-7094

Gallup Field Office
2330 East Hwy 66
Gallup, NM 87301-4769
(505) 722-4357 ext 3

Kayenta Field Office
Highway 163
P.O. Box 429
Kayenta,AZ 86033-0768
(928) 697-8482

Shiprock Field Office
N. Hwy 491
P.O. Box 3393
Shiprock, NM 87420
(505) 368-4260

St. Michaels Field Office
Highway 264
St. Michaels, AZ 86511-0499
(928) 871-4528

U.S. Forest Service

Coconino National Forest
www.fs.usda.gov/coconino
1824 S. Thompson St

Flagstaff, AZ 86001
(928)527-3600
Forest Supervisor: Scott Russell

Kaibab National Forest
http://www.fs.usda.gov/kaibab
800 S 6th St.
Williams, AZ 86046
(928)635-8200
Forest Supervisor: Michael Williams

Utah Department of Environmental Quality
195 North 1950 West
P.O. Box 144810
Salt Lake City, UT 84114-4810
(801) 536-4400

Utah Department of Transportation
Region 4 East
708 S. 100 W.
Richfield, UT 84701
(435) 636-1470

Appendix I. Funding Sources

1. Arizona Water Protection Fund (AWPF)
   3550 North Central Avenue
   Phoenix, AZ 85012
   Phone: (602) 771-8528
   http://www.azwpf.gov/

2. North American Wetlands Conservation Act (NAWCA)
   Division of Bird Habitat Conservation, (703) 358-1784, dbhc@fws.gov
   http://www.fws.gov/birdhabitat/Grants/NAWCA/index.shtm

3. National Fish and Wildlife Federation (NFWF)
   1133 Fifteenth St., N.W., Suite 1100
   Washington, D.C. 20005
   Phone: (202) 857-0166
   http://www.nfwf.org/

4. Natural Resources Conservation Service (NRCS)
   http://www.nrcs.usda.gov/wps/portal/nrcs/main/az/programs/

5. Partners for Fish and Wildlife
   U.S. Fish and Wildlife Service
   2321 W. Royal Palm Rd., Suite 103
   Phoenix, AZ 85021
   (602) 242-0210 (x250)
   Kris_Randall@fws.gov
   http://www.fws.gov/partners/

6. USFWS Tribal Wildlife Grants
   Joe Early- (505) 248-6602
   http://www.fws.gov/southwest/NAL/grants.html

7. EPA Wetland Program Development Grant
   Leana Rosetti, rosette.leana@epa.gov
   (415) 972-3070
   http://www.epa.gov/region9/water/wetlands/grants/

8. American Indian Environmental Office Tribal Portal- U.S. EPA

http://www.epa.gov/tribalportal/grantsandfunding/index.htm

9. USDA Grant Programs
   http://www.doi.gov/NISC/global/ISAC/ISAC_Minutes/2011/Tab2/USDA_Grants_Wkbk_%20FY12%20_FINAL_112211.pdf

10. USDA Rural Development Grants
    http://www.rurdev.usda.gov/RD_Grants.html

11. Arizona Invasive Species Advisory Council
    http://az.gov/invasivespecies/res_grants.html

12. Arizona Heritage Fund
    (623) 236-7530
    http://www.azgfd.gov/w_c/heritage_program.shtml