

4.0 Environmental Consequences

4.1 Introduction

The description of the affected environment and disclosure of effects concentrates on not only the significant issues generated through scoping, but also on the purpose and need of the proposed project. This includes such items as the capacity of the action to control the spread of invasive and noxious weeds, access to vital services, potential health impacts associated with the use of herbicides, potential impacts to industries such as agriculture and mining, and the ability of the Navajo and other Native American groups to collect plants for traditional purposes if the use of herbicides is authorized. In addition, several other key resources are fully analyzed within the scope of this PEIS including threatened, endangered, and sensitive plant and animal species as well as culturally significant plants.

For items within this analysis, the effects assessment consolidates the discussion of the impacts where appropriate, and highlights the relationship between local short-term uses of the environment, and the maintenance as well as enhancement of long-term ecosystem productivity.

Cumulative effects are those that result from the incremental impact of the Proposed Action or the alternatives when added to other past, present, and reasonably foreseeable future actions regardless of who undertakes those activities (40 CFR 1508.7). The cumulative effects analysis is found after the discussion of direct and indirect effects for the major resource groupings in Chapter 5, and if none are predicted, such analysis is documented. Cumulative effects analysis is keyed to the major issues, the purpose and need, and to other resource areas disclosed in this chapter and: (1) must be additive with other activities found within the project impact zone, and (2) the effect of the proposed action and alternatives must overlap in time and space with these other activities. The project impact zone for this analysis is considered to be the land area for the Navajo Nation managed by the Bureau of Indian Affairs- Navajo Regional Office and other federal, state, or county lands adjacent to or within the Navajo Nation. It includes all Navajo Nation Indian Allotments and Trust lands found within Utah, Arizona, and New Mexico.

This chapter should be read together with Chapter 2 (Proposed Action and Alternatives), which explains the methods the BIA will use to treat vegetation and alternatives considered for integrated weed treatment prescriptions, and Chapter 3 (Affected Environment), which describes the important resources and their occurrence and condition on the Navajo Nation. The descriptions of environmental effects in this chapter build upon and relate to information presented in these earlier chapters to identify the types and distribution of resources that could be affected by integrated weed treatment prescriptions and how these effects might occur.

The description of effects assumes that best management practices and mitigation measures would be followed by the BIA to ensure that risks to human health and the environment from different treatment methods are kept to a minimum (see Appendix E).

4.2 Geologic Setting

4.2.1 Geology and Mineral Resources

Bedrock geology and mineral resources are not likely to be impacted by vegetation treatments since treatments rarely impact more than a few feet below the ground's surface and many of the valuable geologic resources found on the Navajo Nation are likely buried dozens to hundreds of feet below the earth's surface. However, extraction operations, such as mining, could pose potential issues when implementing weed management projects. Additionally, surface geology, including eolian and alluvium deposition and migration, may be impacted by weed management activities. Vegetation can influence how surface soils are deposited and stabilized at sites.

Treatments that increase the risk of erosion or do not replace noxious weed populations with native vegetation can have cascading effects on future soil deposition processes and secondary weed infestations. Surface treatments, methods common to all alternatives such as chemical, manual, or cultural treatments will likely have little to no impact at mining sites. As herbicides are applied to plants on the surface, they have little ability to cause much physical disturbance to the soil. Even when utilizing methods that require removal of above-ground portions of the plant before applying herbicide, such as cut stump, much of the below-ground plant material is left intact, reducing dust exposure and the potential for unearthing contaminated mine waste. Manual and biological treatments can be selective in terms of the target species being removed from a site, reducing the potential for erosion. Cultural treatments, such as planting native vegetation or crop cultivation can help stabilize soils, limiting dune migration and allowing alluvial and eolian deposits to establish at sites. Grazing, however, can increase erosion in the short-term as vegetation is removed at a site.

In areas where mining operations have been or were conducted, such as uranium or coal mining, there is the risk that ground-disturbing vegetation treatments pose potential problems, such as the removal of monocultures of large noxious trees such as tamarisk or Russian olive. The U.S. EPA has identified several sites where mine tailings, ponds, and waste were improperly buried when uranium mining operations were abandoned in the 1960s, leaving some of it exposed or near the surface (TerraSpectra Geomatics 2007). Their studies indicate that more unidentified sites may exist across the Navajo Nation. In such areas, ground disturbing activities could pose significant health risks to field crew members applying treatments, by increasing exposure to radioactive or contaminated dust. Unearthing mining waste and contaminated soil can also increase the risk of contamination to nearby wells and water sources during subsequent precipitation and runoff events. Such impacts can pose significant health risks to field crew members implementing treatments and to neighboring communities. This disturbance can also encourage some weed species to spread, encouraging secondary invasions if left untreated or unrestored with native vegetation. Additionally, the Office of Surface Mining and the U.S. EPA have jurisdiction on the overall management, maintenance, and reclamation of sites.

4.2.1.1 Alternative 1 - No Action

The No Action Alternative would not provide management recommendations for the control of annual weed species that could contribute to increased eolian sediment transport on the Navajo Nation, such as Russian thistle. The No Action alternative also does not provide for the restoration of native vegetation at treated sites. Strategic control of Russian thistle would not be developed, likely contributing to its continued spread, further decreasing landscape stability through increased dune migration and windblown sands (Draut et al. 2012). A lack of control through BIA-sponsored projects would allow weeds to continue to spread, increasing the migration and creation of sand dunes on the Navajo Nation. Sand dune migration and creation can impact local communities through the increase in blowing sand, which could impact public health and damage property. Some communities may experience issues with accessibility as roads are covered in sand and debris. The increase in eolian sediments would also negatively impact the productivity of nearby rangelands and agricultural areas.

Mineral extraction activities on the Navajo Nation currently only assist with limited weed management projects. Oil, gas, coal, and mineral extraction operations typically leave the main mining/extraction areas devoid of vegetation, which can provide ideal conditions for many disturbance-prone weeds to grow. Currently, the Peabody Western Coal Company does assist with weed management projects in the Moenkopi Cooperative Weed Management Area. Other companies may also address weed problems in adjacent areas on BIA managed lands as part of their lease agreements with the BIA. However, comprehensive and collaborative efforts on Indian lands do not currently take place outside of those listed above. Without a cooperative and integrated approach, many noxious weed species are likely to continue to spread and impact ecological, economic, and cultural resources on the Navajo Nation. If weeds are allowed to spread on to mining or natural oil and gas extraction areas, there would be limited opportunities for weed management activities to be addressed.

The No Action Alternation would likely have little to no impact on below-ground geologic or mineral resources. However, no provisions would be in place to avoid weed treatments in areas potentially contaminated by mining waste. This could increase the risk of exposure to radioactive waste or contaminated soils, which could impact field workers and neighboring communities.

4.2.1.2 Alternative 2 - Proposed Action

In terms of surface geology resources, the Proposed Action would include the control of several annual weed species, such as Russian thistle, which have contributed to decreased sediment stability on the Navajo Nation. Further, the Proposed Action would allow for the restoration of native plants, including perennial grasses, which are preferred for soil stabilization. Long-term success with native plant restoration and noxious species management could help reduce or stabilize existing sediment transport issues by providing a competitive advantage for native perennial grasses. Effects will likely be minor as other environmental factors, such as reduced

precipitation, hotter temperatures, and overgrazing can also contribute to dune migration and increased sediment transport.

The Proposed Action weed treatments would be excluded from mining areas and from abandoned uranium mining regions. Thus, this action would result in no impacts to mining or geologic resources. Mine sites in active operation are typically devoid of vegetation and highly disturbed. This makes them places where several species of noxious weeds can establish. However, mines are required to maintain natural resources at their sites in compliance with the Office of Surface Mining and Reclamation Enforcement and the U.S. EPA. These agencies often require that top soil be preserved from sites for reclamation and that native seed mixes be used to stabilize soils on site. Indirectly, weed management projects in areas near mining sites could help reduce the potential for noxious weed species to spread to mining sites. Restoration of native vegetation could also further encourage the spread and establishment of native plants and grasses to mine sites once areas are reclaimed.

4.2.1.3 Alternative 3 - No Biological Control

The No Biological Control Alternative would likely result in the same impacts as the Proposed Action as biocontrols will have little to no impact on issues related to management of geologic resources or mining operations.

4.3 Paleontological Resources

There is potential for negative impacts to paleontological resources (i.e., fossils) as a result of several invasive and noxious weeds treatments. Treatments involving the most ground disturbance are likely to present the greatest threat because paleontological resources could be exposed and adversely affected as a result of project implementation. Vehicular off-road travel also has potential to damage some paleontological resources, as well as chemical treatment if chemicals are directly applied to the resources. Furthermore, erosion caused by the removal of vegetation or vegetation treatment activities can impact previously buried paleontological resources through exposure to the aboveground environment. The potential effects of weed treatments proposed for each Alternative Action are evaluated below.

If, through the course of pre-treatment fieldwork (e.g., during in-field identification of treatment areas, cultural resource inventories), paleontological resources are identified within the project area, the type of resource and its location shall be recorded. This information will be incorporated into the planning process and the resource avoided during treatment activities. If a resource cannot be avoided, or previously unidentified paleontological materials are encountered during the course of a noxious weed control activity, then the Navajo Nation Minerals Department (NNMD) will be contacted and consulted. All identified paleontological resources will be evaluated, and an assessment of effect and a decision on resource management shall be completed in consultation with NNMD on a case-by-case basis.

In the interim prior to consultation with NNMD, any activities that would result in the removal or movement of an imbedded fossil or damage to any paleontological resource will cease. Paleontological resources shall be protected using the avoidance measures outlined in the Section 106 Programmatic Agreement associated with implementation of the NNIWMP. The resources will be avoided and protected until such time as a course of action is agreed upon and approved by both NNMD and BIA.

4.3.1 Alternative 1: No Action

The No Action Alternative has the potential to cause the increase of undesirable non-native vegetation. However, noxious/invasive weeds generally pose no more significant threat to paleontological resources than do native plants. Rather, certain types of vegetation, both non-native and native, have potential to cause detrimental effects to the fossil resources. For example, trees, woody shrubs, and other types of plants with large and/or deep-growing roots can damage fossils by growing through and around them causing them to break and splinter. Several invasive woody species (e.g., tamarisk) have been targeted by the Noxious Weed Program through ad hoc weed management projects. Consequently, the result of the No Action Alternative would likely mean fewer invasive woody plants would be removed and controlled. The proliferation of these plants increases the possibility of paleontological resources being damaged by tree root growth.

In addition, the limited weed treatments under the No Action Alternative would increase the risk of wildfire from fire-prone invasive species such as red brome, cheatgrass, and tamarisk. Wildfires, which tend to be hotter and more intense than prescribed burns (Winthrop 2012), have potential to cause spalling, oxidation, and other heat-related damage to exposed fossils.

4.3.2 Alternative 2: Proposed Action

All the weed treatments considered under the NNIWMP are available for use under Alternative 2. These consist of Manual, Mechanical, Cultural, Biological, and Chemical controls. All Manual Control methods, except for hand-cutting plants above ground level, cause some level of subsurface disturbance and thus have potential to adversely impact paleontological resources. However, unless the manual treatment is performed directly on the resources or in fossil-bearing strata with observed fossils present, the likelihood of manual control treatments damaging paleontological resources is remote.

Mechanical Control treatment methods such as grubbing, tillage, and use of heavy machinery have high ground-disturbing impacts (e.g., compaction, erosion, sediment and soil mixing) and can damage paleontological resources whether they are shallowly buried or exposed on the surface. Treatment methods like mowing, though considered to have low to moderate levels of ground disturbance, can also cause damage to fossils if they are driven or mowed over. As with cultural resources, the effects of fire to paleontological resources depend on several factors, but the most likely damage would be if an unprotected fossil were exposed to the heat generated from a fire. This has the possibility of causing the fossil to spall and crack.

Some Cultural Control weed treatments, such as livestock grazing and active native vegetation reseeding or replanting, can result in a high degree of ground disturbance and have potential to damage or destroy paleontological resources. For example, livestock can have detrimental effects due to trampling and defecation. Broadcast reseeding by hand or by mechanical sprayer mounted on a vehicle with rubber tires is likely to have little or no significant impact on most paleontological resources unless a fossil is driven upon directly. However, reseeding/replanting methods resulting in ground disturbances (i.e., injecting or tilling seeds into the soil and utilizing plant cuttings, deep potted plants, containerized plants, and bundled native-vegetation “poles” requiring deep augured holes) or use of tracked vehicles can cause undesirable effects to fossil resources. Similarly, some erosion control techniques, such as installing erosion blankets, brush layering, and brush revetment, can possibly damage fossils. Comparatively, others (e.g., mulching) pose little or no threat to paleontological resources.

Proposed Biological Control methods consist of utilizing USDA-approved insects and pathogens tested for their effectiveness in controlling the target plants. Other than indirect effects, such as increased erosion resulting from de-vegetation, the proposed biological control methods have almost no likelihood of significantly affecting paleontological resources.

Chemical Control methods involve using herbicides to control unwanted non-native plant species, and there are various potential effects from using this treatment. Some herbicides and application solutions contain salts which can cause spalling in sandstone. Dyes and other ingredients in herbicides can stain or change the color of materials on which they land. However, there are several herbicide application methods that can be utilized to minimize the possibility of chemicals being deposited on fossils. Methods such as cut stump, basal bark, and frill or “hack and squirt” target individual plants one at a time; these methods seem to be the least likely to cause chemical contamination issues. However, in addition to the negative effects of chemicals being accidentally applied directly to fossils, some application methods also have potential to damage paleontological resources. For example, using wheeled equipment for spraying or driving off road to reach application sites has the potential to damage exposed or shallowly buried fossils if they are driven over. For these reasons, the particular chemical application methods being considered for any given treatment area should be fully assessed for possible negative impacts prior to implementation.

4.3.3 Alternative 3: No Biological Control

Noxious/invasive weed treatments under Alternative 3 are the same as those under the Proposed Action (Alternative 2), with the exception that no biological control techniques would be utilized. The potential effects of each proposed weed control treatment under Alternative 3 were evaluated under Alternative 2. Because there is no change in the estimated treatment acreage for any of the treatment methods (other than the absence of 500 acres for biological control methods), the potential for negative effects associated with the non-biological control treatments does not change under Alternative 3.

4.4 Soil, Air, and Water Resources

4.4.1 Soil Resources

Different treatment techniques will have different effects on soil resources. Large scale treatments can have the effect of removing top soil and organic layers from sites. The loss of top soil can hinder or prevent the establishment and native recruitment of native vegetation and can encourage further establishment of noxious species at disturbed and altered sites. Compaction of soils through the use of heavy equipment or vehicles at a site can impact the porosity of soil, damage biological crusts, or alter soil microorganisms. These impacts can affect factors such as nutrient cycling, native plant establishment, and water transport at sites. Erosion is another concern with vegetation treatments as the removal of vegetation can loosen soils, increasing the risk of top soil loss and sedimentation. The loss of vegetation can also reduce the water holding capacity of the soils, which could impact plant establishment and alter nutrient cycling and availability. Treatments, such as chemical herbicides, may also alter soils by adding residues to soils. As some chemical herbicides can have negative impacts on the health of humans and wildlife, accumulation of residues can increase the risks of harmful exposure and can alter water quality of surface and groundwater. Some chemical herbicides are also known to alter soil microorganisms such as fungi or bacteria, which are important for decomposition and nutrient cycling.

Some exotic plants contribute toxic chemicals to soils. Tamarisk adds high levels of salt to the soil. Some noxious plants in the mustard family can alter soil chemistry and kill beneficial soil fungi that are needed for certain tree species. Many noxious plants add allelopathic chemicals to the soil, which can inhibit the growth of native species. Tree of Heaven, diffuse knapweed, Russian knapweed, kochia, yellow nutsedge, and spotted knapweed are all known to release allelopathic chemicals into soils, allowing them to outcompete native vegetation in invaded areas. The replacement of native species with noxious weeds, alters soil structure, moisture, and organic matter.

Additionally, the life cycle of some noxious species, such as cheatgrass and kochia, provide a competitive advantage. Cheatgrass germinates twice a year in the fall and spring, allowing it to grow actively in the early spring when most native plants are just initiating growth. This early growth allows it to outcompete other plants for water and nutrients, leading to a cycle where cheatgrass dominates the system, reducing the reproduction and growth of other plants in a system (Pellant 1996). When areas become dominated by cheatgrass, they are less able to efficiently utilize all resources available in the area, such as sunlight, nutrients, and water. In many native plant communities, plant assemblages allow for more efficient use of resources throughout the growing season (Pellant 1996)

When looking at specific treatment methods, those common to all alternatives include manual, mechanical, cultural, and chemical methods. Each alternative differs in the implementation of treatments in terms of coordination and coverage. Manual treatment methods are highly

selective to the target species. Scheduled work in areas such as riparian zones can reduce impacts to soil resources by treating small areas, resulting in low levels of ground disturbance. This would reduce the impacts of erosion or sediment loss at the site and still maintain the water holding capacity of soils in treatment sites. Manual treatments are often employed to help avoid removal of native plants at treatment sites, retaining soil stability and water holding capacity in treated sites.

Mechanical treatment methods are not selective to the target species. Most mechanical treatments would remove vegetation from large treatment areas, such as tilling in farmlands or grubbing of monotypic stands of tamarisk. There would be localized vegetation removal/reduction and soil disturbance. Mowing of vegetation along right-of-ways would have minimal impacts on soil resources, as the vegetation would retain below ground root systems and a portion of the above ground plant, minimizing soil disturbance and keeping soils stable at the treatment site. Prescribed burning may have a short-term impact on vegetative cover. There is slight chance that treatments could increase sediment transport of both soils and burn residues either through eolian or alluvial transport; however, sites should be seeded and restored immediately after completion of repeated treatments if native plant cover is less than 50%. Overall, mechanical treatments that involve uprooting or digging up vegetation, such as grubbing or tilling can contribute the most to top soil loss and soil compaction.

Vegetation treatments that remove large areas of vegetation would potentially result in increased rates of erosion and larger areas of exposed soils, leading to reduced soil productivity. The degree of these effects would vary depending on differences in landform, hydrology, vegetation, and native plant restoration efforts. Erosion results when unstable soils are displaced under the forces of gravity, wind, or water. Although erosion is a natural process, it can increase markedly when vegetation is cleared (BPA 2000). Unnaturally high erosion rates could occur as a result of soil disturbance during vegetation treatments or from the resultant vegetation removal and associated decrease in soil stability. Vegetative cover and organic layers covering the soil dissipate the energy of raindrops and help to reduce runoff. Plant roots also strengthen and bind soil together. Reductions in plant biomass can have varying effects on erosion potential depending on existing cover, soil type, and water availability. The effects of loss of plant cover and organic material may be most pronounced on steep slopes.

The risks of increased erosion on the Navajo Nation would depend on the type of treatment and the local site conditions. High risks would be associated with effects such as amount of soil exposed to rain and wind energy, loss of soil structure, removal of surface organic matter, and clogging of soil pores. Increased erosion would potentially result in increased dust and sedimentation, and reduced soil quality. Reestablishing native vegetation on the site and maintaining organic matter at the soil surface (e.g. plant litter, mulch) would buffer effects and would potentially limit erosion rates. BMPs would be implemented and would minimize soil erosion and runoff from treatment areas.

Herbicides range in their selectivity of target species based on their chemical composition and application method and may affect non-target species if applied directly. Indirectly, use may result in landscape level changes in habitat composition, cover, abundance of insects, or other habitat changes. In terms of soil resources, herbicides have varying effects on soils based on their persistence and mobility to soils and their impacts to soil microorganisms. The most important factors in determining the chemical fate of herbicides in soil are mobility, persistence, and degradation. The extent to which these factors influence herbicides in soil are dependent on a variety of herbicide characteristics, such as adsorption to soil particles, solubility, chemical half-life, degradation, and volatilization. Characteristics that can influence the fate of herbicides within a given area include organic matter content, pH, temperature, moisture content, soil texture and composition, climate, and microbial activity. Most herbicides degrade over time as a result of physical and chemical processes in soil and water. Herbicide degradation rates generally decreases with increasing soil depth, as agents of degradation (light, water, and microorganisms) become less available. Persistence and mobility of herbicides in soils may also be impacted by the formulation or form of the active ingredient. The overall impacts of herbicides on soil resources will largely depend on those selected for a given project, the application rate, and occurrence of retreatment.

4.4.1.1 Alternative 1 - No Action

Under the No Action Alternative, noxious weeds would continue to be treated with the existing ad hoc, project-based management efforts, resulting in an expansion of weed infestations on the Navajo Nation. This would allow noxious weed species to continue to displace native vegetation. In areas where perennial natives are replaced with annual exotics (i.e. rangelands), the shorter-lived plant communities would reduce their effectiveness at stabilizing sandy or loose soils, increasing the risk of top soil loss, altering soil microbial communities, and reducing of water holding capacity of soils (Draut et al. 2012). Native grass communities can also be displaced by tap-rooted weeds, such as knapweeds and thistle, which can increase the potential for erosion and water loss in invaded areas. These factors could result in a loss of soil productivity and biodiversity.

Noxious exotic annual grasses would not be treated under the No Action Alternative. The grasses listed in the target species lists are found in varying concentrations in watersheds, pinyon-juniper woodlands, lower elevation grasslands, shrublands, and riparian vegetation types. The current extent of these populations is unknown as grass species have not been included as part of previous noxious weed efforts by the BIA NRO and its agencies. Most likely they will impact rangeland habitats and disturbed areas near construction sites and farmlands. For some species, such as cheatgrass, such expansion would increase the risk of fire hazards in these priority areas. While cheatgrass is generally confined to grassland and shrubland-grassland habitats, it has been known to occur in dense populations in some woodland areas.

The No Action Alternative would allow for the continued spread of exotic annual grasses, which could increase fire risk in Community Development Areas, forests and woodlands, and

grasslands. This would also cause a loss of native perennial plants, which would be replaced with even more exotic annuals that could increase fire frequency. Over the long-term, such changes could also reduce native bunch grass populations, reducing the quality of some habitats for wildlife species, such as pronghorn, and rangeland quality for livestock. This could lead to declines in effective ground cover on infested sites; increasing erosion rates and a reduction in the productivity of soils. Many sites may also convert from shrubland/grassland ecosystems to annual grass ecosystems, resulting in a general decline in ecological conditions.

Chemical treatments for weed species would continue under the existing ad hoc, project-based management efforts, resulting in fewer acres treated and a less concerted effort at herbicide use. Such treatments could result in an accumulation of herbicide residues in soils, increasing the risk of water contamination through runoff or leaching. This would be an increased concern for projects that use herbicides known to be long-lived and mobile within soils such as picloram, thifensulfuron methyl, and proflam. Also selection of herbicides may not consider counteractive effects that can occur when using two different herbicides in the same location. For example, fluazifop-p-butyl can be rendered ineffective when applied with auxin-mimicking herbicides such as 2,4-D (Tu et al. 2001). Such antagonistic effects would not be readily considered under the No Action Alternative.

4.4.1.2 Alternative 2 - Proposed Action

Under the Proposed Action, noxious weed treatments would be done through an integrated approach, combining different methods to allow for the best control methods for the target weed species identified at the project area. These treatments would be implemented mostly in priority weed treatment areas including riparian areas, roads, right-of-ways, Community Development Areas, designated rangelands, and designated farmlands. These areas have been identified as land cover types where weed infestations are causing significant problems for communities, land managers, federal agencies, and important economic and cultural resources utilized by the Navajo people. As such, beneficial and adverse impacts to soil resources would be most pronounced in these areas. The Proposed Action also outlines methods that can be implemented to reduce erosion, such as cultural treatments where native vegetation is planted or seeded in treatment areas or bankline protection measures to reduce erosion in nearby waterways.

Chemical treatments under the Proposed Action would have a variety of impacts on soil resources depending on which herbicides are selected for treating the target weed species found within the project area. General mobility and persistence characteristics of the 22 herbicides included in the Proposed Action are summarized in **Table 4-1**. Some of the herbicides covered under Alternative 2 can come in different forms, which can have varying effects on soil mobility and persistence. For example, triclopyr butoxyethyl ester has lower mobility and solubility in soils, while the form triclopyr triethylamine salt has very high solubility and a high potential to move through soil profiles. Selection of herbicides should take such characteristics into account when applying herbicides in areas where the groundwater table may be shallow, near wells, or near waterways.

Table 4-1. Herbicide characteristics in soil including potential for movement. Soil adsorption indicates ability of active ingredient to bind to soil particles. Half-life indicates the persistence of the active ingredient in the environment.

Herbicide	Water Solubility (ppm)	Adsorption	Half-Life	Degradation Mechanism	Groundwater Contamination	Surface Water Contamination
2,4-D	31 to 34,000 (increases with pH)	Moderate	10 to 50 days	Photolysis, Microbial	High based on heavy agricultural and urban use	High based on heavier agricultural and urban use
Aminopyralid	250,000	Weak	5 to 343 days	Photolysis, Microbial	High during high rainfall, moderate in other instances	Moderate due to mobility and photodegradation.
Atrazine	33	Moderate	14 to 533 days	Microbial	High due to higher mobility in sandy, loamier soils and high persistence	Moderate due to high persistence but higher adsorption to fine sediments
Chlorsulfuron	300 to 31,800	Weak	14 to 320 days	Hydrolysis, Microbial	Low due to reduced mobility arid environments and hydrolysis	Low due to hydrolytic degradation and
Clopyralid	1,000 to 300,000	Very Weak	2 to 14 months	Microbial	High especially in shallow aquifers and sandy soils	Moderate due to higher volatility in arid climates.
Dichlobenil	21.2	Strong	16 to 241 days	Microbial	Low due to high soil adsorption, but degradates can have higher potential	Low due to high soil adsorption and volatility.
Fluroxypyr	200 to 8000 (lower for MHE)	Strong	2 to 168 days	Microbial	Low due to high soil adsorption	Low due to high soil adsorption and moderate volatility
Fluazifop-p-butyl	1.1 to 2	Strong	15 days	Hydrolysis, Microbial	Low due to high soil adsorption	Low due to low solubility and hydrolysis
Glyphosate	10,000 to 900,000 (higher for IPA salt)	Strong	2 to 197 days	Microbial, Adsorption	Low due to high soil adsorption, but high use can	Low due to high soil adsorption but high use can increase

Herbicide	Water Solubility (ppm)	Adsorption	Half-Life	Degradation Mechanism	Groundwater Contamination	Surface Water Contamination
					increase risks	risks
Imazapic	2,150 to 36,000	Weak to Moderate	106 days to several years	Photolysis, Microbial	Low to moderate with adsorption decreasing with higher pH	Low due to high photodegradation in surface water
Imazapyr	9,740 to 6,500,000 (higher for IPA salt)	Weak	12 to 180 days	Microbial, Photolysis	Moderate with higher persistence in drier climates	Low due to high photodegradation
Isoxaben	1	Moderate	30 days to 1 year	Photolysis	Low but higher in sandier soils and shallow groundwater depths	Low due to photodegradation and low solubility
Metsulfuron methyl	109 to 9,500	Weak	14 to 180 days	Microbial	Low due to low application rate	Moderate. Has high mobility and moderate persistence but can breakdown with UV light
Metribuzin	1,220	Weak	40 to 128 days	Photolysis, Microbial	High due to high mobility and resistance to hydrolysis	Low due to high degradation from photolysis
Paraquat	620,000	Strong	Several years	Adsorption	Low due to high soil adsorption	Variable, but higher in water with high sedimentation
Picloram	430 to 430,000 (higher for K salt)	Weak	3.5 days to 32 years	Microbial, Photolysis	High due to high persistence, solubility and low soil adsorption	Moderate due to photodegradation. Lower for clear, moving water

Herbicide	Water Solubility (ppm)	Adsorption	Half-Life	Degradation Mechanism	Groundwater Contamination	Surface Water Contamination
Thifensulfuron methyl	2,400	Weak	12 to 45 days	Photolysis, Microbial,	Moderate due to high mobility but limited persistence. Degradate has higher potential for contamination	Moderate due to photodegradation and limited persistence.
Triclopyr	7.4 to 2,100,000 (higher for TEA salt)	Strong (esters and amines) Weak (salt)	2 hours to 314 days	Photolysis, Microbial, Hydrolysis	Variable. Acids and sandy soils have higher mobility, but degradation limits persistence	Low due to photodegradation, hydrolysis, and high volatilization. Esters persistence for longer
Pendimethalin	0.275	Strong	90 days	Photolysis, Microbial, Adsorption	Low due to high soil adsorption	Low due to high soil adsorption, but potentially higher with spray drift and irrigation runoff
Prodiamine	0.013	Moderate	19 to 120 days	Photolysis	Low due to low solubility and moderate soil adsorption	Low due to photodegradation and moderate soil adsorption

Source: BPA 2000a-2000m; Tu et al. 2001; SERA 2001, 2004-2004b, 2005, 2006, 2007, 2009, 2011-2011d; EPA 1992, 1993a, 1992a, 1997, 1997a, 1998, 1998a, 1999, 2003, 2007; Vogue et al. 1994; BLM 2016

The information presented in **Table 4-1** shows that most herbicides approved for use under Alternative 2 are highly soluble in water (i.e., greater than 1,000 parts per million (ppm)). High solubility could lead to larger concentrations of herbicides being transported to water sources.

The ability of soils to contaminate ground or surface water resources is a factor of soil adsorption or binding, solubility, mechanism of degradation, and persistence (or half-life). Herbicides that can adhere strongly to soil particles, are less likely to move easily through the soil profile or stay present in water. Additionally, herbicides with shorter soil half-lives have a reduced likelihood that they will leach into groundwater aquifers over time. Some herbicides – 2,4-D, clopyralid, metribuzin, picloram, and atrazine - have a high potential to impact groundwater where soil is permeable, and water is shallow. These herbicides all have low soil adsorption, with 2,4-D having an increased mobility in sandier soils with low organic content, like the arid soils found in the Navajo Nation. For many, the risks for leaching into ground water may increase with changes in soil moistures, temperature, and organic matter content. For example, dichlobenil has higher mobility in soils with low soil moisture and organic matter when temperatures are low. Some herbicides have active ingredients that have a lower risk for groundwater contamination, but their degradates may have higher mobility in soils. Thifensulfuron methyl, for instance, has limited persistence in soil, limiting its ability to contaminate groundwater. Its degradate, triazine amine, however is highly mobile and persistent, increasing the potential for groundwater contamination.

Persistence in the soil also widely varies and is dependent on soil conditions and method of degradation. The half-life of herbicides is largely a factor of how light, water, and microbes contribute to the breakdown of the chemical. Most herbicides examined have a half-life of less than 3 months. However, aminopyralid, imazapic, paraquat, and picloram have half-lives that can last for a year or more, increasing the risk of transport to water sources either through percolation or during run-off events. For chemicals such as picloram, which is known to impact human health and wildlife, their persistence is due to their limited breakdown by soil microorganisms.

Studies on the potential impacts on soil organisms show that some herbicides can cause a temporary shift in soil microbial populations by reducing biodiversity and relative biomass of individual species (USFS 1996). There is the potential for inhibiting growth of some microbial species, which could impact nutrient cycling and decomposition rates in some areas if chemicals are chronically present. Studies have indicated that glyphosate could inhibit the metabolism and growth of some soil microbes after initial applications, such as soil algae and cyanobacteria. Additionally, picloram has been shown to be toxic to soil microorganisms, which is likely due to its high persistence in soils. Overall, these effects are not expected to persist because the negative effects are temporary and populations generally recover after a few days or weeks as the herbicides degrade and dissipate at the site (SERA 2011, 2011c).

Cultural treatments included under the Proposed Action are generally selective to the target species. Grazing in Community Development Areas to reduce weed covers could result in localized vegetation removal. Goats and other grazing animals can cause soil disturbance with their grazing, but it is of short duration and grazed areas will be allowed to recover following treatments. Livestock grazing deferment areas will allow native vegetation to re-established while the target weed species should be weakened by the grazing treatment. Other methods included in this integrated weed management technique (seeding with native plant species and the use of weed-free hay and materials) will generally result in high native vegetative cover, creating beneficial impacts to soil resources. The use of perennial native vegetation to replace noxious species and restore impacted sites could reduce the risks of eolian and alluvial transport, increase water holding capacity, and increase soil organic content in some treatment sites such as rangelands and riparian areas.

Biological treatments proposed under Alternative 2 will use only approved insects and pathogens, which are selective to the target species and result in subtle changes to the cover and density of the target species, and thus to the environmental condition. Many of the agents proposed for use will result in localized impacts to target vegetation. Biological agent work by weakening the host plant either through damage to plant parts. Some work by destroying the reproductive parts of the plants, while others damage leaves, shoots, and roots of the plants, weakening their ability to reproduce both vegetatively and through seed dispersal. The use of biological treatments will likely have minimal impacts to soil resources as most damage is done to specific parts of the target species and isolated to the season when the agents are most active (spring and/or summer).

4.4.1.3 Alternative 3 - No Biological Control

Under Alternative 3, fewer acres of weeds would be treated as the use of biological control agents would not be permitted. This could increase the potential for weeds, such as knapweeds and thistles, to spread in certain areas. The anticipated spread of knapweeds and other proposed target weed species would still contribute to increase soil erosion, allelopathic chemicals, and disturbance. While Alternative 3 would include requirements for maintenance of treatment sites to include re-treatment, a lack of passive control techniques may increase the overall costs for projects as well in terms of time, staff, and travel.

4.4.2 Water Resources

Weeds and weed treatments can have varying impacts on hydrology and water quality within the Navajo Nation. In terms of hydrology, vegetative cover on sites influences factors such evapotranspiration (ET) rates, precipitation interception, groundwater infiltration, and surface run-off. Dense stands of noxious species with deep tap roots or rhizomatous root systems, such as tamarisk or camelthorn, can often access groundwater stores at much greater depths than many native plant species, providing a competitive advantage in drought-stricken areas. If such weed species replace more multi-layered plant communities, it could reduce soil stability and

contribute to sedimentation, top soil loss, bank line erosion, and channelization in riparian areas. If dense populations of weeds are removed, an area may experience a shift in hydrological conditions either through increased ET rates, reduced precipitation interception, lowered groundwater interception, and increased surface run-off. In areas where infestations are sparse, or where native vegetation is still present, such changes are less dramatic and removal would result in insignificant changes to hydrologic conditions at treatment sites.

Water quality of the Navajo Nation may also be impacted by weed treatments based on the size of the treatment area, the methods used, and the efforts to restore native plants to treated sites. Major concerns associated with vegetation treatments include increased sediment and turbidity in watershed from erosion and contamination of water from pesticides. Water can become contaminated from pesticides either through accidental localized spills near open water, from overspray or drift of herbicides from treatment areas, through heavy use of herbicides beyond label instructions, and from the use of non-aquatic herbicides in or near aquatic areas. Herbicides used to control weeds are subject to public scrutiny because of potential impacts on humans and the environment. Negative effects from the use of herbicides are possible in the aquatic environment. Pesticides can enter water ways through direct applications, surface runoff, or leaching into groundwater aquifers (see Soil Resources section for runoff and leaching potential). When in the water system, herbicides can create cascading effects which can impact vegetative, animal, and human health.

Water quality standards for surface water and public drinking water have been developed by NNEPA, which include standards for some pesticides. Surface water standards are used to assess if watersheds are impaired, affecting human health, wildlife, and the environment. Drinking water standards, which are typically lower concentrations, use what are called maximum contaminant levels (MCLs) for many water contaminants, including synthetic organic contaminants such as herbicides. There are a number of pesticides monitored for both water quality standards. For the purposes of weed control, 2,4-D, atrazine, diquat, glyphosate, and picloram are commonly used herbicides with surface and/or public drinking water standards associated with them (**Table 4-2**)

Table 4-2. Water Quality standards for herbicides as defined by the Navajo Nation Environmental Protection Agency.

Active Ingredient	Surface Water Standard (mg/L)*	Drinking Water MCL (mg/L)
2,4-D	9.33	0.07
Atrazine	32.667	0.003
Diquat	2.053	0.02
Glyphosate	93.333	0.7
Picloram	-	0.5

*Surface water standards are based on Primary and Secondary Human Contact standards as outlined in the NNEPA Surface Water Quality Standards 2013.

Vegetation treatments in and around watersheds can exacerbate water quality issues and contribute to watershed impairments by increasing temperature, salinity, toxic organics, and turbidity. While most watersheds around Navajo Nation have not been impaired due to pesticide contamination, impairments from *E. coli*, selenium, sedimentation, and turbidity have been found in rivers along the border such as the Paria River, the Rio Puerco, the San Juan River, and the La Plata River (See Chapter 3). Pesticides, however, are a real concern for water quality standards, as they have been detected in near NAPI/NIIP agricultural areas during surface water testing on the Navajo Nation (Eric Rich, personal communication 2014). Erosion in existing watershed should be assessed and stabilization of these areas should be made prior to treatments (see Appendix D).

Additionally, some herbicides can impact important groundwater wells that provide drinking water to households on the Navajo Nation. Herbicides that raise the most concern are those that can endure for a long period of time in the environment and have a limited ability to breakdown in soils and water or adhere to soil particles. Such herbicides have a greater potential for moving from treatment sites to surface waters, or even to groundwater sources. Thus, an analysis of the environmental fate of herbicides is important for determining the risks associated with their proposed use.

4.4.2.1 *Alternative 1 - No Action*

The No Action Alternative would not provide a strategic approach toward removing and controlling weed populations on the Navajo Navajo, allowing several species to continue to spread, especially along riparian corridors and near open water sources. Riparian weeds, such as perennial pepperweed, Ravenna grass, and leafy spurge would not be treated under the No Action Alternative and would be allowed to spread, especially to areas downstream of the original infestation. These infestations can impact water quality, bankline erosion, and water temperatures.

In terms of negative impacts, weeds in riparian corridors can reducing streambank stability, increasing turbidity, and altering stream temperatures and other chemical and physical properties of water. Noxious weeds tend to form monocultures, replacing more diverse native plant assemblages. Such shifts alter sedimentation along riparian corridors and open water sources, which impact nutrient inputs and flooding regimes. For example, dense stands of tamarisk are effective at trapping large amounts of sediment along riparian corridors, interfering with impact nutrient inputs, preventing flood waters from reaching the floodplain where energy can dissipate, and eventually disconnecting rivers from their floodplains (Shafroth et al. 2005). Such disconnections have a positive feedback effect, resulting in floods that can further excise banklines and making river channels more flashy and unstable.

In terms of positive impacts, some noxious grasses can also reduce runoff to watersheds by establishing ground cover early in the season and using early seasonal moisture. However, such ground cover is often short lived as many of these annual grasses die off later in the growing

season, allowing for more surface runoff, erosion, and sedimentation. Additionally, their establishment can interfere with the regeneration of cottonwoods and willows (two desirable native species that stabilize stream corridors).

The continued spread of some noxious weeds would contribute to indirect effects as well. For example, cheatgrass can have negative and positive impacts on water resources even if populations are a considerable distance from waterbodies. Fire frequency and size may increase in cheatgrass infested areas. Fire-related impacts on water bodies from burned areas would be amplified, including a higher risk of erosion and sedimentation, increased turbidity, and the probability for large-scale nutrient loading.

Since weed treatments, especially those using chemical methods, would necessarily not be coordinated with other land users or adjacent land managers, overuse of herbicides in some areas could result in increased runoff of herbicides into surface and ground water supplies. Fear of non-native plants can prompt non-judicial use of pesticide and herbicides by individual land users, resulting in over application and potentially increasing the amount of chemicals entering water bodies through runoff. This is largely a concern for the use of many herbicides that are available for use over the counter to local land users, such as glyphosate. Additionally, buffers around surface waters and wells would not be required, which could lead to the application of non-aquatic herbicides or those with high mobility in areas where they have a greater likelihood of entering these important water sources. Areas with large weed populations located near the boundaries of the Navajo Nation or that form along borders with lands managed by other federal or tribal agencies would also not be managed in a coherent fashion. Such scenarios increase the amount of herbicide applied in an area, increasing the amount that can runoff and potentially affect water quality in nearby surface waters.

Chemical treatments may reduce water quality and impact human health. The effects of herbicides into surface water would depend on herbicide properties (**Table 4-1**), application method, environmental factors and application rate. These factors all affect how herbicide is transported from application areas to surface and ground water sources. Additionally, there can be synergistic effects between different herbicides that may render them more harmful or ineffective. Applications of some herbicides, which do not have approved aquatic formulations, in areas adjacent to surface waters also increases the risks for water contamination, especially in cases where herbicides are applied aerially, increasing the risks of drift.

There could be indirect effects of herbicide applications with increased nutrient loads to surface and ground water, leading to algal blooms and eutrophication of the water body. Pesticides with high solubility and persistence in the environment are more likely to contribute to negative effects. For example, some of the non-aquatic formulations of 2,4-D, which can be heavily used in agricultural operations, have high solubility and low soil adsorption which can increase their presence in the environment.

Mechanical methods employed under this Alternative also have the potential to negatively impact water quality on the Navajo Nation. In riparian areas, the removal of vegetation near the bankline would result in increased erosion, which can lead to increased sedimentation and turbidity in surface waters. Without an integrated and coordinated weed treatment plan, widespread weed infestations, especially those along riparian corridors are likely to increase channelization of waterways, potentially migrating important streams and water sources away from their current locations. Such migration could affect surface run-off and important exchanges between groundwater and surface water resources. Channelization will likely compound issues related to large flow events, where dense stands of trees can be uprooted, resulting in property and infrastructure damage.

Biological treatments are not likely to impact water quality as impacted areas often leave the target plants intact. Plants are killed slowly and remain in place with little likelihood of runoff or sedimentation.

4.4.2.2 Alternative 2 - Proposed Action

The proposed action may impact the hydrology of the Navajo Nation by altering the overall water balance in large treatment sites and altering water use. Short term impacts from clearing large stands of noxious species would result in an increase in exposed bare ground, which could temporarily increase evaporation from treated sites, reduce precipitation interception from vegetative cover, and increase surface run-off. These impacts would taper off as sites become revegetated, resulting in short-term changes to water balance at sites.

The impacts of evapotranspiration (ET) rates from the removal of large woody noxious weeds, such as tamarisk or Russian olive, may be mixed if sites are restored with native species. Studies comparing evapotranspiration rates of large woody noxious with native vegetation show different results, some indicating higher ET water losses with restoration of native vegetation and some indicating lower ET rates overall (Nagler *et al.* 2003, 2005, 2007; Hultine *et al.* 2009; Gaddis 2008). Such results suggest that replacement of exotic woody species in riparian areas with native vegetation may not result in much difference in regional ET rates for the Navajo Nation. Thus, overall changes in evapotranspiration may be mixed depending on how treatment methods alter the density of vegetation and the exposure of bare ground.

Noxious species with deep taproots, such as tamarisk or camelthorn, can impact groundwater availability, especially in areas where aquifers are shallow. Removal of such species may increase overall infiltration to aquifers as native plant communities often do not form the same dense deep root systems, especially within active floodplains (Nagler *et al.* 2010). However, removals in areas that are far from major surface water bodies are not likely to result in gains to groundwater recharge. Removal may also decrease interception of precipitation on the surface as more bare ground is exposed, especially following large-scale clearing treatments. Loss of living vegetative cover from sites may temporarily increase surface water run-off. Such impacts would be most pronounced immediately following removal of vegetation through any of the proposed

methods. Restoration of native vegetation through cultural treatments may affect long-term infiltration and precipitation interception based on variations in plant density and coverage. However, such impacts are likely to be small in scale. This is because replanting native vegetation can reduce overall density of vegetation from dense thickets or monocultures of weed species that tend to diverse coverage of grasses, trees, and shrubs. This transition may decrease interception rates, allowing for more infiltration of water into groundwater aquifers.

Of the herbicides used on the Navajo Nation for weed management, picloram, 2,4-D, glyphosate, and atrazine have specific MCLs. The standards are used to assess the quality of water being distributed to the public for consumption and are used for testing public groundwater systems, including wellheads. Of these, 2,4-D and glyphosate have aquatic formulations which tend to break down rapidly in water.

Picloram potentially causes damage to the central nervous system, weakness, weight loss, and diarrhea in persons exposed to levels exceeding the MCL. Drinking water levels considered “safe” for short-term exposure are, for a 10 kilogram (22 pound) child consuming one liter of water per day, a 1- to 10-day exposure to 20mg/L or up to at 7-year exposure to 0.7 mg/L. NNEPA’s MCL for picloram is 0.5 parts per million (ppm). If picloram is released to soil, it will not be expected to adsorb to the soil and may leach to groundwater, a conclusion supported by detection of picloram in ground water samples.

2,4-D potentially causes nerve system damage from short-term exposures at levels above the MCL. Drinking water levels of 2,4-D considered “safe” for short-term exposures are, for a 10-kilogram child consuming 1-liter of water per day, a 1-day exposure of 1mg/L, or a 10-day exposure of 0.3mg/L. NNEPA’s MCL for 2,4-D is 70 parts per billion. While 2,4-D has a relatively short half-life, it has a tendency to drift off sites where it is applied, affecting non-target species and increasing the risk of short-term exposure. This pesticide is monitored due to its heavy use in both agricultural and urban areas, increasing the risk for contamination.

Glyphosate potentially causes lung congestion and increased breathing rates at levels exceeding the MCL. Drinking water levels considered “safe” for short-term exposure are, for a 10-kilogram child consuming 1 liter of water per day, up to a 10-day exposure to 20mg/L or up to a 7-year exposure to 1mg/L. NNEPA’s MCL for glyphosate is 0.7 ppm. After glyphosate is applied, it strongly adsorbs to soil, remains in upper soil layers, and exhibits a low propensity for leaching. Glyphosate may enter aquatic ecosystems and drinking water sources via runoff. Standards for glyphosate were established due to the heavy use of the herbicide in commercial and urban settings.

Atrazine is a known endocrine disruptor shown to alter the natural hormonal system in animals and humans and is known to cause reproductive and cardiovascular issues at levels above the MCL. Drinking water levels of atrazine considered “safe” for short term exposures are, for a 10-kilogram child consuming 1-liter of water per day, a 1- to 10-day exposure of 0.1mg/L, or a longer

term exposure of 0.05mg/L. NNEPA's MCL for atrazine is 0.003 parts per million. Atrazine is considered to have relatively high mobility and is long-lived in the environment since it is not readily broken down by photolysis or hydrolysis.

Because of water quality concerns, the BIA must work cooperatively with the Navajo Nation EPA to ensure treatments comply with the Safe Drinking Water Act and 40 CFR Part 141. These include mitigation measures to follow herbicide label instructions, buffer distances for mechanical and chemical treatments from surface waters, correct container disposal procedures, and clean-up of personnel equipment away from wellheads and water sources, which are outlined in Mitigation Measures (Appendix E). While herbicides can be used around wellheads, it is more desirable to use manual or cultural methods within about 100 feet of wellheads. Extensive use of grazing around wellheads can raise nitrate levels in the water, so manual methods of treatment will be the preferred method in this project. If herbicides must be used the treatment should be timed with the driest periods to prevent leaching of herbicides directly back into the wellhead.

Cultural treatments that include the use of targeted grazing would increase surface runoff due to trampling and soil compaction. Heavily grazed sites could increase runoff up to nine times that of lightly grazed systems. However, grazing treatments are usually short-term and treated areas have been known to recover quickly from high impact, short-term grazing. Grazing treatments can also affect water quality due to nutrient loading and fecal coliforms. Excess nutrients can cause algal blooms and reduced oxygen levels. Severity of the effects would depend on the number of animals used, the intensity and duration of the treatment, and the distance to surface water.

There would be minimal effects to impaired waters from the use of biological agents. Target plants would be killed slowly and usually remain in place with little likelihood of runoff or sedimentation.

4.4.2.3 Alternative 3 – No Biological Control

This method would limit management techniques available to grazing, mechanical, chemical, and manual treatments. Control of species, such as knapweeds, leafy spurge, and field bindweed, would be limited to chemical and mechanical methods, which also have potential to result in water contamination. This is a major concern in irrigated farms, which are often situated near rivers and streams. Chemical treatment for these species often requires the use of herbicides known to impact water quality standards. While some could be controlled through targeted grazing, the use of livestock would increase soil erosion and top soil loss in treated locations. Without the use of biological treatments, leafy spurge, which is known to impact riparian areas, would likely spread along riparian corridors, replacing valuable riparian plant species. Such replacement may affect erosion, sedimentation, and nutrient inputs in these areas.

4.4.3 Air Quality

There would be some impacts to air resources under any of the action alternatives. In addition to the treatment of weeds, it is necessary to consider the impacts to air during transportation of workers who are treating infestations as they travel to and from worksites.

Gaseous emissions – including sulfur dioxide, carbon monoxide, oxides of nitrogen, and volatile organic compounds – would result from the combustion of gas and diesel in vehicles used to transport workers or from the use of heavy machinery. The amounts of these emissions would depend upon the size, type, age, fuel efficiency and loads hauled by the engines used for transportation and during treatment operation. Air pollutant emissions of newer, more efficient engines are less than those of older models, but even the emissions from older, less efficient engines would constitute minor sources of air pollution.

Road dust will also be generated during travel to and from worksites and during treatment applications which use motorized vehicles. Since speeds are generally slow during treatments, the impact during treatment would be minimal. Depending upon the mileage driven on dirt or gravel roads going to and from the project site, the speed driven while traveling, the number of vehicles traveling, and the weight of the loads being carried, there could be a substantial amount of dust generated during travel to and from worksites. These impacts would be temporary and have a short duration, and not be expected to have a long-term impact.

During ground applications of herbicides some spray drift will occur. This drift is not expected to produce any ambient air quality impacts since this spray drift is short term in nature and limited to areas immediately adjacent to where plant populations are being sprayed. The quantity of the herbicide release into the atmosphere is not expected to have any long-term impact on air quality.

4.4.3.1 *Alternative 1 – No Action*

Under the No Action Alternative limited weed management activities would be conducted without the use of integrated and coordinated efforts to address major weed issues on the Navajo Nation. Noxious weeds would continue to indirectly affect air quality by increasing the chance of damaging wildfires (of particular importance in this regard are early-successional annuals like cheatgrass or red brome that dry out early in the growing season and tend to form a continuous fuel layer across broad areas [Brooks et al. 2004]). Large wildfires greatly influence regional air quality (more so than prescribed burns), as emissions of the pollutants described above typically increase in proportion to the acres burned. The No Action Alternative is therefore expected to increase total air pollutant emissions over time due to a projected increase in wildfire acres if weeds are left untreated.

4.4.3.2 *Alternative 2 - Proposed Action*

Impacts common to both the Proposed Alternative and the No Biological Control Alternative are those related to aerial spraying and prescribed burning. Aerial spraying has the potential for

greater spray drift than that associated with ground application. Drift is dependent on pesticide form and volatility, weather conditions, and application method. Herbicides with a high risk of volatility, such as 2,4-D, dichlobenil, and triclopyr can create herbicide vapor which can travel farther and over a longer time than liquid spray droplets (Dexter 1995). Herbicides that are in dust or powder form are also more likely to drift into non-treatment areas than herbicides that are in liquid or pellet forms. The size of the spray droplets can also contribute to the potential for drift, with smaller size droplets more likely to travel long distances than larger droplets. Weather conditions can influence the volatility and drift potential for herbicides. For example, the volatility of 2,4-D can triple when temperatures increase from 60 to 80°F. Such vaporization is exacerbated during periods of low relative humidity.

The method of aerial application may also influence drift. Aerial applications applied by fixed wing aircraft can have the potential for more off-site movement than those applied by helicopter. Additionally, applications that minimize the distance between the nozzle or applicator and the target area can minimize the potential for drift. Wind direction, velocity, and stability, can also influence the potential for drift. Applicators should note if windy conditions have the potential to move herbicides into non-target areas. Lastly, the configuration of the application nozzles can also influence the ability of herbicides to drift. High pressure can cause spray droplets to decrease in size. The angle and type of nozzles (e.g. hollow cone, flat fan, whirl chamber, etc.) can influence the direction and movement of the spray path during flight. Nozzles angled forward can produce more drift than those angled backwards relative to the aircraft.

Both the Proposed Alternative and the No Biological Control Alternative will result in some negative impacts related to aerial spraying. This would increase localized exposure to volatilized herbicides immediately after spraying treatments are conducted, which could impact those who have chemical sensitivities to herbicides. However, the impacts would be short-term and would dissipate shortly after applications are completed. Additionally, BMPs and mitigation measures proposed for aerial spraying will reduce these effects.

Another treatment method included in both the Proposed Alternative and the No Biological Control Alternative which could generate negative impacts to air quality is prescribed burning to control weed populations. The most common air pollutants in smoke are carbon monoxide (CO), carbon dioxide (CO₂), particulate matter less than 10 micrometers in diameter (PM₁₀), and particulate matter less than 2.5 micrometers in diameter (PM_{2.5}). A less common but important class of pollutants in smoke is volatile organic compounds (VOC), which can make up 1% of the mass of pollutants emitted from fires. VOC emissions can negatively affect human health and contribute to the formation of smog. The BLM Vegetation Treatment EIS (BLM 2007), however, identified particulate matter as the most serious air pollutant emitted from fires. These small particles are carried by winds over long distances and can result in exceedances of the health-based National Ambient Air Quality Standards for PM₁₀ and PM_{2.5}. Fine particulate matter (PM_{2.5}) can travel especially far, and has more potential negative health effects than the coarser PM₁₀ size fraction.

BMPs that can minimize the air quality impacts from prescribed burns include only burning during optimal weather and fuel conditions to ensure the most impact on target weed populations with the least impact on air quality. Before implementing a specific prescribed burning project, land managers are required to prepare a burn plan which includes provisions to minimize air quality impacts, and to comply with multiple federal rules and regulations including the Clean Air Act and National Interagency prescribed fire policy. With these measures in place it is expected that impacts from prescribed fire will be local and short-term in duration.

4.4.3.3 Alternative 3 – No Biological Control

Alternative 3 would have impacts similar to those described under the Proposed Action.

4.5 Vegetation

4.5.1 Noxious Weeds

The impacts on vegetation are two-fold when considering weed management. Consideration of vegetation must look at how weed management and treatments will impact both the target weed populations and native desirable vegetation when implementing projects. As such, impacts to vegetation are anticipated through any weed management alternative. If weeds are left untreated, they will likely outcompete and replace native vegetation communities, impacting habitat quality, forage quality, and potentially contributing to loss of rare plant species. Treating weeds, however, through any means will likely result in some impacts of native vegetation found at project sites. Minor impacts could include uprooting small plants, some exposure to herbicides in neighboring areas, trampling from increased foot traffic at project sites, and damage to leaves or plant parts of nearby plants. Major impacts to native vegetation may include die-off of native plants from herbicide drift, damage to root systems or stems while using heavy machinery, or total loss of native vegetation at sites that are completely cleared of vegetation. The degree to which desirable vegetation is impacted is largely a factor of how treatments are planned and implemented.

It is also worth noting that some of the exotic species targeted for control under all of the Alternatives have been incorporated into Navajo cultural practices, and thus implantation of any weed control techniques will have impacts on these resources. Species such as field bindweed, cheatgrass, puncturevine, Russian thistle, and tamarisk have been used for medicinal and/or ceremonial purposes (Mayes and Lacy 1989). All of these species, however, are very well established across the Navajo Nation (and surrounding public lands), and it is difficult to imagine even the most successful weed control campaign completely eradicating any of them. Therefore, it seems likely that cultural use of these plants will continue regardless of the Alternative chosen. Furthermore, a given cultural need may generally be satisfied by any of a group of (usually related) species, with the specific plant or plants chosen based on what is locally and seasonally available (Elmore 1944). Thus if a particular exotic species were to become less common there would typically be a variety of native species available that could be used in its place.

Table 4-3. Target species meeting treatment objectives by alternative. Alternative 1 refers to the No Action Alternative, Alternative 2 refers to the Proposed Alternative, and Alternative 3 refers to the No Biological Control Alternative.

Common Name	Objective	Alt 1	Alt 2	Alt 3
Leafy spurge	Prevent	Yes	Yes	Yes
African rue	Prevent	No	Yes	Yes
Tree of Heaven	Prevent	No	Yes	Yes
Fountaingrass	Prevent	No	Yes	Yes
Squarrose knapweed	Prevent	No	Yes	Yes
Japanese brome	Prevent	No	Yes	Yes
Blue mustard	Eradicate	No	Yes	Yes
Ravenna grass	Eradicate	No	Yes	Yes
Yellow starthistle	Eradicate	Yes	Yes	Yes
Bull thistle	Eradicate	Yes	Yes	No
Canada thistle	Eradicate	Yes	Yes	Yes
Dalmatian toadflax	Eradicate	Yes	Yes	Yes
Musk thistle	Eradicate	Yes	Yes	No
Perennial pepperweed	Eradicate	Yes	Yes	Yes
Scotch thistle	Eradicate	Yes	Yes	Yes
Spotted knapweed	Eradicate	Yes	Yes	No
Tall whitetop	Eradicate	Yes	Yes	Yes
Sahara mustard	Eradicate	No	Yes	Yes
Uruguyan pampas grass	Eradicate	No	Yes	Yes
Yellow nutsedge	Eradicate	No	Yes	Yes
Sulphur cinquefoil	Eradicate	No	Yes	Yes
Common Mediterranean grass	Eradicate	No	Yes	Yes
Tamarisk, Saltcedar	Eradicate	Yes	Yes	Yes
Camelthorn	Control/Eradicate	No	Yes	Yes
Halogeton	Control/Eradicate	Yes	Yes	Yes
Siberian Elm	Control/Eradicate	No	Yes	Yes
Tamarisk	Control/Eradicate	Yes	Yes	Yes
Diffuse knapweed	Control/Eradicate	Yes	Yes	No
Russian knapweed	Control/Eradicate	Yes	Yes	No
Russian olive	Control/Eradicate	No	Yes	Yes
Johnsongrass	Control/Eradicate	No	Yes	Yes
Cheatgrass	Local Control/Monitor	Yes	Yes	Yes
Field bindweed	Local Control/Monitor	Yes	Yes	No
Jointed goatgrass	Local Control/Monitor	Yes	Yes	Yes
Puncturevine	Local Control/Monitor	Yes	Yes	No
Rescuegrass	Local Control/Monitor	No	Yes	Yes
Ripgut brome	Local Control/Monitor	No	Yes	Yes
Smooth brome	Local Control/Monitor	No	Yes	Yes
Bald brome	Local Control/Monitor	No	Yes	Yes
Red brome	Local Control/Monitor	No	Yes	Yes
Spreading wallflower	Local Control/Monitor	No	Yes	Yes
Horehound	Local Control/Monitor	No	Yes	Yes
California burclover	Local Control/Monitor	No	Yes	Yes
Russian thistle	Local Control/Monitor	No	Yes	Yes
Field brome	Local Control/Monitor	No	Yes	Yes
Kochia	Local Control/Monitor	No	Yes	Yes

4.5.1.1 Alternative 1 – No Action

Under the No Action alternative, some weed treatments would still be implemented under the noxious weed program. However, several of the weed species proposed for management in this plan, such as diffuse knapweed, kochia, Russian thistle, and several noxious brome grasses would not be addressed or managed under the current weed program. This would increase their ability to spread and cause further impacts to rangeland, farmland, roads, and riparian areas. Weeds identified as Category A priority species that are managed for prevention and eradication are often found in neighboring areas outside of the Navajo Nation or on other federal lands. Species such as squarrose knapweed and Ravenna grass have already been detected in small populations on the Navajo Nation. Without management or treatment of these weeds, they would be allowed to spread on to the Navajo Nation and result in further impacts to biodiversity, grazing, and habitat quality.

Species currently being treated under the current Noxious Weed Program will likely not be treated in an integrated and coordinated effort for the Navajo Nation, which could allow large populations of weeds to continue to expand. Without monitoring and regular mapping of weed populations, project planning would likely focus on small problem populations instead of allowing for large-scale projects that would address weed management from a landscape scale. Populations of several of the target weed species addressed under the current Program, such as knapweeds, thistles, camelthorn, and halogeton will likely be treated but not at the levels or with the same coordination to prevent populations to continue to spread.

Treatments on paved road systems under control of the BIA and other agencies (i.e. State Departments of Transportation and Navajo Nation DOT) would be implemented in a piecemeal fashion. Weeds commonly occurring along roads and corridors, such as camelthorn, thistles, and knapweeds, would continue to expand. This would continue to allow roads to act as major conduits for the spread of weeds into major ecosystems and land use areas found within the project area. This would promote the continual spread of these weeds and eventually result in declines in biodiversity in the project area within the next 10 to 15 years.

Some species of weeds can also increase the chance of wildfires, which can create disturbance events that allow weed seeds to have a competitive advantage. In recent years, the severity and intensity of wildfires in the West have increased dramatically from levels in the 1970s and 1980s. Annual weeds such as Sahara mustard, kochia, Russian thistle, red brome, and cheatgrass can dry out early, increasing fuel loads and allowing wildfire to start and spread easily. These species also result in a gradual reduction and replacement of native grasses and forbs with less desirable non-native species.

4.5.1.2 Alternative 2 – Proposed Action

The removal of non-native species is a considerable concern on the Navajo Nation as they have heavily impacted riparian areas, croplands, households, and roads. Noxious plant species spread along travel routes and from construction sites, where they often expand, replacing diverse native

plant communities with monocultures. By treating weeds with an integrated approach, the removal of noxious weed species would help restore native plant communities, preserving biodiversity, forage quality, and important habitat in the region. The most effective means of control involves the use of several methods implemented at different times depending on the biology of the target weed species.

In the short term, vegetation in and around project areas may be moderately affected. There is potential for the negative impacts to native vegetation in treated areas due to root damage from heavy machinery or increased foot traffic, pesticide drift, and the implementation of non-specific treatment methods. However, careful planning and mitigation measures can limit the overall effects of such impacts. These include setting up buffers around large populations of native vegetation, following pesticide label instructions, and training field crews to be familiar with desirable native vegetation versus target weed species. In the long-term, native vegetation will likely increase in coverage at treatment sites, maintaining biodiversity and ecological health to treatment sites.

The proposed action would authorize the use of biological controls. Eleven species would be targeted: leafy spurge, yellow starthistle, bull thistle, Dalmatian toadflax, spotted knapweed, diffuse knapweed, Russian knapweed, Canada thistle, musk thistle, field bindweed, and puncturevine. Each of these species has a variety of biological agents that have been tested and approved for use. The use of the more than one agent for a single species is done to provide greater means of control. Some agents may impact the target species by destroying seeds or the reproductive capacity of a plant. Other agents may form galls in roots or stems, preventing the plant from allocating resources toward flowering and growth. Success in the use of biological control insects is also dependent on the size and density of existing populations. In general, populations that are continuous, fairly dense, and occupy a rather large area (1 acre or more) are more successful biological control sites. Typically, insects crawl, jump, or fly from one plant to the next, so scattered, less dense populations influence the reproductive success of the insect and the overall ability of the biological control to achieve treatment objectives.

Valentine (1980) noted that before introduction, insects must be determined to be highly damaging to the target plants while at the same time being virtually harmless to native plants. All of the biological control agents proposed for use under Alternative 2 have undergone extensive research and environmental analysis by APHIS prior to approval. As a result, the BIA does not foresee any adverse impacts with the introduction of these insects on native plants. Normally, a period of 15 to 20 years is necessary to build up sufficient insect populations to bring about an economic treatment level (USFS 1992).

However, the relationship between laboratory testing and field behavior is not always predictable and there is still the potential for biological control agents to impact non-target plants. For example, the flowerhead weevil (*Rhinocyllus conicus* Froeh) was released to treat Eurasian thistles. While the weevil did not show preference for a variety of native thistles, it was

observed causing damage to several native thistle species after some initial releases (Louda et al. 1997). Such impacts are not expected when using biological agents and site based testing of agents near target areas is recommended by APHIS and the BIA to determine feasibility of use and specificity testing. As with all treatments, there would still be risks associated with unforeseen effects from the use of these agents to different vegetation communities.

The use of targeted grazing for cultural control would generally occur in herbaceous communities and would be limited to Community Development Areas on the Navajo Nation. Targeted grazing would be limited to buildings and fenced areas where noxious weeds are common and where the use of herbicides may be a concern for public health. The use of grazing would likely cause direct impacts to non-target vegetation in project areas by browsing, trampling, or kicking up of plants. The extent of these effects would depend on the animals used and the condition of the site prior to grazing. For example, while sheep and goats both prefer forbs, sheep tend to consume more grass than goats (Walker et al. 1994). Disturbance at grazing sites may also encourage the recolonization of sites with target weed species. Grazing animals can also spread weeds to non-infested areas by transporting seeds or plant parts on their fur on in their dung. These impacts are likely to be minimized as grazing animals will be quarantined after treatments, and their excrement will be collected and burned to reduce the unintended spread to other areas.

Additionally, timing of grazing treatments would also be important as some weed species lose their palatability over time as they develop toxins, spines, or distasteful compounds, which could cause grazing animals to prefer native plants over target weed species. The effectiveness of grazing would be greatest when treatments are done before plants produce seed, during times of drought, or when implemented repeatedly over time. Overall, grazing treatments provide another method of control for areas where other treatment methods may not be feasible or reasonable.

Manual techniques are very selective: they generally affect only the vegetation that has been targeted for treatment. Surrounding vegetation could be crushed or damaged by workers or debris. Manual cutting treatments, such as clipping or use of brush cutters, could encourage regrowth of multiple-stemmed sprouts for noxious tree species. To kill the trees, the roots must be treated as well. Otherwise, every cycle of cutting will result in more sprouts and over time the tree stem density can increase (Nowak 1993). Therefore, manual techniques used for large populations of woody weed species should also incorporate the use of chemical treatments for better control and eradication. Manual treatments for low-growing species, such as pulling of young plants or mowing of noxious grasses, would likely have little impact on non-target vegetation except for the removal of the wrong plant within the treatment area.

Mechanical treatments are often non-selective as they are best implemented to clear or cut large areas of dense vegetation. As such, many of the methods used for mechanical treatments remove vegetation with little ability to avoid or select specific plants to remove within the treatment area.

The exception to this is the use of feller-bunchers which can select and cut individual trees from a site. Use of heavy machinery also results in disturbance to the ground through rutting and compaction (e.g. tillers, bulldozers, grubbers, etc.) as machines are transported and used within project sites. The size and weight of such machines would increase soil compaction and disturbance within treatment areas, potentially altering soil productivity. Changes in soil productivity could alter plant growth of native vegetation or encourage the growth and establishment of noxious weeds in the treatment area. Equipment that only cuts vegetation above the surface, such as mowers or mulchers, would have reduce impacts to soils plant productivity by reducing soil disturbance through the removal of underground plant parts, but may still result in soil compaction. Altogether, these impacts could negatively affect any unidentified desirable native vegetation or federally and tribally listed species that could be found within the treatment areas.

Additionally, the effectiveness of mechanical treatments is limited for noxious weed control. Use of such machines could facilitate the spread of seeds and plant parts within treatment areas. Thus it is recommended mechanical treatments be combined with follow-up selective herbicide treatments to prevent recolonization of treated areas with target weed species and to facilitate the growth of native vegetation.

Because herbicides are designed to kill plants, damage to non-target plant species is probable despite cautious planning and implementation. Broadcast spraying, whether through ground or aerial applications, has the greatest likelihood for damage with the risks for non-target plants increasing the closer they are to the application site. The level and extent of damage that can occur after broadcast applications are conducted is also dependent on site-specific conditions, including wind speed and foliar interception of pesticides. Non-target and sensitive plant species are most likely to be impacted indirectly through off-site drift, surface runoff, or wind erosion. The level of impact will depend on the selectivity of the herbicide, its fate within the environment once applied, the amount applied, and the level of exposure needed for damage to occur to non-target plant species.

The impact that herbicides will have on a particular plant is largely based on how the chemical works to prevent growth or cause damage. The Weed Science Society of America (WSSA) has developed a classification system for herbicides based on the mechanism of action (2011). The classification system groups herbicides based on the biochemical pathways that control the growth and development of plants. These mechanisms help in the selection of herbicides to provide a variety of biochemical methods to control target populations.

To assess the potential impacts of herbicides on non-target plants, the BIA reviewed literature and findings from Ecological Risk Assessments (ERAs) conducted by the BLM and the U.S. Forest Service, and EPA Registration Eligibility Decision assessments (REDs) for each of the proposed herbicides for use under Alternative 1. These assessments examine the effects of herbicides for off-site drift, surface runoff, and wind erosion often using modeling software that

examines how different application methods, chemical composition and properties in the environment, and toxicology information affect how herbicides can impact the environment. The analyses look at the toxicity of the herbicides on a variety of plant species, such as common crops, grasses, and surrogate species for federally listed species. This information is then used to assess the impacts of herbicides on non-target weed species. Non-target weed species are separated into sensitive species and tolerant species. Sensitive species are often species that share common characteristics with the target species, such as form (grass, herbaceous, woody) and duration (annual vs. perennial). Sensitive species can also include threatened, endangered, or sensitive species that are federally or tribally listed. Tolerant plant species are those that are not expected to be harmed by the herbicide based on its selectivity or its mode of action in the target plant. For example, grasses would be tolerant plant species for herbicides that are selective to broadleaf weeds or dicots.

The BLM and USFS used landscape modeling tools for their analyses include AgDRIFT® (off-site drift), GLEAMS (soil fate analysis and surface runoff potential), CALPUFF (wind erosion modeling), and PRZM (ground water modeling). The EPA uses PRZM-EXAMS (runoff modeling) and GENECC (generic expected environmental concentration modeling) along with studies and incident reports to examine the ecological impacts of herbicides to decide labeling and use. EPA analyses, however, do not often model the extent of impacts associated with specific methods of application, but rather assess the likelihood that an herbicide may or may not result in impacts to non-target species. Thus EPA analyses do not associate risks of exposure with distance to treatment site or environmental conditions. It is also important to note that all modeling and analyses are general in nature and are not able to account for impacts of all desirable native or crop species that could be found within treatment areas on the Navajo Nation. Such risk assessments only provide a general idea of impacts associated with each of the herbicides covered under this plan.

Below, each of the herbicides covered under Alternative 2 are described by mode of action, proposed use, and potential impacts to non-target vegetation. The results of the assessments are also summarized in **Table 4-4**.

2,4-D

2,4-D is a synthetic auxin, which is a hormone that regulates the growth of plants. The herbicide works by altering the metabolism and growth of impacted plants, causing abnormal growth and transport of nutrients. It is selective to broadleaf plants, or dicot plants, but not for grasses. Plant community diversity studies have shown that 2,4-D can be used for noxious plant management without significantly affecting species diversity (USFS 2006). It can be used as both a pre-emergent and a post-emergent herbicide to control target species before germination and after establishment. 2,4-D has limited effectiveness on managing and controlling perennial thistles, but can be effective for controlling some biennial thistles such as bull or Scotch thistle in some scenarios. Two aquatic formulations of 2,4-D (2,4-D diethanolamine salt and 2,4-D butoxyethyl ester) of 2,4-D may also be effective for controlling broadleaved plants in riparian areas when

used as spot treatments based on the label instructions without causing substantial harm to native aquatic plants.

Off-site drift modeling performed by the U.S. Forest Service indicates that 2,4-D has a likelihood for adversely affecting non-target plant species (SERA 2006). Modeling indicates that sensitive plant species, or native broadleaved plants, may be affected within 100 ft of ground applications and up to 300 ft for aerial applications, even at low (0.5 lbs a.i./ac) to typical (1 lb a.i./ac) application rates. Tolerant species are not likely to be affected beyond the main application area for either aerial or ground applications at all application rates.

Surface runoff modeling indicates that runoff in areas with high precipitation and high clay content has the potential to result in adverse impacts to sensitive plant species based on soil adsorption. There is also the potential for impacts to sensitive plants from surface runoff in areas with loamy soils with 100 in. or more of annual rainfall when 2,4-D is applied at the highest application rate (5 lbs a.i./ac). Tolerant plants are not likely to be impacted by surface runoff at any application rate regardless of soil composition or annual rainfall.

Aminopyralid

Aminopyralid is a synthetic auxin mimicking herbicide which alters the growth of plants. The herbicide works by altering regulation of plant growth resulting in abnormal cell division and growth. Aminopyralid is selective to broadleaf plants and has limited impact on grasses. The herbicide was developed as an alternative to herbicides like 2,4-D, picloram, metsulfuron methyl, and clopyralid. The herbicide is labeled as a post-emergent and is most effective when applied in the early spring to late summer when plants are actively growing. The herbicide is not proposed for use in aerial applications or near riparian or aquatic treatment sites.

Based on ecological risk assessments, aminopyralid has the potential to harm non-target broadleaf plants through off-site drift and surface runoff. AgDRIFT modeling conducted by the U.S. Forest Service indicates that broadcast ground applications could impact sensitive plants up to 300ft away from the application site when using the highest application rate of 0.11 lb a.i./ac. At the typical application rate of 0.078lb a.i./ac, sensitive plants up to 100ft away were at potential risk of adverse effects. Modeling also indicates that tolerant plant species are not likely to be impacted by broadcast ground applications at any application rate (SERA 2007, BLM 2016). The impacts of aerial applications for aminopyralid were not examined as they will not be permitted under this Alternative.

Adverse impacts for sensitive plant species as a result of surface runoff are highest in areas with clay soils and 15 in. or more of annual rainfall. As soils on the Navajo Nation are predominantly loamy to sandy soils, the risks of impacts are relatively low for most of the project area, with increased risk in areas with higher soil clay content and during wet periods with significantly higher rainfall.

Atrazine

Atrazine is selective herbicide that is used to control annual, biennial, and perennial broadleaf weeds and grasses. It is classified as a synthetic auxin, impacting the regulation of nutrient transport resulting in abnormal growth and death of target plant species. Atrazine is most heavily used in agricultural and roadway applications. It can be used for both pre-emergent and post-emergent control of target weed species. Under Alternative 2, atrazine can be used for aerial broadcast, ground broadcast, and spot applications to treat a wide variety of target weed species.

Off-site drift from broadcast applications do pose a moderate to low risk to sensitive plant species. AgDRIFT modeling performed by the U.S. EPA (Corbin & Anderson 2009) using application rates ranging from 1-4 lbs a.i./ac at a distance of 66ft indicated a moderate to high risk of damage for sensitive plant species depending on the application method used. In the study they investigated different methods for forestry, corn and sorghum, and turf and residential applications. Risks were higher for aerial application methods than for ground treatments and higher risks for plant seedlings and aquatic vegetation.

There is also the strong potential for damage to sensitive plants through to surface runoff. Atrazine weakly absorbs to soils and can be persistent in both soil and water. The study, however, since modeling work for the study was focused on downstream dilution rather than potential based on soil type or weather, modeling results were not indicated. As atrazine is heavily used in agricultural and natural resource settings, modeling of atrazine dilution in the study was not feasible.

Chlorsulfuron

This selective herbicide is used on perennial broadleaf weeds and grasses. Chlorsulfuron is classified as an ALS inhibitor. ALS is an important enzyme plants use to synthesize proteins required for cell growth. Chlorsulfuron can be used as a pre-emergent or post emergent herbicide as it can inhibit seed germination and can kill established plants. Only small concentrations are needed to kill target plants. Under Alternative 2, chlorsulfuron can be applied through ground broadcast applications and foliar spot treatments.

Broadcast applications have a moderate risk to cause adverse impacts to sensitive plant species outside of the application area. Modeling from both the U.S. Forest Service (SERA 2004) and the BLM (2007c) indicate that sensitive plants up to 900ft away from the application area could be impacted by off-site drift at any application rate (0.047 to 0.062 lb a.i./ac). Tolerant plant species, however, are not likely to be impacted by broadcast operations at any application rate or distance from the application area.

Surface runoff presents a low potential for impacts for sensitive plants. Areas with high clay content and over 15" of annual rainfall could pose a risk to sensitive plants at or above the standard application rate (0.056lb a.i./ac). These results indicate that some sensitive plants could

be at risk for adverse impacts in runoff areas during periods of high rainfall. Tolerant plants are not likely to be impacted by surface runoff in the project area at any application rate, regardless of soil content based on rainfall and climate in the region.

Clopyralid

Clopyralid is a selective herbicide used to kill and control broadleaf weeds. It is classified as a synthetic auxin that is rapidly absorbed across leaf surfaces where it disrupts nutrient transport resulting in abnormal plant growth and plant death. As clopyralid is more rapidly absorbed by leaves than roots, it is most effective in post-emergent treatments. Clopyralid is approved for aerial broadcast, ground broadcast, and spot foliar treatments under Alternative 2.

Off-site drift from aerial and ground broadcast treatments pose a risk to non-target broadleaved species. Ground and aerial broadcast treatments may cause damage to sensitive plants at distances at or below 500ft from the application site at the typical application rate of 0.35 lb a.i./ac. At the high application rate of 1 lb a.i./ac, sensitive plants could have adverse effects at distances over 900 ft from the application site. Aerial applications posed higher risks than ground applications (SERA 2004a, BLM 2007). Tolerant plant species, however, are not likely to experience damage or adverse impacts from broadcast treatments at any application rate.

Surface runoff poses a low risk to sensitive plants, with some damage to plants in areas where runoff is likely (high clay soils) and annual rainfall is greater than 15 inches. Runoff is not likely to affect tolerant plant species.

Dichlobenil

Dichlobenil is a broad-spectrum herbicide that is selective for annual and perennial grasses, broadleaf weeds, and woody plants. It is classified as a cellulose inhibitor and works by disrupting the production of cellulose need to build cell walls. The herbicide works most strongly on growing points and root tips of plants, allowing it to be used as both a pre-emergent and post-emergent herbicidal treatment. It is known to reduce the growth of mycorrhizal fungi for some tree species (Hamel et al. 1994), which could impact growth and establishment of some tree species. Additionally, its major metabolite, 2,6-dichlorobenzamide (BAM) has similar impacts within treated areas and can persist within treated areas for longer periods than the parent chemical (USEPA 1998). Dichlobenil is approved for use under Alternative 2 for broadcast ground applications and spot treatments.

Surface runoff does pose a significant risk to sensitive plants as dichlobenil is moderately mobile in coarser soils and can be persistent within water (Stavola and Turner 2003). This increases the potential for the herbicide to be transported off-site during major storm events. EPA modeling suggests that sensitive non-target plants may be at risk of damage if concentrations of dichlobenil exceed 0.23 lb/ac in associated runoff (USEPA 1998). EPA estimates assumes that approximately 2% of applied dichlobenil can potentially be transported from the treatment site through surface runoff. The degree of damage risk increases with increasing application rates

which can range from 2-20lbs/ac. Some impacts may also be associated with off-site drift from broadcast treatments, however these have not been adequately modeled or investigated based on method or application rate.

Diflufenzopyr

Diflufenzopyr is a selective, systematic herbicide used to manage post-emergent annual broadleaf weeds and to control and suppress perennial broadleaf weeds and annual grasses. The herbicide is classified as an auxin transport inhibitor, which works by blocking the transport of natural and synthetic auxin hormones in plants causing them to accumulate in the meristem and roots of affected plants. This imbalance disrupts plant growth regulation, resulting in stunted growth and death for target plant species. Diflufenzopyr is approved for use under Alternative 2 for ground broadcast and spot treatments.

Off-site drift modeling indicates that there is low risk to sensitive plant species for ground broadcast applications at typical (0.075 lb a.i./ac) and high (0.1 lb a.i./ac) application rates. BLM modeling indicates that sensitive plant species have a low risk of damage within 25 ft of the application area (2007b). Additional modeling also suggests that protected species, such as rare, threatened or endangered species, may also be at low risk for damage from off-site drift by broadcast treatments up to 100ft from the application area. Tolerant plant species are not likely to be impacted at all by off-site drift at all application rates.

Surface runoff does pose a slight risk to sensitive plants found in clay soils with higher annual rainfall amounts. GLEAMs modeling performed by the BLM indicates that plants in clay soils that receive more than 15" of annual rainfall could experience some damage from runoff of soils treated with diflufenzopyr (2007b). Soils with slightly higher loam content that receive more than 25" of annual rainfall could also increase the risk of damage to sensitive plant species. However, tolerant plant species are not likely to be impacted by the transport of herbicide outside of application areas by surface runoff.

Fluroxypyr

Fluroxypyr is a selective herbicide used to control and manage broadleaf weeds. It is classified as a synthetic auxin which disrupts nutrient transport resulting in abnormal growth and death of target species. It is most effective when used to treat post-emergent plants and can also be effective on some woody plant species. Under Alternative 2, fluroxypyr can be applied using aerial broadcast, ground broadcast, and spot treatments.

Off-site drift has varying effects on sensitive and tolerant plant species. Non-target tolerant plant species within the treatment area have a low risk of damage when herbicide is applied using aerial broadcast, ground broadcast, or backpack application methods. Sensitive plant species have moderate to low risk of damage during aerial applications up to 900 ft from the application site at the typical application rate (0.5 lb a.i./ac). During ground broadcast applications, low boom applications can still impact sensitive plants up to 500 ft from the application site while

high boom applications can still cause some damage to sensitive plants up to 900 ft from the application site (SERA 2009, BLM 2016).

Transport of fluroxypyr from application sites through surface runoff and wind erosion, however, was found not likely to result in damage to sensitive or tolerant plant species.

Fluazifop-p-butyl

Fluazifop-p-butyl is a selective herbicide used to control annual and perennial grasses that are part of the *Poaceae* family, with limited effects dicots and non-Poaceae grasses. It is classified as an ACCase Inhibitor which works by inhibiting the synthesis of fatty acids which are needed to build and repair cell membranes for plant growth. When applied, it is rapidly absorbed by plant leaves making it an effective post-emergent herbicide. It is proposed for use under Alternative 2 for aerial broadcast, ground broadcast, and spot treatments.

Transport of fluazifop-p-butyl through off-site drift results in a slight risk of damage to sensitive plant species, which varies depending on application method and droplet size based on modeling performed by the U.S. Forest Service based on the typical applicate rate of 0.32 lb a.i./ac (SERA 2014). The inclusion of droplet size in the off-site drift modeling is based on inconsistent product label instructions, which indicate that coarse droplets can help control and limit the potential for drift, but which also note that these same products should not use nozzle tips that deliver coarse or large droplet sprays. Based on the AgDRIFT® modeling, fine sprays result in a wider area of impact for sensitive plant species, with aerial applications causing potentially damage sensitive plants up to 300ft from the application area, ground applications with a high boom up to 100ft, and ground applications with a low boom up to 25ft. If coarse sprays are used, aerial applications represent a slight risk for damage for sensitive plants up to 100ft from the application site and ground applications are not likely to result in damage to sensitive plant species.

Glyphosate

Glyphosate is a non-selective herbicide that can cause damage to all groups or families of non-target plants to varying degrees. It is classified as an EPSP Inhibitor, meaning it interferes with amino acid synthesis leading to the depletion of several protein compounds that are needed for protein synthesis and plant growth and which may also interfere with other important pathways necessary for plant growth and regulation (Lee 2000)

Because it is non-selective, glyphosate can be highly effective as a spot treatment in areas where a large variety of noxious plants dominate and where few non-target plants are present. It is best used in areas where bare ground is desired. However, it also has low residual activity, losing efficacy where it is applied in short periods of times. Glyphosate does have an aquatic formulation (glyphosate isopropylamine salt) that is approved for use in and around riparian and wetland habitats. It can be applied under Alternative 2 through aerial broadcast, ground broadcast, and spot treatments.

Off-site drift does have the potential to result in significant damage to non-target plant species. AgDrift modeling done by the U.S. Forest service indicates a high to moderate risk of damage to sensitive plant species at a traditional application rate of 1 lb a.i./ac up to 900 feet from the application area during aerial applications. For ground treatments, risk of damage is low for sensitive plants with decreasing risk of damage up to 500 feet from the treatment area. No damage is expected for tolerant plant species (SERA 2011)

Damage from wind erosion and surface runoff is unlikely for sensitive plant species, due to glyphosates strong affinity for soil. This makes the herbicide less available to for plant roots to absorb it from the soil or from soil particles.

Imazapic

Imazapic is a selective, systemic ALS inhibitor herbicide. These herbicides work by inhibiting an important enzyme needed to synthesize proteins. Due to its activity, only small concentrations of the herbicide are needed to kill target plants and it is highly effective for spot applications of highly aggressive weed species that have not responded well to other herbicides or treatment methods. Imazapic is effective on annual and perennial broadleaf weeds and grasses. Short-term studies show it to be effective as a pre-emergent herbicide when applied in the fall as well as a post-emergent herbicide (Masters et al. 2001, Kirby et al. 2003). It can be very effective in controlling weeds such as leafy spurge, cheatgrass, white top, and perennial pepperweed. Under Alternative 2, imazapic can be applied using ground broadcast and spot application methods.

Off-site drift can pose a very low risk of damage to sensitive plant species. Very low risk of damage is possible up to 50ft from the application area for ground applications using application rates ranging from 0.0313 to 0.1875 lb a.i./ac (SERA 2004b). Modeling also indicated that tolerant species were not likely to be impacted by aerial or ground broadcast treatments.

Surface runoff does pose a minimal risk for damage to aquatic plants when applied at the maximum rate of 0.1875 lb a.i./ac. The risk is most prominent in areas with high precipitation (greater than 50" of annual rainfall) and clay soils. For the Navajo Nation, these impacts might be seen after significant rainfall events in some watersheds where higher application rates have been applied.

Imazapyr

Imazapyr is also an ALS inhibiting herbicide that is used to control a variety of grasses, broadleaf weeds, vines, and brush species. It is most effective as a post-emergent herbicide, but can also be used for pre-emergent applications as it works both through foliar and root absorption. Imazapyr has been found to be effective in controlling tamarisk in riparian zones along with a variety of aquatic weed species. Several formulations and brands of imazapyr are registered with the EPA for aquatic use and compliance with the herbicide label is necessary to

determine the proper use for the chemical. It can be applied to treatment areas through aerial, ground broadcast, and spot application methods.

Imazapyr is an effective herbicide that can cause significant damage to non-target plant species even through indirect means. Off-site drift can result in significant damage to sensitive species up to 900 feet from the treatment areas for aerial and ground broadcast treatments. Even tolerant plants may experience some damage within the treatment area and in directly adjacent areas at typical application rates (0.45 lb a.i./ac). Damage to sensitive plant species can also occur through wind erosion if significant amounts of soils contaminated with imazapyr are moved, which may occur during major dust storms. Surface runoff also has the potential to result in damage to aquatic plants in areas with clay soils and greater than 15" of annual rainfall, increasing the potential for damage if heavy rainfall events occur after applications. Tolerant plant species are not likely to be impacted from the transfer of herbicide through wind erosion or surface runoff events (SERA 2011a).

Isoxaben

Isoxaben is a pre-emergent herbicide for the control of broadleaf weeds. It is classified as a cellulose inhibitor as it blocks the conversion of glucose to cellulose, interfering with cell wall construction and preventing seed germination and seedling formation. While most grass species are more tolerant of isoxaben, it has been shown to affect the growth of some species such as ryegrass (USEPA 2010). It is proposed for use under Alternative 2 for ground broadcast and spot treatments.

Despite being a pre-emergent herbicide, isoxaben has been shown to impact grasses in later growth stages in areas treated with the herbicide (EPA 2010). Such impacts could be the result of off-site drift or runoff of herbicide away from treatment areas. AgDRIFT modeling reported by the U.S. Forest Services indicates a low risk to sensitive plant species within 25 ft of the treatment area at a traditional application rate (0.75 lb a.i./ac) (SERA 2001). Modeling by the U.S. EPA indicates that risk may be as much as 250ft away from the treatment area at higher application rates (up to 1 lb a.i./ac) (2010). Moderate risk of damage to sensitive plants is also possible from surface runoff based on the moderate persistence of the herbicide. Risk of damage is higher in areas where surface runoff is likely (high clay content, over 50" of annual rainfall) and at higher application rates (USEPA 2010, SERA 2001).

Metsulfuron methyl

Metsulfuron methyl is a selective herbicide for annual and perennial broadleaf weeds and brush. It can be used in both pre-emergent and post-emergent applications and is classified as an ALS inhibitor. It works by interfering with the synthesis of large amino acid chains, affecting growth and important plant regulation processes. Metsulfuron methyl has been effective at controlling a variety of noxious species that may become unresponsive to other herbicide treatments and has been effective at controlling tall whitetop, perennial pepperweed, bull thistle, musk thistle,

Scotch thistle, and yellow starthistle. Under Alternative 2, metsulfuron methyl is proposed for aerial broadcast, ground broadcast, and spot applications.

Off-site drift from ground and aerial applications does have the potential to damage sensitive plant species outside of the application area for both typical application rates (0.03 lb a.i./ac) and high application rates (0.15 lb a.i./ac). For aerial and ground applications, damage to sensitive plants was modeled to within 500 to 900 ft of the treatment area, with higher risks of damage closer to the treatment areas. Tolerant plants may also experience damage from broadcast treatments, with aerial applications potentially causing damage to plants within 25 ft of the application area. Tolerant species with inside treatment areas may also experience damage during any broadcast treatments.

Surface runoff could also pose significant risks to sensitive plant species. Modeling performed by the U.S. Forest Service (SERA 2005) indicates a moderate to high risk of damage to sensitive plants in areas with clay soils and more than 15" of annual rainfall and low risk of damage to tolerant plant species in areas with more than 50" of rainfall per year. Metsulfuron methyl is not likely to impact sensitive or tolerant plant species in areas with loamy to sandy soils.

Additionally, wind erosion also has the potential to damage sensitive plant species. BLM modeling indicated that soils contaminated with metsulfuron methyl could pose a risk of damaging sensitive plant species during significant wind erosion events, such as dust storms due to the moderate persistence of the herbicide in soils (BLM 2007). On the Navajo Nation, such damage could potentially occur if dust storms occur a few days after herbicide treatments are implemented in some areas.

Metribuzin

Metribuzin is a selective herbicide used for the treatment of broadleaf weeds and grasses. It is classified as a Photosystem II inhibitor, which blocks the transfer of electrons during photosynthesis causing damage to chlorophyll and several lipids and proteins and resulting in abnormal growth and death. It can be used as both a pre-emergent and post-emergent herbicide for the control of weeds such as thistles, Dalmatian toadflax, kochia, field bindweed, and johnsongrass. Under Alternative 2, metribuzin can be used in aerial broadcast, ground broadcast, and spot treatments.

Off-site drift has the potential to cause significant risks to sensitive plant species within 15 feet of the treated area. Metribuzin, as well as at least one of its metabolites, is considered highly mobile in soil, and therefore surface runoff could also pose serious risks to sensitive plant species. Additionally, wind erosion could potentially cause damage to sensitive species, as the compound shows low to moderate persistence in the soil, with a half life of up to approximately 3 weeks depending on soil type (EFSA 2006).

Paraquat

Paraquat is a selective herbicide used to control annual broadleaf weeds and grasses. It is classified as a Photosystem I inhibitor, meaning it interrupts the exchange of electrons during photosynthesis, initiating a chain of oxidation and reduction reactions that eventually weaken the integrity of cell membranes causing leaf wilt and desiccation. Paraquat is used as both a pre-emergent and post-emergent herbicide and has shown to be effective in the control of musk thistle, cheatgrass, and Russian thistles. Under Alternative 2, paraquat would be approved for aerial broadcast, ground broadcast, and spot application treatments.

Off-site drift from aerial applications are expected to result in the most impact to non-target plant species outside of the treatment area. EPA analysis determined that damage could happen to sensitive plant species at higher application rates (max rate 11lb a.i./ac) but that damage from drift or runoff was less likely at lower application rates (0.07 lb a.i./ac) (EPA 1997). Their analysis also indicated that aerial applications at the higher rate would likely pose a risk to non-target plants but would likely not cause harm during ground applications.

Because paraquat binds strongly to soil particles, wind erosion and surface runoff are not likely to impact non-target plant species outside of the treatment area (EPA 1997)

Pendimethalin

Pendimethalin is a selective herbicide used to control broadleaf weeds and grasses and is approved for pre-emergent use. It is classified as a mitosis inhibitor, where it disrupts the formation of microtubules in dividing cells, preventing cell growth, seedling development and roots. It is most effective on roots of developing weeds. Under Alternative 2, pendimethalin can be used for aerial broadcast, ground broadcast, and spot applications. It is effective for the treatment of kochia and rescuegrass.

Off-site spray drift of broadcast applications of pendimethalin could potentially impact sensitive plant species. The EPA Spray Drift Task Force did find during its studies that indicated that ground broadcast applications could lead to 1% volume of the herbicide traveling 100ft from the treatment site and 5% of aerial applications (EPA 1996)

Because pendimethalin is persistent within soils and strongly binds to clay particles, it does have the potential to damage sensitive plant species during surface runoff events. The EPA analysis of pendimethalin characteristics indicate that such damage would occur during heavy rainfall events immediately after applications. However, pendimethalin's strong affinity for soil particles would make reduce the longevity of such impacts (EPA 1996).

Damage from wind erosion is not seen as a likely risk due to how strongly adsorbed pendimethalin is to soil particles. While events such as dust storms are likely to move soils contaminated with the herbicide outside of the application area, much of the herbicide would be unavailable to plants.

Picloram

Picloram is a selective herbicide used for the control of annual broadleaf and woody plant species, with some effectiveness on grasses. It is classified as a synthetic auxin which results in abnormal growth or death for treated plants. Picloram is used as a post-emergent herbicide and can help suppress spotted knapweed. However, some weeds have developed a resistance to picloram, including yellow starthistle. Under Alternative 2, picloram can be used in aerial broadcast, ground broadcast, and spot application treatments.

Offsite drift of picloram for aerial and ground broadcast applications may cause significant damage to sensitive plant species outside of the application area. AgDrift modeling by the U.S. Forest Service (SERA 2011c) indicates that for aerial applications, plants within 25 ft of the treatment area have a high risk of damage with risk decreasing up to 1000 ft away. For ground broadcast applications, plants within 1000ft of the application area have low to moderate risk of damage with, damage increasing with closer proximity to the treatment area. Tolerant species have a low risk of impact if found within the application area, but are not likely to be impacted outside of the area.

Runoff does present a risk to sensitive non-target plant species in areas where runoff is favored, such as areas with high clay soils and a wide range rainfall amounts. GLEAMS modeling by the U.S. Forest Service (SERA 2011c) indicates that areas with high clay soils and annual rainfall above 15 inches per year can be at significantly high risk for damage, with the risk increasing with higher precipitation. Modeling also indicated a low risk for sensitive plants in watersheds with loamy soils and 100-150 inches of annual rainfall. Tolerant species are not likely to be impacted by runoff from treated areas.

Because picloram can persist for a significant amount of time, there is a risk of damage from wind erosion to sensitive plants (BLM 2007). Damage from wind erosion is most likely in arid environments and after dust storm events that impact treated areas. On the Navajo Nation, dust storms are becoming more frequent, increasing the risk of pesticide transport and indirect damage (Draut et al. 2012).

Prodiamine

Prodiamine is a selective herbicide used for the control of annual broadleaf weeds and grasses. It is also classified as a mitosis inhibitor and is most effective as a pre-emergent herbicide. The herbicide kills and prevents seedling growth by interfering with the formation of microtubules in dividing cells. Under Alternative 2, prodiamine can be used in ground broadcast and spot applications.

Prodiamine is highly persistent in soils (soil half-life of up to 120 days), and binds strongly to soil particles (University of Hertfordshire 2013), thus there is the potential off-site transport through surface runoff or wind erosion as sediment is transported away from treated areas.

Damage to non-target species from these routes, however, would likely be limited due to its low solubility in water and strong affinity for soil particles.

Overall, aerial and ground broadcast spraying of herbicides have the most potential to impact native plant populations as they are used to treat large areas with little specificity for native plants within the area. Use of broadcast and aerial spraying could impact non-target plants as pesticide drift would also increase. Plants could experience no effect, reduced vigor, or death depending on the sensitivity of the plant species to the specific pesticide and the dose the plant was subjected to. The use of such methods, however, would be limited to areas where noxious weeds have effectively crowded out native vegetation and where plant species of concern are not present. Broadcast spraying would also not be permitted under certain weather conditions, such as windy events or periods where precipitation is anticipated. The mitigation measures specified below would effectively reduce the overall impacts treatments on desired native vegetation within project areas.

Thifensulfuron methyl

Thifensulfuron methyl is a post-emergent herbicide used to control broadleaf weeds. Under Alternative 2, it can be applied through aerial broadcast, ground broadcast, and spot application treatments. Thifensulfuron methyl is classified as an ALS inhibitor which interferes with a key enzyme in plants used to synthesize necessary amino acids and proteins, eventually resulting in the death of the plant. Thifensulfuron methyl is often used for the control of spreading wallflower and is highly potent even at low application rates. It is often used in combination with tribenuron methyl.

Off-site drift could pose significant damage to sensitive plant species, especially valuable crops. Lee et al. (2005) listed thifensulfuron methyl as one of 28 “high potential risk” herbicides with regard to off-site drift, based on peer-reviewed studies showing damage to non-target species at sublethal levels, and frequency of drift complaints lodged with state and county agriculture agencies.

Surface runoff could also pose significant damage to sensitive vegetation as thifensulfuron is weakly adsorbed to soil particle (particularly in soils with low organic content, as in many areas across the Navajo Nation), increasing the chances of off-site transport (PSD 1991). Risk of damage is most significant in areas with high runoff potential (clay soils and heavy annual rainfall). On the Navajo Nation, the risk of damage from surface runoff would be most pronounced in washes neighboring treatment areas during heavy rainfall events.

Wind erosion also has the potential to cause unintended impacts on nontarget sensitive plant species. With a relatively long half-life in soil (up to approximately 3 weeks), significant quantities of herbicide may be transported off-site by erosion from wind events occurring days or weeks after application (PSD 1991).

Triclopyr

Triclopyr is a selective herbicide used for the control of broadleaf and woody species. It is classified as a synthetic auxin which works by disrupting the normal growth and viability of plants. There are two commercial formulations of triclopyr, triclopyr TEA and triclopyr BEE. Triclopyr TEA has relatively lower toxicity for terrestrial plants (NOEC=0.333lb/ac) than triclopyr BEE (NOEC=0.003lb/ac), making the risk characterization for triclopyr TEA lower than for triclopyr BEE. Triclopyr TEA is also EPA-approved for aquatic use. It is effective at controlling woody species such as salt cedar and Russian olive because it does not damage grasses and sedges (Washington Department of Ecology 2004). It is proposed for use under Alternative 2 for aerial, ground broadcast, spot, and aquatic applications.

Potential for damage from off-site drift is largely a factor of application method and distance from the initial treatment site. At the typical application rate (1 lb a.i./ac) for either formulation, AgDrift modeling indicated that potentially damaging exposure to sensitive plants could occur within 300ft of the application site. At the maximum application rate (10 lbs a.i./ac), damage from drift would affect plants at a distance greater than 900 feet from the application site (BLM 2007, SERA 2011d). Additionally, broadcast spraying has also been found to decrease the diversity of lichens and bryophytes, especially less drought tolerant species (Newmaster et al. 1999). It is also shown to inhibit the growth of ectomycorrhizal fungus of conifers, potentially impacting the growth and establishment in forested areas (SERA 2011d).

For damage from surface runoff, triclopyr TEA has the potential to cause some damage during high rainfall events (greater than 200 in/yr) in areas with clay soils. Triclopyr BEE poses higher risks due to its higher toxicity and could impact sensitive plants in areas with rainfall averaging between 15 to 25 inches per year. Risk to sensitive plant species significantly increases if the maximum application rate is used, with triclopyr acid potentially impacting plants in clay, loamy, and sandy soils in areas with 25 inches or more of rainfall per year and triclopyr BEE harming plants in all but the most arid environments (BLM 2007).

Wind erosion also poses the risk of damage to sensitive plant species. Modeling done by the U.S. Forest indicated that following significant wind erosion events (i.e. dust storms), sensitive plant species may be impacted within 50 feet of the application area (SERA 2011d). The impacts of wind erosion largely depend on the timing of applications and the distance to the application site.

Table 4-4. Herbicide selectivity and application timing. Selectivity indicates if the herbicide targets specific types of plants. Pre-emergent herbicides are those that are applied to sites before plants emerge. Post-emergent herbicides are applied after the plants have emerged and are actively growing. Refer to the herbicide label for specific timing instructions for applications. For impacts analysis, risk of damage is based on a comparison of the modeled hazard quotient and the EPA calculated level of concern for sensitive and tolerant plant species or the toxicity level at which damage can occur. Low risk = 1-10x LOC, Moderate Risk = 10-100x LOC, High Risk = >100x LOC, Not likely <1xLOC.

Herbicide	Selectivity	Mode of Action*	How it Works	Pre-emergent	Post-emergent	Off-Site Drift Impacts	Wind Erosion Impacts	Surface Runoff Impacts	Source
2,4-D	Broadleaf Weeds	Synthetic Auxin	Growth regulator	X	X	Moderate to slight risk to sensitive plants 100-300ft from application area with distance increasing with higher application rates (0.5 - 4lbs /ac). Not likely to impact tolerant plants.	Not Likely	Slight risk for sensitive plants in clay soils with over 15" annual rainfall. Not likely to impact tolerant plants.	USFS
Aminopyralid	Broadleaf Weeds	Synthetic Auxin	Growth regulator		X	High to slight risk to sensitive plants 50-300ft from application area with risk increasing as distance decreases and application rate increases (0.03-0.11lb/ac). Not likely to impact tolerant plants Ground broadcast applications only.	Not Likely	Slight risk for sensitive plants in clay soils with 15" of annual rainfall. Not likely to impact tolerant plants.	USFS
Atrazine	Broadleaf weeds and grasses	Synthetic Auxin	Growth regulator	X	X	Moderate to low risk to sensitive plant species at 66ft from application area for all application rates (1-4 lbs/ac). Potential for risk could extend up to 1000ft for ground and 1 mile for aerial treatments at higher application rate. Higher risk for aerial applications than ground applications. Highest risk for plant seedlings and aquatic vegetation	Not Examined	Risk of damage for sensitive plants in runoff areas is present due to high persistence in soils and weak soil adsorption.	EPA
Chlorsulfuron	Perennial broadleaf weeds and grasses	ALS Inhibitor	Blocks protein synthesis	X	X	Sensitive plants have a risk of impact at all application rates (0.047-0.062 lb/ac) up to 900ft away from the application site. Higher risks associated with closer distances. Not likely to impact tolerant plant species. Ground broadcast applications only.	Not Likely	Sensitive plants have moderate risk in areas with clay soils and more than 15" of annual rainfall. Tolerant plants not likely to be impacted in area.	BLM USFS
Clopyralid	Broadleaf weeds	Synthetic Auxin	Growth regulator		X	High to slight risk to sensitive plants up to 500ft from application area. Risk increases with decreasing distance to application area and increasing application rates (0.35 - 1lb/ac). Not likely to impact tolerant plant species.	Not Examined	Slight risk to sensitive plants in areas with clay soils and more than 15" of annual rainfall. Not likely to impact tolerant plant species.	USFS
Dichlobenil	Annual and perennial grasses, broadleaf weeds, and woody plants	Cellulose Inhibitor	Inhibits cellulose production	X	X	Not examined, but potential for drift to impact aquatic communities from ground applications. No buffers were indicated.	Not Examined	Potential for damage to sensitive plants when concentrations exceed 0.23lb/ac in surface waters. It is estimated that 2% of dichlobenil runs off site following applications. Potentially high to low risk of damage to sensitive species based on concentration applied to site.	EPA

Herbicide	Selectivity	Mode of Action*	How it Works	Pre-emergent	Post-emergent	Off-Site Drift Impacts	Wind Erosion Impacts	Surface Runoff Impacts	Source
Diflufenzopyr	Annual broadleaf weeds and annual grasses	Auxin Transport Inhibitor	Inhibits growth		X	Low risk to sensitive plant species within 25ft of the application area at all application rates (0.075 - 0.1 lb/ac) for all broadcast applications. Low risk to listed species within 100ft of application area for all broadcast applications. Not likely to impact tolerant species.	Not Likely	Low risk to sensitive plants in areas with clay soils and more than 25" of annual rainfall and in loamy soils in areas with more than 50" of annual rainfall.	BLM
Fluroxypyr	Broadleaf weeds	Synthetic Auxin	Growth regulator		X	Moderate to low risk to sensitive plants up to 900 ft for aerial and high boom ground applications and 500ft for low boom applications at traditional application rate (0.5 lb/ac). Low risk to sensitive plants during backpack applications up to 100ft. Low risk to tolerant plant species within the treatment area.	Not Likely	Not Likely	USFS
Fluazifop-p-butyl	Annual and perennial grasses	ACCCase Inhibitor	Growth regulator		X	Low risk to sensitive plant species at traditional application rate (0.32 lb/ac): up to 300ft for aerial applications with fine droplets and 100ft with coarse droplets, 100 ft for ground high boom and 25 ft for ground low boom applications. Not likely to impact tolerant plant species.	Not Likely	Not Likely	USFS
Glyphosate	Non-selective	EPSP Synthase Inhibitor	Blocks protein synthesis		X	High to moderate risk of damage to sensitive plant species at application rate of 1 lb/ac up to 900 ft from application area from aerial applications. Low risk for ground applications at the same rate up to 500 ft from application area. Not likely to impact tolerant plant species outside of application area.	Not Likely	Not Likely	USFS**
Imazapic	Broadleaf weeds	ALS Inhibitor	Blocks protein synthesis	X	X	Low risk to sensitive plant species at a range of application rates (0.0313-0.1875 lbs.ac) up to 100 ft from application area for aerial applications. Very low risk up to 50ft for ground applications. Not likely to impact tolerant plant species outside treatment area.	Not Likely	Low risk to some sensitive plant species at the maximum application rate (0.1875 lbs/ac) in areas with clay soils and 50-150" of annual rainfall.	BLM

Herbicide	Selectivity	Mode of Action*	How it Works	Pre-emergent	Post-emergent	Off-Site Drift Impacts	Wind Erosion Impacts	Surface Runoff Impacts	Source
Imazapyr	Annual and perennial grasses and broadleaf weeds	ALS Inhibitor	Blocks protein synthesis	X	X	High risk of damage to sensitive plant species at typical and high application rates (0.45lb/ac to 1.5 lb/ac) for aerial and high boom broadcast treatments. High to moderate damage for ground broadcast treatments, and moderate to low damage with backpack treatments. All are at or below 900 ft from application area. Low risk of damage to tolerant plants within the application area. Not likely to impact outside of the area.	Potential for damage to sensitive plant species from contaminated dust during significant wind erosion events (i.e. dust storms)	Moderate to low risk to sensitive plant species in areas with clay soils and moderate rainfall (above 25" of annual rainfall). Risk of damage increases with higher rainfall, higher application rates, and higher clay soil content.	BLM USFS
Isoxaben	Broadleaf weeds, grasses, and vines	Cellulose Inhibitor	Inhibits cellulose production	X		Low risk to sensitive plants species within 25ft of application area for ground broadcast treatments (0.75 lb/ac). At higher application rates (1 lb/ac), sensitive species may be impacted within 250ft of the treatment site. Not likely to impact tolerant plant species.	Not Examined	Moderate risk to sensitive plant species in areas with potential for runoff (high clay soils and moderate at annual rainfall) at high application rates (1 lb/ac). Risks decreases with lower annual rainfall and lower application rates.	USFS EPA
Metsulfuron metyl	Annual, biennial, and perennial broadleaf weeds and brush	ALS Inhibitor	Blocks protein synthesis		X	Moderate to low risk of damage to sensitive plant species within 500ft of application area under typical aerial application rates (0.03lb/ac). Sensitive plants could be damaged within 900ft of the treatment area under application rates (0.15lb/ac) for aerial applications. For ground applications, low risk of damage to sensitive plants within 500ft of the treatment area at all application rates. Some risk of damage to tolerant plants within the application area for ground applications and within 25ft of the application area for aerial applications.	Potential for damage to sensitive plant species from contaminated soil during significant wind erosion events (i.e. dust storms).	Moderate to high risk of damage to sensitive plants in clay soils with annual rainfall totals over 15". Low risk of damage to tolerant species in clay soils with greater than 50" of annual rainfall.	USFS BLM
Metribuzin	Broadleaf weeds and grasses	Synthetic Auxin	Growth regulator	X	X				EPA
Paraquat	Annual broadleaf weeds and grasses	Photosynthesis I electron diverter	Cell membrane disruptor	X	X	Not likely to impact sensitive plant species through ground or aerial applications at lowest application rate (0.07 lb a.i./ac). Some risk of damage to sensitive species during aerial applications at max application rate (1 lb a.i./ac).	Not Likely	Not Likely	EPA

Herbicide	Selectivity	Mode of Action*	How it Works	Pre-emergent	Post-emergent	Off-Site Drift Impacts	Wind Erosion Impacts	Surface Runoff Impacts	Source
Picloram	Annual and perennial broadleaf weeds and brush	Synthetic Auxin	Growth regulator		X	High to low risk of damage to sensitive plants up within 900ft of application area under aerial applications (0.35lb/ac). Moderate to high risk of damage to sensitive plants up to 900 ft of application area under ground broadcast treatments. Low risk of damage to tolerant species within application area for both broadcast treatments	Potential for damage to sensitive plant species from contaminated soil during significant wind erosion events (i.e. dust storms).	Moderate to high risk of damage to sensitive plants in clay soils with annual rainfall totals over 15" and potential risk of damage in loamy soils with rainfall around 100" annually. Not likely to impact tolerant plant species.	BLM USFS
Thifensulfuron methyl	Broadleaf weeds	ALS Inhibitor	Blocks protein synthesis		X			Significant risk of damage due to weak adsorption to soils. Risks are highest in clay soils with moderate annual rainfall.	EPA
Triclopyr	Broadleaf weeds and woody plants	Synthetic Auxin	Growth regulator		X	Moderate to low risk of damage to sensitive plant species depending on application rate. At typical rate (1lb/ac), damage could occur within 300ft of application site. At maximum rate (10 lbs/ac), damage could occur within 900ft of application site. Not likely to impact tolerant plant species.	Low risk to sensitive plant species up to 50 ft. from the treatment site with ground applications, with higher risk of damage following significant wind erosion events after applications.	Low risk of damage to sensitive plant species. Potential damage in areas with clay soils and heavy rainfall events. Risk of damage is higher for triclopyr BEE.	BLM USFS
Pendimethalin	Broadleaf weeds and annual grasses	Mitosis Inhibitor	Interferes with new plant growth	X	X	Potential for damage to sensitive plants. EPA Spray drift studies estimate rate at 100 ft downwind from treated site are 1% of applied spray volume from ground applications and 5% from aerial applications.	Not Likely	Potential for damage to sensitive plant species during runoff events. Damage most likely during heavy rainfall immediately after applications	EPA
Prodiamine	Broadleaf weeds and grasses	Mitosis Inhibitor	Interferes with new plant growth	X					

**Assessment for higher toxicity formulations

4.5.1.3 Alternative 3 – No Biological Control

This Alternative would limit management techniques available and the impacts of other treatments. Although this Alternative would have similar impacts to Alternative 2 for mechanical, cultural, manual, and chemical treatments, without the use of biological control, the long-term and large-scale effectiveness of those treatments may be limited. Treatment sites with heavy infestations of species targets by biological controls would need to be retreated more often using other methods, such as chemical or mechanical control.

It is important to note that agencies adjacent to the Navajo Nation have already begun implementing the use of biological controls on their lands, such as the U.S. Forest Service and the City of Flagstaff. These releases suggest that biological control agents may move onto the Navajo Nation, if they have not already. Thus, the No Biocontrol Alternative does not guarantee that such agents will not be present in the region, but that BIA would not be authorized to perform releases, monitor populations, or manage agents for the purposes of weed control. This would include the movement of agents to areas where they may be more effective at controlling target weed populations.

Without the use of biological control, many of the proposed target weed species that have permitted biological control agents would have an increased potential for spread on the Navajo Nation. An expansion in their populations would increase their impacts on the landscape and may require the BIA to redirect weed control projects toward addressing such problem populations. Since this passive method of control would not be available, proposed control treatments for specific sites would be higher in cost to account for the use of mechanical and/or chemical treatments used.

4.5.2 Threatened, Endangered, Candidate, and Sensitive (TEC&S) Plant Species

As discussed in Chapter 3, the Navajo Nation supports 39 plant species that have been given a special status based on their rarity or sensitivity. Special status plants include 7 species that are federally listed as threatened or endangered, and one for which there is a conservation agreement in place that precludes the need for federal listing. The remaining 31 special status species are tribally listed through the Navajo Nation Department of Fish and Wildlife (NNDFW). Many of these species are threatened by competition with nonnative plants and other noxious species, and therefore weed control treatments have the potential to improve habitat for TEC&S plant species. Herbicides, biological control agents, and other weed control treatments, however, may also pose negative effects to particular TEC&S plant species. The potential effects of each alternative on TEC&S plant species are discussed below.

4.5.2.1 Alternative 1 – No Action

Under the No Action alternative, some weed treatments would still be implemented on the Navajo Nation, with impacts as described above for the Proposed Alternative. However not all the weed species listed in the plan would be targeted, and thus some weeds could continue to expand and invade native plant communities, potentially degrading the habitat TEC&S plant

species. Moreover, weed control treatments on the Navajo Nation would continue to be conducted in a piecemeal fashion rather than as part of a coordinated, integrated effort. Attempting to control weeds in this manner reduces the overall effectiveness of the treatments, and allows for continued degradation of native plant communities including TEC&S species.

Additionally, as described earlier in this document, several weed species including Russian thistle, red brome, and cheatgrass can increase the likelihood of wildfires in an ecosystem. These wildfires can directly kill TEC&S plant species and indirectly impact them by degrading the hydrologic regime and other aspects of their habitat.

4.5.2.2 Alternative 2 – Proposed Action

All of the weed control techniques considered for use under Alternative 2 have the potential to impact populations of TEC&S plant species. However, implementation of the mitigation measures described below along with the buffers required or recommended by the U.S. Fish and Wildlife Service (FWS) and/or the NNDFW for projects in the vicinity of TEC&S plant species populations should minimize the potential for harm from most control methods. Two control methods, biological controls and herbicides, could potentially impact TEC&S plant species despite these measures, as effects from both of these methods can spread beyond their intended taxonomic or geographic targets.

As described above and in Chapter 2, biological controls utilize organisms which target specific weed species and through predation or parasitism reduce the ability of the weed to thrive and outcompete native species. Biological control agents are rigorously tested for host-specificity before being approved for use in the wild, to minimize the chance that the organism will switch hosts from the weed to a native species and cause unintended harm. Thus there should be no direct effect on TEC&S plant species from the use of biological controls. There may, however, be indirect effects of biological control agents on native species, including TEC&S species, if the weed species being targeted has become well established in the vegetation community, and has come to serve an important ecological role in the community (Pearson and Callaway 2003). An important local example is the case of the tamarisk leaf beetle, which, as discussed in Chapter 2, caused unintended harm to the southwestern willow flycatcher by decimating its nesting habitat. This species is not being considered for further use in the area, but the example points to the necessity to thoroughly study the possible unintended consequences of biological control agents before utilizing them for weed control.

Despite the rigorous testing of potential biological control agents for host-specificity, there have also been cases in which a biological control agent, once released into the wild, has directly impacted populations of native species, particularly when those native species are closely related to the weed species being targeted. As described above, the flowerhead weevil (*Rhinocyllus conicus*) has been used to control exotic thistles in the U.S. Despite being tested for host-specificity before its release, the weevil has since shown that it can cause harm to native thistles as well as the weeds it was intended to control (Louda et al. 1997). The only TEC&S plant

species on the Navajo Nation which is closely related to a weed species being proposed for biological control is Rydberg's thistle, and while the flowerhead weevil is not being considered for control of exotic thistles under this plan, the potential for negative impacts on this species should be carefully considered before utilizing any biological control agent to treat exotic thistles.

Herbicides also have the potential to impact TEC&S species, particularly by spray drift if aerial spraying is used. With the large number of herbicides being considered for use in the plan (21) and TEC&S plant species in the study area (39), it is not feasible to discuss the potential impacts of each herbicide on each species here. Instead, a general discussion of broad classes of herbicides on different categories of TEC&S plant species will be presented.

Herbicides are typically classified as either "broad-spectrum" or "selective" based on whether their mode of action works on plants in general or targets one or more specific plant groups (broadleaf dicots, grasses, shrubs, etc.). See Table 4-4 for the selectivity classification of herbicides proposed for use in the plan. Broad spectrum herbicides considered for use in the plan include glyphosphate, imazapyr, paraquat, picloram, thifensulfuron-methyl, and triclopyr. These herbicides have the potential, if used inappropriately, to impact any of the TEC&S species on the Navajo Nation.

The remainder of the herbicides considered in the plan are selective to one degree or another. Herbicides which are selective for grasses and/or sedges could impact any of the six listed monocot species such as Navajo sedge or Gooding's onion. Several herbicides are selective for annual grasses, and thus could particularly impact Parish's alkali grass (the only listed annual grass in the study area). Most of the herbicides under consideration are selective for broadleaf weeds, and thus have the potential to impact any of the 24 listed broadleaf dicots, as well as the Utah bladder fern. A few herbicides are selective for woody species, including fluroxypyr, glyphosphate, and metsulfuron-methyl. These herbicides could impact woody species on the federal and Navajo Nation lists, which include round dunebroom, Navajo saltbush, Grand Canyon goldenweed, and Arizona rose sage. Cacti are often somewhat resistant to foliar herbicide application due to their thick, waxy cuticle, but the four TEC&S cacti in the study area may be impacted by herbicides that are absorbed through the roots, such as atrazine, fluroxypyr, imazapyr, and others considered for use in the plan.

Unintended impacts to TEC&S plant species, while always a possibility with the use of herbicides to control weeds, can be minimized by following the mitigation measures listed in the previous section, and by observing the required or recommended buffer zones around populations of TEC&S species when planning treatments.

4.5.2.3 Alternative 3 – No Biological Control

This Alternative would result in similar impacts to those described above for the Proposed Alternative, but without the potential impacts from biological control agents. However, by not

utilizing biological control agents, land managers would be required to lean more heavily on other control techniques, such as pesticides and mechanical removal, and thus the potential for negative impacts from those techniques would be increased under this Alternative.

4.5.3 Wetlands

Effects of both weeds and weed control treatments on water quality were assessed in the Water Resources section. Weed infestations can pose problems for riparian areas and emergent wetlands in several ways, by lowering the water table or increasing bank erosion and channelization, as well as by outcompeting native species and degrading wetland habitat for native plants and the animal species that depend on them. Weed control treatments can also impact riparian and wetland areas by increasing sedimentation and turbidity, or by contamination from herbicide use. These effects to water quality can likewise impact riparian and wetland vegetation, as described below for each of the Alternatives.

4.5.3.1 Alternative 1 – No Action

Under the No Action Alternative, some weed treatments would still be implemented, with the potential effects as noted for Alternative 2. These effects, however, both positive and negative, would be weaker under this Alternative as treatments would not be as widespread across the Navajo Nation. Moreover, lacking a coherent, integrated weed management strategy, the negative effects of weed infestations on native species, including riparian and emergent wetland species, would be felt more strongly than under either of the Action Alternatives.

4.5.3.2 Alternative 2 – Proposed Action

Under this Alternative, weed control treatments could have the effect of increasing surface runoff from cleared areas, which could increase sedimentation and turbidity in riparian areas and emergent wetlands. Although increased sedimentation and turbidity are known primarily to affect the fauna in wetland ecosystems, they can also result in decreases in macrophyte growth and diversity as less light penetrates the water column (Henley et al. 2000). However, any increases in sedimentation and turbidity resulting from clearing weeds from a given area would likely be short term in nature, as natural plant regrowth and/or active restoration after treatment would reduce this effect until the sediment load in the affected riparian area or emergent wetland returned to approximately its pre-treatment condition.

Herbicides sprayed manually or aerially have the potential to affect riparian areas and emergent wetlands either directly, through spray drift, or indirectly, through migration in the groundwater away from target sites. Contamination of water resources could lead to unintended impacts to riparian and wetland vegetation, as non-target plants could be harmed by herbicides in the water they depend upon. Careful application of herbicide treatments, following the manufacturers' recommendations along with the buffer zones and mitigation measures described above should minimize the potential for negative impacts from herbicide treatments. Only aquatic approved herbicides will be permitted for application near wetlands. Non-aquatic approved herbicides

with high aquatic toxicity, such as picloram, will require a 300ft buffer from the daily high water mark.

Overall, impacts to riparian and emergent wetland plant species from weed control treatments under this alternative are likely to be minimal, and of short duration. The long-term benefits of removing or minimizing the presence of noxious, nonnative species will likely outweigh any potential negative effects.

4.5.3.3 Alternative 3 – No Biological Control

Effects under this Alternative would be similar to those noted above for the Proposed Alternative. However, without the use of biological control treatments, treated areas would be focused on the use of mechanical and/or herbicide treatments, thus resulting in increased negative impacts relative to the Proposed Alternative. Under this Alternative, fewer acres would be treated. However, overall positive impacts from the removal of weed species and restoration of native plant communities would be similar.

4.6 Wildlife

4.6.1 Threatened, Endangered, Proposed, and Sensitive Fish Species and Designated Critical Habitat

There are six fish species that have special status based on their sensitivity, rarity and restricted ranges on the Navajo Nation. Five species are federally listed as endangered and candidate (E&C). One fish species is tribally listed (G4) by the Navajo Nation Department of Fish and Wildlife (NNDFW). There is not sufficient information to determine that the species is in jeopardy, but there is reason to consider it. Effects from the treatment methods are analyzed based on their impacts to the following E, C&G4 species and/or their designated or proposed critical habitat (CH): Colorado pikeminnow (E), humpback chub (E), razorback sucker (E), Zuni bluehead sucker (E), roundtail chub (C) and mottled sculpin (G4). There would be no direct effects to E, C&G4 fish species because there are no treatments that are proposed to target weeds within aquatic habitats. Treatments would occur adjacent to CH for Colorado pikeminnow, humpback chub, razorback sucker, and Zuni bluehead sucker.

Five of the six E, C&G4 species occur only within the San Juan River, along the northern border of the Navajo Nation. The San Juan River has naturally high turbidity of 10 Nephelometric Turbidity Unit (NTU) due to the input of high sediment loads from tributaries in Arizona and New Mexico during thunderstorms in April – June and the highly erodible geology (USBR 2002). A level of 5 NTU is the maximum turbidity level for drinking water standards; ideally levels should be below one NTU. Additionally, other inputs of sediment occur from agricultural plots that occur along the banks of the San Juan River, and from roads that access these plots. Livestock grazing along the bank of the river also contributes to increased sediment loads. Organochlorine pesticides are found in low concentrations from agriculture along the San Juan River; however, are not significant enough to affect fish and wildlife (USGS 1998). Elevated

contaminants that have been shown to affect fish reproduction and overall health and are detected in the San Juan River include aluminum, arsenic, copper, selenium, zinc and polynuclear aromatic hydrocarbons (PAH) (SJRIP 1999). Aluminum is associated with the sediment geology and increases with higher flows. Selenium is naturally occurring in alkaline soils and outcrops of selenium bearing rocks of Cretaceous marine origin; however, levels tend to be higher near irrigated farm lands, uranium mining, and oil refineries (USBR 2002). PAH occurs naturally and are byproducts from combustion engines, coal fired generation plants and forest and agricultural fires (USBR 2002). Zinc occurs from mine tailing in the Upper Animas River; and there is no identifiable source for copper (USBR 2002).

Zuni bluehead sucker occurs in smaller drainages on the Navajo Nation within four subunits including Kinilichee Creek, Red Clay Wash, Canyon de Chelly, and Little Whiskey Creek. Zuni bluehead suckers require small desert stream systems that have clean, clear water and abundant riparian vegetation. This species is highly susceptible to increased sedimentation, which affects reproduction and the availability of food resources.

4.6.1.1 Alternative 1 – No Action

There would be no direct effects to E, C&G4 fish species because no aquatic treatments would occur in the project area. Minimal, uncoordinated non-native weed treatments would continue to occur in riparian areas under the current management strategy. Non-native weed infestations would continue to expand, which could lead to long-term degradation of the riparian conditions. The expansion of weeds within riparian areas would result in long-term alteration of the aquatic habitat by interrupting natural relationships of native plants to biological, geomorphological and hydrological processes and features. Some of these processes and features include geomorphology of the stream bank, morphology of the channel (i.e. width and depth), natural dissipation of flood energy, transport of sediment, ground water recharge, maintaining aquatic and riparian food chains, and maintaining water temperatures. The invertebrate food base would be compromised and limited to species that occur on noxious vegetation.

The increased risk of fire potential would also result in both direct and indirect impacts to fish species on the Navajo Nation. There would be an increased fire potential from saltcedar and Russian olive infested areas that would further reduce native vegetation that is not adapted to fire. An indirect impact of this effect would be faster expansion of saltcedar since it is adapted to fires. The effects to E, C&G4 fish species and/or critical habitat in a fire event include a reduction in local populations and adverse changes to aquatic habitat due to direct mortality or indirectly from increased sedimentation, nutrients, and ash input into the stream. Turbidity would increase and prevent beneficial algal production for benthic feeding fish.

The expansion of fire-adapted non-native weeds in upland areas, such as cheatgrass, would increase the wildfire potential for these areas. Wildfires in the upland areas would cause increased erosion, runoff, and ash that would directly or indirectly affect the aquatic habitat. Turbidity would increase and prevent beneficial algal production for benthic feeding fish. The

effects to E, C&G4 fish species and/or critical habitat include a reduction in aquatic habitat quality and food supply.

Implementation of this action would result in the greatest expansion of weeds throughout the project area and riparian corridors. Non-native weed treatments that do occur under this alternative would primarily be chemical treatments and have similar effects as discussed above for the other alternatives. This alternative would have minimal, short-term impacts to critical habitat and existing fish species composition and population trends of E, C&G4 fish species in the project area.

4.6.1.2 Alternative 2 – Proposed Action

Weed treatments are proposed for riparian and upland areas along habitat of all fish species and critical habitat for the Colorado pikeminnow, humpback chub, razorback sucker, and Zuni bluehead sucker. Repeated treatments in the riparian areas using various methods would be necessary for most weed species because seeds in the soil can be viable for 5, 10, or more years. Therefore, reoccurring treatments would be authorized until the desired control objective is reached. The annual combination of methods to be used is expected to vary depending on specific site conditions.

Mechanical, manual and cultural treatments within upland and riparian areas would have short-term, localized impacts on vegetation and soil. When vegetation is removed utilizing these methods, bare soil would be exposed with the potential to cause temporary and localized turbidity in the water bodies. Implementing best management practices (BMPs) would minimize runoff and soil erosion off of treatment areas so that any sediment moving into species' habitat would be such a small amount that it would be an immeasurable effect to the species or its habitat. Prescribed burns would create ash, which would temporarily and locally increase turbidity. Pile burning and prescribed burns would require a site specific burn plan and would be conducted 300ft outside of the floodplain. Mitigation measures and BMPs would be applied to minimize effects to species habitat. These measures were developed in consultation with the U.S. Fish and Wildlife Service and the Navajo Nation Department of Fish and Wildlife specifically for the Navajo Nation Integrated Weed Management Plan. The use of biological treatments would have no direct effects to E, C&G4 fish species or their habitat, and may potentially provide an additional food source for insectivorous fish. Also, the use of biological control near aquatic habitats would result in less erosion impacts. Biological controls typically decrease vigor in host plants; leaving the root system in tact to hold the soil in place.

4.6.1.2.1 Effects of Herbicides on Aquatic Organisms

There are 20 herbicides proposed for use, however only herbicides that have been determined to be practically non-toxic to fish species will be used within the riparian zone. Only aquatic formulations of 2,4-D, glyphosate, triclopyr and imazapyr would exclusively be used within 25 feet of the daily high water mark. Herbicides that are practically non-toxic to fish and mollusks (White 2007) require a 25 feet (7.6 meters) 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 feet (91 meters) 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. All herbicide applications would follow required protection measures. Implementing these features would minimize herbicide exposure to such small levels that the effect would be immeasurable to the species or its habitat. The long-term benefits to habitat and critical habitat floodplain areas and its riparian vegetation include improved function, reduced erosion, and an improved invertebrate foodbase due to the return of the native riparian vegetation.

The best available information for acute, subchronic, and chronic toxicity for the herbicides proposed for use by the BIA is discussed below. The results indicated that use of herbicides by the BIA would not cause adverse effects on wildlife or wildlife habitat. All herbicides have to be approved through the U.S. Environmental Protection Agency (EPA) registration process to evaluate human health and ecological risks. Product registration through the U.S. EPA requires only data that supports the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The USDA Forest Service (USFS) and Bureau of Land Management (BLM) have done independent risk assessments on the pesticides used on Forest Service and BLM lands to further evaluate the human health and ecologic risks associated with the herbicide. These risk assessments use published scientific literature, modeling and data collected for product registration to evaluate the potential for impacts on terrestrial wildlife from exposure to herbicides. There are difficulties in assessing possible risks because toxicity testing is often performed on laboratory animals, which may not be representative of free ranging wild animals or only a few wildlife species are tested. Therefore, the risk assessments typically employ exposure estimates that yield conservative assessments of possible risks (Kendall et al. 2001; USFS 1992).

Many of the herbicides proposed for use by the BIA on the Navajo Nation have been evaluated by the USFS or BLM and their toxicology data are included below. However, there are eight herbicides proposed for use by the BIA that have only been evaluated for risk from toxicology data required by the EPA's pesticide registration process. These herbicides include: atrazine, dichlobenil, isoboxen, metribuzin, paraquat dichloride, pendimethalin, prodiamine, and thifensulfuron methyl.

Table 4-5 shows the ecotoxicity categories for aquatic organisms as defined by the USEPA. The aquatic animal toxicity endpoint for acute assessment includes the lowest tested EC_{50} (concentration of pesticide in water that causes immobilization in 50% of the test population) or LC_{50} (concentration of pesticide in water that causes lethality in 50% of the test population) for freshwater fish and invertebrates from acute toxicity tests.

Table 4-5. Ecotoxicity Categories for Aquatic Organisms (from USEPA at http://www.epa.gov/oppefed1/ecorisk_ders/toera_analysis_eco.htm).

Hazard Indicators	Very Highly Toxic	Highly Toxic	Moderately Toxic	Slightly Toxic	Practically Non-Toxic
Acute concentration (mg/L)	<0.1	0.1-1	>1-10	>10-100	>100

2,4-D – The toxicity of 2,4-D varies by chemical form and organism. In fish, ester formulations tend to be more toxic, while amine salts are practically nontoxic. Risk is greater to fish when there is direct applications to water bodies or accidental direct spills. The ester formulations of 2,4-D are approximately 200 to 1,000 times more toxic to fish than the amine formulations, when toxicity is measured by acute (24- to 48-hours) LC₅₀ (concentration causing 50% mortality [medium lethal concentration]) values (BLM 2007). While these esters are chemically stable, they are short lived in natural water because of biological degradation. At the typical application rate, 2,4-D poses a moderate risk to fish and aquatic invertebrates when accidentally sprayed or spilled directly into a stream or pond (BLM 2007). Routine and acute and chronic exposure scenarios do not pose a risk to fish.

Aminopyralid – Aminopyralid has a low order of acute toxicity to aquatic animals (Marino et al. 2001). Low acute risk was predicted for sensitive, early stage (egg-and-fry) fish, where they would be susceptible under the accidental spill of aminopyralid in a small pond at the highest application rate. Aquatic invertebrates do not have sensitivities to acute or longer-term exposures to aminopyralid (Henry et al. 2003 and Putt 2002, BLM 2016).

Atrazine – Atrazine is moderately to highly toxic to fish and aquatic invertebrates. Early life-stage studies with fish and amphibians have indicated that atrazine is highly toxic and teratogenic. Atrazine also affects reproduction in a number of invertebrates at concentrations of 1 ppm or less. Atrazine is not expected to bioconcentrate based on study that showed Brook trout were below the detectable limit of atrazine after 44 weeks of exposure at a mean concentration of 0.74 mg/L (USEPA 2003a).

Chlorsulfuron – Chlorosulfuron is not registered for aquatic use. Chlorsulfuron’s physical and chemical properties suggest that it is highly soluble in water, and is likely to remain dissolved in water and runoff from soils into water bodies. In addition, this herbicide has a long half-life in ponds, but it is not likely to bioconcentrate in aquatic wildlife (BLM 2007). None of the application scenarios evaluated, including accidental direct spray and spill of chlorsulfuron, pose any risk to fish and aquatic invertebrates in streams and ponds (BLM 2007).

Clopyralid –Based on limited acute bioassays, clopyralid appears to be relatively non-toxic to fish and aquatic invertebrates (BLM 2007). The risk assessment only predicted risks to aquatic organisms associated with accidental spills, with low risk to fish and aquatic invertebrates for the

typical application rate and low risk to fish and moderate risk to aquatic invertebrates for the maximum application rate (BLM 2007).

Dichlobenil – The acute toxicity data indicate that technical grade dichlobenil is moderately toxic to freshwater fish and slightly to moderately toxic to freshwater invertebrates. The primary degradate 2,6 dichlorobenzamide (BAM) is practically nontoxic to freshwater fish and invertebrates. Tests of aquatic invertebrates conducted with a 50% formulation indicated that it is moderately toxic (Stavola and Turner 2003). Adverse chronic effects on reproduction or growth of freshwater fish and invertebrate occurred at exposure concentrations of 0.33 ppm for fish and 1.0 ppm for invertebrates (Stavola and Turner 2003). The degradate, BAM is less toxic than the parent chemical where chronic effects in fish occurred at concentrations of 18 ppm and in invertebrates were not affected.

Fluroxypyr – Fluroxypyr-MHE, and fluroxypyr acid are classified as practically nontoxic to fish. Acute toxicity studies in fish indicate that nominal exposure levels of up to 100 mg/L of fluroxypyr-MHE do not cause detectable adverse effects (SERA 2009). This apparent lack of toxicity is likely to be at least partially attributable to the low water solubility of fluroxypyr-MHE— about 0.09-0.136 mg/L. Fluroxypyr-MHE is also more toxic than fluroxypyr acid to aquatic species (SERA 2009). Fluroxypyr-MHE, however, will be hydrolyzed rather rapidly to fluroxypyr acid, precluding the possibility of long-term exposure. The risk assessment for tolerant invertebrate species is below the level of concern by a factor of 10 for acute exposures and a factor of 100 for longer-term exposures. However, acute fluroxypyr-MHE exposures have high risk to mollusks and may cause decreased shell deposition (SERA 2009, BLM 2016).

Fluazifop-p-butyl- Sensitive and tolerant fish and aquatic invertebrate species are at high risk for accidental spill scenarios based on a water concentration of about 5.8 mg a.e./L fluazifop-p-butyl (SERA 2014). The acute LC₅₀ values for technical grade fluazifop-p-butyl and formulations of fluazifop-p-butyl range from about 0.25 mg a.e./L (SERA 2014) to 4.2 mg a.e./L. Hazard quotients for aquatic invertebrates were above the level of concern for accidental spill scenarios.

Glyphosate – Glyphosate has an aquatic formulation approved for aquatic use. Glyphosate is an acid, but it is commonly used in the isopropylamine salt form. When applied to foliage it is quickly absorbed by the leaves and rapidly moves through the plant. It acts by preventing the plant from producing an essential amino acid. Glyphosate is metabolized by some plants, while others do not break it down. Glyphosate will remain in the soil unchanged for a varying length of time depending on the soil texture and organic matter content. The half-life of glyphosate is reported to be from 3 to 130 days (BPA 2000). This immobility in the soil reduces the potential for glyphosate to enter water bodies.

Based on bioassays technical grade glyphosate is classified as non-toxic to practically non-toxic in freshwater fishes (SERA 2011). Some formulations are more toxic to fish than technical grade

glyphosate. At the typical application rate, the less toxic formulation of glyphosate poses little risk to fish or aquatic invertebrates, except under accidental spill scenarios, for which there is a low to moderate risk to fish and a low risk to aquatic invertebrates (BLM 2007). At the typical application rate, the more toxic formulation of glyphosate poses a high risk to fish and aquatic invertebrates under accidental spill scenarios, and low risk under routine acute exposure scenarios (moderate risk to fish species) (BLM 2007). At the maximum application rate, the less toxic formulation of glyphosate poses a low risk to fish and aquatic invertebrates and at the maximum application rate pose moderate to high risk to fish and low risk to aquatic invertebrates under accidental spill scenarios (BLM 2007).

Imazapic - Imazapic is essentially nontoxic to terrestrial mammals, birds, amphibians, aquatic invertebrates, and insects. It does not bioaccumulate in animals, as it is rapidly excreted in urine and feces (Tu et al. 2001). Accidental direct spray, spill, off-site drift, and surface runoff scenarios generally pose no risk to fish or aquatic invertebrates when imazapic is applied at either the typical or maximum application rate (BLM 2007).

Imazapyr – Imazapyr is relatively non-toxic to fish and aquatic invertebrates (SERA 2004b). No adverse effects to fish and other aquatic organisms appear to be likely at either the typical application rate or the maximum application rate for normal exposure (BLM 2007).

Isoxaben – Isoxaben is highly persistent in soils, but breaks down quickly in water. Isoxaben is moderately toxic in acute scenarios for fish. The LC₅₀ for rainbow trout and bluegill sunfish over a 96-hour period is 1.1 mg/L (BPA 2000i). It is practically non-toxic to freshwater invertebrates, where the LC₅₀ for *Daphnia magna* over a 48-hour period is >100 mg/L (BPA 2000i).

Metribuzin- Metribuzin and its degradates are very mobile and highly persistent, and have the potential to contaminate ground water and surface water. However, the persistence of the parent metribuzin in surface water may be lessened by its susceptibility to photolytic degradation (EPA 1998). Laboratory studies indicate that technical grade metribuzin is slightly toxic or practically non-toxic to freshwater fish on an acute basis. The LC₅₀ for rainbow trout and bluegill sunfish is 42 ppm and 75.96 ppm respectively (Mayer and Ellerzieck 1986, USEPA 1998). There are no acute levels of concern for freshwater fish and aquatic invertebrates at any registered application rate. Growth was affected in early-life stages of rainbow trout from 94% a.i. of technical grade metribuzin. The LOEC is 3.0 (Gagliano and Roney 1992). Technical grade metribuzin is moderately toxic to slightly toxic to aquatic invertebrates at all exposure concentrations of active ingredient (84-93% a.i.) on an acute basis (USEPA 1998). Reproduction was affected at all exposure levels and the LOEC was 0.32 mg a.i./L mean measured concentration, the lowest concentration tested and NOEC is 1.29 (Gagliano and Bowers 1992).

Metsulfuron methyl – According to Ecological Risk Assessment, metsulfuron methyl poses almost no risk to fish or aquatic invertebrates in streams and ponds under accidental, acute, and chronic exposure scenarios involving application of typical and maximum rates (although an

accidental spill at the maximum application rate poses a low risk to sensitive fish species) (USEPA 1993). Values from 96-hour LC₅₀ values for acute toxicity in bluegill sunfish and rainbow trout ranged from approximately 150 mg/L to 1,000 mg/L for both species (SERA 2005). In rainbow trout, signs of sub-lethal toxicity include erratic swimming behavior, lethargy, and color change at concentrations around 100 mg/L, with a NOEC of 10 mg/L (SERA 2005). One investigation did not observe any effects on rainbow trout hatching, larval survival, or larval growth over a 90-day exposure period, at a NOEC of up to 4.5 mg/L (SERA 2004c). The NOEC of 10 mg/L for sub-lethal effects in rainbow trout is approximately 100 times more sensitive than bluegill sunfish that has a NOEC of 1,000 mg/L.

Metsulfuron methyl is relatively non-toxic to aquatic invertebrates. Based on acute bioassays in daphnids, metsulfuron methyl is relatively non-toxic, with an acute median exposure concentration (EC₅₀) value for immobility ranging from over 150 mg/L to 720 mg/L and acute NOEC values for immobility ranging from over 150 mg/L to 420 mg/L (SERA 2005). Typically, the endpoint for aquatic invertebrates when exposed to high concentrations of metsulfuron methyl is a decrease in growth rate.

Paraquat Dichloride– Paraquat dichloride is very immobile in the soil as it strongly adsorbs to clay crystalline lattices. Therefore, it may be found in surface water associated with soil particles carried by erosion, but is not likely to contaminate groundwater. It does not hydrolyze or photodegrade in aqueous solutions. Paraquat dichloride is slightly toxic to fish in acute scenarios, with LC₅₀ ranging from 15-38.68 ppm a.i. in rainbow trout and 13-156 ppm a.i. in bluegill sunfish (USEPA 1997). Paraquat dichloride is moderately toxic to aquatic invertebrates, where the EC₅₀ is 1.2-8 ppm ai.

Pendimethalin- Pendimethalin is moderately to highly toxic to fish based on acute toxicity studies evaluated by U.S. EPA using maximum application rates. The LC₅₀ values for rainbow trout, bluegill sunfish and channel catfish were 0.138, 0.199, and 0.418, respectively (USEPA 1997a). In studies using the typical formulated product with 45% active ingredient, LC₅₀ values were 0.52, 0.92 and 1.9 mg/L respectively for rainbow trout, bluegill sunfish (USEPA 1997a), and catfish (USEPA 1997a). A chronic life-cycle study involving fathead minnow exposed to 98.3% a.i. resulted in a NOEC of 0.0063 mg/L and a LOEC of 0.0098 mg/L for reduced egg production (USEPA 1997a).

Technical grade pendimethalin was found to be highly toxic to freshwater invertebrates based on acute toxicity LC₅₀/EC₅₀ values of 0.28 and 1.0 mg/L, respectively, for *Daphnia magna* and crayfish (*Procambarus simulans*) (USEPA 1997a). A study that exposed *Daphnia magna* to formulated Pendimethalin (45.6%) resulted in a LC₅₀/EC₅₀ value of 5.1 mg/L (USEPA 1997a).

Picloram – According to the ERAs, when applied at either the typical or the maximum application rate, picloram poses low risk to sensitive fish species under acute exposure scenarios (SERA 2003). Under accidental spill scenarios, risks to sensitive fish are high, risks to tolerant

fish are low (for both application rates), risks to aquatic invertebrates are low for the typical rate, and risks to aquatic invertebrates are moderate for the maximum rate.

Prodiamine- Prodiamine is very water-insoluble and is not able to hydrolyze. Therefore, there is a high acute toxicity to freshwater fish and aquatic invertebrates. The LC₅₀ for rainbow trout at 96-hours is 0.83 mg/L, for bluegill sunfish at 96-hours is 0.55 mg/L and for *Daphnia* at 48-hours is 0.66 mg/L (USEPA 1991).

Thifensulfuron methyl- Thifensulfuron methyl is soluble, therefore there may be extensive movement into the soil column and wash-off from foliage and surface soil may be extensive. However, thifensulfuron methyl is practically nontoxic on an acute basis to fish and aquatic invertebrates, where 96-hr LC₅₀>100ppm for fish and 48-hr LC₅₀>1000 ppm for aquatic invertebrates (USEPA 2011).

Triclopyr — Commercial formulations of triclopyr include a triethylamine salt (TEA) and a butoxyethyl ester (BEE). When applied at the typical or maximum application rate, triclopyr TEA poses no risk to fish or aquatic invertebrates in streams or ponds under acute and chronic exposure scenarios (BLM 2007). Under an accidental spill scenario, there would be low risk to fish and aquatic invertebrates. When applied at the typical rate, triclopyr BEE would pose a moderate risk to fish and a low risk to aquatic invertebrates under acute exposure scenarios, and a high risk to fish and a moderate risk to aquatic invertebrates under a scenario involving an accidental spill into a stream or pond. Triclopyr acid would pose a moderate risk to fish and a high risk to aquatic invertebrates under an accidental spill scenario involving the maximum application rate. Triclopyr BEE would pose a high risk to fish and a moderate risk to aquatic invertebrates under acute exposure scenarios at the maximum rate, and high risk to fish and aquatic invertebrates as a result of an accidental spill into a stream or pond.

Sublethal effects of Garlon 4® on salmonids occur at concentrations between 0.32 and 0.43 mg/L, where fish were lethargic, while behavioral changes to Garlon 3A® would occur at 200 mg/L. Subchronic toxicity in fathead minnows (at the embryo-larval stages) was observed when the fish were subjected to 140 mg/L of triclopyr TEA for 28 days (SERA 2003a). This study found that survival of these minnows was greatly reduced at this toxicity level. Based on acute lethality, aquatic invertebrates are equally sensitive as fish to the various forms of triclopyr (SERA 2003a). No significant effects have been noted on frog embryos with the application of Garlon 3A® and Garlon 4®. Studies on embryos and tadpoles of three frog species using Garlon 4®, exposure to 0.6, 1.2, and 4.6 ppm a.e. caused no effect on hatching success, malformations, or subsequent avoidance behavior of embryos, although the two higher concentrations were associated with mortality or immobility in tadpoles (SERA 2003a).

Adjuvants

Toxicity data suggests that adjuvants have the potential to cause acute, and potentially chronic adverse effects to aquatic species for herbicides that are applied at high application rates (Muller

1980; Lewis 1991; Dorn et al. 1997; Wong et al. 1997). Studies have shown that using the surfactant polyethoxylated tallow amine (POEA) with glyphosate-based herbicides is three times more toxic than glyphosate alone (Perkins et al. 2000, Relyea 2012). Groundwater Loading Effects of Agricultural Management Systems (GLEAMS) modeling conducted by the BLM show that there were risks for special status and non-special status aquatic organisms in streams and ponds associated with direct application of POEA to the water body with no dilution or drift (BLM 2007). This scenario is highly conservative and highly unlikely under the BIA application practices. GLEAMS modeling also predicted that there was a risk to special status aquatic organisms with applications of POEA at the maximum rate at a distance of 100 feet from the water body (BLM 2007). This would require a buffer zone of 300 feet for aerial applications of POEA at maximum rate in an area containing special status species. The BIA's mitigation measures do not permit aerial applications of glyphosate formulations containing POEA in any riparian zones.

The adjuvant R-11 is a nonylphenol ethoxylate that is acutely toxic to aquatic organisms and is suspected to be an endocrine-disrupting chemical (BLM 2007). The BIA has not and will not use this R-11 in its herbicide applications.

When selecting adjuvants, BIA weed coordinators must follow all label instructions and abide by any warnings. In general, adjuvants compose a relatively small portion of the volume of herbicide applied. Nonetheless, selection of adjuvants with limited toxicity and low volumes is recommended for applications near aquatic habitats to reduce the potential for the adjuvant to influence the toxicity of the herbicide.

4.6.1.4 Alternative 3 – No Biological Control

Weed treatments are proposed for riparian and upland areas along habitat of all fish species and critical habitat for the Colorado pikeminnow, humpback chub, razorback sucker, and Zuni bluehead sucker. Repeated treatments in the riparian areas using various methods would be necessary for most weed species because seeds in the soil can be viable for 5, 10, or more years. Therefore, reoccurring treatments would be authorized until the desired control objective is reached. The annual combination of methods to be used is expected to vary depending on specific site conditions.

Alternative 3 would allow the use of all proposed methods with the exception of biological control. Without the use of biological control, some weed populations might not meet their management objectives for their populations. The impacts from cultural, manual, mechanical and chemical treatments are similar to those proposed under Alternative 2.

4.6.2 Terrestrial Wildlife Species

Introduction of noxious weeds into native plant communities has had a number of negative impacts on various wildlife species. Weeds displace native forage, often reducing forage availability and use; modify habitat structure by replacing native bunch grasses with forbs and

shrubs; and alter ecosystem interactions, changing how species interact with each other (Duncan 1997). Also, exotic annual grasses can replace native grass species, particularly in disturbed or overgrazed areas. Cheatgrass displaces native perennial grasses and shrubs by germinating early and having extensive and fast-growing shoot and root systems (University of Wyoming and Colorado State University 2013). Bedunah and Carpenter (1989) found a 50 to 90 percent reduction in elk winter forage on bunchgrass sites in western Montana after invasion by spotted knapweed. Another study found elk use of forest habitats was substantially lower on sites dominated by knapweeds than on sites dominated by native grasses (Sheley et al. 1999). Herbicide applications to treat spotted knapweed increased winter elk forage by 47% at sites with low to moderate weed infestations in Montana (Rice et al 1997b).

Areas that have been impacted by noxious weeds may support fewer wildlife species than in areas with intact native plant communities. Many noxious weeds form monocultures, which reduces habitat diversity and therefore decreases the availability of wildlife habitat. Small mammal populations were reduced as native vegetation communities were replaced by knapweed (Kurz 1995). Cavity nesting and timber gleaning birds were present in native cottonwood forests, but rare or absent from the tamarisk patches studied on the Rio Grande (Ellis 1995). Monocultures of noxious weeds also increase the risk for wildfire (Knapp 1996, Link et al. 2006, Busch 1995, Hohlt et al. 2002, Racher et al. 2002), which greatly reduces habitat availability to wildlife. Some noxious weeds are poisonous to wildlife, which reduces the availability of food resources. Furthermore, the Navajo Nation is open rangeland, and, therefore, competition from livestock already exists for limited native resources.

4.6.2.1 Effects of Cultural and Mechanical Weed Control on Wildlife

Weed control methods other than herbicide application that would be implemented are presented in Chapter 2 of the PEIS. Native revegetation in areas where weed control occurs, particularly in riparian areas, roadsides and cut banks or slopes, may be an important part of the program to stabilize soils and provide wildlife habitat. Hand pulling, mowing and heavy machinery may be implemented. Hand pulling and mowing would require up to 30 people involved in the removal of weeds in areas that are difficult to treat using other methods. This method is not effective for long-term utilization against large infestations of weeds. Short-term disturbance effects on wildlife could occur from hand-pulling and mowing treatment methods. Heavy machinery may impact ground dwelling or burrowing wildlife by causing burrows to collapse. Mitigation measures will be employed to mitigate the effects to these species habitat. These methods would provide a long-term benefit for wildlife resources through improved habitat.

4.6.2.2 Effects of Biological Control on Wildlife

The release of approved biological control agents could lead toward less reliance on herbicides. There is no expected effect on fish and wildlife across the Navajo Nation from introduction of proposed biological control agents. There will be no biological control of tamarisk in the project area. The BIA Natural Resource Office currently monitors the status of the tamarisk leaf beetle across the Navajo Nation.

There is concern that a biological agent could switch hosts from noxious to native species in the same genus or family if the noxious resource becomes limited. This could cause indirect impacts to species of concern through altering food availability or habitat. One wildlife species of concern is the Western seep fritillary (*Speyeria nokomis*), a NNFWS Group 3 listed species that utilizes an array of plant species as nectar sources, including introduced thistles, horsemint (*Monarda* sp.), and joe pye weed (*Eutrochium* sp.) (Selby 2007). Selby (2007) emphasizes the need for diverse nectar sources throughout adult flight to increase fecundity. If Canada thistle and leafy spurge are left unchecked they can replace diverse native communities with dense monocultures that would compromise this species habitat (Selby 2007). Introducing biological control agents in this species habitat will eliminate potential deleterious effects from using other treatment methods, including erosion from mechanical methods and herbicide overspray that could impact this host plant and other native nectar resources. Native flowing plant species seed could be planted onsite to provide a native plant nectar source for this species.

4.6.2.3 Effects of Herbicides on Wildlife

The best available information for acute, subchronic, and chronic toxicity for the herbicides proposed for use by the BIA is discussed below. The results indicated that use of herbicides by the BIA would not cause adverse effects on wildlife or wildlife habitat. **Table 4-6** below shows the ecotoxicity categories for terrestrial organisms as defined by the USEPA. The terrestrial animal endpoints for acute avian and mammalian assessment includes the lowest tested LD₅₀ (medium lethal dose of pesticide that causes 50% lethality of the test population) or LC₅₀ (concentration of dietary pesticide that causes lethality in 50% of the test population). For non-target insects the endpoints include an acute, single dose of pesticide that causes 50% mortality in a test population of bees (LD₅₀).

Table 4-6. Ecotoxicity Categories for Terrestrial Organisms. (from 40 CFR 156.64: Toxicity Category).

Terrestrial Organism	Very Highly Toxic	Highly Toxic	Moderately Toxic	Slightly Toxic	Practically Non-Toxic
Avian: Acute Oral Concentration (mg/kg-bw)	<10	10-50	51-500	501-2000	>2000
Avian: Dietary Concentration (mg/kg-diet)	<50	50-500	501-1000	1001-5000	>5000
Wild Mammals: Acute oral concentration (mg/kg-bw)	<10	10-50	51-500	501-2000	>2000
Non-target insects: Acute concentration (µg/bee)		<2	2-11		>11

2,4-D – In birds, 2,4-D ranges from being virtually nontoxic in its butyl ester form to moderately toxic as an amine salts. Mammals are moderately sensitive to exposure. In addition, mammals and large birds would be at risk for consumption of vegetation contaminated by 2,4-D. Large

mammals and large birds would be at moderate acute and chronic risk when ingested at both the typical and maximum application rates (large birds face high acute risk for ingestion when the maximum application rate is applied), and small mammals face low acute risk for ingestion scenarios involving the typical and maximum application rates. Long-term consumption of contaminated vegetation would be unlikely if the vegetation were to show signs of damage. It is relatively nontoxic to bees. Most LD₅₀ values for 2,4-D range from 300 to 1,000 mg/kg, though sensitivity varies greatly between animal groups and chemical forms (Ecobichon 2001, Tu et al. 2001).

Studies in rats suggested 2,4-D was not cancer causing, though liver damage was seen at relatively low dosages. Pregnant rats showed no evidence of birth defects, though fetuses showed evidence of toxic effects. No effect on reproduction or fertility has been demonstrated in rats, and 2,4-D did not cause genetic defects in most studies (SERA 2006). While an association between 2,4-D exposure and canine malignant lymphoma has been reported (Hayes et al. 1991), a causal mechanism was not identified. In a recent review of 2,4-D epidemiology and toxicology, Garabrant and Philbert (2002) concluded that evidence that 2,4-D might be carcinogenic was “scant.”

2,4-D can bioaccumulate in animals. Residues have been reported in milk, eggs, and meat products. The BLM risk assessment indicated that insectivores and large herbivores eating large quantities of grass and other vegetation are at risk from routine exposure to 2,4-D, suggesting that 2,4-D should not be applied over large application areas where foragers would only consume contaminated food (BLM 2007).

Aminopyralid – There is little risk to large and small mammals from low and high concentrations of aminopyralid. There is a minimal effect of small mammals consuming contaminated vegetation or prey for both acute and long-term exposure scenarios (SERA 2007, BLM 2016). Acute hazard quotients approach levels of concern at the highest application rate when large birds consume contaminated grasses and small birds consuming contaminated insects. Birds are more sensitive to acute than long-term exposure of aminopyralid. No consequential effects were detected in bees and earthworms when the maximum concentration was administered through direct contact, vegetation and soil.

Atrazine –Atrazine is low toxicity to birds and mammals based on acute oral LD₅₀ ranging from 672 mg/kg in rats to 4,237 mg/kg in Japanese quail (USEPA 2003). Toxic effects in mammals include sedation, labored breathing, ruffled fur, and protruding eyeballs (US EPA 2003a). Atrazine did not cause irritation or sensitization of the skin in rabbits and guinea pigs, but was irritating to the eyes of rabbits (USEPA 2003). In a 28-day feeding study, body weight loss was observed in sheep at the lowest dose tested of 50 mg/kg/day of the atrazine 80W formulation (US EPA 2003). In studies on rats, atrazine was shown to be an endocrine disruptor; impacting puberty onset, development of reproductive organs, and embryotoxic effects (US EPA 2007).

Avian toxic effects from atrazine include weakness, hyperexcitability, muscle incoordination, tremors, and weight loss (Hudson et al. 1984). In an 8-day dietary study, the LC₅₀ for the 99% active ingredient were all greater than 5,000 ppm in Japanese quail, bobwhites, pheasants, and mallards (USEPA 2003). Pheasants given 15 weekly doses of up to 400 mg of atrazine (80% active ingredient) showed no change in weight gain, number of eggs laid, eggshell thickness, survival, and weight of offspring (US EPA 2003). Injection of eggs with atrazine caused reduced hatching at 400 ppm (the highest dose tested) (USEPA 2003). No teratogenic effects were observed. The LC₅₀ of mallard eggs immersed in an aqueous emulsion of atrazine is a concentration equivalent to a field application greater than 400 lb/acre (USEPA 2003).

Atrazine has a low potential for bioaccumulation in animals and is readily metabolized to nontoxic metabolites and rapidly excreted through the kidneys (US EPA 2003).

Chlorsulfuron –Chlorsulfuron has a low order of acute toxicity; with oral LD₅₀ levels in the male and female rat, bobwhite quail, and mallard duck reported to be >5,000 mg/kg (SERA 2004). The acute dermal LD₅₀ has been reported to be >3,400 mg/kg. It is considered to be a mild irritant to the skin and a moderate eye irritant.

Chlorsulfuron is not considered to be a reproductive, mutagenic, or carcinogenic compound as reports that rats fed up to 5,000 ppm per day for up to 2 years did not show evidence of carcinogenicity (SERA 2004). Teratology studies of rats and rabbits showed no evidence of developmental effects. A 3-generation study in rats showed slight decreased fertility at the highest doses of 2,500 ppm, but no decrease in fertility was observed at doses up to 500 ppm. In their mutagenic tests, Chlorsulfuron did not cause genetic damage.

Clopyralid –Clopyralid is not likely to pose a risk to terrestrial animals, however there are several scenarios under which there would be low acute risk to a variety of animals at the typical and maximum application rates. For the typical application rate, small mammals are at risk from 100% absorption of direct spray and consumption of contaminated insects and vegetation (BLM 2007). For the maximum application rate, insects are at risk from direct spray, large birds are at risk from the consumption of contaminated vegetation, and small birds face risk from the consumption of contaminated insects (BLM 2007). Application of clopyralid at the maximum application rate also poses a low chronic risk to large mammals and large birds consuming contaminated vegetation.

It does not bioaccumulate in animal tissue. The acute oral toxicity in rats was LD₅₀ greater than 4,300 mg/kg (relatively nontoxic). In rabbits, clopyralid had a dermal LD₅₀ of greater than 2,000 mg/kg (relatively nontoxic). Clopyralid caused slight skin irritation and eye irritation in rabbits. Rats showed no adverse effects after 4 hours of exposure to concentrations of 1.3 mg/L in air (SERA 2004a).

Clopyralid showed no evidence of oncogenicity in a 2-year feeding study in mice or rats at the highest dose tested. It showed no evidence of developmental toxicity in mice and rabbits at the

highest dosage tested. No effects on reproduction were observed in study of two generations of rats at the highest dose tested. No evidence of mutagenicity was observed in a number of laboratory studies on mice and rats. Based on the results of these animal studies, clopyralid is not classified as a carcinogen, teratogen, mutagen, or reproductive inhibitor (SERA 2004a).

Dichlobenil –Dichlobenil is slightly to moderately toxic to mammals with an acute oral LD₅₀ ranging from greater than 3,160 mg/kg for rats to 270 mg/kg for rabbits. Oral doses of 200 to 400 mg/kg of dichlobenil to rabbits caused an increase in SDH (serum sorbitol dehydrogenase) activity and death in some animals (US EPA 1998a). The same study showed that rats receiving lethal doses of dichlobenil suffered liver and kidney damage, while rabbits suffered centrilobular necrosis of the liver. The dermal “no observable effect level” (NOEL) for rabbits has been reported as 100 mg/kg/day, and the acute dermal LD₅₀ has been reported as 1,350 mg/kg/day (US EPA 1998a). No significant local skin reactions were noted at any test concentration. Dietary NOELs of 50 ppm have been reported for mice, rats, rabbits, and pigs (US EPA 1998a). Neurotoxic effects of dichlobenil have been observed in mammals, including depression in rabbits (US EPA 1998a) and muscle hypotomus in rats exposed to the dichlobenil degradate 2,6-dichlorobenzamide (US EPA 1998a).

Toxicity to birds is slight to very slight, with LD₅₀ ranging from greater than 1,189 mg/kg/day for pheasants to greater than 5,000 mg/kg/day for Japanese quail. The dichlobenil LD₅₀ for honey bees was reported to be greater than 120.86 mg/bee (US EPA 1998a).

Fluroxypyr –Fluroxypyr acid and fluroxypyr-MHE are relatively non-toxic to mammals. Even at the highest application rates (0.5 lb/acre) fluroxypyr exposure levels are not likely to cause adverse effects in terrestrial animals. The acute toxicity of oral exposure to fluroxypyr is low, where the acute oral LD₅₀ in rats is greater than 2000 mg/kg for both fluroxypyr acid and fluroxypyr-MHE (SERA 2009). Moderate acute risks were found for scenarios including the consumption of fish by a predatory bird after an accidental spill (HQ=0.5), the consumption of contaminated insects by a small mammal (HQ=0.3), the consumption of contaminated grasses by mammals (HQ=0.2), and the direct spray of a small mammal under the assumption of 100% absorption (HQ=0.1) (SERA 2009). The upper bound of the highest chronic HQ is associated with the consumption of contaminated grasses by a large bird feeding exclusively in the treated area (HQ=0.2). All other HQ values for terrestrial organisms are below the level of concern by factors of greater than 10 to greater than 100,000. A hazard quotient (HA) is the ratio of the potential exposure to a substance and the level at which no adverse effects are expected. If the HA is less than one, then no adverse effects are expected as a result of exposure.

At the maximum application rate of 0.5 lb a.e./acre, there is no basis for asserting that adverse toxic effects in birds are plausible. The acute toxicity in avian species is low, where LD₅₀ values are greater than 2000 mg a.e./kg bw for both fluroxypyr acid and fluroxypyr-MHE (Durkin 2009). There is low chronic risk for small birds consuming contaminated surface water (HQ= 0.00007) and medium chronic risk for predatory birds consuming contaminated fish (HQ=0.5).

However, these HQ values are below the level of concern (1.0) by factors of 2 to somewhat over 14,000 (SERA 2009, BLM 2016).

Fluazifop-p-butyl- Hazard quotients for acute exposure for small mammals were higher than the most conservative level of concern (LOC) for several scenarios. Small mammals (20 g) have high hazard quotients for typical application rates for contaminated broadleaf foliage, contaminated tall grass, and contaminated short grass (SERA 2014). Consumption of contaminated insects poses a medium risk to small mammals. Acute exposure to contaminated short grass poses a medium risk to larger mammals (400 g). The HQs associated with the longer-term consumption of contaminated vegetation are much higher, reflecting the substantial difference between the acute “no observed adverse effect concentration” (NOAEC) (43 mg a.e./kg bw) and the longer-term NOAEC (0.63 mg a.e./kg bw/day) (SERA 2014). Decreased body weight gain is a common effect observed in experimental mammals exposed to fluazifop-P-butyl in acute, subchronic, and chronic toxicity studies. In terms of the productivity of mammalian wildlife, adverse effects on reproduction and development are also a concern.

There are no data to suggest that levels of acute exposure of fluazifop-P-butyl will cause adverse effects in birds. The reported LC₅₀ values for the acute dietary studies for fluazifop-butyl are >21,348 ppm (acid equivalent [a.e.]) for mallards and 15,799 ppm (a.e.) for pheasants. Several of the central estimates for chronic exposure in small birds (10g) associated with the consumption of contaminated vegetation exceed the level of concern and some by substantial margins (SERA 2014). All of the upper bound HQs for the consumption of contaminated vegetation, with the exception of large bird consuming contaminated fruit, exceeds the level of concern for small and large birds and all forms of vegetation.

Fluazifop-p-butyl will cause adverse effects in sensitive terrestrial arthropods based on a LD₅₀ of 0.004 lb a.e./acre for direct spraying (0 ft) of all herbicide application methods, including aerial, high boom ground broadcast, low boom ground broadcast, and backpack spraying (SERA 2014). This application rate is below the maximum application rate. Adverse effects in sensitive terrestrial arthropods will have adverse effects for aerial spraying 25-300 ft downwind, high boom ground broadcast 25-50 ft downwind, and low boom ground broadcast 25 ft downwind. Direct spraying of all herbicide application methods, based on an LD₅₀ of 0.13 lb a.e./acre, will cause adverse effects in sensitive terrestrial arthropods.

Glyphosate –Glyphosate applications pose low to moderate risk to several terrestrial wildlife species under multiple exposure scenarios involving typical and maximum application rates (SERA 2011). Glyphosate is reported to be nontoxic in the rat, with a reported oral LD₅₀ of 5,600 mg/kg and over 10,000 mg/kg in mice, rabbits, and goats (SERA 2011). The toxicity of the technical grade acid of glyphosate and Roundup® are nearly the same. The oral LD₅₀ for the trimethylsulfonium salt is reported to be about 750 mg/kg in rats, which indicates moderate toxicity (SERA 2011).

The acute dermal LD₅₀ for glyphosate and the isopropylamine salt are reported to be >5,000 mg/kg, and the dermal LD₅₀ for the trimethylsulfonium salt are reported to be >2,000 mg/kg.

Studies of glyphosate lasting up to 2 years have been conducted with rats, mice, dogs, and rabbits, and with few exceptions no effects were observed (SERA 2011). Some tests have shown that reproductive effects may occur at high doses (over 150 mg/kg/day), but there have been little to no reports of mutagenic, developmental, or carcinogenic effects. Exposure scenarios with the greatest risk are direct spray and acute consumption of contaminated vegetation and insects (BLM 2007).

Imazapic - Imazapic is essentially nontoxic to terrestrial mammals, birds, amphibians, aquatic invertebrates, and insects. It does not bioaccumulate in animals, as it is rapidly excreted in urine and feces (Tu et al. 2001). Accidental direct spray, spill, off-site drift, and surface runoff scenarios generally pose no risk to fish or aquatic invertebrates when imazapic is applied at either the typical or maximum application rate (BLM 2007).

The oral LD₅₀ of imazapic is greater than 5,000 mg/kg for rats and 2,150 mg/kg for bobwhite quail, indicating relative nontoxicity by ingestion (USFS 2005). The LD₅₀ for honeybees is greater than 100 mg/bee, indicating that imazapic is nontoxic to bees. Imazapic is nonirritating to eyes and skin, even in direct applications. The inhalation toxicity is very low. Chronic consumption in rats for 2 years and in mice for 18 months elicited no adverse effects at the highest doses administered. Chronic consumption by dogs for 1 year caused minimal effects (Tu et al. 2001).

Imazapic may be mixed with other herbicides such as picloram or 2,4-D. Combining imazapic with other herbicides should not increase the toxicological risk over that of either herbicide when used alone (Tu et al. 2001).

Imazapyr –Imazapyr is practically nontoxic to mammals and birds (SERA 2011a). In birds, the LD₅₀ was reported to <2,150 mg/kg and in mammals between 4,800 and 5,000mg/kg (SERA 2011a). Imazapyr has not been found to be mutagenic and there has been no evidence to support developmental effects. EPA has classified imazapyr as a Class E compound, one having evidence of noncarcinogenicity. The only scenario involving the typical application rate that would pose a low risk to wildlife, includes a small bird consuming contaminated insects (BLM 2007). For the maximum application rate, the following scenarios pose low risk to wildlife: direct spray of small animals and insects, consumption of contaminated vegetation by large mammals and large birds, and consumption of contaminated insects by small mammals and small birds (BLM 2007).

Isoxaben –For birds and mammals, the overall acute dietary and oral toxicity is practically nontoxic and there is little potential to bioaccumulate. The LC₅₀ for bobwhite quail and mallard duck for dietary toxicity and oral toxicity in rats is >5000 mg/kg (BPA 2000a). Isoxaben is a slight skin irritant, where the acute dermal toxicity LD₅₀ in rabbits is >2000 mg/kg. This product may

cause moderate eye irritation that may be slow to heal. In chronic studies, Isoxaben is considered slightly oncogenic. It has shown to interfere with reproduction in animals, cause birth defects in laboratory animals at doses toxic to the mother. The liver is the main target organ of isoxaben in rats, mice and dogs. The relevant overall short-term NOAEL is 110 mg/kg bw/day, based on the 90-day and 1-year dog studies. The long-term NOAEL is 5 mg/kg bw/day, based on the 2-year rat study where progressive glomerular nephritis was observed at the LOAEL of 114 mg/kg bw/day. Isoxaben is practically non-toxic to honey bees when they come in direct contact with the herbicide. The acute contact toxicity is LD₅₀ is >100 µg/bee (BPA 2000a).

Metribuzin- Metribuzin is slightly toxic to mammals on an acute oral basis with toxicity values for laboratory rats at 2200 mg/kg for females and 2300 mg/kg for males and for laboratory mice 711 mg/kg for females and 698 mg/kg for males (USEPA 1998). Small herbivorous/insectivorous mammals are at acute high risk for broadcast application of nongranular metribuzin at application rates greater than or equal to 4.0 lbs a.i./acre. The levels of concern for endangered herbivorous/insectivorous mammals are exceeded for application rates greater than single applications of 1.0 lb a.i./acre or multiple applications of 0.5 lbs a.i./acre or greater. Chronic levels of concern for small mammals is exceeded at registered application rates equal to or above 0.5 lbs a.i./acre for broadcast applications of nongranular products.

Metribuzin is moderately toxic to birds on an acute oral basis and practically non-toxic to birds on a subacute basis. The LD₅₀ for acute oral toxicity is 169.2 mg/kg (USEPA 1998) and for subacute dietary toxicity is >4000 ppm for small birds and >5000 ppm for large birds (USEPA 1998). Chronic effects in avian reproduction include a reduction in body weight at 14-days post hatch at all levels tested for Northern bobwhite quail, but not for mallard ducks (Hancock 1996). The NOEC and LOEC for Northern bobwhite quail is <62 ppm and for Mallard ducks is >368 ppm (Hancock 1996). Technical grade metribuzin is practically non-toxic to honey bees in acute contact scenarios. The LD₅₀ for honey bees is 60.4 µg/bee (USEPA 1998).

Metsulfuron methyl –Metsulfuron is practically nontoxic to birds, mammals, invertebrates, and bees. Acute oral LD₅₀ was greater than 5,000 mg/kg in rats and 2,000 in mallard ducks; acute dermal LD₅₀ was greater than 2,000 mg/kg in rabbits (SERA 2005). Based upon the results of animal studies, metsulfuron methyl is not classified as a carcinogen, mutagen, teratogen, or reproductive inhibitor (SERA 2005).

Paraquat Dichloride–Applications with moderate concentrations of paraquat (1.0 lbs cation/acre) may produce residues on grass that result in high risk for small and medium herbivorous and small insectivorous mammals, restricted use medium insectivorous mammals, and endangered large herbivorous and small insectivorous mammals. At the highest application rate (1.6 lbs cation/acre) produces residues in grass that result in high risk for small and medium herbivorous and insectivorous mammals, restricted use levels of concern for large herbivorous mammals and endangered species levels of concern for large insectivorous mammals. Medium and high application rates of paraquat (1.0 and 1.6 lbs cation/acre) are high chronic risk for

mammals (USEPA 1997). The level of concern is exceeded for birds and presents high acute risk at application rates at or above 1.49, 0.60, and 0.3 lbs cation/acre. At application rates of 0.5 and 5 lbs cation/acre, paraquat can cause reduction of hatchability, significant mortality and reduced growth to mallard duck eggs (USEPA 1997). Environmental fate data indicate that paraquat once applied and dried is not expected to pose a risk, and if washed off plant surfaces is very strongly adsorbed to clay particles. Therefore, the registered uses of paraquat are expected to reduce acute risks and are not expected to pose a chronic risk to mammals or birds.

Paraquat is relatively non-toxic to bees in dry crystalline and liquid formulations of technical and technical end-product (TEP) paraquat dichloride, where contact LD₅₀ ranged from 6.04->144 µg/bee (USEPA 1997). There is a risk for honey bees when directly sprayed with high concentrations of paraquat dichloride CL.

Pendimethalin- Pendimethalin is slightly toxic to birds on an acute oral and subacute dietary basis, where LC₅₀ values are 4,187 – 4,640 ppm (USEPA 2003). No chronic bird reproduction studies have been completed for this chemical. Pendimethalin is slightly toxic to small mammals on an acute oral basis, which is based on a study that showed female rats had a LD₅₀ of 1050 mg/kg and male rats had a LD₅₀ of 1250 mg/kg (U.S. EPA 2003). Pendimethalin is practically non-toxic to honey bees on an acute contact basis, where the LD₅₀ >49.7 µg/bee (USEPA 2003).

Picloram –Picloram is almost nontoxic to birds, relatively nontoxic to bees, and low in toxicity to mammals. Mammals excrete most picloram residues unchanged and it does not bioaccumulate in animal tissue. Formulated products are generally less toxic than picloram (SERA 2011b). Tu et al. (2001) and SERA (2011b) report an acute oral LD₅₀ for rats for picloram of greater than 4,000 milligrams per kilogram (mg/kg). LD₅₀s were reported to be greater than 2,500 and 5,000 mg/kg for mallard ducks and bobwhite quail, respectively. The acute dermal LD₅₀ in rabbits was reported to be greater than 2,000 mg/kg. In laboratory test with rabbits, picloram was not shown to be a skin irritant, but was a moderate eye irritant. Weight loss and liver damage in mammals has been reported following long-term exposure to high concentrations of picloram. Picloram is classified as a Class E carcinogen, a compound having evidence of noncarcinogenicity. Picloram showed no evidence of birth defects in rats or rabbits, and it was negative in two tests for mutagenicity (SERA 2011b).

Male mice receiving picloram at dietary doses of 1,000 to 2,000 mg/kg/day over 32 days showed no clinical signs of toxicity or changes in blood chemistry, but females did show decreased body weight and increased liver weights. Liver effects were also seen in rats at very high doses of 3,000 mg/kg/day over an exposure period of 90 days, and above 225 mg/kg/day for 90 days. Dogs, sheep, and beef cattle fed low levels of picloram for a month experienced no toxic effects. The ester and amine salt showed low toxicity in animal tests (SERA 2011b).

Based on these studies, picloram does not appear to cause genetic damage or birth defects, has little or no effect on fertility and reproduction, and is not carcinogenic (SERA 2011b). There

have been some concerns expressed that picloram acts synergistically with 2,4-D or other ingredients to cause chronic effects on wildlife. There is some evidence that high concentrations of picloram and 2,4-D esters have an additive, but not synergistic, effect. Picloram and 2,4-D are both rapidly excreted in an unchanged form by mammals reducing the risk of their interaction. In one study, a test group of sheep was fed a single dose of picloram (72 mg/kg) and 2,4-D (267 mg/kg) and others were fed a mixture of 7.2 mg/kg of picloram and 27 mg/kg 2,4-D for 30 days. There was no evidence of toxicity in any of these sheep (Dow 2001).

No adverse effects on endocrine activity have resulted from numerous studies conducted on mammals and birds to determine picloram toxicity values. The evidence indicates that the endocrine system in birds and mammals is not affected by exposure to picloram at expected environmental concentrations (DOW 2001).

Prodiamine- Prodiamine is practically nontoxic to slightly toxic to small mammals on an acute oral, dermal and inhalation toxicity scenarios, where in rats $LD_{50} > 5000$ mg/kg, $LD_{50} > 2000$ mg/kg, and > 1.81 mg/L respectively (USEPA 1992). Prodiamine is practically nontoxic to birds on an acute oral and dietary basis, where $LD_{50} = > 2250$ mg/kg for bobwhite quail and $LC_{50} = > 10,000$ ppm for mallard duck and bobwhite quail in an eight-day dietary study (USEPA 1991). Avian reproduction may be at chronic risk from maximum and typical residues on short grass where NOEL is exceeded. Direct spraying on honey bees is practically non-toxic with the $LC_{50}/EC_{50} > 100$ µg/bee (USEPA 1991).

Thifensulfuron methyl- Thifensulfuron methyl is practically nontoxic to mammals on an acute oral basis, where the LD_{50} is > 5000 mg/kg (USEPA 2011). However, exposure through drinking water alone is a potential concern for acute toxicity in mammals and birds and chronic exposure in birds. Thifensulfuron methyl is slightly toxic for acute oral scenarios ($LD_{50} > 2510$ ppm for Mallard duck) and practically nontoxic for acute dietary scenarios in birds ($LC_{50} > 5620$ for both Bobwhite quail and Mallard duck). A slight reduction in the production of eggs and hatchlings was observed at a concentration of 1250 ppm (USEPA 2011). The NOAEC is 250 ppm for Bobwhite quail. Upon acute direct contact with honey bees thifensulfuron methyl is practically nontoxic ($LD_{50} > 12.5$ µg/bee) (USEPA 2011).

Triclopyr —Risks calculated for the application of both formulas of triclopyr are the same and pose a risk to insects, mammals, and birds under several exposure scenarios (SERA 2003a). The following scenarios pose a low risk for applications at the typical rate and a moderate risk for applications at the maximum rate: first-order and 100% absorption of direct spray by small mammals, 100% absorption of direct spray by insects, acute consumption of contaminated vegetation by large mammals and large birds, acute consumption of contaminated insects by small birds and small mammals, and chronic consumption of on-site contaminated vegetation by large mammals and large birds. In addition, for the maximum application rate, there would be low risk associated with acute consumption of contaminated vegetation by small mammals following an accidental spill, acute consumption of contaminated small mammals by carnivorous

mammals, and chronic consumption of off-site contaminated vegetation by large mammals. No risk is predicted for small mammals as a result of acute or chronic consumption of contaminated vegetation or water, or for predatory birds as a result of consumption of contaminated fish. The oral LD₅₀ levels in rats have been reported in the range of 630 to 729 mg/kg (SERA 2003a). Acute toxicity LD₅₀ values for mammals are reported to be 310 to 713 mg/kg, and ducks were reported to have an oral LD₅₀ of 1,698 mg/kg (SERA 2003a). The acute dermal LD₅₀ has been reported to be >2,000 mg/kg in rabbits. Triclopyr is considered to be a slight irritant to the skin and eye. Studies indicate that triclopyr does not pose a carcinogenic, mutagenic, reproductive, developmental risk to animals (SERA 2003a).

4.6.2.4 Effects of Herbicides on Amphibians

Amphibians are potentially the most herbicide sensitive group of wildlife because of their permeable skin, anatomy which facilitates respiration through their skin and complex life cycles. Most amphibian species require moisture or some form of water to complete their life cycle, and most are aquatic in their egg or larval stages. As a result, amphibians often serve as indicator species for environmental and ecological impacts related to land management activities. It is unknown if safety standards for other kinds of vertebrates are adequate for reptiles and amphibians (Hall and Henry 1992).

Carey and Bryant (1995) reviewed the numerous pathways through which amphibians could be impacted by chemicals in the environment. They suggest that adult and larval amphibians are not necessarily more sensitive to chemicals than other terrestrial or aquatic vertebrates. However, sublethal effects can manifest as increased susceptibility to disease, increased predation, altered growth rates, or disrupted development. They suggest “endocrine-disrupting toxicants can have effects at tissue levels well below detectable levels,” and that “toxicants designated as safe should not be considered to be free of endocrine-disrupting effects until proven otherwise.” Hayes et al. (2002) found that atrazine at contaminant levels much lower than EPA drinking water standards can cause hermaphrodites and reduce laryngeal size in frogs. Herbicides used with surfactants may also increase the risk to amphibians and reptiles. Studies have shown that using the surfactant polyethoxylated tallow amine (POEA) with glyphosate-based herbicides is three times more toxic than glyphosate alone (Perkins et al. 2000, Relyea 2012).

Atrazine and glyphosate POEA are non-aquatic herbicides with moderate to high aquatic toxicity (White 2007) and would require a 300 feet (91 meters) buffer from the daily high water mark within riparian areas. These herbicides would not be used for aerial applications by either fixed wing or rotary aircraft within riparian areas. All herbicide applications would follow required protection measures. These mitigation measures will minimize the potential for amphibians to be exposed to herbicides during sensitive developmental stages. Cultural and mechanical methods of weed control may have temporary disturbance or mortality impacts on amphibians. During terrestrial stages, amphibians could be trampled or run over by a vehicle or mower, but such events would be rare. Biological control methods would not likely have impacts on amphibians.

4.6.2.5 Alternative 1 – No Action

This alternative has the potential for the highest loss of wildlife habitat. Minimal, uncoordinated non-native weed treatments would continue to occur under the current management strategy. Non-native weed infestations would continue to expand, which could lead to long-term degradation of wildlife habitat. As weed infestations continue to expand there will be high losses of available forage for ungulates such as elk, mule deer, and pronghorn during the next 10-year period. Livestock grazing will continue the spread of the noxious weeds, and compete with wildlife for native forage. Leafy spurge, Russian knapweed, cheatgrass, yellow starthistle, Sahara mustard, brome grasses and thistles would also expand and invade previously uninfested grasslands replacing palatable, nutritious food for elk, deer and pronghorn. The potential for non-native grasses such as cheatgrass would increase the wildfire potential for these areas. Wildfires would reduce habitat availability for small mammals and butterfly species, forage for ungulates, and a prey base for raptor species.

Noxious weeds in riparian areas will continue to spread and out-compete native vegetation. Native riparian habitats may become replaced with monocultures of noxious tamarisk and Russian olive. This habitat replacement would reduce nest and foraging areas for migratory and riparian dependent bird species, such as yellow-billed cuckoo, yellow warbler, Lucy's warbler, and Bell's vireo.

Implementation of this action would result in the greatest expansion of weeds throughout the project area. Non-native weed treatments that do occur under this alternative would primarily be chemical treatments and have similar effects as discussed above for the other alternatives. This alternative would have minimal, short-term impacts to wildlife composition and population trends in the project area.

4.6.2.6 Alternative 2 – Proposed Action

Repeated treatments using various methods would be necessary for most weed species because seeds in the soil can be viable for 5, 10, or more years. Therefore, reoccurring treatments would be authorized until the desired control objective is reached. The annual combination of methods to be used is expected to vary depending on specific site conditions.

Mechanical, manual and cultural treatments would have short-term, localized impacts while people are working in the area. Wildlife may be temporarily displaced, but disturbance would be limited in extent and duration. Vehicle and other ground based mechanized equipment used for weed treatment activities would generate noise impacts. However, these impacts are expected to have a short duration and minimal impact to wildlife. The short-term impacts to wildlife would be outweighed by the benefits of habitat improvement from weed removal activities. Also, the relatively small areas proposed for treatment on an annual basis in relation to the entire habitat available for wildlife species makes these impacts immeasurable on a population level for most species. Breeding and migrating season timing restrictions and nest buffer restrictions required in

the mitigation measures would reduce the likelihood of disturbance impacts on birds and wildlife during the breeding and migrating season.

Biological controls would create no disturbance to vertebrate animal species or desirable forage species. There may be a chance that biological controls would affect some of the nectar plants used by the Western seep fritillary (discussed above); however, this species relies on diverse plant species for nectar sources and is not likely to be adversely affected. Biological controls could interact with other insects, but controls have been extensively tested and shown not to have adverse impacts on native insect species.

When vegetation is removed utilizing these methods, bare soil would be exposed with the potential for topsoil erosion. However, it is recommended to implement native species planting in combination with weed removal projects. Prescribed burns would create ash and smoke, which would temporarily and locally reduce visibility and impact wildlife habitat. Pile burning and prescribed burns would require a site specific burn plan and must follow the mitigation measures for species of concern. Mitigation measures and Best Management Practices would be applied to minimize effects to species habitat. These measures were developed in consultation with the U.S. Fish and Wildlife Service and the Navajo Nation Department of Fish and Wildlife specifically for the Navajo Nation Integrated Weed Management Plan.

Impacts that may occur due to the result of using herbicides include the loss of non-target vegetation used by wildlife and effects to wildlife health due to exposure to herbicides. Aerial applications have the greatest potential to affect wildlife because they typically cover the largest treatment area. Fluzafop-p-butyl and 2,4-D may provide a slight risk to small and large mammals when consuming contaminated vegetation. Fluzafop-p-butyl also may have adverse effects on wildlife reproduction. Triclopyr, pendimethalin and proflaminate are moderately toxic to amphibians and terrestrial arthropods. Atrazine could exhibit endocrine-disrupting effects via inhibition of androgen receptors in mammals, amphibians and potentially reptiles (Rohr et al. 2006). Also, the use of glyphosate is a concern for areas with amphibians. None of the herbicides listed above will be used in aerial spraying scenarios.

Currently, the herbicides used by the BIA on the Navajo Nation include imazapyr, metsulfuron-methyl, 2,4-D, and triclopyr, with over 80% of treatments using imazapyr. These herbicides will likely continue to be the herbicides used for most BIA treatments. However, the inclusion of all the proposed herbicides will allow BIA managers more options in choosing herbicides that best match treatment goals and application conditions, and are less toxic, and, therefore, reduce the overall risk potential for wildlife species. The long-term positive impacts on wildlife communities under this alternative would include improvements to habitat, forage production and overall ecosystem function. All herbicide applications will adhere to the buffer requirements and other mitigation measures listed for special status species. Aerial applications of herbicides will follow the mitigation measures developed for the species of concern located near the project area.

4.6.2.7 Alternative 3 – No Biological Control

This Alternative would limit management techniques available and the impacts of other treatments. Although this Alternative would have similar impacts to Alternative 2 for mechanical, cultural, manual, and chemical treatments, without the use of biological control, the long-term and large-scale effectiveness of those treatments may be limited. Treatment sites with heavy infestations of species targeted by biological controls would need to be retreated more often using other methods such as chemical or mechanical control.

Without the use of biological control, the cost for vegetation treatments would likely be higher as more time and money is spent on other forms of treatments that require more manpower, equipment, and monitoring to reduce impacts to native vegetation inside and outside of treatment sites. Sites would also require more intensive retreatments to control resprouting weeds and secondary infestations.

4.6.3 Special Status Wildlife Species

As discussed in Chapter 3, the Navajo Nation supports 34 wildlife species that have been given special status based on their rarity or sensitivity. There are 9 species that are federally listed as threatened or endangered, and one species that has not been detected on the Navajo Nation but occurs on adjacent land. The remaining 25 special status species are tribally listed through the NNDFW. Also, migratory birds are protected under the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712). Many of these species are threatened by competition from livestock, habitat degradation, and limited distribution (see the discussion under Terrestrial Wildlife Species). Non-native plant species reduce the suitability of some habitats to support special status species. Some species, such as butterflies, require specific host plants for their larval stage. For some special status wildlife species, it is the structure rather than the species composition of the habitat that makes it suitable. For example, the southwestern willow flycatcher occurs in riparian areas with dense growths of deciduous shrubs and trees (USFWS 1995) and kangaroo rats require open, grassland conditions. Noxious plant species can alter the structure of habitats making them less suitable for supporting sensitive wildlife species. Therefore, weed control treatments have the potential to improve habitats for these species. The potential effects of each alternative on special status species are discussed below and a summary is provided in **Table 4-7**.

4.6.3.1 Alternative 1 – No Action

This alternative has the potential for the highest loss of wildlife habitat. Minimal, uncoordinated non-native weed treatments would continue to occur in riparian areas under the current management strategy. Non-native weed infestations would continue to expand, which could lead to long-term degradation of special status wildlife species habitat. As weed infestations continue to expand there will be high losses of available forage for ungulates such as pronghorn and bighorn sheep during the next 10-year period. Livestock grazing will continue the spread of the noxious weeds, and compete with wildlife for native forage. Leafy spurge, Russian knapweed, cheatgrass, yellow starthistle, Sahara mustard, brome grasses and thistles would also expand and

invade previously uninfested grasslands replacing palatable, nutritious food for bighorn sheep and pronghorn. The potential for non-native grasses such as cheatgrass would increase the wildfire potential for these areas. Wildfires would reduce habitat availability for small mammals and butterfly species, forage for ungulates, and a prey base for raptor species.

Noxious weeds in riparian areas will continue to spread and out-compete native vegetation. Native riparian habitats may become replaced with monocultures of noxious tamarisk and Russian olive. This habitat replacement would reduce nest and foraging areas for migratory and riparian dependent bird species, such as yellow-billed cuckoo, yellow warbler, and southwestern willow flycatcher.

As Dalmatian toadflax and bull thistle populations expand and grow into one another, small mammal populations would diminish due to reduced losses of forage and cover. This would reduce the prey base for large raptor species including northern goshawk and Mexican spotted owl.

Implementation of this action would result in the greatest expansion of weeds throughout the project area. Non-native weed treatments that do occur under this alternative would primarily be chemical treatments and have similar effects as discussed above for the other alternatives. This alternative would have minimal, short-term impacts to wildlife composition and population trends in the project area.

4.6.3.2 Alternative 2 – Proposed Alternative

Under this alternative up to 5,000 acres across the Navajo Nation would be treated with an integrated weed management approach annually. All of the methods for weed control have the potential to impact populations of special status wildlife species. However, implementation of the mitigation measures along with the buffers recommended by the U.S. Fish and Wildlife Service and the NNDFW for projects in the vicinity of special status wildlife species should minimize the impacts to these species.

Mechanical, manual and cultural treatments would have short-term, localized impacts while people are working in the area. Wildlife may be temporarily displaced, but disturbance would be limited in extent and duration. Vehicle and other ground based mechanized equipment used for weed treatment activities would generate noise impacts. However, these impacts are expected to have a short duration and minimal impact to wildlife. The short-term impacts to wildlife would be outweighed by the benefits of habitat improvement from weed removal activities. Also, the relatively small areas proposed for treatment on an annual basis in relation to the entire habitat available for wildlife species makes these impacts immeasurable on a population level for most species. Breeding and migrating season timing restrictions and nest buffer restrictions required in the mitigation measures would reduce the likelihood of disturbance impacts on birds and wildlife during the breeding and migrating season. Also, avoidance measures would be implemented to protect the host plant of the Western seep fritillary.

Biological controls would create no disturbance to vertebrate animal species or desirable forage species. There may be a chance that biological controls would affect some of the nectar plants used by the Western seep fritillary (discussed above); however, this species relies on diverse plant species for nectar sources and is not likely to be adversely affected. Biological controls could interact with other insects, but controls have been extensively tested and shown not to have adverse impacts on native insect species.

When vegetation is removed utilizing these methods, bare soil would be exposed with the potential for topsoil erosion. However, it is recommended to implement native species planting in combination with weed removal projects. Prescribed burns would create ash and smoke, which would temporarily and locally reduce visibility and impact wildlife habitat. Pile burning and prescribed burns would require a site specific burn plan and must follow the mitigation measures for species of concern. Mitigation measures and Best Management Practices would be applied to minimize effects to species habitat. These measures were developed in consultation with the U.S. Fish and Wildlife Service and the Navajo Nation Department of Fish and Wildlife specifically for the Navajo Nation Integrated Weed Management Plan.

Impacts that may occur due to the result of using herbicides include the loss of non-target vegetation used by wildlife and effects to wildlife health due to exposure to herbicides. Aerial applications have the greatest potential to affect wildlife because they typically cover the largest treatment area. Fluzufop-p-butyl and 2,4-D may provide a slight risk to small and large mammals when consuming contaminated vegetation. Fluzufop-p-butyl also may have adverse effects on wildlife reproduction. Triclopyr, pendimethalin and proflaminate are moderately toxic to amphibians and terrestrial arthropods. Atrazine could exhibit endocrine-disrupting effects via inhibition of androgen receptors in mammals, amphibians and potentially reptiles (Rohr et al. 2006). Also, the use of glyphosate is a concern for areas with amphibians. None of the herbicides listed above will be used in aerial spraying scenarios.

Currently, the herbicides used by the BIA on the Navajo Nation include imazapyr, metsulfuron-methyl, 2,4-D, and triclopyr, with over 80% of treatments using imazapyr. These herbicides will likely continue to be the herbicides used for most BIA treatments. However, the inclusion of all the proposed herbicides will allow BIA managers more options in choosing herbicides that best match treatment goals and application conditions, and are less toxic, and, therefore, reduce the overall risk potential for wildlife species. The long-term positive impacts on wildlife communities under this alternative would include improvements to habitat, forage production and overall ecosystem function. All herbicide applications will adhere to the buffer requirements and other mitigation measures listed for special status species. Aerial applications of herbicides will follow the mitigation measures developed for the species of concern located near the project area.

4.6.3.3 Alternative 3 – No Biological Control

This Alternative would limit management techniques available and the impacts of other treatments. Although this Alternative would have similar impacts to Alternative 2 for mechanical, cultural, manual, and chemical treatments, without the use of biological control, the long-term and large-scale effectiveness of those treatments may be limited. Treatment sites with heavy infestations of species targeted by biological controls would need to be retreated more often using other methods such as chemical or mechanical control.

Without the use of biological control, the cost for vegetation treatments would likely be higher as more time and money be spent on other forms of treatments that require more manpower, equipment, and monitoring to reduce impacts to native vegetation inside and outside of treatment sites. Sites would also require more intensive retreatments to control resprouting weeds and secondary infestations.

Table 4-7. Treatment effects on threatened (T), endangered (E), candidate (C), and Navajo Nation Department of Fish and Wildlife (NNDFW) G3 and G4 species on the Navajo Nation by Alternative.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Black-footed ferret (BFF)	E	G2	Prairie dog towns >198 acres or a complex of town (2 or more within 7 km). Prairie dogs rely on native vegetation for food and cover. There are no known BFF populations on the NN.	Negative - weeds would eliminate food of prairie dogs which is ferret prey.	If BFF exist on NN, they may be affected by disking, plowing or prescribed burns during the breeding season.
California Condor	E	G4	Walls of major river canyons or cliffs surrounding desert scrub or grasslands. Introduced at Vermilion Cliffs and use small portion of NN for foraging.	Neutral - weeds should not affect food or physical habitat	Mitigation measures include mechanical, prescribed fire, and ground application of herbicides require 1 mile and aerial application of herbicides require 1.5-mile buffer from suitable nesting sites, known roosting sites. Dispose of trash. If condor detected, stop treatment and call NNDFW.
Kanab ambersnail	E	G4	Known to occur in the Grand Canyon and may have suitable habitat in western NN in tributaries of the Colorado River and Little Colorado River, other springs and creeks near Echo Cliffs and Navajo Mountain. Use monkey flower and watercress for foraging and egg laying.	Negative - tamarisk may be reducing native aquatic vegetation required by the species. Long-term potential for loss of limited riparian habitat to increased weed populations could negatively impact the species.	No treatments would occur in aquatic habitat. Mechanized, manual and chemical spot treatments would require a 200ft buffer from suitable habitat. Low aerial spraying requires a 150ft buffer and high aerial spraying requires a 1/8-mile buffer from suitable habitat.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Southwestern willow flycatcher (SWFL)	E	G2	Breeds in dense willow, cottonwood, and tamarisk thickets and woodlands along streams and rivers. Tamarisk leaf beetle has decimated breeding habitat along Colorado River and tributaries. Known to breed along the San Juan and Colorado Rivers and migrate through riparian habitat on NN.	Neutral - has been shown to nest in tamarisk and Russian olive. The tamarisk leaf beetle has affected tamarisk dominated nesting habitat making this habitat type non-sustainable.	By implementing mitigation measures current nest stands would be maintained whether comprised of native or nonnative vegetation. No biological control of tamarisk will occur on NN. Breeding season and migratory timing restrictions and buffers around nest patches would reduce the impact of any disturbance to nesting SWFL from treatments. Treatments would occur far from occupied nests that there would be no disturbance impacts to nesting SWFL. Planting native willows after treatments would expedite establishing future nesting stands of native tree species.
Mexican spotted owl (MSO)	T	G3	The MSO is known to nest in high elevation mixed conifer, pine-oak and canyons. MSO is known to occur within or adjacent to the Chuska Mountains, Defiance Plateau, Canyon de Chelly, Black Mesa and canyon lands in the north.	Negative - weeds could reduce prey habitat for small mammals and passerine birds. Long-term potential for weed population increases to reduce or replace native vegetation and reduce amount of MSO prey habitat and negatively impact population trends of MSO.	Implementing mitigation measures requires mechanical, prescribed fires, and aerial and mechanized chemical spraying to have ¼-mile buffer from the edge of the PAC which would reduce disturbance or toxicity impacts to MSO to insignificant levels. This would not impact the population trend of MSO on NN.
Mexican gray wolf	E	G1	Wolves existing in the wild are a nonessential experimental population released in Apache and Gila National Forest. This species does not occur on the NN.	Neutral - weeds should not affect food or physical habitat	With no known populations there would not be any impacts.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Western yellow-billed cuckoo (YBCU)	T	G2	This species is associated with mature stands of cottonwood-willow riparian deciduous forest. Known to breed along the San Juan River on the NN.	Negative- weed trees could replace the dense cottonwood/willow habitats they need. Long-term potential for loss of limited riparian habitat to increased populations of noxious weeds could reduce the native plant species used for nesting and negatively impact the species.	Breeding season timing restrictions and buffers around nesting areas would make any disturbance or toxicity impacts to the YBCU from weed treatments unlikely to occur.
Northern River otter	–	G1	This species is highly aquatic, occurring along rivers where they hunt, travel, and take refuge. Otters feed on fish, amphibians, turtles, crayfish, and other aquatic animals. A population recently identified along the San Juan River adjacent to NN.	Neutral- not dependent on vegetation.	There would not be any impacts to otters or their prey from the proposed terrestrial weed treatments.
Bald eagle	D	G2	Bald eagles nest in mature old growth forests near large bodies of water. Eagles winter roost in large trees, river bottoms or near canyon rims, usually within a few miles of ponds, lakes or rivers with adequate prey. There are few nesting records on NN with migrating records using various lakes, including Wheatfields, Tsaille, Many Farms, Morgan, Red Lake, Black Lake and various lakes in Chuska Mountains.	Neutral- terrestrial weeds should not affect prey or physical habitat.	Implementing mitigation measures recommended by the NNDFW of 1/3 mi buffer from active nest for brief activities (spot spraying, mechanical or manual treatments); 0.5 miles for light activities (mechanical and mechanized ground chemical treatments); and 3/4 mile for heavy activities (prescribed fire, aerial spraying) would remove impacts from disturbance.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Golden Eagle	–	G3	Nest on steep cliffs near desert grasslands and desert scrub foraging habitat. Nesting on NN occurs across all elevations on sandstone, limestone, and volcanic origin cliff faces.	Negative - weeds could reduce prey habitat for small to medium mammals. Long-term potential for weed population increases to reduce or replace native vegetation and reduce amount of golden eagle prey habitat and negatively impact its population trends.	Implementing mitigation measures recommended by the NNDFW of 0.375 mi buffer from active nest for brief activities (spot spraying, mechanical or manual treatments); 0.5 miles for light activities (mechanical and mechanized ground chemical treatments); and 3/4 mile for heavy activities (prescribed fire, aerial spraying).
Northern leopard frog	–	G2	Breed in permanent wetlands, ditches, small streams, ponds with rooted vegetation such as sedges, cattails, or rushes. Historic populations on the NN occurred in the Chuska Mountains, Little Colorado River, Colorado River, San Juan River, Navajo and Chinle Creeks, Canyon de Chelly, and near Tuba City, Cameron, Thoreau, and Newcomb.	Negative- tamarisk and Russian olive, if large enough, may compete for sunlight and nutrients from cattail, sedges and rushes. It is not likely that this species would be affected by noxious sedges and grasses.	Mitigation measures would remove impacts from disturbance. No treatments would occur in aquatic habitat. Mechanical and manual treatments would require a 200ft buffer from open water habitat. No applications of herbicides would be used in occupied/potentially occupied habitat. Native vegetation planting would occur after noxious species removal. No target grazing would be used in the habitat.
Pronghorn	–	G3	Pronghorn occur in grasslands, desert scrub, juniper, and sagebrush woodlands. On the NN, pronghorn occur in New Lands area, north of Flagstaff, and checkboard lands in New Mexico.	Negative- due to loss of forage. Long-term potential for weed populations to reduce available native plant forage species and negatively impact pronghorn population trends. Also, certain weeds can provide predator cover. This reduces the area where pronghorn are safe from predators and has negative impacts to fawn survival and population trends on NN.	Treatments require a 1-mile buffer from potential lambing areas during breeding season. Other than disturbance treatments would not directly impact pronghorn. Indirect impacts would be limited to a small area that there would not be a measurable impact and no impact on population trends on the NN.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Bighorn sheep	–	G3	Bighorn sheep occupy arid, precipitous rocky slopes, ridges, cliffs, and canyons. On the NN, bighorn sheep occur along the San Juan River and possibly along the Little Colorado River.	Negative- due to loss of forage. Long-term potential for weed populations to reduce available native plant forage species and negatively impact bighorn sheep population trends. Also, certain weeds can provide predator cover. This reduces the area that bighorn sheep are safe from predators and has negative impacts to fawn survival and population trends on NN.	Treatments require a 1-mile buffer from potential lambing areas during breeding season. Other than disturbance treatments would not directly impact bighorn sheep. Indirect impacts would be limited to a small area that there would not be a measurable impact and no impact on population trends on the NN.
Ferruginous hawk	–	G3	This species nests in badlands, rolling desert grasslands, and desert scrub. Most nests on NN are on clay or rock pinnacles, small buttes, or short cliffs. The NN is used by this species year-round breeding and wintering in northwestern New Mexico and Chinle Valley and Dilkon area.	Negative - weeds could reduce prey habitat for small and medium mammals. Long-term potential for weed populations to reduce or replace native vegetation, reduce amount of hawk prey habitat, and negatively impact its population trends.	Implementing mitigation measures recommended by the NNDFW of 0.5 mi buffer from active nest for brief activities (spot spraying, mechanical or manual treatments); 5/8 mile for light activities (mechanical and mechanized ground chemical treatments); and 3/4 mile for heavy activities (prescribed fire, aerial spraying) would remove impacts from disturbance.
American dipper	–	G3	This species nests near clear, unpolluted streams with a variety of riffles, pools, and waterfalls. They occur on the NN on the east and west faces of the Chuska Mountains, upper Canyon de Chelly, Little Colorado River and upper Piute Canyon.	Neutral- not dependent on vegetation.	Mitigation measures recommended by the NNDFW of 50-200ft buffer from occupied nesting habitat outside of breeding season for mechanical treatments; no mechanical, mechanized ground or aerial chemical treatments within 1/8 mile from active nest; and a 328ft buffer for spot spraying or manual treatments from active nest will remove impacts from disturbance.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Western seep fritillary	–	G3	This species occurs in perennially wet meadows with seeps, springs, and streams and open grasslands. Violets found in wet soils are its larval host plant. On NN, this species occurs in Chuska Mountains and Defiance Plateau, Tsaile, Wheatfields, Whisky Creeks, and two springs near Washington Pass.	Negative - Weeds could out-compete their larval host plants. Long-term potential for weed population increases to reduce or replace native plants and outcompete host plant and negatively impact population trends. Some noxious species are used for nectar plants.	Mitigation measures recommended by the NNDFW include no chemical or mechanical treatments permitted within 200ft of occupied habitat year-round and no target grazing within wet areas containing host plants during the mating season will remove impacts from disturbance.
Townsend's big-eared bat	–	G4	Roosts and hibernates in limestone or sandstone caves, lava tubes, mine tunnels, and other man-made structures. Uses a variety of habitats for foraging, including coniferous forests to pinyon-juniper woodlands, riparian woodlands, desert lands. Only two known roost caves near Shiprock and Page.	Neutral- not dependent on vegetation.	Mitigation measures recommended by the NNDFW require a 200ft buffer for all treatments from occupied roost sites during breeding period would remove impacts from disturbance during breeding.
Chisel-toothed kangaroo rat	–	G4	The chisel-toothed kangaroo rat constructs burrow systems within Great Basin desert scrub with open areas dominated by grasses, shadscale, 4-wing saltbush, or blackbrush. Prefers surface soils undisturbed by cattle grazing. On NN, this species occurs near Navajo Bridge in Marble Canyon.	Negative- this species prefers undisturbed and sparsely vegetated habitats. Long-term potential for weed populations to diminish available native plant habitat and negatively impact local populations of the species.	Proposed treatments would not likely impact chisel-toothed kangaroo rat because they are less likely to occur in areas dominated by nonnative weeds. Mitigation measures recommended by the NNDFW require a 200ft buffer for mechanical and target grazing treatments from occupied habitats year-round. Long-term effects would include maintenance or possible increase of habitat quantity and quality.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Banner-tailed kangaroo rat	–	G4	The banner-tailed kangaroo rat constructs burrow systems within Great Basin desert grassland and desert scrub with heavier soils. Presence of grasses is necessary, but extremely dense or high vegetation is avoided. Occupied habitat on the NN includes small remnant populations just west of Chinle, possible on Navajo Mountain, with patches of desert land in NM.	Negative- this species prefers grasses, but avoids dense and tall vegetation, which is created from monocultures of nonnative species. Long-term potential for weed population increase to decrease the suitability of habitat for this species which will negatively affect the population.	Mitigation measures recommended by the NNDFW require a 200ft buffer for mechanical and target grazing treatments from occupied habitats year-round. They may be affected when fluzafop-p-butyl and 2,4-D are used for herbicide treatments. Long-term effects would include improved quality and quantity of native kangaroo rat habitat.
Navajo mountain vole	–	G4	These voles occur in dry grassy areas of conifer forests, including ponderosa pine, monotypic sagebrush, greasewood/desert-olive, juniper stand, tamarisk, and pine flats. This species occurs on NN in Navajo Mountain, Black Mesa, Defiance Plateau, and Chuska Mountains.	Negative- needs native plants in meadows, riparian, and grass for food and cover. Long-term potential for weed populations to diminish available native plant habitat and negatively impact local populations of the species.	Mitigation measures recommended by the NNDFW require a 200ft buffer for mechanical and target grazing treatments from occupied habitats year-round. They may be affected when fluzafop-p-butyl and 2,4-D are used for herbicide treatments. Long-term effects would include improved quality and quantity of vole native vole habitat.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Arizona (Wupatki) pocket mouse	–	G4	This species occupies Great Basin desertscrub with sparse cover of greasewood, snakeweed, rabbitbrush, ephedra, shortgrass, and short junipers. Occupies smaller disjunct range of a narrow swath of western NN from northern Echo Cliffs south to Wupatki National Monument.	Negative- this species prefers sparsely vegetated habitats. Long-term potential for weed populations to diminish available native plant habitat and negatively impact local populations of the species.	Proposed treatments would not likely impact Arizona pocket mice because they are less likely to occur in areas dominated by nonnative weeds. Mitigation measures recommended by the NNDFW require a 200ft buffer for mechanical and target grazing treatments from occupied habitats year-round. Long-term effects would include maintenance or possible increase of habitat quantity and quality.
Kit fox	–	G4	Dens in desertscrub and desert grasslands with sparse saltbush, shadscale, greasewood, sagebrush, or grasses. Known on NN from east of Chuska Mountains and Chinle Valley in AZ and UT.	Negative-this species prefers sparse shrub and grass vegetation for creating dens. Long-term potential for dense non-native grass population to change habitat structure and impact local populations of the species.	Mitigation measures from NNDFW include a buffer of 200ft for mechanical and target grazing methods from occupied habitats year-round and all treatments require a 1/8-mile buffer from active den during breeding season. These measures would reduce the effects of treatments on these species.
Northern goshawk	–	G4	Nests in drainages, canyon bottoms, and north-facing forest slopes with ponderosa pine stands, mixed species, spruce fir and aspen stands composed of large, mature trees and high canopy closure. On NN occurs in Chuska Mountains, Defiance Plateau, and Black Mesa.	Neutral - weeds should not affect food or physical habitat	Mitigation measures recommended by the NNDFW require a buffer of 1/4 mile from nest sites all year round for all treatments. These measures would remove impacts from disturbance.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Clark's grebe	–	G4	Nests in freshwater lakes, and marshes with extensive open water bordered by emergent vegetation. Only documented from Morgan Lake on NN.	Neutral- aquatic weeds would affect this species physical habitat by limiting open water, but aquatic treatments are not proposed in this plan and this species should not be affected by terrestrial weeds.	Mitigation measures recommended by the NNDFW require a 200ft buffer from lake-side vegetation or within 100-year floodplain for mechanical treatments. Prescribed fire, target grazing, mechanized ground and aerial herbicide spraying require 1/8 mile from active nest during breeding season. Chemical spot and manual treatments require 330ft from active nest during breeding season. These measures would remove impacts from disturbance.
Northern saw-whet owl	–	G4	Tree cavities in open ponderosa pine, Douglas-fir, and mixed conifer forests and old growth riparian woodlands. No documented breeding on the NN.	Negative - weeds could reduce prey habitat for small mammals. Long-term potential for weed populations to reduce or replace native vegetation, reduce the amount of owl prey habitat and negatively impact population trends of northern saw-whet owl.	Mitigation measures recommended by the NNDFW require at 1/8-mile buffer from active nest for all treatments during breeding season. These measures would remove impacts from disturbance.
Burrowing owl	–	G4	Nests in ground burrow, often deserted prairie dog burrow in dry, open grasslands, desert scrub, or grasslands with sparse junipers. Potential range on NN includes all low-elevation desert land to juniper habitats.	Negative - weeds could reduce prey habitat for small mammals. Long-term potential for weed populations to reduce or replace native vegetation, reduce the amount of owl prey habitat and negatively impact population trends of burrowing owls.	Mitigation measures recommended by the NNDFW require a ¼-mile buffer from active nest sites for all treatments during breeding season. Mechanical treatments require 1/8-mile buffer from nest site year-round. These measures would remove impacts from disturbance.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Belted kingfisher	–	G4	Nests in burrows in earthen banks near major water source with clear water, riffles and lack of overgrown vegetation for lotic habitats and small lakes/ponds or coves and shallow bays of larger lakes. On NN, known from Chuska Mountains, Morgan Lake and the Little Colorado River.	Negative- non-native trees would create dense monocultures on bank line habitat required by belted kingfisher nests. Long-term potential for weed populations to reduce nesting habitat and negatively impact population trends of belted kingfisher.	Mitigation measures recommended by the NNDFW require no treatments in nesting habitat year round, prescribed fire, target livestock grazing, and mechanized ground and aerial chemical spraying require 1/8-mile buffer from active nest during breeding season. Chemical spot and manual treatments require 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance. Long-term benefits would include protection of this species habitat.
Mountain plover	–	G4	Nests in flat to slightly rolling expanses of grassland, semi-desert, or badlands with short sparse vegetation, large bare areas, areas typically disturbed by grazing, and plowed or fallow agricultural fields. On NN, occurs in Chuska Mountains and Black Mesa to Little Colorado River.	Negative- this species prefers sparsely vegetated habitats. Long-term potential for weed populations may create a dense monoculture and negatively impact local populations of the species.	Mitigation measures recommended by the NNDFW require no treatments in nesting habitat year round, prescribed fire, target livestock grazing, and mechanized ground and aerial chemical spraying require 1/8-mile buffer from active nest during breeding season. Chemical spot and manual treatments require 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance. Long-term benefits would include protection of this species habitat.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Dusky grouse	–	G4	Nests in open stands within mixed conifer forests. On NN, they are known from Chuska Mountains.	Neutral - weeds should not affect food or physical habitat	Mitigation measures recommended by the NNDFW require 1/8-mile buffer from nest site year-round for mechanical treatments; prescribed fire, target livestock grazing, and mechanized ground and aerial chemical spray require a 1/8 mile buffer from active nest during breeding season; chemical spot and manual treatments require 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance. Long-term benefits would include protection of this species habitat.
Yellow warbler	–	G4	Nests in wet deciduous, willow, thickets and disturbed and early successional habitats. Migration habitats include semi-open scrub or shrub lands or second growth forests near wetlands. No current breeding records on NN.	Negative- weed trees could replace the willow or early successional habitats they need. Long-term potential for loss of limited riparian habitat. Weed populations could reduce the native plants used for nesting and negatively impact the species.	Mitigation measures recommended by the NNDFW require a 1/8-mile buffer from active nests during breeding season. Mechanical, mechanized ground and aerial spraying require 1/8-mile buffer from habitat patches for breeding and potential habitat year-round. These measures would remove impacts from disturbance.
Hammond's flycatcher	–	G4	Nest in high elevation typically dense, old growth mixed conifer and aspen forests with cool microclimates. Migrates in mid-elevation forest and riparian areas. On NN, occurs in Chuska Mountains.	Neutral- weeds will not affect nesting habitat in dense old growth forests.	Mitigation measures recommended by the NNDFW require a 1/8-mile buffer from active nest year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
American Peregrine falcon	–	G4	This species nests in steep cliffs and forages in wetlands and forest habitat. This species nests throughout the NN where appropriate habitat exists, including the Chuska Mountains, Canyon de Chelly, Black Mesa north to Glen Canyon, the Dilkon Buttes, and canyon reaches of the San Juan, Colorado, and Little Colorado Rivers.	Neutral- weeds will not affect nesting habitat on cliffs. Peregrines eat diverse and common prey species in varied habitats.	All treatments would require a ½-mile buffer from known nesting site during breeding season. This buffer would limit the impact of weed treatments on nesting peregrines. No indirect effects are expected due to the small weed treatment are would not impact peregrine foraging behavior or prey species abundance.
Northern pygmy-owl	–	G4	Nests in tree cavities near opening in forests and wooded canyons. Migrate to lower elevations to use woodlands or prairie foothills as wintering habitat. On NN, found in Chuska Mountains and Tsegi Canyon.	Negative - weeds could reduce prey habitat for small mammals and passerine birds. Long-term potential for weed populations to reduce native vegetation used for nesting and prey habitat which would negatively impact population trends of northern-pygmy owl.	Mitigation measures recommended by the NNDFW require 1/8-mile buffer from nest year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 1/8-mile buffer from active nest during breeding season. These measures would remove impacts from disturbance.
Flammulated owl	–	G4	Nests in tree cavities in open conifer or aspen forests often with brushy understory of saplings or oak shrubs; areas with old-growth preferred. On NN, known from Chuska Mountains, Defiance Plateau, and Black Mesa.	Neutral- weeds will not affect nesting habitat in old-growth forest conifer or aspen forests. Flammulated owls eat diverse and common insect species.	Mitigation measures recommended by the NNDFW require a 1/8-mile buffer from nest site year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 1/8-mile buffer from active nest during breeding season. These measures would remove impacts from disturbance.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Band-tailed pigeon	–	G4	Nests in mixed-conifer forests, preferably Pine-Douglas-fir forests and spruce-fir with abundant berry-producing fruit. On NN, it is known from the Chuska Mountains.	Neutral- weeds will not affect nesting habitat in mixed-conifer forests. Band-tailed pigeons travel long distances to feed and utilize a variety of plants.	Mitigation measures recommended by the NNDFW require a 1/8-mile buffer from nest site year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance.
American three-toed woodpecker	–	G4	Nests and winters in spruce, fir, aspen or mixed-conifer forests, preferably mature or old-growth, or fire-killed with large numbers of bark beetles. On NN, only known from the Chuska Mountains.	Neutral- weeds will not affect nesting habitat in forests. Their primary food source of bark beetles would not be affected by weeds.	Mitigation measures recommended by the NNDFW require a 1/8-mile buffer from nest site year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance.
Tree swallow	–	G4	Nest in existing cavities in deciduous and coniferous forests near open fields and water. On NN, known from Chuska Mountains.	Neutral- weeds will not affect nesting habitat in existing cavities in forests. Tree swallows eat diverse and common insect species.	Mitigation measures recommended by the NNDFW require a 1/8-mile buffer from nest site year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Sora	–	G4	Nests in wetlands with shallow to intermediate water depth and fine leaved emergent vegetation; floating and submerged vegetation increases habitat quality. Known from various ponds and lakes on NN, including in Chuska Mountains, Morgan Lake, and near Tuba City.	Negative- Sora prefers native cattails and bulrushes for breeding and avoids tamarisk. Long-term potential for weed population to reduce or replace native vegetation and affect population trends of soras.	Mitigation measures recommended by NNDFW require a 200ft buffer from lakes and 150ft from Category I wetlands. Prescribed fire, target grazing and mechanized ground and aerial spraying require 1/8-mile buffer from active nest during breeding season. Chemical spot and manual treatments require 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance.
Gray vireo	–	G4	Prefers pinyon-juniper woodlands and juniper-sagebrush associations. Nests in pinyon pine, sagebrush, sumac, mountain mahogany and oak species. On NN, distribution unknown, but potential to occur in pinyon-juniper woodlands.	Neutral- weeds will not affect nesting habitat in pinyon-juniper and juniper-sagebrush. Gray vireos eat diverse and common arthropods and fruit.	Mitigation measures recommended by NNDFW require mechanical, prescribed fire, target grazing and mechanized ground and aerial spraying require a 1/8-mile buffer from nest site during breeding season. Chemical spot and manual treatments require 330ft buffer from active nest during breeding season. These measures would remove impacts from disturbance.
Milk snake	–	G4	Uses rocks, logs, stumps, boards and other surface objects as cover in river valleys, desert scrub, grasslands, pinyon-juniper, and coniferous forests. No records exist on NN.	Neutral- weeds will not affect the various habitats in which this species occurs. Milk snakes eat diverse prey items.	Mitigation measures recommended by NNDFW require that no mechanical treatments within occupied habitats, which would remove impacts from disturbance.

Common Name	Federal Status	Tribal Status	Species Native Habitat	Expected Response to Noxious or Invasive Weeds (Alternative 1)	Expected Response to Noxious or Invasive Weed Treatments (Alternatives 2 and 3)
Chuckwalla	–	G4	Habitat consists of low desert lands, rocky canyons and margins of grass-oak woodlands. On NN, range includes deep canyons and adjacent desert lands of Little Colorado River, Marble Canyon and San Juan River.	Neutral- this species has a wide distribution occurring in drought-tolerant habitats. Chuckwalla has a varied diet including plants and insects.	Mitigation measures recommended by NNDFW require that no mechanical treatments within occupied habitats, which would remove impacts from disturbance.
Rocky mountainsnail	–	G4	Occurs in leaf litter or within rocks within steep-sloped, northern-aspect coniferous forests and steep walled canyons. One record of this species occurs on the south slope of Navajo Mountain and most from Chuska Mountains.	Neutral- plant community composition is not required for potential habitat. Physical factors such as cool, moist microclimate and leaf mold are more important.	Mitigation measures recommended by NNDFW require that ground-disturbing treatments (mechanical and manual) require a 200ft buffer from occupied habitat year-round. Implementing these measures would remove impacts from disturbance.
Yavapai mountainsnail	–	G4	Occur in steep-sloped northern-aspect coniferous forests with dense mossy groundcover over exposed rock/boulder substrate. Species occurs on and around Navajo Mountain and Canyon de Chelly National Monument.	Neutral- it is unlikely that non-native vegetation will grow in the required habitat of this species.	Mitigation measures recommended by NNDFW require that ground-disturbing treatments (mechanical and manual) require a 200ft buffer from occupied habitat year-round. Implementing these measures would remove impacts from disturbance.

4.7 Agriculture

As stated previously, agricultural practices are an important aspect of Navajo life and culture. However, weeds and weed management are likely to impact grazing, farming, and industrial agricultural efforts currently pursued on the Navajo Nation.

4.7.1 Rangeland Management

Noxious weed species have largely become a major problem on permitted rangelands on the Navajo Nation. Unsustainable grazing management practices have created conditions that facilitate the spread of many exotic weed species. Many weeds, such as thistles and grasses, are spread by grazing animals that forage or travel through infested areas. Seeds, leaves, and other plant parts can often attach themselves to animal coats as they travel across rangelands, facilitating their spread. As noxious weeds spread, they could also reduce the forage available at sites. Annual noxious species, such as grasses and some thistles, could replace valuable perennial forage species, altering vegetative cover and seasonality of plant communities (Draut et al. 2012). Such changes have synergistic effects as well, including increased erosion, loss of topsoil, and further degradation of habitats.

The value of noxious species as forage is limited. Many species may only be palatable for a short period of time before they begin flowering or producing seeds. Sheep and goats, and to some extent cattle, are effective at reducing weed populations for a variety of species. The Western Region Sustainable Agriculture, Research, and Education Project has developed guidelines for the targeted grazing of twelve weed species covered under this plan including: leafy spurge, yellow starthistle, bull thistle, Canada thistle, Dalmatian toadflax, musk thistle, perennial pepperweed, Scotch thistle, spotted knapweed, tall whitetop, diffuse knapweed, Russian thistle, and kochia (Davison et al. 2005). Grazing of these species must be done with special consideration of to the animal being used, the growth stage of the plant, the size of the area being treated, and how often they are being grazed. These considerations are made to both protect the health of the animals and to develop grazing regimens that will be effective at controlling weed species (Davison et al. 2005). Livestock typically will not actively forage on these species unless limited forage stresses the animal to seek alternative plants or unless they are specifically trained to eat certain species at certain stages of their growing cycle. Others produce harmful chemicals that can make livestock sick or result in death. For example, halogeton produces sodium oxalate, which increases in toxicity as the plant matures. At higher doses, oxalates cause hypocalcemia causing damage to the kidneys and rumen walls, and inhibiting energy metabolism (Panter et al. 2011). Additionally, Russian knapweed and yellow starthistle produce toxins that cause “chewing disease” or nigropallidal encephalomalacia. When animals graze for prolonged periods of time on these species, they can develop a neurological disorder that makes it difficult for them to swallow, eventually starving the animal to death (Dawson 2011, Panter et al. 2011). While these species have been previously identified for control through previous BIA weed management efforts, the lack of coordinated control and management on the Navajo Nation has led to their continued spread on rangelands.

Weeds also have impacts on the economics of rangeland management. Agricultural economists determined the direct impacts caused by leafy spurge on grazing lands and wildlands in North Dakota. Direct annual losses from leafy spurge in one state included reduced personal income from cattle producers by around \$9 million and an additional \$15 million reduction in lost cash outlays due to reduced livestock production. Leafy spurge infestations have also been linked to reduced cattle carrying capacity, which in turn results in reduced income and buying power for ranchers and operators. In terms of ecosystem service, leafy spurge has been linked with lost value of wildlands through reduced soil and water conservation and loss recreational value to rangelands as well (Beck 1994). Other economic analyses estimate that problematic rangeland species, such as cheatgrass, exotic knapweeds, and leafy spurge have caused an estimated loss of \$2 billion annually throughout the United States (DiTomaso 2000). Much of these economic losses are strongly tied to reduced production, increased management costs, and decreased land values.

4.7.1.1 Alternative 1 – No Action

The No Action Alternative would treat weeds on rangelands on a project-by-project basis using chemical, mechanical, and manual techniques already implemented by weed coordinators. These treatments would allow limited control and management of noxious species, but would not track or monitor the success of treatments across the Navajo Nation. This Alternative would not require coordination of weed management activities with neighboring agencies or the use of additional weed control techniques on rangelands. It would also not address management of additional noxious species that may impact rangeland health, including Russian thistle and several exotic brome species. The No Action Alternative also would not provide mechanisms for monitoring and preventing infestations of new weeds within the area.

Many weed species would continue to spread on the Navajo Nation by livestock movement to different pastures and locations. The spread of weeds by animals could have additional impacts including reduced value to wool as plant parts with burs or hooks become tangled on animal coats. The spread of some toxic noxious species, such as kochia or Russian thistle, would increase coverage and could put some herds at increased risk of poisoning as they replace more valuable forage species. Thus, under the No Action Alternative, livestock grazing on certain rangeland species would negatively impact the health of livestock on the Navajo Nation.

As weeds are likely to continue to spread at the same infestation rates currently witnessed on the Navajo Nation under this Alternative, ranchers and grazing permit holders will likely see increases in the costs of managing livestock on their customary use areas. Ranchers and grazing permit holders would need to increase supplemental feedings for livestock and wildlife, as more palatable plant species are replaced. Supplementation, however, may also cause a positive feedback on the spread and introduction of exotic plant species under this Alternative. Some permit holders may use hay or feed that contains weed seeds or parts, which is often cheaper but could introduce new weeds to rangeland areas. Loss of quality forage may also reduce the

quality and quantity of the meat produced, as animals browse on lower quality plants or suffer ill effects from eating weeds on rangelands.

Past grazing practices, altered fire regimes, and introduced species have resulted in rangelands dominated by noxious annual grasses. These factors would continue to facilitate the spread of weeds on rangeland in the Navajo Nation. While the removal of livestock and the implementation of grazing management can help address some weed problems on a case-by-case basis, it would not address the management and control of weeds on adjacent lands or through practices that may be less harmful or intrusive to the cattle.

Lastly, under the No Action Alternative follow-up treatments or restoration of native plant communities would not be prioritized. Removal of vegetation from rangelands can exacerbate existing problems, as even noxious species may be holding soils in place in some degraded areas. Treatment of those weeds, especially in areas where infestations may be large, would result in synergistic impacts that worsen issues such as erosion and topsoil loss. The No Action Alternative also would not address the long-term needs for treated areas to recover. After the treatment of an area, land users may decide to place cattle immediately back on to pastures. Grazing recently treated areas can reduce the efficacy of treatments and may result in secondary infestations or the reintroduction of previously eradicated weeds. Such impacts would perpetuate the cycle of increased erosion, decreased biodiversity, decreased vegetative cover, and poor forage values that impact the overall value and utility of rangelands.

4.7.1.2 Alternative 2- Proposed Action

The Proposed Alternative would treat weed infestations based on a combination of different weed management techniques. This alternative also includes additional management tasks such as weed mapping and inventory, maintenance recommendations for treated sites, and monitoring of projects to assess their progress and efficacy. While the majority of the infested lands on the Navajo Nation would not be treated under the Proposed Alternative, coordination with neighboring agencies can provide more effective control in identified project areas. This would be especially important in the checkerboard areas of the Eastern Navajo Agency area, where tribal land is intermixed with land owned by other federal, state, and private entities. Control techniques that will have the most impact on rangelands would be the use of Chemical methods, biological control agents, cultural methods such as targeted grazing and native plant restoration.

Chemical Control

Some of the chemicals proposed for use under the Proposed Alternative would have impacts on livestock species. Many of these impacts associated with the use of herbicides have been examined in the Wildlife section for each herbicide. However, some herbicides proposed for use do have some significant impacts that could specifically affect livestock such as sheep, goats, or cows. These impacts may be reflected in laboratory testing on sheep or pigs, who serve as surrogates for larger mammals. Herbicides that could potentially result in toxic impacts to livestock are examined below.

2,4-D – Large mammals may experience moderate acute and chronic toxicity when ingesting 2,4-D off of treated vegetation. In mammals, 2,4-D has been shown to disrupt cell membranes, interfere with cell metabolism, and uncouple oxidative phosphorylation (SERA 2006), all of which can lead to cell death. Animals ingesting large amounts of the herbicides can have health impacts ranging from changes in body weight and appetite to adverse effects on the liver and kidney enzymes. 2,4-D can bioaccumulate, leaving residues on milk, eggs, and meat products.

Atrazine – While atrazine does have low toxicity for mammals, some studies on sheep have indicated body weight loss for sheep (USEPA 1984b). Other effects in mammals include sedations, labored breathing, ruffled fur, and protruding eyeballs (USEPA 1984b). Atrazine is also a potential endocrine disruptor, which can alter the reproductive health and growth of exposed animals (USEPA 2007).

Dichlobenil – Dichlobenil is slightly to moderately toxic to mammals. The USEPA product registration review (2008) noted that tested mammals suffered liver and kidney damage at high doses. It has also been noted for testing as a potential endocrine disruptor.

Fluazifop-p-butyl – Fluazifop has been shown to be moderately toxic to small mammals and does pose a risk to animals at typical application rates (SERA 2014). Animals are at risk during scenarios involving direct spray exposure and consumption of contaminated vegetation, including foliage and tall grasses. Impacts include decreased body weight and adverse effects on reproduction and development.

Paraquat Dichloride – Paraquat is moderately toxic to large mammals when ingested. It can pose a potential risk to mammals as applications that use moderate concentrations can leave residues on grasses. Some studies have also indicated residues of the herbicide can be found in the milk, fat, and meat of cattle, goats, horses, and sheep of animals that graze on treated vegetation (EPA 1997).

Picloram – Picloram has been shown to have some harmful effects on large mammals. The risk assessment conducted by the U.S. Forest Service (SERA 2011b) indicated that larger mammals would be most at risk when eating contaminated grasses and vegetation. One study (Sassaman et al. 1984) estimated that the LD₅₀ for cattle is at doses above 750 mg/kg and for sheep at doses above 1,000 mg/kg.

Triclopyr – Triclopyr can pose a slight risk at typical application rates to moderate risk at higher application rates for large mammals that consume contaminated vegetation, whether through acute or chronic consumption. These risks are also present if off-site vegetation is contaminated and consumed (SERA 2011c). Mammals exposed to higher doses can suffer from adverse effects to the kidneys and developmental impacts including maternal toxicity (SERA 2011c).

Overall, the use of chemical methods to treat weeds in range management units will need to consider the impacts of the proposed herbicides on livestock species. The herbicides proposed

are slightly to moderately toxic to large mammals, with the most serious effects occurring in the event of accidental spills or direct spraying. The risks of such exposures would be minimized with the implementation of Best Management Practices, which include removing animals from treatment areas prior to treatment, mixing and preparing herbicides away from the main project area to prevent spills, and deferring cattle to allow native vegetation to reestablish and to prevent animals from grazing potentially contaminated forage.

Cultural Control

Methods that actively or passively treat weed infestations by restoring native vegetation will have some impacts at project sites. Restoration of native plants species include perennial grass and shrub species, which would improve forage production in many areas where weeds may have replaced native vegetation. Any adverse impacts from native plant restoration are related to increased foot traffic at sites while native plants are installed, monitored, and/or maintained such as increased erosion, soil compaction, and sedimentation along bank lines. Such impacts would be short-term in duration and would likely not result in negative impacts range management units.

Overall, such methods would largely benefit rangeland health by restoring more diverse plant communities and improving forage quality in many rangeland management areas. Diverse native plant communities are comprised of plants that take advantage of conditions that differ at sites both temporally and spatially. This diversity maximizes the overall productivity of sites and can allow for longer grazing seasons (Pellant 1996). An increase in plant biodiversity would also increase carrying capacity at some sites and allow for more sustainable grazing by animals with varying grazing habits. For example, cattle tend to eat newer shoots and leaves of plant, leaving behind portions of a plant that are closer to the ground. Horses, on the other hand, tend to eat the entire plant when grazing in grasslands, pulling up even portions of the plant's roots when grazing. Having a variety of different native vegetation would allow different livestock species to utilize the same area more sustainably. Higher plant diversity would also permit areas to better sustain wildlife populations which may graze in these same units.

Proper use of targeted grazing would also impact treatment sites. Treating weeds with livestock requires attention to the timing of treatments, the cover and density of species being treated, and the size of treatment area for grazing to help control weed infestations. While livestock have been known to contribute to the spread of noxious weeds, grazing management experts note that proper application of targeted grazing can provide competition and reduced coverage of several noxious species, including cheatgrass, leafy spurge, and Japanese brome (Frost and Launchbaugh 2003, Mosley and Roselle 2006). Some land managers and federal agencies have found that the proper use of targeted grazing can increase the cover perennial grass species and forbs, while reducing non-native annual grasses (Mosley and Roselle 2006).

If targeted grazing is not properly implemented, the risk for adverse impacts would increase. Improper timing of treatments may have animal grazing on weeds when their production of

harmful chemicals or plant parts is highest. Grazing during these times would increase the risk to the animal for poisoning. If animals are not kept in small areas, animals may not experience enough grazing pressure to consume weeds, leading them to graze more heavily on native plants, which may help unintentionally contributed to the spread of undesirable weeds. Mismatching the grazing animal with the species being treated would result in similar effects. Thus it will be important to implement proper Best Management Practices and training for those wishing to use targeted grazing to address weed issues in treatment areas.

However, even with proper implementation, targeted grazing could increase site-specific effects as animals are often concentrated in small areas to increase pressure to graze on less palatable exotic species. This method can increase erosion and the potential for sedimentation as animals trample areas and vegetation is removed. Such impacts, however, would be short in duration, especially if native plants are restored at treated areas.

Biological Control

Many of the biological control agents proposed for use under this alternative would treat many of the species that impact rangeland health. Biological agents have not been shown to impact livestock or wildlife species directly and can be used to treat weeds in a less intrusive manner. The method would save land users money and time during treatments as livestock would only need to be removed from treatment sites when agents are first placed on sites and when they are collected for distribution purposes. The size of an area needed to place agents would also be minimal as long as it introduces the agents to a sizeable treatment area. Once the agents are placed, cattle would only be moved occasionally as workers come to sites to check the impacts of the biological agents on target weeds and to collect agents to potentially move them to other treatment sites. As weeds are reduced by biological agents, other native species will likely return to sites, improving forage value and species diversity.

Indirectly, there is evidence to suggest that some biological agents may impact food webs for treatment sites. In some instances, the application of biological control agents has resulted in some target species increasing in production in response to increased herbivory, thus increasing competitive growth between the target species and some native plant communities (Louda et al. 2003, Pearson and Calloway 2003). In other instances, decreases in target weed populations have altered some food webs, which could potentially alter the coverage of some native and non-native plant species (Pearson and Calloway 2003). However, many of the agents proposed for use on the Navajo Nation have been permitted by the USDA for more than 10 years after extensive testing. There have been no known reports of them having such impacts in similar project areas around or near the Navajo Nation. To minimize adverse impacts, application of biological control agents should be done in consultation with the USDA APHIS program to help with species monitoring and maintenance of agent populations.

4.7.1.3 Alternative 3 – No Biological Control

Under this Alternative, weed control treatments would be limited to the use of cultural, mechanical, manual, and chemical treatment methods. Many of the proposed biological control agents are proposed for noxious species that impact rangelands. Under this alternative, use of chemical, manual, or mechanical treatments would be used instead to treat weed populations. Such treatments would risk exposing wildlife to harmful chemicals, such as 2,4-D or fluazifop-p-butyl. Use of mechanical treatments on agricultural areas would result in erosion and soil compaction in treated areas in order to control and limit the spread of some noxious weed populations. Implementation of such treatments require that livestock be deferred from treatment sites for extended periods of time to limit their exposure and for their safety. Such deferment can increase the cost for managing livestock for many permit holders and could reduce the productivity of some managed herds.

However, under Alternative 3, many of the indirect impacts related to the use of biological control agents would not be an issue. While biological control agents are not expected to cause major direct impacts to grazing and rangeland management, indirect impacts from the application of biological agents could interfere with existing food web interactions or result in target weed species expressing more aggressive compensatory responses (Louda et al. 2003). Such indirect impacts could have impact to the quality and quantity of native forage available for grazing purposes.

4.7.2 Farming

Weeds negatively impact the practice of farming for many agricultural permit holders located on the Navajo Nation by impacting productivity and crop yields, increasing erosion and topsoil loss, reducing land values, and increasing the costs of managing farm plots. Lands managed by NAPI-NIPP, weeds have also impacted their suitability as wildlife habitat and forage as well as posing a risk to their marketable crops. As weeds invade agricultural lands and farm plots, they outcompete desired crops and plants. Crowding, allelopathy, and altered growing seasons are all previously discussed mechanisms that contribute to the spread of noxious weed species on farmlands. One study on the impacts of weeds on North American crops determined that weeds resulted in close to \$7.5 billion in annual yield losses (WSSA 1984). To treat and manage weed infestations, land users often utilize many of the same weed treatments described in Alternative 2 to reduce the cover and spread of weeds.

While weeds, by definition are considered undesirable, some species may provide some beneficial impacts that are useful for agricultural operations. Deep-rooted weeds can bring nutrients from the subsoil to the topsoil, making them more available for some crop species. Weeds can also provide habitat for beneficial insects and serve as alternative food sources for pest species, thus lessening the impacts on desired vegetation. Some noxious plant species can also serve as a source of biomass for biogas operations (Pimentel et al. 2005).

However, the target weed species identified through this project that would be treated on agricultural landscapes have more negative impacts than positive ones on the Navajo Nation. Many agricultural permit holders use their farms for subsistence, while a few are able to sell their goods for potential income. Weed management projects implemented through the BIA would address declines in natural resource values for agricultural areas related to the spread and presence of noxious weed species.

4.7.2.1 Alternative 1 – No Action

Under the No Action Alternative, weed treatments would not be conducted in a coordinated fashion using an integrated approach. This approach would permit weeds to continue to spread and would not address treatment of major agricultural weeds such as Sahara mustard, kochia, and several noxious bromes. Noxious weeds have resulted in an overall reduction in crop yields for small family farms and larger farming operations on the Navajo Nation. A recent weed management proposal from the Navajo Agricultural Products Industry (NAPI) estimates that several noxious weed species currently cover 1,340 acres of land managed by the program.

It would also only authorize the continued use of imazapyr, metsulfuron methyl, 2,4-D, and triclopyr. Continued use of these herbicides on agricultural sites, where herbicide use can tend to be elevated, may result in some species developing herbicide resistance. If species develop herbicide resistance, it would limit the chemical options available for the treatment of species. For example, herbicides recommended for kochia, which has been well documented for its resistance to several herbicides (Heap 2015), include 2,4-D, atrazine, dichlobenil, fluroxypyr, glyphosate, isoxaben, metribuzin, pendimethalin, and proflaminate. Under Alternative 2, if kochia develops a resistance to 2,4-D herbicides, none of the other recommended herbicides would be approved for use, further limiting options for control of this species.

Herbicide use under this alternative would also likely be higher than other proposed alternatives as agricultural sites represent areas where the use of herbicides tend to be higher than other priority locations. Increased use may result in more concentrated herbicide residues found on non-target vegetation, which could be consumed by humans or animals. This is a significant concern on the NAPI-NIIP site, where the majority of weed infestations have been documented on the rangeland surrounding the main agricultural fields. These areas are managed and maintained to provide habitat and forage for wildlife species. Use may also increase the risk for surface water contamination through either direct spray in fields neighboring water ways or through surface runoff.

Mechanical and manual treatment methods would also be utilized more often under the No Action Alternative. Increased use of these methods would increase erosion and could negatively impact valuable topsoil. Vegetation would be removed in larger treatment sites, but replanting of native vegetation or more desirable cover crop species would not be prioritized. Without this integrated approach, treated areas would be at increased risk of top soil loss, soil moisture loss, and secondary weed invasions. Prescribed burning also would not be authorized to treat target

weed species. However, the increased spread of some weeds would increase fire risk for infested areas. Species such as cheatgrass alter existing fire regimes, resulting in fires that occur more frequently. While such fires can be beneficial for agricultural operations by recycling important nutrients back into the ground and removing dead plant material, alterations to fire regimes may result in fires that occur during inopportune times, impacting crop yields or resulting in expensive damage.

4.7.2.2 Alternative 2– Proposed Action

An integrated approach towards noxious weed management would provide farmers and land users with several options for treating weed species on farm plots. For farm plots, the use of chemical, cultural, manual, biological, and mechanical techniques is proposed. Targeted grazing would not be utilized on farming plots.

Chemical Control

Herbicides are often an effective and efficient weed control method to use on cropland. Herbicides are often applied to control a wide variety of native and non-native plant species. As a result, croplands experience more frequent applications of herbicides than most other land use types, thus increasing the potential risks associated with elevated herbicide application rates and chronic exposure. Currently the most commonly used herbicides by the BIA are imazapyr, metsulfuron methyl, 2,4-D, and triclopyr.

While it is assumed that herbicides will impact non-target plant species, the sensitivity of some plants may differ in relation to plant form, family, or application rate. Since herbicides are designed to impact plant species, the EPA requires them to undergo phytotoxicity testing. This level of testing is typically done on a few common agricultural species to determine how plants may respond to different treatment rates of a given herbicide.

In the case of farming, some of the more popular crops cultivated by land users on the Navajo Nation include corn, wheat, peaches, hay, beans, and squash. The Navajo were encouraged to farm these marketable crops when agricultural land use permits were initially issued. While permit holders may cultivate other crops, these still remain as some of the more popular plants to grow on dryland and irrigated farming areas. Because the U.S. EPA only requires testing on a few of the crop species during Tier II studies, many herbicides may not test all potential crops or may assume that impacts to a species in a particular family may be related to impacts to other species in that family. For example, impacts to squash, which are part of the cucurbit family, can be estimated through toxicity testing on cucumbers; soybeans can often be used to determine how sensitive other legumes will respond as well. As hay is often a mix of different grasses, legumes, and other herbaceous plants, impacts to alfalfa and ryegrass can be used. Not much information, however, is available for peaches or other stone fruit trees as they are not part of the list of standard test species typically evaluated by the U.S. EPA. Occasionally, herbicide manufacturers may provide data on the impacts of herbicides on this family of plants, however none of the herbicides proposed have reported this information.

Table 4-8. EC₂₅ values for all proposed herbicides on major crops and/or related species on the Navajo Nation. The EC₂₅ value is the amount applied that would result in at least 25% of the plant communities to have an adverse reaction to the herbicide. All values are reported as pounds of active ingredient per acre (lbs a.i./ac). Values for peach trees are not determined for the pesticides proposed, and thus are not reported below.

Crop	Corn		Wheat		Hay*		Beans [^]		Squash [°]		References
	Seedling	Vegetative	Seedling	Vegetative	Seedling	Vegetative	Seedling	Vegetative	Seedling	Vegetative	
2,4-D Acid	>4.2	>4.2	2.1 ⁺	0.2		2.07	1.71	0.008	0.53	0.015	USEPA 2009, Montague 2000
2,4-D Amine	>4.0		0.0054	0.32	>4.0	>2.07	0.26	0.0093			
2,4-D Esters	3.4	0.17	>4.0	0.34	>4.0	>2.03	0.036	0.058			
Aminopyralid	>230.8	>230.8	>230.8	>230.8	>230.8	>230.8	2.7	0.75	>57.7	12	USEPA 2005, BLM 2016
Atrazine	>4.0	>4.0			0.004+	>4.0	0.19	0.026	0.013	0.008	USEPA 2012
Chlorsulfuron	0.0048	0.0031	0.022	0.93			0.014	0.00031	0.004	0.098	McKelvey and Kuratle. 2003.
Clopyralid			>0.037	>0.27			0.0046	0.0053			Montague B. 2000.
Dichlobenil	<1.14		<1.14		>0.25		<1.14		<1.14		Montague B. 2000.
Fluroxypyr	0.178	>0.25	0.079	>0.25	>0.25	>0.25	0.072	0.00042	0.075	0.01	Montague B. 2000.
Fluazifop-p-butyl ¹		0.0071		0.13	0.45	0.018		0.5		0.5	Montague B. 2000., SERA 2014
Glyphosate acid		0.43		0.176		0.98	>10	0.32		0.46	Chetram R.S. 1994.
Imazapic	0.0076	0.019			0.014	0.0046	0.041	0.036	0.0014	0.0032	Montague B. 2000.
Imazapyr	0.025	>0.0156	0.0046	0.012			0.012	0.034	0.0043	0.0009	Montague B. 2000.
Isoxaben			>0.888	>0.888	>0.888	0.014	0.29	>0.888	>0.888	0.089	USEPA 2010
Metsulfuron methyl	0.00091	0.00303					0.00041	0.000018			Montague B. 2000.
Metribuzin			0.024	0.37					0.029		Burge, C.L. 1992.
Paraquat dichloride		0.16	>0.86	0.061							Montague, B. 2000, USEPA 1997
Pendimethalin	0.02	0.035			0.03	0.1	0.02	0.035	2.4		USEPA 1996
Picloram	>1.0	0.25	0.02	0.032			0.00001	0.0003		0.0011	Montague B. 2000.
Prodiamine	>1.5	>1.5			0.026	>1.5	1.135	>1.5	0.08	0.061	Montague B. 2000.
Thifensulfuron methyl	>0.0311				0.0069*		>0.0311		<0.00027		Montague B. 2000.
Triclopyr-BEE	>2	0.46	>2	0.8	0.036	0.037	0.17	0.038			SERA 2011c
Triclopyr-TEA	>0.23	0.32	>0.69	>0.69			>0.28	0.028			

*Values for ryegrass are used as a substitute.

[^]Values for soybeans used as a substitute.

[°]Values for cucumbers used as a substitute.

¹EC₅₀ values reported

The EC₂₅ value reported for different herbicides are largely a function of the approved application rates for the given herbicide. If an herbicide has a maximum application rate of 10lbs a.i./acre per season, an EC₂₅ value of 2lbs a.i./acre may not be as concerning as an EC₂₅ value of 0.05lb a.i./acre. Determining if a particular herbicide is toxic to specific plants, then must come from an understanding of how the herbicide is applied and used in an area. Additionally, some plants may show greater sensitivity to an herbicide than others, which may warrant limited use of that herbicide around that particular crop. Table 4-8 outlines the reported EC₂₅ values for the most common agricultural species found on the Navajo Nation

Based on the EC₂₅ values for the most popular crops for the Navajo Nation, some crops do show greater phytotoxicity to the proposed herbicides than others. Other plants have greater sensitivity to the proposed herbicides at different stages of growth. For example, corn shows greater phytotoxicity to 2,4-D ester during the juvenile growing phase than during seedling emergence. However, for this analysis the sensitivity of a plant to a particular herbicide is relative to the other plants tested, unlike animal toxicity ratings which are determined based on specific pesticide doses (see Wildlife and Public Health sections for more information). For instance, when looking at thifensulfuron methyl phytotoxicity, squash plants are more sensitive than ryegrass, which is more sensitive than corn or soybeans. When examining plant phytotoxicity data, the relative concentrations must be compared with the standard and maximum herbicide application rate being used to treat an area.

To assess the potential for herbicide treatments to adversely impact farming operations on the Navajo Nation, the EC₂₅ values were compared to determine which species would have greater sensitivity to the proposed herbicides. It is important to note that these only indicate if a crop is potentially more sensitive to adverse effects than others and does not indicate whether or not a particular herbicide should be avoided. Corn plants show the greatest sensitivity to fluazifop-p-butyl than the other crops tested. Wheat seedlings are highly sensitivity to 2,4-D amine formulations and imazapyr. Growing hay plants have greater sensitivity to isoxaben. Soybean seedlings show the greatest sensitivity to aminopyralid, clopyralid, metsulfuron methyl, and picloram. Growing soybeans and other legumes have greater sensitivity to all 2,4-D formulations, aminopyralid, chlorsulfuron, clopyralid, fluroxypyr, and metsulfuron methyl. Squash seedlings show higher sensitivity to thifensulfuron methyl than many of the other crops. Growing squash plants demonstrate high sensitivity to 2,4-D acid formulations, atrazine, imazapic, imazapyr, and picloram.

The use of herbicides also introduces the risk of herbicide resistance on farmlands for many weeds where herbicide use is already high. Herbicide resistance can occur through natural selection, through mutation, or through genetic engineering and has been documented in a few instances for the target weeds species covered under this alternative (Prather et al 2000). Species that have shown herbicide resistance in other locations in the United States include yellow starthistle, Johnsongrass, yellow nutsedge, Russian thistle, and cheatgrass, with kochia resistance documented in Utah, New Mexico and Colorado (Heap 2015). To reduce the risks of weed

populations developing herbicide resistance on agricultural lands, land users would be able to select other herbicides to use to reduce selective pressure. Pairing chemical treatments with mechanical and cultural techniques, would also reduce the use of herbicides in many treatment areas over time, reducing the potential for plants to become resistant to a particular herbicide.

Herbicide use could also result in indirect impacts to agricultural lands and operations. Some herbicides can interfere with beneficial insects, such as honeybees and other beneficial insects (see Wildlife). Such interactions would interfere with crop production. In the case of honeybees and other pollinators, there may be a reduction of production of certain crops. In some instances, natural enemies of agricultural pests may be impacted, resulting in an increase in crop damage and losses. Increased use of these herbicides would result in greater risk of humans and wildlife consuming herbicide contaminated vegetation and a higher risk of herbicide runoff into neighboring water bodies. Agricultural workers and people living near or downstream from treatment areas would also be at increased risk due to increased use of herbicides for farmlands. However, long-term impacts of weed management on agriculture would be positive through improved land values and less compromised crop yields.

Cultural Treatments

On the Navajo Nation, cultural treatments in farming areas under Alternative 2 include implementing crop rotation and planting cover or forage crops to limit competitive growth of noxious weeds. Crop rotation is an agricultural tool that is used to control weeds by limiting the ecological niches available to various weed species. In a crop rotation system, different crops are grown in systematic and varying sequences on the same landscape, replacing the monoculture of crops that are typically seen. These variations can provide temporal and spatial diversity to a field, utilizing how different plants may use nutrients and space during the growing season. Under temporal diversification, a farmer may grow corn one year and then soybeans the next, followed by alfalfa. For spatial diversification, squash, beans, and corn may be grown together in a distinct spatial pattern, providing a synergistic relationship between each of the different plants (Liebman and Dyck 1993, Postma and Lynch 2012). Crop rotation can be used to help control weeds by altering how different plants are utilizing a growing space, preventing a few weed species from dominating an area (Liebman and Dyck 1993, Shrestha et al. 2004). Using crop rotation would reduce the reliance of farmers on herbicides and more disruptive weed control methods.

The use of cover and forage crops can also be utilized in a crop rotation system, or if a field needs to rest after extensive use. The use of cover crops would limit the spread of weeds into areas that might need to be taken out of use for various reasons and could provide additional benefits including improved soil quality, reduced erosion, and better nutrient management (Shrestha et al. 2004). Cover crops used could include native plants and grasses or other desirable vegetation species, such as plants that provide forage for wildlife. Selection and use of cover crops should be done in consultation with local Cooperative Extension agents or NRCS

agricultural programs to ensure that use of certain species will not result in unintended issues for farmers.

Finally, use and timing of different fertilization methods can help reduce weed cover on farm areas. Similar to crop rotation, different fertilizers may provide a competitive advantage for preferred crop species, allowing them to outcompete non-native weed species. Some studies have indicated that a reduction in nitrogen fertilizer could alter weed competition in agricultural settings, reducing cover while not impacting crop yields (Blackshaw et al. 2002). Selecting and modifying fertilization schedules would be done in consultation with an agricultural specialist such as Cooperative Extension agent or an NRCS specialist. Use of fertilization manipulations to help reduce weed cover alter nutrient availability at the site for the purposes of agricultural enterprises, but should be not result in significant changes in productivity or yield.

Biological Treatments

The costs of controlling noxious weeds in agricultural settings using conventional pesticides is likely to increase and some herbicides may be found unacceptable due to environmental or health and food safety considerations. Other land users may prefer not to use chemicals to treat and control weeds on their use areas. Biological control has been used to provide cost-effective and environmentally benign long-term control of different weed species.

Conventional pesticide treatments are not always practical and alternative methods to chemical treatments should be employed to protect the agricultural economy, native people, and the natural environment. Establishment of natural enemies of exotic weed pests can provide a permanent reduction in pest population densities, substantially reducing their economic impact (California Department of Agriculture 2001).

Use of biological control agents in agricultural areas would reduce the need for more disturbing control methods such as mechanical or chemical treatments. While biological control methods would not completely eradicate or kill noxious weeds at sites, they would provide a competitive advantage to desired crop species. Many of the biological agents proposed are specifically tested for impacts on important agricultural species, so the risk of cross-species impacts would be minimal. Use of biological control agents would temporarily close fields or areas as agents are released to areas or if site-specific testing is needed prior to full implementation. Closure of such areas may reduce productivity or yield of these areas, but the overall impact would be relatively small. Over the long-term use of biological agents would improve agricultural operations as less time and money would be needed to eradicate and control weed species in agricultural areas.

Mechanical and Manual Treatments

Agricultural areas are often subjected to burning, tilling, plowing, and other mechanical methods to improve the growth of desirable crops. Use of these techniques for weed control would be a continuation of current methods to cultivate and manage agricultural fields on the Navajo Nation.

In the short-term, additional mechanical and manual treatments on agricultural fields would increase localized erosion and soil turnover. If treatments are implemented during the active growing season, some crops may be harmed resulting in a reduced productivity to a site. If treated areas are not replanted with either native plants or a desirable cover crop, some weed species may return or secondary infestations may occur. However, implementation of Best Management Practices would reduce many of the potential adverse impacts. In the long-term, however, treatment of weeds will help agricultural fields to improve their productivity and would provide economic benefits to farmers.

Prescribed burning would be utilized as a management technique under the Proposed Alternative. Fire is used in croplands as a technique to remove dead plant material left after harvesting to facilitate soil work (e.g., disking, plowing), suppress overwintering pathogenic fungal spores, or reduce the seed banks of crop competitors. Cropland fuels are typically dried crop stubble and weeds and the fire type is usually surface.

Although the effects of burning on cropland itself may be beneficial, the future of cropland burning may be uncertain. Air quality regulations, loss of cropland by development, and the farming of areas further north due to climate change, provide a less favorable environment for this type of weed control. Suggested alternatives include leaving crop or weed residues on the soil but this technique does not work with weeds that have gone to seed or ones that propagate vegetatively, such as Russian knapweed. Plowing would involve more soil and land disturbance and can distribute seeds and propagating vegetative parts. (McCarty 2011)

4.7.2.3 Alternative 3 – No Biological Control

Impacts that could occur under the No Biological Control Alternative would be largely similar to those described under the Proposed Alternative. Without the use of biological controls, projects would need to utilize other methods to control weeds at proposed treatment sites. Other passive methods such crop rotation, use of cover crops, and modifying fertilizer applications, as well as the use of chemical and mechanical methods could be used as well. Overall, these would not result in significantly different impacts to agricultural areas than those described under the Proposed Alternative.

4.8 Public Health

All proposed alternatives would use of herbicides, mechanical, and manual treatments at varying degrees. These techniques all pose some level of risk towards human health. The potential impacts related to human health of each of the proposed actions are similar, but can differ based on the mitigation measures used. Below is a discussion of impacts associated with each method and how these impacts may differ based on the different alternatives.

4.8.1 Mechanical and Manual

Potential health risks to workers from manual and mechanical noxious weed control measures are minor and include cuts, burns, allergies, and skin irritations. The direct effects on human

health would be greatest to allergy and contact dermatitis sufferers who are sensitive to noxious weeds or other wild land vegetation. Skin irritations may result from reactions to the various noxious weeds on contact, such as spotted knapweed and leafy spurge, or to the physical parts of the plant itself, such as spines and awns in thistles and brome grasses. Some safety measures for work with noxious or invasive weed control would be implemented under each alternative to greatly reduce the risk to workers. Gloves, long-sleeved shirts, pants, and boots would prevent injuries or irritations and, therefore, no serious human health effects are anticipated by manual and mechanical removal of weeds. In the long term, the removal of target weed species would reduce allergens and hazardous contact with weed species for the public.

There is also the risk of workers coming into contact with cutting blades such as those on saws, mulchers, shredders, and drills which can cause significant injuries. The risk of injury can increase if workers operate equipment in an unsafe manner, such as on steep or uneven terrain, on unstable soils, or near water, which can cause workers to lose control of the equipment. Rocks and debris may also be kicked up during operations. High noise levels for heavy machinery or power tools can cause hearing impairment. These impacts can be reduced through the use of personal protective equipment such as ear plugs, gloves, hard hats, and boots. Safety training can also reduce the risk of injury by instructing workers on the safe operation of heavy machinery. Equipment operators should also take care not to come into contact with electrical power lines, as contact could result in serious injury or death.

The public could suffer injury if debris from vegetation removal is flung from equipment. Safety buffers, signage, and perimeter marking should be implemented around project areas. Accidental fuel and oil spills could also contaminate water supplies and operators should avoid operating vehicles near waterways when possible and should never refuel near water bodies.

Environmental hazards could also affect workers such as heatstroke, hypothermia, and overexertion resulting in heart attacks or worsening existing health problems. Some weed projects are likely to occur in remote areas which would increase the time for medical help to reach them, resulting in serious injury or death.

4.8.1.1 *Alternative 1 – No Action*

Under the No Action Alternative, project participants would not be required to receive training on Personal Protection Equipment, equipment handling, and safety protocols. While some projects may implement them to address some known risks, some projects may not adequately address risks described above.

Additionally, the ad hoc removal of noxious weeds on the Navajo Nation could lead to their spread in some priority areas. This spread could increase injuries and allergies among local residents who come into contact with harmful plant parts (spines, awns, and chemical irritants) or pollen from the plants.

4.8.1.2 *Alternative – Proposed Action*

Under the Proposed Action, safety training would be required for all projects to educate participants of known health risks associated with different treatment methods, proper use of Personal Protection Equipment, proper equipment handling, and emergency safety protocols. These will include regular on-site briefings to remind participants of necessary safety information. Heavy machinery would only be operated by training and experienced operators to reduce the risks of injuries to other workers. These will reduce the risks of injuries to workers who implement mechanical and manual treatments. While some workers may experience skin irritation, cuts, and burns, the use of PPE and safety training can help workers identify such injuries and treat them appropriately.

4.8.1.3 *Alternative 3 – No Biological Control*

The impacts associated for mechanical and manual treatments under the No Biological Control Alternative would be similar to those described under the Proposed Action.

4.8.2 Prescribed Burning

All proposed alternatives would make use of prescribed burning to treat some weed populations. Any projects using prescribed burning must develop a burn plan and corresponding EA for the activity per the BIA Wildland Fire Management Plan (2006). Occasionally prescribed burning will be carried out for restoration projects to control weeds in riparian areas or to encourage grass production for grazing. Prescribed burning treatments include risks to ground crews and nearby communities and residences. Workers can be burned during treatments and the public can be exposed to danger if fire escape.

Smoke from burning weeds can spread over a wide area, causing problems for people with respiratory conditions such as asthma and emphysema, and for those who are reactive to chemicals in the smoke. Inhaled smoke can cause rapid swelling (like hives) in the lungs and throat (urticarial, pulmonary swelling, and anaphylactic response) and sometimes death (Munson 2004).

Smoke from burning operations is also a major concern for fire crews and residents. Particulate matter can affect lung function and aggravate sensitive individuals. In some areas, it can be linked to premature death. Firefighters holding the fireline or those downwind of active burns are exposed to greater levels of smoke pollution. Long-term effects of smoke exposure by firefighters have not been documented but some evidence has shown that cardiopulmonary disease and premature death is higher than in the general population (Gabbert 2010).

Gases in smoke include carbon dioxide (CO₂), carbon monoxide (CO), and nitrogen oxides (NO_x). Most will diffuse into the atmosphere but workers on firelines may be exposed to higher levels of these gases. Wood smoke contains polynuclear aromatic hydrocarbons (PAH) which contain several carcinogenic compounds. Recent studies indicate that higher exposure to PAHs may increase the risk for multiple health issues including cancers, respiratory disease, and

cardiovascular disease (Adetona et al. 2011, Aisbett et al. 2007, Booze et al. 2004, Brotherhood et al 1990, Dost 1991, Edwards et al. 2005, Gabbert 2010, Harrison et al. 1995, Leonard et al. 2007, Matema et al. 1992, McMahon and Bush 1992, Naeher et al. 2007, Reinhardt and Ottmar 2004, Swiston et al. 2008, Tak et al. 2007, Wolfe et al. 2004).

A 2004 study on chronic smoke exposure for wildland firefighters (Reinhardt and Ottmar) identified fifteen substances of potential concern in wildfire fire smoke including aldehydes, polycyclic aromatic hydrocarbons, carbon monoxide, benzene, and respirable particulate matter. Only benzene and formaldehyde were found to pose a cancer risk greater than 1 per million. Two other substances, acrolein and respirable particulate matter resulted in hazard indices greater than 1.0. The estimated cancer risks ranged from 1.4 to 220 excess cancers per million. Noncancerous hazard indicators were higher (9 to 360) depending on the exposure group.

Smoke can reduce visibility along roads and increase the danger of accidents, although this is not a major issue in most areas where treatments are carried out. Removing flammable weeds (i.e. cheat grass and saltcedar) will decrease the risk of unplanned wildfires. Wildfires can threaten public health and welfare and reduce air and water quality. The biggest impact of wildfires is damage to homes and property, which can impact mental and physical health for some residents (BIA 2014).

Because all prescribed burning projects will require separate planning and environmental analysis under all alternatives per the existing BIA Wildland Fire Management Plan (BIA 2006), all impacts from burning activities should be similar.

4.8.3 Chemical

All herbicides used by the BIA must be EPA-approved under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) which states that pesticides can only be approved by the EPA if they can demonstrate that they will not result in adverse impacts to the environment. To further enforce this aspect of all approved herbicides, chemical labels provide strict instructions on how herbicides can be used to treat plant populations and federal and tribal pesticide applicators are required to comply with those instructions. The health risk of herbicide applications is primarily the function of the amount of chemical handling and length of exposure to the herbicide. The time needed in a given field season to apply herbicides on the ground is significant. Of the methods used to ground apply herbicides, backpack applications have the greatest potential for worker exposure (USFS 2005).

The health risk to the public from herbicides is primarily a function of the amount of inadvertent exposure through contact with treatment vegetation, consumption of contaminated vegetation or water, and herbicide drift. Whether a person is exposed to treated vegetation is a function of the probability of a person coming in contact with the treated vegetation within several hours or days of application. As all alternatives involve the use of herbicides, they all have the potential for the worker or general public to be exposed to an herbicide. However, the potential for exposure

would not exceed the daily exposure level determined to be safe by the U.S. EPA over a 70-year lifetime of daily exposure.

According to Munson (2004) herbicides can cause temporary or permanent damage, or can make pre-existing conditions worse. In addition to various cancers, herbicides can cause damage to skin, eyes, lungs, liver, kidneys, muscles, nervous system (including the brain and behavioral changes), hormone systems, immune system, and digestive system. They can also have effects on reproduction and can cause genetic damage. All synthetic herbicides, including glyphosate, have had serious effects on some people. However, when used as labeled, herbicides are normally considered safe to humans and their environment.

Some herbicides (such as 2,4-D, atrazine, and picloram) can travel through air, water, and soil (as discussed in the Soils, Air, and Water Section), where they have the potential to affect people miles away from where they are applied. Some herbicides are known to persist in areas where they have been applied for significant amounts of time (sometime for over a year), meaning they can have effects long after they are applied (see **Table 4-1**). Because the problems can occur remote from the time and place from the application, people can be affected without knowing that herbicide is the cause.

For all these reasons, the use of other weed management techniques besides chemical applications or prescribed burning is preferable whenever feasible. When herbicides or burning are used, advance notice and a means of evacuation, with a safe place to evacuate to, can help mitigate the effects for some vulnerable people.

4.8.3.1 Herbicide Risk Assessments

The following primary referenced literature was used to analyze potential human health risk associated with the application of herbicides.

- Herbicide Fact Sheets completed by the Bonneville Power Administration for the Transmission System Vegetation Management Program (BPA 2000-2000m)
- Herbicide Risk Assessments completed by the U.S. Forest Service under contract with Syracuse Environmental Research Associates (SERA 2001, 2004-2004b, 2005, 2006, 2007, 2009, 2011-2011c, 2014)
- U.S. EPA Registration Decision documents for atrazine, dichlobenil, metribuzin, paraquat, thifensulfuron methyl, pendimethalin, and prodiamine (EPA 1992, 1997, 1997a, 1998, 1998a, 2003, 2011)
- BLM Vegetation Treatment Herbicide Risk analysis for herbicides for 17 Western States (2007a) which includes ecological risk assessments for additional herbicides proposed in the updated Vegetation Treatment plan.

The purpose of risk assessments is to quantify the long-term risks from an action using standards of safety that are generally accepted by the scientific and health communities. Risk assessments are done based on research and analysis compiled from U.S. EPA pesticide registration decision documents, modeling research, and other scientific reporting conducted by federal agencies and scholarly research. Risk assessments have three parts. The first part describes the exposure analysis that estimates the range of possible doses to workers, the general public, and aquatic organisms. A variety of scenarios and exposure pathways are examined that could result in dermal and oral exposures. The second section displays the hazard analysis where tests and data related to the toxicity of the herbicides are reviewed. Of particular interest is a value known as the “No Observed Effect Level” or NOEL. NOEL is 100 times less than the highest doses at which no adverse effects were noted in test animals.

The NOEL, in combination with various safety factors, is a partial basis for determining the safety of human doses and is useful for determining the possible noncarcinogenic effects of herbicides, such as effects on liver and kidney functions. The hazard analysis also reviews data on the possible carcinogenicity of the chemical. The third section has the risk analysis where the dose levels calculated in the exposure analysis are compared to the NOEL levels to determine the noncarcinogenic effects of herbicides. Because NOEL levels are based on animal tests, it is assumed that the NOEL established for each animal should be at least 100 times greater than the doses estimated for humans to provide a Margin of Safety (MOS). This risk analysis also indicates the probability of developing cancer based on a projection of the lifetime doses received from spraying.

Toxicity test data on laboratory animals are available for herbicides proposed for use in this analysis. Most tests have been conducted under EPA pesticide registration/re-registration requirements for use in the United States. EPA uses test data to determine conditions for use of herbicides in the United States.

Label restrictions on herbicides are developed to mitigate, reduce, or eliminate potential risks to humans and the environment. Label information and requirements include: personal protective equipment, user safety, first aid, environmental hazards, directions for use, storage and disposal, general information, mixing and application methods, approved uses, weeds controlled, and application rates.

Analysis of herbicides used in this PEIS assumes compliance with the product label during handling and application. Additional environmental protection measures have been developed by other federal agencies and technical experts to further reduce potential risks to human health and the environment during application of herbicides. These measures are detailed in the Mitigation Measures (Appendix E) and will be implemented during analysis and application of weed control methods to further ensure worker and public safety.

4.8.3.2 Factors Affecting Hazard of Herbicide Use

Method of Application – How herbicides are applied can have a direct impact on the potential of human health effects. According to risk assessments completed on herbicide usage on federal lands, herbicide applicators are at a higher risk than the general public from herbicide use. The risk assessments compared risks to workers for all types of applications, including aerial, backpack, ground mechanical, and hand applications (such as the use of a spray bottle). Lower risks were estimated for ground mechanical application as compared to other methods, even though the total amount of herbicide applied in a given day was higher. Risks associated with backpack and hand application of herbicides were estimated to be the highest, due to workers being closer to the spray nozzle and containers in which the herbicides were carried. Backpack and hand application was also reported to increase the likelihood of a worker receiving repeated exposures that may remain on the worker's skins for an extended period of time.

Length of Exposure – The magnitude of a dose that is hazardous to health depends on whether a single dose is given all at once (acute exposure), multiple doses are given over longer periods (chronic exposure), or regularly repeated doses or exposures occur over periods ranging from several days to months (subchronic). EPA develops Reference Doses (RfDs), which are an estimate of a daily dose over a 70-year life span that a human can receive without an appreciable risk of deleterious effects (USEPA 2003). RfDs include a “safety factor” where the NOEL is divided by a factor, usually 100, to account for uncertainty and hypersensitive individuals. The 100 value is derived by including a safety margin of 10 for extrapolating study results from mammals to human, and an additional safety factor of 10 for variation in population response to a particular compound.

The RfD is a conservative toxicological threshold in relation to this analysis because it assumes daily exposure over a 70-year life span, and because the RfD is calculated from the NOEL, assuming humans are 100 times more sensitive than animals (uncertainty factor of 100). Actual environmental exposures for herbicide treatments in this project would typically be a few days each year for substantially less than 70 years.

Potential doses to workers or the public from the application of herbicides would be transitory. Lifetime RfDs are used as a convenient and conservative comparison for determining the significance of human doses. Lifetime RfD values are based on daily feeding studies, whereas workers and the general public would not be exposed daily over a lifetime. Maximum duration of exposure for workers on a yearly basis was estimated in the range of 10 to 40 days for commercial applicators (USEPA 1995).

Route of Exposure – Substances are tested for acute toxicity and chronic toxicity by placing the chemical in the animal's stomach or food, respectively (USEPA 1996). Test substances are also applied to the shaved skin of an animal to estimate dermal LD₅₀ (EPA 1996).

Skin acts as a protective barrier to limit and slow down movement of a chemical into the body. Studies of pesticides applied to the skin of humans indicate that, for many, only about 10 percent or less passes into the blood. In contrast, absorption of a chemical from the small intestine is quicker and more complete than from the skin (Feldmann and Maibach 1974; Ross et al. 2000). For this reason, dermal LD₅₀s are usually much higher than oral LD₅₀s. A person can tolerate greater doses of a substance without becoming sick when exposure is through skin contact rather than through ingestion (Hayes 1991).

Test organisms are also administered substances in air to estimate inhalation LD₅₀s. The onset of illness can occur more quickly through inhalation exposure than by oral or dermal contact due to rapid entry of the substance into the bloodstream. However, studies with pesticide applicators (who receive higher exposures than the general public) indicate dermal exposures are greater than inhalation exposures (Ross et al. 2000).

4.8.3.3 Uncertainty

With the exception of accidental exposures or exposures under conservative scenarios, workers and the general public would not be exposed to an herbicide at concentrations that result in adverse health effects. This conclusion is predicated on employees and contractors wearing appropriate personal protection and applying herbicides in accordance with label instructions. By doing so, possible exposure by contact or through drift would result in a dose below that determined to be safe by the EPA over a lifetime of daily exposure. It is also predicated on the finding, supported by toxicological studies, that a person can be exposed to some amount of a contaminant and not have an adverse effect (i.e. the dose determines the effect).

All the herbicides proposed for use by the BIA must be registered for use by the U.S. EPA and the corresponding state agencies responsible for governing herbicide use for the project area. Registration of these herbicides and Federal regulations adopted to protect workers and the general public has required more scientific information and justification for the use of herbicides. Nevertheless, there are scientific reports and sections of this document that outline associations between chemical exposures and alterations of the immune system, autoimmune disorders, and increases in the probability of carcinogenesis (Neilsen et al. 2001, Citron 1995, Glover-Kerkvliet 1995). The literature raises concerns about additive and synergistic effects of exposure to more than one herbicide, unstudied or unknown consequences of low level chronic exposures, toxicity of inerts, byproducts or contaminants of herbicides, and uncertainties about the health effects of sensitive populations. There is also the realization that it is difficult, if not impossible, for government or any scientific agency to fully evaluate a chemical and all potential combinations to ensure there would not be an adverse effect.

Use of herbicides to control noxious weeds is not without risk. All chemical exposure results in some level of health risk, the risk primarily being a function of the dose, or amount a person or organism is exposed to over a period of time. However, the same literature that raises concern over health effects also clearly reports that effects occur at doses significantly higher than that

expected through use of herbicides by the BIA. The estimated dose of each herbicide that a worker or person of the general public may be exposed to through the use of the herbicide by the BIA would be below that determined to be safe by the U.S. EPA for a lifetime of daily exposure. Therefore, minimal health effects and risks to workers and the general public are anticipated by the use of herbicides by the BIA and its cooperators.

4.8.3.4 Risks for Proposed Herbicides

The following discussion examines the herbicides proposed under Alternative 2 with appropriate interpretation of environmental impacts. Use of these herbicides would be the same under Alternative 3. Alternative 1 would also utilize these same herbicides, but may also include the use of many other U. S. EPA-approved herbicides to treat weed populations, of which there are thousands. Due to the uncertainty of knowing which additional herbicides may be used under Alternative 1, Based on a review of risk assessments, current literature, and other federal agency EISs (BIA 2014, BLM 2007, USFS 2005, BLM 2016) it appears the probability of the use of these herbicides causing chronic toxicity or carcinogenicity is very low. The acute toxicity ratings, as assigned by the U.S. EPA (**Table 4-9**), are based on the LD₅₀ determined for each pesticide (**Table 4-10**). Each pesticide is given ratings based on the concentration determined to kill over 50% of test animals when applied orally, dermally, or through inhalation. These ratings provide a relative measure of how much harm these chemicals can have on human health. It is important to note that all chemicals do have a dosage at which humans can experience toxic effects. While a chemical may be classified as “not toxic,” high levels of exposures, whether acute or chronic, can still result in adverse effects to human health when the dose exceeds those listed for each chemical and exposure type.

Table 4-9. Toxicity ratings as defined by the U.S. EPA. Formulated pesticide products are given acute toxicity rating by the U.S. EPA based on these categories. Lethal dosage (LD₅₀) is based on acute toxicity for rats. LD₅₀ refers to the dose at which 50% of the test animals were killed during safety tests.

Category	Equivalent Dose	Oral LD ₅₀ (mg/kg)	Dermal LD ₅₀ (mg/kg)	Inhalation LD ₅₀ (mg/L)
IV - Not toxic	>1 pint	>5,000	>5,000	>2
III – Slightly Toxic	1 ounce to 1 pint	500-5,000	2,000-5,000	0.5-2
II – Moderately Toxic	1 teaspoon to 1 ounce	50-500	200-2,000	0.05-0.5
I – Highly Toxic	<1 teaspoon	<50	<200	<0.05

2,4-D – This herbicide could be used to treat a wide variety of target species including: knapweeds, thistles, leafy spurge, blue mustard, perennial pepperweed, tall whitetop, Sahara mustard, sulphur cinquefoil, halogeton, camelthorn, Russian olive, field bindweed, puncturevine, spreading wallflower, horehound, and California burclover. As discussed in 4.4.1 Soil Resources, the relatively high mobility of 2,4-D makes it an extremely poor choice where ground water is close to the surface or to areas adjacent to surface water. Where such conditions prevail, however, an aquatic-approved form of 2,4-D can be used to avoid potential problems with ground water contamination.

In terms of toxicity, the doses at which 2,4-D can have adverse human effects are considered moderately toxic when ingested, slightly toxic when exposed dermally, and slightly to not not toxic when inhaled. Effects from such acute exposures have been reported. Dermal contact has been reported to cause nervous system reactions such as pain, tingling, numbness, and paralysis (BPA 2000a, Tu et al. 2001). Ingestion of large amount of 2,4-D has been reported to result in death within 1 to 2 days, while ingestion of smaller doses has resulted in neuromuscular problems (BPA 2000a). Chronic exposure has been known to result in liver, kidney, digestive, muscular, and nervous system damage (BPA 2000a, Tu et al. 2001). In terms of carcinogenicity, there is evidence to suggest a link between exposure and different forms of cancer such as non-Hodgkin's lymphoma and cervical cancer, but no causal factor has been identified (Tu et al. 2001). Thus, the EPA currently classifies 2,4-D as having no evidence of being carcinogenic. 2,4-D also has potential endocrine disruption effects on the thyroid and the gonads and is included in the U.S. EPA list of Tier 1 Chemicals for screening (2009).

Aminopyralid – Aminopyralid is recommended for use in controlling yellow starthistle, Squarrose knapweed, Canada thistle, bull thistle, musk thistle, spotted knapweed, tall whitetop, sulphur cinquefoil, diffuse knapweed, and Russian knapweed. Aminopyralid's longevity in areas where it is applied can vary greatly based on its soil half-life and how it is degraded in the environment. Risk assessments conducted by the U.S. Forest Service and Bonneville Power Administration indicate that aminopyralid is slightly to not toxic with potential developmental and reproductive effects at higher doses (BPA 2000b, SERA 2007, BLM 2016). These effects include decreased body weight for offspring, increased weight of large intestines, and adverse effects on the immune system and endocrine function.

Atrazine – Atrazine is recommended for control of red brome and kochia. Atrazine's high mobility and persistence in the environment increases its likelihood of contaminating ground and surface water. U.S. EPA (2007) has determined that atrazine is an endocrine disrupter, and has been shown to affect pregnancy and sexual development in children. It is not currently considered to have carcinogenic or mutagenic effects by the U.S. EPA or the World Health Organization. In terms of its toxicity, atrazine is classified as slightly toxic for oral and dermal effects and not toxic for inhalation.

Chlorsulfuron – This herbicide can be used to treat blue mustard, Dalmatian toadflax, perennial pepperweed, and tall whitetop. Chlorsulfuron is broken down to smaller compounds by soil microorganisms with a half-life of 14 days in acidic soils to almost a year in alkaline soils. These characteristics indicate that chlorsulfuron is short-lived in the environment and not likely to cause contamination of water sources. Based on the results of animal studies, chlorsulfuron does not cause genetic damage, cancer, or birth defects, and has little or no effect on fertility, reproduction, or development of offspring (SERA 2004). It is classified as being Not Toxic by the U.S. EPA for all routes of exposure.

Clopyralid – This herbicide can be used to treat thistles, knapweeds, and camelthorn. Clopyralid has a moderate duration in soils, lasting from 2 to 14 months. This herbicide can be highly mobile, potentially contaminating groundwater resources and damaging non-target plants, although no extensive off-site movement has been documented (Tu et al. 2001). The Nature Conservancy (Tu et al. 2001) noted that clopyralid is not toxic to fish, birds, mammals, and other animals, though it can cause severe eye damage. The Journal of Pesticide Reform (Cox 1998) noted that chronic toxicity was demonstrated with clopyralid use in a 2-year study with rates that found hyperplasia of the stomach lining. They also referenced a 1-year study of dogs that demonstrated an increase in liver weights and a decrease in the amount of red blood cells. Clopyralid was also tested by the Environmental Protection Agency, and their conclusions were that this herbicide caused a substantial toxicity to fetuses and birth defects when exposed to high doses.

Dichlobenil – Dichlobenil can be used to treat leafy spurge, perennial pepperweed, Dalmatian toadflax, biennial thistles, Russian thistle, field bindweed, and kochia. Dichlobenil can have a longer presence in soils, due to its moderate adsorption, decreasing the risks of ground and surface water contamination. It has a half-life that can range from two weeks to 6 months and is primarily degraded through microbial digestion. Dichlobenil has been found to be a potential human carcinogen and can cause liver and kidney damage at higher exposure levels (USEPA 2008). The herbicide also has the potential to cause hormonal changes with prolonged exposure, which has led to further testing by the U.S. EPA to examine its potential as an endocrine disrupter (USEPA 1998, USEPA 2009). Dichlobenil is classified as slightly toxic for oral and dermal exposure and not toxic for inhalation exposure.

Fluroxypyr – Fluroxypyr can be used to treat spotted knapweed, squarrose knapweed, diffuse knapweed, and kochia. It has a low risk for contaminating water supplies due to its high affinity for soil particles. Toxicology studies on fluroxypyr (SERA 2009) indicate that acute and subchronic exposure to the herbicide at higher doses can result in kidney damage and minor indirect neurological impacts such as weakness and salivation. Impacts to the general public increase if exposed to fluroxypyr by swimming in or drinking contaminated water supplies (SERA 2009, BLM 2016). Fluroxypyr is classified as slightly toxic for oral and dermal doses and not toxic for inhalation doses.

Table 4-10. Toxicity of proposed herbicides as determined through oral, dermal, and inhaled LD₅₀ concentrations and additional adverse human health effects related to exposure. LD₅₀ concentrations are compared to the maximum application rates to determine risk for the public. All application rates are determined by the U.S. EPA for the maximum amount of active ingredient (a.i.) applied to a site per acre per year. LD₅₀ rates are reported by the U.S. EPA based on numerous animal test studies as part of the pesticide registration process. The herbicides are listed from least toxic to most toxic based on oral ingestion studies.

Herbicide	Oral LD ₅₀ (mg/kg)	Dermal LD ₅₀	Inhalation LD ₅₀ (mg/L)	Adverse Human Health Effects
Chlorsulfuron	5,545	>2,000	5.9	Little to no effect on fertility, reproduction, or offspring development. Does not cause genetic damage, cancer, or birth defects.
Aminopyralid	>5,000	>5,000	>5.79	Causes eye irritation. Potential effects on development and reproduction at high doses. No evidence of carcinogenicity or mutagenicity.
Imazapic	>5,000	>5,000	>2.38	Can cause moderate skin and eye irritation. Not a known carcinogen or mutagen.
Imazapyr	>5,000	>2,000	>1.3	Can cause moderate skin and eye irritation. Not a known carcinogen or mutagen.
Isoxaben	>5,000	>2,000	>2.68	Can cause eye irritation and corneal damage due to binding agents in formulation. The additive crystalline silica is also a listed carcinogen. Has been shown to cause birth defects and adverse impacts on reproduction. Classified as a possible human carcinogen and mutagen.
Metsulfuron methyl	>5,000	>5,000	>5.3	Mild to moderate skin and eye irritant. Not classed as a carcinogen or mutagen. Is not known to impact or inhibit reproduction or development.
Prodiamine	>5,000	>2,000	>1.81	Does show increased toxicity during pregnancy for fetus and mother. Adverse impacts on liver and thyroid. Classified as a possible human carcinogen.
Thifensulfuron methyl	>5,000	>2,000	>5.03	Mild eye irritant. Not carcinogenic or mutagenic. Has little to no effect on reproduction, development, or fertility.
Glyphosate	4,320	>2,000	1.6-5.63	Possible alteration of intestinal microbial community. Not carcinogenic. Has potential as an endocrine disrupter.
Clopyralid	4,300	>5,000	>3.0	Can cause severe eye damage. Does not cause cancer or genetic mutations. Some evidence of reproductive or developmental effects at higher doses.
Dichlobenil	4,250	>2,000	>3.3	Impacts to liver and kidneys with acute exposure. Classed as a possible human carcinogen. Has potential as an endocrine disruptor.
Picloram*	4,012	>2,000	>8.11	Acute poisoning can lead to nervous system damage, weakness, and diarrhea. Chronic exposure can result in liver damage. Mild to moderate skin and eye irritant. Chronic exposure can also lead to development impacts. Not a known carcinogen or mutagen.
Fluroxypyr	2,405	>2,000	>6.2	Can cause damage to the liver at higher doses. Workers are at increased risk of exposure. Potential effects if swimming in or drinking contaminated water. Not likely to be carcinogenic or mutagenic.
Metribuzin	2,300	>5,000	0.72	Subchronic exposure has been linked to abnormal liver function and adverse impacts to reproduction. Known endocrine disruptor. Not a known carcinogen or mutagen.

Herbicide	Oral LD ₅₀ (mg/kg)	Dermal LD ₅₀	Inhalation LD ₅₀ (mg/L)	Adverse Human Health Effects
Fluazifop -p-butyl	>2,000	>2,110	1.7-5.2	Slight eye irritation, moderate skin irritation, and adverse effects to the liver with prolonged exposure. Increased risk of impacts to the general public through the long-term consumption of contaminated vegetation. Not likely to be carcinogenic or mutagenic.
Pendimethalin	>1050	>2,000	320	Possible human carcinogen affecting the thyroid. Mild skin and eye irritant. Some adverse effects on liver function. Has not been shown to cause birth defects, or affect reproduction.
Atrazine	1869	>2,000	5.8	Causes endocrine disruption with most impacts affecting pregnant women and children. Known effects include preterm delivery, fetal growth retardation, delayed onset of puberty, and mammary tumors. Not likely to be carcinogenic or mutagenic. Has potential as an endocrine disruptor.
Triclopyr	630	>2000	>4.8	Mildly toxic to developing embryos. High doses can cause adverse birth defects and maternal toxicity. Not classed as a human carcinogen. Can cause mutations but with no adverse effects.
2,4-D	375	>2,000	1-100	Neurological, cardiac, hepatic, and renal toxicity with high doses. Chronic high doses could increase risk of cataracts and retinal degeneration. Some correlation with non-Hodgkin's lymphoma and cervical cancer. Currently classed as not a human carcinogen. Has potential as an endocrine disrupter.
Paraquat	283	>2,000	0.001	Toxic if ingested or dermally adsorbed. Known to adversely impact the liver, kidneys, and lungs. Can cause moderate to severe eye irritation and moderate skin irritation. Reclassed as non-carcinogenic, but found to be weakly mutagenic.

Fluazifop-p-butyl – Fluazifop is recommended for the treatment of Johnson grass, common Mediterranean grass, and red brome. Fluazifop is broken down in the environment through microbial degradation and photolysis and has a soil half-life of about two weeks. It has a lower risk of contaminating water resources due to its strong adherence to soils and low persistence. There is concern for the general public with increased consumption of contaminated vegetation when consumed over the long-term. Since use of fluazifop in agricultural settings is increasing, such contamination is a greater risk where it is used to treat food crops. Potential health impacts from exposure to fluazifop include slight eye irritation, moderate skin irritation, and adverse effects on the liver at high doses (SERA 2014). It is not considered to be carcinogenic or mutagenic. Fluazifop is classified as slightly toxic for oral and dermal doses and slightly toxic to not toxic for inhalation doses

Glyphosate – Glyphosate is a broad-spectrum, nonselective, systemic herbicide used for control of annual and perennial plants including grasses, sedges, broad-leaved weeds, and woody plants. Glyphosate strongly binds to soil particles and is broken down through microbial digestion and hydrolysis, with a soil half-life ranging from 2 days to over 6 months. The USDA Forest Service (SERA 2011) noted that there is little evidence to suggest that glyphosate will cause adverse effects related to human health or within the environment at the anticipated levels of exposure. The Extension Toxicology Network (1994) concluded that glyphosate is poorly absorbed by the digestive tract and is largely excreted unchanged by mammals. However, a recent review of studies on long-term ingestions of glyphosate indicate that the herbicide may impact the intestinal microbial community, which could have links to disorders such as autism, Alzheimer's, depression, diabetes, and heart disease (Samsel and Seneff 2013). Glyphosate carcinogenicity was documented in one study that stated that people who were occupationally exposed to this herbicide had a threefold risk to hairy cell leukemia (Cox 2004). They also noted potential mutagenicity problems and referenced a study that documented chromosome mutations at the lowest doses of glyphosate applied (Vigfusson and Vyse 1980). However, these studies were not done based on U.S. EPA requirements and thus did not fit the criteria for registration as possible carcinogen. Additionally, the heavy use of glyphosate for agricultural and natural resource management increases the risk of exposure to the general public through runoff, the consumption of contaminated vegetation, and dermal exposure. Based on the U.S. EPA registration decision report (1993a), glyphosate is classified as slight toxic for oral and dermal exposures and slightly to not toxic for inhalation exposures.

Imazapic – Imazapic is a selective herbicide for both the pre- and post-emergence control of some annual and perennial grasses and broad-leaved weeds. The Nature Conservancy (Tu et al. 2001) reported that imazapic is moderately persistent in soil with a half-life averaging about 120 days. It has a low potential for runoff, and microbes are the primary agent responsible for its breakdown. Imazapic is not considered carcinogenic and the U.S. Environmental Protection Agency has classified it as a “Group E” compound, or one that has not shown evidence of

causing cancer in humans (Tu et al. 2001). Exposure can cause skin and eye irritation. Imazapic has been classified as not toxic for all types of exposure routes.

Imazapyr - Imazapyr is a broad-spectrum herbicide that can be applied as a pre- or post-emergent herbicide to control many annual and perennial weeds (Tu et al. 2001). Imazapyr is weakly bound to soils and has a half-life that ranges from 12 to 180 days, though there are reports that it can be active up to 2 years after application (SERA 2011a). Imazapyr generally remains in the upper 20 inches of soil and does not run off into streams or demonstrate much lateral movement. However, it should not be applied where runoff water may flow onto agricultural lands or adjacent to wetlands or standing surface water. Human health studies on imazapyr indicate that is slight skin and eye irritant (SERA 2011a). It is not known to be carcinogenic or mutagenic and does not appear to impact reproduction or fetal development (Cox 1996). Imazapyr has been classified as not toxic for oral exposures and slightly toxic for dermal and inhalation exposures.

Isoxaben - Isoxaben is a pre-emergent herbicide which can be used for the control of Russian thistle and kochia. It moderately binds to soils and has an estimated half-life ranging from 30 days to a year with photolysis being the main mechanisms for chemical breakdown. It has a relatively low risk for contaminating surface and ground water, but the risk increases in areas with sandier soils and shallow groundwater reservoirs. Studies indicate it can cause moderate eye irritation and the potential to cause slight temporary corneal injury. It is also slightly oncogenic and formulated products often contain crystalline silica, which is a known carcinogen. Isoxaben is known to interfere with reproduction and fetal development (BPA 2000i). Isoxaben has been classified as not toxic for oral exposures, and slightly toxic for dermal and inhalation exposures.

Metsulfuron methyl – Metsulfuron methyl is a selective pre- and post-emergence herbicide designed to control broad-leaved weeds and some grasses. The USDA Forest Service (SERA 2005) reported that metsulfuron methyl remains unchanged in the soil with a half-life ranging from 12 days in sandy soils to 180 days in silt loam soil. They also noted that metsulfuron methyl is broken down to non-toxic and non-herbicidal products by soil microorganisms and chemical hydrolysis. Based on the results of animal studies, metsulfuron methyl is not classed as a carcinogen, mutagen, developmental inhibitor, or reproductive inhibitor (SERA 2005). Studies have indicated that it can result in mild, temporary skin and eye irritation at high doses (BPA 2000j). As such, metsulfuron methyl is classified as not toxic for all routes of exposure.

Metribuzin – Metribuzin is a selective herbicide that can be used to control Japanese brome, field sandbur, Johnsongrass, rescuegrass, bromes, Russian thistle, and kochia. Ecological risk assessments (EFSA 2006, USEPA 1998a) indicate that metribuzin has a high risk of contaminating groundwater and surface water sources due to its weak adsorption to soil and its moderate half-life (ranging from 40 to 128 days). The primary mechanism for the breakdown of metribuzin is through photolysis and microbial activity. Based on animal studies (USEPA

1998a), metribuzin can have adverse effects on liver function and reproduction at high doses. It has been shown to be an endocrine disruptor, and is not classed as a carcinogen or a mutagen. Metribuzin has been classified as slightly toxic for oral and inhalation exposures and not toxic for dermal exposures.

Paraquat – Paraquat is a non-selective herbicide that can be used to control annual weeds, such as cheatgrass and other *Brome* sp. Paraquat has strong soil adsorption and can persist in soils for several years as it is resistant to breakdown by microbes, photolysis, and chemical hydrolysis. It has the potential to contaminate surface water if contaminated soil particles are carried through erosion (USEPA 1997). Animal studies indicate that paraquat can be toxic when small amounts are ingested or inhaled (USEPA 1997) resulting in adverse effects to the liver, kidneys, and lungs which can lead to death. Contact exposure to the eyes can cause moderate to severe irritation, while dermal exposure results in mild to moderate skin irritation. It is not classed a carcinogen by the U.S. EPA, but is a weak mutagen. Paraquat is classified as moderately toxic for oral exposures, highly toxic for inhalation exposures, and slightly toxic for dermal exposures.

Pendimethalin – Pendimethalin is a selective herbicide used to control annual grasses and some broadleaf weeds through pre- and post-emergence applications. It can bind strongly to soils, reducing the risk of contaminating groundwater or surface water through percolation or erosion. It has a soil half-life of around 90 days and is broken down by sunlight and soil microorganisms. Pendimethalin is classified as a possible human carcinogen affecting the thyroid (EPA 1997a). It can also cause irritation of the eyes and skin with direct contact. Pendimethalin is classified as slightly toxic for oral and dermal exposures and not toxic for inhalation exposures.

Picloram – Picloram is a selective herbicide and is used to prevent regrowth of woody plants, noxious weeds, and brush. The USDA Forest Service (SERA 2011b) found that picloram can stay moderately active in soils and may exist at toxic levels in plants for more than a year after application at normal rates. This study also noted that the breakdown of this product is through microorganisms and sunlight with long-term buildup of picloram in the soil generally not a major concern. However, picloram cannot be used in areas with shallow water tables due to the risk of contamination. Picloram does not cause genetic damage or birth defects, and has little or no effect on fertility or reproduction (SERA 2011b). Some studies have indicated that it can result in developmental effects and that it can be a mild to moderate eye and skin irritant. High doses can result in damage to the central nervous system, weakness, and diarrhea while chronic toxicity can result in liver damage. Picloram is classified as slightly toxic for oral and dermal exposures and not toxic for inhalation exposures.

Prodiamine – Prodiamine is a selective pre-emergent herbicide used for the control of broadleaf weeds such as kochia, rescuegrass, and Johnsongrass. Because prodiamine is moderately adsorbed by soils and is primarily broken down by sunlight, it has a low risk of contaminating water sources. Its soil half-life is also relatively short, staying active in soils from 19 to 120 days. Based on animal studies, prodiamine has been shown to have adverse effects on the liver

and thyroid (BPA 2000m, USEPA 1992). It is classed as a carcinogen as it has resulted in the development of thyroid tumors (Hurley 1998, COM 2001) and the liver (USEPA 1992) during various animal studies. It shows fetal toxicity at high doses and developmental and maternal toxicity at 1 g/kg/day. It is also slightly toxic when inhaled and dermally adsorbed (BPA 2000m). It is classified as not toxic for oral exposures.

Thifensulfuron methyl – Thifensulfuron methyl is a broad spectrum post-emergent herbicide that can be used to treat broad leaf plants such as spreading wallflower, kochia, and Russian thistle. It is active in soils for a relatively short time with soil half-life of 12 to 45 days. Thifensulfuron methyl is broken down in the environment by sunlight and microbes. However, there is moderate risk of ground water and surface water degradation due to its weak affinity for soil particles. The risk is highest if a precipitation event creates runoff that impacts a treated area. Health risk evaluations (FAO 2011) indicate that thifensulfuron methyl is a mild eye irritant. It does not cause cancer, genetic damage, or birth defects and has little to no effect on fertility or reproduction. Thifensulfuron methyl is classified as not toxic for oral and inhalation exposures and slightly toxic for dermal exposures.

Triclopyr – Triclopyr is used almost exclusively in the treatment of woody noxious trees like tamarisk and Russian olive. It is broken down rapidly to inert substances by soil microorganisms with a half-life ranging from 2 hours to 314 days depending on environmental conditions. Previous analyses (SERA 2011c) indicate that triclopyr has a low risk of contaminating water sources as it binds tightly with clay and organic matter and has a half-life of less than 24 hours in water. Based on the results of animal studies, triclopyr does not cause birth defects and has little or no effect on fertility or reproduction. Triclopyr is mildly toxic to developing embryos but studies suggest that it likely does not cause genetic damage. Due to discrepancies in carcinogenic studies, triclopyr cannot be classified as a human carcinogen (BPA 2001). Triclopyr is classified as slightly toxic for oral and dermal exposures and not toxic for inhalation exposures.

4.8.3.5 *Synergistic Effects of herbicides*

The impact of synergistic effects of herbicides is also a valid concern for the general public. This process is a special type of interaction in which the combined impact of two or more herbicides is greater than the impact predicted by adding their individual effects. The USDA Forest Service (2005) defined three types of synergism that include: (1) interaction of the active ingredients in an herbicide with its inert ingredients; (2) the interactions of these herbicides with other herbicides; and (3) the cumulative impact of not only spraying by the lead agency but others as well and its influence on the public.

In terms of synergism between herbicides, there are few studies that look at synergistic impacts of using two or more herbicides together. Many herbicides, however, are sold in combined formulations. No one can guarantee the absence of a synergistic interaction between herbicides and/or other chemicals to which workers or the public might be exposed. For example, exposure

to benzene, a known carcinogen that comprises 1 to 5 percent of automobile fuel and 2.5 percent of automobile exhaust, followed by exposure to any of these herbicides could result in unexpected biochemical interactions (USFS 2005). Analysis of the infinite number of materials a person may ingest or be exposed to in combination with chemicals is outside the scope of this analysis. There is some indication, however, the simultaneous exposure to 2,4-D and picloram may induce effects not associated with exposure to 2,4-D and picloram alone (EXTOXNET 1993). Another study also indicates that the combined use of 2,4-D and glyphosate could increase the risk of rhinitis (Slager et al. 2009).

The BIA predicts that the use of herbicides, even though there is documentation that supports the opposite viewpoint, will not cause adverse human health impacts. There are several reasons why we have reached that conclusion and they are: (1) the amount of area treated represents less than 0.1 percent of the total associated with the Navajo Nation; (2) scheduled work will be under the control of a certified pesticide applicator and personal protective gear will be worn by all workers; and (3) only approved herbicides for that specific set of environmental conditions will be used. This will prevent any individual from getting exposure levels where the RfD is reached and reduce the potential for the long-term health effects to very low probabilities.

4.8.3.6 Endocrine Disruption

Recent studies raise suspicion regarding the potential for some herbicides to be hormonally active. However, there is no evidence indicating that herbicides considered for application would pose risks to the general public at the recommended application rates and expected exposure levels based on the herbicide label instructions and the size of the area that could be treated for any of the proposed alternatives.

The endocrine system is a complex network of glands and hormones that regulates many bodily functions in animals including growth, development, metabolism, and maturation. The endocrine glands (including pituitary, thyroid, adrenal, thymus, pancreas, ovaries, and testes) release measured amounts of hormones into the bloodstream that act as chemical messengers throughout the body to control many vital functions (NRDC 1998).

The Food Quality Protection Act (FQPA) requires that U.S. EPA develop tests to screen for chemicals with the potential to mimic hormones. Chemicals that do mimic or antagonize hormones can cause biochemical changes in tissues are called endocrine disrupting chemicals (Damstra et al. 2002) or hormonally active agents (HAAs). One concern over HAAs is due to the fact that the endocrine system is closely linked with the brain and the immune system. All three systems communicate with one another to affect body development and functioning. Adverse effects on this network have been blamed for a variety of maladies ranging from cancer to infertility to behavioral problems (Felsot 2001).

Chemicals, other than our own hormones, can interact with components of the endocrine system. Scientists have discovered that many kinds of chemicals, including natural food biochemicals as

well as industrial chemicals and some pesticides, can mimic the action of the hormones estrogen or testosterone. Concern has been expressed about potential effects on the thyroid hormone during early development (Felsot 2001, Damstra et al. 2002).

Two general types of tests are used to screen chemicals for endocrine disrupting abilities. The most widely used tests are *in vitro* tests. These tests are conducted in a test tube or dish using cells and, in some cases, the actual protein receptors, enzymes, and genes involved in the biochemistry of the endocrine system. *In vitro* tests can be used to quickly screen large numbers of chemicals for their ability to interact with different biochemical components of the endocrine system.

Positive *in vitro* tests, however, do not necessarily indicate that a substance will actually disrupt hormone functioning in a whole organism. Considerable caution is necessary in extrapolating from *in vitro* to *in vivo* (whole live animal) effects. *In vitro* screening tests are properly used to determine which chemicals should be subjected to a second type of test, the *in vivo* test where live animals that are given various doses of chemicals. In some cases, the chemical is injected beneath the skin or directly into the body cavity. Developmental and reproductive toxicity studies with live animals over several generations are especially useful for determining if a substance adversely affects the endocrine system.

All chemicals that have been tested *in vitro* (except for the drug DES or diethylstilbesterol) are thousand to millions of times less potent than the natural estrogen hormone estradiol (Felsot 2001). Also as exhibited by estradiol, all chemicals tested *in vitro*, appear to show definitive threshold effects (i.e. NOELs) for estrogenic activity. No pesticides, food biochemicals, or other synthetic chemicals have definitively shown greater and/or different *in vitro* effects at low doses as compared to higher doses. Although our natural hormones function at very miniscule levels in the body, endocrine disrupter tests have shown that interactions of hormone receptors with natural and synthetic chemicals are still related to dose during exposure. Even chemicals capable of interacting with the endocrine system at sufficiently high doses have not been found biologically active at low doses (USFS 2005).

In light of concerns regarding the potential for pesticide exposure to interfere with hormones and hormone receptors, the U.S. EPA formed the Endocrine Disruptor Screening Program (EDSP) to assess the potential for chemicals to be endocrine disruptors in 1998. In 2009, the EDSP published the screening protocols for the first round of evaluations that would be used to determine which chemicals may present a potential risk for endocrine disruption based on *in vitro* and *in vivo* testing, potential exposure pathways, and known adverse health impacts. After screening an initial collection of 52 pesticides, the U.S. EPA released a list of 18 pesticides that could potentially act as endocrine disruptors in 2015 (www2.epa.gov/ingredients-used-pesticide-products/endocrine-disruptor-screening-program-tier-1-assessments) Of the 52 pesticides examined by the EDSP, five of the herbicides proposed for approval under this action were included (USEPA 2009): 2,4-D, atrazine, dichlobenil, glyphosate, and metribuzin. Of these

five, atrazine, dichlobenil, and metribuzin showed potential effects on the estrogen, androgen, and thyroid hormone pathways to suggest potential as endocrine disruptors.

Atrazine – Atrazine is known to affect the reproductive system by interfering with androgen synthesis (Thomas and Thomas 2001). Carey and Bryant (1995) reviewed the numerous pathways through which amphibians could be impacted by chemicals in the environment. They suggest that adult and larval amphibians are not necessarily more sensitive to chemicals than other terrestrial or aquatic vertebrates. However, sublethal effects can manifest as increased susceptibility to disease, increased predation, altered growth rates, or disrupted development. They suggested that endocrine disruptors could have effects on tissues at levels below detectable levels and that pesticides labeled as safe should not also be considered as having no effect on the endocrine system until proven otherwise. Their position is substantiated by a recent study indicated that atrazine, at concentrations below the U.S. EPA drinking water standard, can interfere with larval development in frogs (Hayes et al. 2002). EDSP screening of atrazine showed evidence of downstream interferences of atrazine with estrogen and androgen pathways, which be related to known neuroendocrine pathway interactions of other triazine-like chemicals (USEPA 2015a)

Dichlobenil – During a reregistration review of dichlobenil, the USEPA noted that new studies indicated potential for the herbicide to affect reproductive development (1998). The review looked at several animal studies and noted lower birth weights, increased maternal and fetal toxicity, and delayed maturation of the uterus. These effects were observed at both high and low dose rates. During the Tier 1 EDSP screening, dichlobenil showed evidence of being an androgen binder and decreased testosterone production during *in vitro* and *in vivo* studies (USEPA 2015b). These studies are suggestive of dichlobenil as a potential endocrine disruptor.

Metribuzin – Metribuzin is known to impact the thyroid at high doses. In rat studies, metribuzin resulted in decreased weight for the uterus and mammary glands in females and increased thyroid weight in males at high doses. Low doses also resulted in changes to thyroxine and triiodothyronine, which help control growth, development, and metabolism. Developmental studies also indicate that metribuzin exposure can reduce fetal body weight and interfere with bone calcification (USEPA 1998a). EDSP Tier 1 screening resulted in increased thyroid sizes for animals exposed to metribuzin, indicating interactions of the chemical with the thyroid pathway (USEPA 2015c)

Herbicides need to be recognized for their potential health effects and used safely, cautiously, and in moderation. Used in this manner, they can have positive effects on reducing hazardous fuels and restoring native vegetation and natural ecosystems. When used as part of an Integrated Weed Management system, the overall effect is positive.

4.8.3.7 Impurities, Surfactants, Adjuvants, and Inert Ingredients in Herbicide Formulations

During commercial synthesis of some pesticides, byproducts can be produced and carried over into the products eventually formulated for sale. Occasionally byproducts or impurities are considered toxicologically hazardous, and their concentrations must be limited so that potential exposures do not exceed levels of concern (Felsot 2001).

Technical grade picloram and clopyralid contains hexachlorobenzene (HCB) as a byproduct of the synthesis of the active ingredients (SERA 2011b). HCB is also a byproduct of chlorinated solvents used extensively in industry and occasionally around the home. HCB was registered as a fungicide until banned by U.S. EPA over concerns that it may be carcinogenic. As a result, U.S. EPA has imposed a limit of 100 parts per million (ppm) HCB in Tordon® and other pesticides containing picloram. The manufacturer of Tordon® officially maintains HCB levels in formulated picloram at 50 ppm or less (i.e. 50 milligrams per liter of formulation). Average concentrations of HCB in picloram have been estimated at 8 ppm (USEPA 1995). Therefore, HCB comprises only 0.000005 percent of the Tordon® formulation, which is then further diluted by a factor of 350 when the spray solution is prepared.

Given the dilution of formulations by water in the final spray solutions, estimates of HCB exposure from use of picloram- or clopyralid-containing products have shown that resulting residues in the environment and exposure levels to bystanders are not significantly different from current background levels. Longer-term dose estimates for the general public exposed to HCB in clopyralid were about 25,000 to several million lower than the acute or chronic toxicity dose (SERA 2004a). The central estimates of worker exposure under normal conditions to HCB were estimated to be lower than the background levels of exposure by factors of about 1,000. Thus, for commercially sold products which are more diluted than technical grade products, there appears to be no basis for asserting that the use of clopyralid or picloram in accordance with the label by the forests would result in substantial increases in the general exposure of either workers or members of the general public to HCB.

The potential presence of dioxin in formulations containing chlorinated chemicals is also a concern for some pesticides. Dioxins are a group of chemicals involving 76 different types of related molecules called congeners, each having from 2 to 8 chlorine atoms. The toxicity of each of the types of dioxin molecules is different. Toxic potency is determined by the spatial arrangement of the chlorine atoms in the molecule rather than the mere presence of chlorine. Of all of the congeners, one—TCDD (2, 3, 7, 8-tetrachloro-para-dibenzodioxin)—is the most potent. All other congeners are considered 10 to 10,000 times less potent than TCDD. Congeners with the greatest number of chlorine atoms are the least potent (Van den Berg 1998)

TCDD and a few other dioxin congeners are byproducts of the synthesis of trichlorophenol. Most of the other dioxin congeners contain more chlorine than TCDD but are byproducts of the combustion of biomass (e.g., wood) and municipal waste. Dioxin congeners have always been in the environment as a result of natural fires and volcanic eruptions, and burning coal, wood, and

gasoline (Alcock et al. 1998, Gribble 1994). Thus, dioxin congeners are ubiquitous but, with the exception of TCDD, their potency is quite low, they are unlikely to be absorbed through the skin, and, thus, they are not of much toxicological concern (Safe 1990)

TCDD is a byproduct of the active ingredient in 2,4,5-T. This herbicide was used as a mixture with 2,4-D to defoliate vegetation during the Vietnam War. In the past, a few imported formulations of 2,4-D were shown to contain some highly chlorinated dioxin congeners; the same congeners found in the environment and believed to be primarily the result of combustion processes. Current quality control procedures during manufacturing having essentially eliminated any dioxin congeners of concern from domestic 2,4-D formulations. Thus, use of 2,4-D products manufactured in the U.S., whether at home or in agriculture or forestry, do not contaminate the environment with the dioxin congener of greatest regulatory concern, TCDD (USEPA 2000).

Byproducts of atrazine are also known to pose the same risks to human health as the parent chemical. These metabolites are chlorinated atrazine compounds, desethylated atrazine (DEA), desisopropyl atrazine (DIA), and diaminochlorotriazine (DACT). Each of these metabolites has similar potency and persistence in groundwater as atrazine and can pose a risk of adverse human health effects (USHHS 2006). DIA and DEA are sometimes used as surrogates for determining potential atrazine contamination for water sources (USGS 1999).

A major metabolite of dichlobenil is 2,6-dichlorobenzamide (BAM), which leaves a major residue on treated plants and poses a health risk to humans and animals. BAM has been shown to have slightly greater acute toxicity than its parent compound and is classified as a possible human carcinogen with many of the same effects as dichlobenil (USEPA 1998). However, the risk of adverse effects from exposure is considered low (Björklund et al. 2011).

The proprietary nature of herbicide formulations limits understanding of the risks posed by inert ingredients (inerts) and adjuvants in herbicide formulations. Unless the compound is classified as hazardous by the U.S. EPA, the manufacturer is not required to disclose its identity. It could be suggested that the inert in these herbicides are not toxic, or their toxicity would be reported to the U.S. EPA. This would hold true if considerable toxicological testing of inerts has been done. That, however, has not been the case. The U.S. EPA is increasing the testing requirements for inerts, but in many cases the inerts currently in use have not been tested rigorously and their toxicity is not well characterized. Nonetheless, studies on the toxicity of technical grade formulations, which often contain the inerts, will account for toxicity of the inerts. These studies do not report human health concerns at the levels of herbicide use proposed by the BIA for this project.

The literature does report considerable information on the types of inerts and adjuvants present in the herbicides proposed for use by the BIA. Reports indicate that the most common impurities of the technical grade 2,4-D include other phenoxyacetic acids, a variety of chlorinated phenols,

and possibly low levels of nitrosamines in the amine salts (Ibrahim et al. 1991). Transline, the commercial formulation of clopyralid contains clopyralid as the monoethanolamine salt and isopropyl alcohol, an approved food additive (SERA 2004a). Both Tordon 22 and 22K contain the potassium salt of picloram (24.4 percent); the remaining percentage consists of polyglycol 26-2—the DOW name for polyethylene glycol—a widely used family of surfactants considered to have low toxicity and frequently used in the formulation of ointments and cosmetics (Neilsen et al. 2001). The USDA Forest Service (SERA 2011c) reports that Garlon® formulations of triclopyr contain ethanol and kerosene. Technical formulations of imazapyr contain isopropyl alcohol and isopropanolamine salts of imazapyr (SERA 2011a). Glyphosate has been reported to contain small amounts of nitrosamine and N-nitroglyphosate (SERA 2011). Formulations of paraquat and metribuzin also previously contained nonylphenol as an inert ingredient. However, recent U.S. labeling requirements to note the presence of nonylphenol have led to many manufacturers to eliminate it from their herbicide formulations (Patterson 2004, Turner and Williams 2002).

Roundup®, a formulation of glyphosate, contains the surfactant polyoxyethyleneamine (POEA), and it contains 1,4-dioxane, classified by the U.S. EPA as a probable human carcinogen. However, carcinogenic studies of Roundup® by the U.S. EPA have shown the herbicide to be noncarcinogenic (SERA 2011). Isoxaben and prodiamine also contain the inert additive crystalline silica (as kaolin), which is also listed as a known carcinogen (BPA 2000i, 2000m). Its inclusion in most formulations has led to these isoxaben to be classed as a possible carcinogen by the U.S. EPA. The U.S. Forest Service (2005) reports that the inerts in Escort®, which contains metsulfuron methyl, are confidential. They do report, however, that the inerts in Escort® are not classified by the U.S. EPA as toxic.

Many herbicide formulations contain dyes or use dyes in their final mixtures to help identify where the products have been applied. Use of dyes makes it less likely for an individual to inadvertently or intentionally consume contaminated vegetation. Including dyes in formulations or herbicide mixtures also makes it easier for workers to see if non-project areas have been contaminated and to allow for prompt remedial action. Dyes may also pose risks to humans and wildlife. The most common dyes used with herbicides are Milori blue, Heliogen blue, Lithol rubine, Hi-Light Spray Indicators, and Sico Fast Orange (USFS 2005). Little information is available on toxicity of the majority of dyes used in the industry due to proprietary reasons.

Surfactants are also commonly used in herbicide formulations. Surfactants are added to herbicides to improve herbicide mixing and absorption or permeation of the herbicide into the plant. Like dyes, and other inerts, there is limited information on the types of surfactants used and toxicity of surfactants, especially since the industry considers the surfactant to play a key role in the effectiveness of the herbicide formulations. Most knowledge of surfactants is proprietary information and not disclosed. The glyphosate risk assessment (SERA 2011), which provides some assessment of surfactant formulations on the toxicity of glyphosate, reported that toxicity of glyphosate alone was about the same as the toxicity of glyphosate and surfactant

mixer and greater than the toxicity of surfactants alone. Whether this same pattern would hold true of other herbicides having the same or different surfactants is unknown. If so, toxicological studies performed on herbicide formulations (which contain inerts and surfactants) may accurately portray the toxicity and risks posed to humans by the surfactant.

4.8.3.8 Alternative 1 – No Action

Chemical use under this alternative may also increase the risks of exposure to the general public and workers. Without an integrated approach, the overall use of pesticides would likely be higher under the No Action Alternative as they would not be done with consideration or preference for other control methods being implemented together to provide greater control of weed species. Under the No Action alternative, many other chemical herbicides may be used to manage weed populations. These chemicals may have synergistic effects with those examined in this analysis that may render the herbicides ineffective or may exacerbate adverse effects on the environment or the general public. While the chemicals examined in this analysis are deemed to be generally safe for use without resulting in adverse impacts to human health when applied in accordance with the chemical label, non-judicious applications or a lack of care in planning chemical treatments may result in increased risks for the general public.

The No Action Alternative would also have a higher potential for exposing the general public to higher concentrations of herbicides. Under this Alternative, weed treatment projects would not be required to coordinate treatments with other agencies and the community. Since projects would not need to notify adjacent land users, other land management agencies near the project area, or the general public, some individuals who may wish to avoid exposure to herbicides may not be able to do so. Additionally, this could result in project areas being treated with several different rounds of chemical herbicides in a manner that is outside of the chemical's label instructions. Such treatments could increase the presence of certain herbicides in the environment, increasing the exposure risk for the general public.

4.8.3.9 Alternative 2- Proposed Action

Under the Proposal Action Alternative, 21 herbicides are permitted for use on the Navajo Nation (**Table 2-3**). Additionally, a number of mitigation measures would also be implemented for proposed ground treatment such as buffer zones from water bodies and sensitive areas, public notification prior to application, and weather condition monitoring all reduce the potential for public exposure from herbicide application. Safety training and adherence to mitigation measures for work with noxious weeds would greatly reduce the risk to workers.

Of the 21 herbicides proposed under Alternative 2, isoxaben, prodiamine, dichlobenil, and pendimethalin have been classified by the U.S. EPA as possible human carcinogens based on animal studies. Other studies have suggested a potential link between 2,4-D and cervical cancer and non-Hodgkin's lymphoma (Tu et al. 2001), but these studies have not met the criteria for the U.S. EPA to consider classifying the herbicide to change its classification of 2,4-D as being noncarcinogenic. Paraquat, metsulfuron methyl, and triclopyr are considered to have some

mutagenic and reproductive properties. The general public will be exposed to little, if any, herbicides as treatments implemented under Alternative 2. If they are, the duration of exposure will probably be in the duration of a few minutes (for those traveling through treatment areas) to a few days (for those living near treatment sites) and it is predicted that applications that use a low application rate are not predicted to approach the RfD. We foresee that applicators may have the potential to exceed the RfD, and that would only take place if a spill of concentrated herbicide occurred during mixing. We expect this to be reduced to a low probability if they are trained, use required protective clothing and equipment, and follow steps outlined in the safety and spill plan.

Cultural methods would not impose a risk to the human health of workers or the public. There is a risk of human injury when using grazing animals for intensive vegetation treatments. If many animals are concentrated in a small area for feeding, there will be fecal droppings with potential health effects by direct contact or by spreading fecal coliforms into neighboring waters or streams. Such spread could occur directly, if animals are allowed to close to water sources, or indirectly through runoff during precipitation events.

Agents used for the biological control of noxious weeds have been studied and tested for a variety of risks to the general population. None of the agents proposed under this plan are known to have any impacts to human health. Minor injuries could occur when trapping and transporting agents from different treatment sites (USFS 2005, BLM 2007). These impacts would be limited to workers, and would not affect the general public.

It should also be noted that the BIA would use an adaptive management approach for managing weeds. Information obtained from monitoring studies and new information regarding herbicides would be used to reduce effects should they become evident.

4.8.3.10 Alternative 3 – No Biological Control

Under Alternative 3 (No Biological Control), impact to Public Health would be similar to those described under Alternative 2. Because the No Biological Control alternative would not change the amount of acres treated using the other control methods, no difference in impacts to human health are anticipated.

4.9 Socioeconomics

BIA is under regulatory guidance to provide for the sustainable management of trust agricultural land and rangelands for the economic benefit of the tribe. The BIA is directed to operate and manage Indian ranges on the principle of sustained-yield management in accordance with 25 United States Code (USC) 466, U.S.C. 3701 et seq. (3701-3711) , 25 Code of Federal Regulations (CFR) 25 CFR 166.301-313. In light of the regulatory guidance, the goal of the BIA Noxious Weed Management Program is to keep Indian agricultural lands sustainable and economically viable and to restore degraded lands. This goal needs to be accomplished while minimizing adverse effects for the affected communities. Reducing the spread of noxious weeds

will improve the productivity of grazing and agricultural lands for wildlife and domestic livestock. This would economically benefit ranchers, farmers and hunting guides who make their living off the land.

4.9.1 Economic Loss

4.9.1.1 Alternative 1- No Action

Economic losses from noxious weeds include the direct costs from loss in production in agriculture, forestry, recreation, and tourism. These effects will be discussed under Resource Use Patterns. In addition to these costs, noxious weed infestations can reduce the value of land for a variety of purposes. On production-oriented land, noxious weeds are usually considered in land appraisals. The presence of noxious weeds reduces carrying capacity for grazing and wildlife and lowers the value of the land for multi-purposes.

Noxious species impact the economy and cost billions of dollars every year. Economic impacts on Indian lands can expect to strain the already fragile economy on the Navajo Nation due to decreased forage for livestock, marketable crops, and accessibility to cultural and natural resources. Additional roads and disturbance from development and construction can increase the spread of noxious weeds. The economic boost provided by oil and gas drilling is not sustainable and steps to reduce the spread of noxious weeds and employment of integrative weed management techniques is needed.

Some of the most damaging and widespread noxious weeds within the Navajo Nation include Russian knapweed, camelthorn, and tamarisk. The latter two species are hardy invaders of wetlands and riparian areas on Indian lands in the west. Camelthorn is also known to grow into building and structures, further degrading their integrity and reducing property values. These and other noxious plants impact agriculture, industry, human health and the protection of natural areas. Economic experts estimate that for every year we delay addressing the issue, the costs of controlling noxious weeds may increase two- to three-fold (BIA 2014). The continued spread of the target weed species reduces the quality of grazing land, farmland, and negatively impacts communities where weeds have invaded and resulted in significant property damage.

The wildland-urban interface is a unique issue where uncontrolled weed invasions such as cheatgrass cause increased fire hazards and potential economic loss and danger to humans.

4.9.1.2 Alternative 2- Proposed Action

Implementation of weed control projects along roads or in certain communities on the Navajo Nation may limit access to some areas, which may be important for economic activities. Such disruption would be due to the implementation of chemical methods at treatment sites. Chemical treatments near recreational sites, such as tribal parks or federal lands, may hinder travel through these areas and could lead some visitors to avoid them altogether. Treatments along roadways would also impact those living in remote areas who may not be able to access important services or facilities due to chemical sensitivities. However, implementation of herbicide treatments is

short-term lasting a few days to a few weeks. Timing of such treatments during the off-season could reduce losses. Treatments could be timed during periods in the year where tourism is slower to reduce economic losses. Additionally, travelers would also be given alternative routes around treatments areas so they can avoid them if necessary.

Treatments in range management units may also cause some short-term economic losses as range animals would need to be deferred. Deferral could increase the costs for raising livestock as ranchers would need to supplement forage with hay or other grains for extended periods of time. If animals are transferred to a different location during deferral, there may be additional costs for providing space and forage for them at the new location. Such costs would depend on where the animals were housed and if there were special agreements in place to help transfer the costs for deferral from the permit holder to the Navajo Nation. Such deferral, however, would be short term as weed treatments will improve grazing lands by reducing competition with preferred native forage vegetation.

4.9.1.3 Alternative 3- No Biological Control

Under the No Biological Controls Alternative, fewer acres would be treated for a similar cost. Since biological control agents do not require extra costs for their purchase, the only associated costs would be related to transporting populations to new treatment sites. Conversely, other weed management techniques require more active and direct costs for equipment, supplies, and personnel. Such costs generally make these methods more expensive and have the potential for greater impact to a site.

4.9.2 Economic Opportunities

4.9.2.1 Alternative 1- No Action

Under the No Action Alternative, the BIA will provide funding for weed management projects that are able to meet the planning and cost-sharing provisions currently employed by the agency. Projects implemented under the No Action Alternative would provide employment opportunities for skilled and unskilled labor on the Navajo Nation. However, such increases in employment would likely be temporary, as no additional monitoring or inventory work would be required to determine the long-term success of projects. Thus, seasonal employment would likely be the only category of jobs impacted by weed treatment projects.

Costs for treating weeds on a per acre basis would remain the same as the BIA would employ the same methods they currently use. The per acre costs largely depend on the size of the area to be treated, the type of chemical being applied if used, the costs for operating and maintaining mechanical equipment (whether owned or rented), labor costs, the costs for performing follow-up treatments and monitoring of the site. These costs can vary widely between projects and agencies based on a variety of factors that influence costs. Previous BIA weed management projects have had per acre costs that have ranged from \$39 to \$4,000. In terms of long-term

costs, the No Action Alternative would lead to higher overall project costs as the size and scope of weed infestations continue to degrade natural resources and land values.

4.9.2.2 Alternative 2- Proposed Action

Funding for the control of noxious weeds may allow the Navajo Nation to hire additional or seasonal staff to carry out weed control projects. A large portion of the weed management funds from the BIA are spent on contractors who carry out the work for the Tribe. The BIA prefers contractors with Native American lineage and membership to perform work. BIA funding and other government grants for weed control facilitate the purchase of weed control equipment for land or lease holders to use at no charge. Several Chapter Houses sponsor volunteer weed pulls or clean-up days for residential lots, thus increasing the appeal of housing areas and giving a positive visual/social appearance.

Implementing an integrated approach on the Navajo Nation for addressing weed issues would provide economic opportunities through job creation and improving land quality. Similar to Alternative 2, weed management projects would provide opportunities for skilled and unskilled laborers as the BIA would hire staff to conduct weed mapping and inventories, to serve as a labor force for implementing weed control and removal projects, and to conduct monitoring and scientific investigation on the efficacy of removal techniques. In the private sectors, contracting jobs for projects managed by the BIA would create additional opportunities for firms providing environmental planning, landscape maintenance, natural resource management, and scientific expertise. In addition to federal funding, the Proposed Action can help cooperating agencies and the BIA to apply for additional funding through grant programs such as non-profits or other native-based funding opportunities.

The integrated approach outlined in the Proposed Action would also help lower per acre costs. The use of biological agents, in coordination with APHIS, has lower costs than many of the other methods proposed. Through the APHIS program, agencies can obtain biological agents for free under the agency's permits. This means that the direct costs for using biological controls would largely be determined by labor and travel costs associated with distributing and monitoring populations. Biological controls would increase the number of acres treated on the Navajo Nation, meaning that resources and funds can be directed toward other control methods for treating additional acres. Monitoring and adaptive management of weed projects would improve the efficacy of weed techniques implemented on the Navajo Nation. In terms of economics, adaptive management of projects controls costs by preventing the long-term use of ineffective treatments for projects, which would result in expensive retreatments and redesigns. Reestablishing native vegetation at treated areas would also help reduce the costs associated with retreatment by increasing competition with target weed species and improving land values.

Projects implemented under Alternative 2 would be higher in overall costs as they would need to include funding for long-term monitoring and retreatments. However, such activities improve the overall success of projects, allowing agencies to address weed problems in other parts of their

management areas. By prioritizing areas and techniques, agencies would implement techniques in a way that effectively treats the target weeds species, while also improving land values and ecosystem services.

4.9.2.3 Alternative 3 – No Biological Control

The No Biological Control Alternative would help to create jobs and economic opportunities on the Navajo Nation in the same ways as Alternatives 1 and 2. Weed control projects will allow for hiring of seasonal staff and equipment purchases. This alternative would also help restore degraded lands and improve rangeland and agricultural productivity. Overall projects costs would also be as high as those proposed under Alternative 2, as retreatment of project sites and monitoring would also be implemented.

However, this alternative will rely on more labor intensive methods through mechanical and chemical treatments and does not permit the use of low cost biological control methods. Thus the total costs for weed projects would be higher than those proposed under Alternative 2. Per acre costs under this Alternative would be similar to the Proposed Alternative but slightly higher due to the use of other methods over biological control methods.

4.9.3 Access to Vital Services, Recreation Sites, Plant Collection, and Customary Use

4.9.3.1 Alternative 1- No Action

The No Action Alternative would not provide coordinated treatments for agencies doing roadside or rights of way treatment. The BIA, Navajo Nation, county, and state departments of transportation all currently do herbicide and mechanical treatments along roads in the project area. Treatments along roadsides would need to be authorized and coordinated on a case by case basis. Lack of coordination may increase the risk of exposure to chemicals along roadways as multiple areas may be treated. The actual number of people affected however by the increase in chemical use would be dependent on how many people may travel on a given set of roadways during the period of treatment, which is likely to be small.

Additionally, weed treatments would limit access to sites for recreation, plant collection, or customary use such as grazing. In terms of recreation, use of trails, campgrounds, or open areas would be limited while treatments are being conducted and for a short period of time after they are completed. As recreational sites are strongly tied to the service industry (i.e. hotels, restaurants) on the Navajo Nation, there may be some economic impact as potential visitors may seek to avoid treatment areas or may opt to visit alternative locations to reduce exposure to chemical or increased dust and noise from mechanical treatments. As the collection of traditional plants for cultural or religious ceremonies does not take place at designated locations and change from year to year, alternative locations for collections could be use in specific collection areas are being treated. Thus access to collection areas will not be impacted.

Access to customary use areas may be restricted depending on the nature of the project and the ability of land users to establish alternative locations for cattle or farming while access is limited. The BIA has commenced some projects within customary use areas, often to address weed issues encountered by grazing permit holders. Projects implemented in these areas would limit land user access while treatments are implemented. It is often recommended that the land user restrict access to these sites after treatments are completed for a few years to allow native vegetation to re-establish. However, enforcement of deferment and restricted access is limited, reducing the actual limitations for accessing customary use areas.

4.9.3.2 Alternative 2 – Proposed Action

As treatments are proposed along roads and rights of way, there is the potential for them to impact access to services and sites used for recreation, religious ceremonies, customary use areas such as ranching or farming, and/or plant collection. Given the remote nature of the Navajo Nation, treatments along roads could hinder some residents who make regular use of different sites within the region. When treatments are implemented along roads and rights-of-way, alternative routes to facilities, communities, and customary use areas would be identified. It is anticipated that a very small portion of the road network will be scheduled for treatment (less than 1% for federal, state, county, and tribal roads). Therefore, it should be feasible to identify alternative routes for those not wishing to travel through treatment areas.

For herbicide treatments, the methods employed along roads will affect how far the herbicide is expected to drift from the application site. Handheld nozzle sprayers or wick applicators will likely produce little drift (USFS 2005). Large noxious trees (i.e. Russian olive and tamarisk) can be treated by directly applying herbicide to cuts in the trunk or to remaining stumps, which limits the risk for non-target vegetation. Some roads and rights of way could also be treated through the use of large boom sprayers attached to a truck or all-terrain vehicle (ATV). Such methods would likely be employed along paved roads and highways. Though the potential for drift is higher under this method, application of mitigation measures related to wind speeds would limit impacts to non-target species.

Plants collected for ceremonial or traditional purposes are likely to be adversely affected by vegetation treatments at specific treatment sites. However, since treatments are proposed for less than 0.01% of the Navajo Nation each year, the overall availability of traditional plants will likely not be impacted. Additionally, consultation with the community and land users can help identify key areas where plants may be gathered or where ceremonies may be performed so that treatments can avoid such areas.

Treatments are also likely to occur adjacent to or near recreational sites such as tribal parks and federal lands (i.e. BLM and NPS areas). These treatments could affect uses such as hiking or camping for those with herbicide sensitivities. Such treatments will be done in coordination with other agencies to provide continuous, which is especially important in the patchwork land areas

of Eastern Navajo Agency. Coordination between agencies will also allow for more congruent notifications for those wishing to avoid treatment areas.

Customary use areas will likely be impacted as they are often used for grazing and traditional farming on the Navajo Nation; two land uses that have been identified as priority sites for weed treatments. Impacts to customary use areas where grazing and farming are common are discussed in more detail in the Agriculture section above. Customary use areas that are designated based on ancestral occupancy not related to grazing or farming, would likely not be affected by weed treatments unless the land user seeks assistance from the BIA for weed control. Cultural techniques that allow for native plant re-establishment at treated sites would require deferment of cattle from these areas. Deferment would limit grazing at treated sites and would require that alternative locations be identified for supporting grazing animals at the treatment site.

Unique to Alternative 2, treatments on the Navajo Nation would be coordinated with other Navajo agencies, allowing for a greater degree of planning. Thus weed projects could be planning to address regional weed issues in coordination with other federal agencies or across Navajo agency jurisdictions. This may allow for larger treatment areas which may limit access, but it would also allow the BIA and its cooperators to identify alternative areas for land users to access while treatments are implemented or access is limited. Identification of alternative use areas could help reduce access issues related to recreation, plant collection, and ceremonial use of project areas.

4.9.3.3 *Alternative 3 – No Biological Control*

Impacts to access would likely be the same as those described under Alternative 2. However, under this Alternative, areas that may have been preferentially treated with biological controls would now need to be treated using chemical or mechanical methods. This shift in treatment methods may increase limitations for accessing vital services, customary use areas, recreational site, and/or plant collection sites. Those wishing to avoid areas where herbicides are used may have more limited options, but it will likely not result in a major significant difference that the limitations described under Alternative 2.

4.10 Cultural Resources

Intensive cultural resource surveys (both for archaeological resources and traditional cultural properties [TCPs]) will be conducted by qualified personnel under the guidance of a historic preservation officer or archaeologist prior to the authorization of any individual noxious weed treatment projects that involve any ground disturbance, mechanical treatments, or chemical treatment outside existing fenced road rights-of-way. All identified cultural resources will be evaluated, and an assessment of effect shall be completed. If historic properties are identified, they will be protected using the avoidance and mitigation measures outlined in the Programmatic Agreement for Cultural Resource Protection created for this NNIWMP and summarized under

Mitigation Measures (Appendix E). These discoveries, or lack of discoveries, will be reported to Navajo Nation Historic Preservation Department (NNHPD) per the Programmatic Agreement (Appendix F).

4.10.1 Alternative 1: No Action

The No Action alternative has the potential to cause an increase of undesirable non-native vegetation. In general, however, noxious/invasive weeds pose no more threat to archaeological resources than do native plants. Rather, certain types of vegetation, both non-native and native, have potential to cause detrimental effects to archaeological resources. For example, trees, woody shrubs, and other types of plants with large and/or deep-growing roots can cause direct damage to buried cultural deposits and surface features through bioturbation. The presence of other plant species that are desirable as food sources or habitat for burrowing animals such as prairie dogs, ground squirrels, and voles can also be indirect sources of harm by supporting populations of these ground-disturbing, and oft-times archaeologically destructive, animals. In addition, both non-native and native vegetation can serve as fuel for wildfires that have potential to cause harm to several types of archaeological resources and TCPs.

Nevertheless, untreated noxious/invasive weeds can reduce the quantity of culturally significant native plants available for spiritual ceremonies, medicinal use, or other traditional applications by outcompeting the native species. Similarly, undesired non-native vegetation can reduce the overall quality of TCPs, and dense weed thickets or brush can limit access to such traditional or sacred sites for conducting ceremonies or collecting plants.

4.10.2 Alternative 2: Proposed Action

Appendix F outlines for all proposed weed treatment methods the mitigation measures to protect cultural resources. As previously noted, no single weed control method will ever achieve effective control of an area infested with invasive weeds. Effective weed control requires using an integrated combination of treatment methods. Furthermore, the treatment methods under Alternative 2 could affect archaeological resources and other cultural resources (particularly culturally important native plants utilized for medicine, spiritual practices, or other traditional purposes) in both positive and negative ways. Consequently, all likely potential effects of combined treatments should be taken into account when considering and applying mitigation measures to protect cultural resources. The following subsections evaluate the potential effects of each proposed weed control technique.

Manual Control – Manual treatments involve utilizing hand tools for cutting undesired non-native plants above ground level; pulling, grubbing, or digging out root systems to prevent sprouting and regrowth; and removing competing plants around desired species. Manual treatments, such as hand pulling and hoeing, are most effective when they consist of complete removal of the plant material, including in most cases the root system. Manual control methods cause subsurface disturbance and thus can adversely affect archaeological sites by mixing cultural deposits, damaging buried features, and possibly contaminating

subsurface cultural remains. Cutting can displace, move, or expose archaeological artifacts found on the surface, making them vulnerable to damage or theft.

Mechanical Control – Mechanical control treatment methods such as grubbing, tillage, and use of heavy machinery have high ground-disturbing impacts (e.g., compaction, erosion, sediment and soil mixing), and can easily damage cultural resources that are buried as well as those above ground. Treatment methods like mowing, though considered to have low to moderate levels of ground disturbance, can also adversely affect archaeological sites and other cultural resources (Odess and Robertson 2007), particularly aboveground artifacts and features.

Effects of fire to cultural resources depend on several factors including resource type, temperature, and duration of exposure to heat. Temperature and duration are influenced by fuel type, fuel load and distribution, fuel moisture content, soil type and moisture, weather, and terrain (Winthrop, 2012). The effects that fire can have on archaeological materials and other physical cultural resources on (or above) the ground surface ranges from negligible to extreme depending on the severity and duration of the fire on the site. This notably contrasts with the range of fire effects on subsurface deposits, which appear to be relatively protected from fire effects below the first few centimeters (approximately 10 cm) except when a burning stump and/or root system provide a conduit for heat penetration to subsurface cultural deposits (Oster et al. 2012). Fire also can significantly affect intangible cultural resources such as certain types of TCPs based on conceptual, oral, and behavioral traditions tied to particular geographic locations. In addition to the fire itself, fire control and suppression techniques have considerable potential to damage cultural resources through a variety of activities such as fireline construction (both hand and mechanically dug), fuel removal, and use of fire retardants and other chemical products. The effects of fire (and fire management and suppression techniques) on cultural resources and archaeological materials has been extensively addressed by Ryan et al. (2012).

Cultural Control – Cultural control treatments include targeted livestock grazing, reseeding and planting native species, and mulching around desired vegetation to limit competitive growth of undesired plants. Some of these treatments, such as livestock grazing and active native vegetation reseeding or replanting, can result in a high degree of ground disturbance and adversely affect archaeological and other cultural resources. For example, livestock can have detrimental effects due to trampling and defecation. However, because 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, its potential to negatively impact cultural resources will be somewhat limited. Though broadcast reseeding by hand or by mechanical sprayer mounted on a vehicle with rubber tires is likely to have little or no significant impact on most cultural resources, reseeding methods requiring ground disturbances (e.g., seeds injected or tilled into the soil) or use of tracked vehicles can cause undesirable effects to cultural resources,

particularly archaeological sites. Similarly, replanting methods utilizing plant cuttings, deep potted plants, containerized plants, and bundled native-vegetation “poles” require deep augured holes (to reach suitable depths for soil moisture) that can severely damage or destroy buried archaeological deposits and features. Likewise, some erosion control techniques, such as installing erosion blankets, brush layering, and brush revetment, can also negatively impact archaeological sites. Comparatively, others (e.g., mulching) pose little or no threat to the integrity of cultural resources.

Biological Control – Proposed biological control methods consist of utilizing USDA-approved insects and pathogens tested for their effectiveness in controlling the target plants. Due to the rigorous testing and small size of insect pathogens it is unlikely that authorized biological control treatments would damage most cultural resources. Nevertheless, insects do have the potential, albeit rather improbable, to damage perishable archaeological items (e.g., baskets, cordage, and artifacts and features made of wood) and some desirable traditionally utilized plants.

Chemical Control – Chemical control methods consist of using herbicides to control exotic plant species, and there are various potential effects from using these methods. Some herbicides and treatment solutions contain salts which can act as desiccants, which in turn can damage old, fragile wood and possibly could cause spalling in sandstone; chemicals may cause corrosion in metals; and some corrosion inhibitors might turn surfaces, particularly metals, blue or black. Similarly, application dyes can permanently discolor archaeological features and artifacts. In addition, some herbicides can increase the acidity of the soil and cause deterioration of the artifacts. Adjuvants and surfactants added to herbicides, including mineral oil, vegetable oil, and methylated seed oil, are organic substances that have some potential, albeit fairly limited, to leach into the subsoil and interfere with radiocarbon dating techniques (BIA 2014, Winthrop 2012).

Herbicides can negatively affect traditional cultural practices of gathering plants for medicine, spiritual practices, or other uses. Drift caused by wind can leave herbicide residue on non-target plants adjacent to treatment areas, causing a health risk to those harvesting and using the plants. This potential hazard is not limited to utilization involving ingesting plants for medicine or food. Traditional basket weaving often involves plant parts being placed in the mouth for processing (cutting, splitting, softening). If herbicide is present on the plant materials being used this poses a health risk to the weavers. Research indicates that nearly half of the plant materials used by Native American basket weavers within treatment areas contained forestry herbicide residue. Even outside of treated areas 3% of the potentially utilized plant materials contained residue, and the residue was present for several months after the application (Segawa et al. 1997). Consequently, any areas being considered for chemical weed control methods need to be fully evaluated for plant gathering use and potential before proceeding with such treatment.

There are several herbicide application methods that can be utilized including cut stump, basal bark, frill or “hack and squirt”, foliar spray, pelletized treatment, and pre-emergence treatment. Some methods have more potential for herbicide to end up in undesired locations than other methods. For example, with foliar spraying the large-scale application of herbicide using a boom or boomless sprayer mounted on an ATV or truck, fixed-wing airplane, or helicopter has greater potential for drifting and contamination than foliar spraying with smaller applicators like a backpack sprayer or spray bottle. Similarly, widespread pre-emergence soil treatment has more possibility of affecting desirable culturally important plants or archaeological resources than the more targeted pelletized treatment method. Given that the cut stump, basal bark, and frill methods target individual plants one at a time, these methods seem to be the least likely to cause chemical contamination issues. Accordingly, the particular chemical application methods being considered for any given treatment area should be fully assessed for potential negative impacts prior to being implemented.

In addition to possible effects from the chemicals themselves, some application methods also have potential to negatively affect cultural resources. For example, using wheeled equipment for spraying or driving off road to reach application sites has the potential to crush archaeological artifacts and damage features on the ground surface if these resources are driven over. Wheeled vehicles can also damage protective soil crusts and accelerate erosion and indirectly affect cultural resources.

4.10.3 Alternative 3: No Biological Control

Noxious/invasive weed treatments under Alternative 3 are the same as those under the Proposed Action (Alternative 2), with the exception that no biological control techniques would be utilized. The potential effects of each proposed weed control treatment under Alternative 3 were evaluated under Alternative 2. Because there is no change in the estimated treatment acreage for any of the treatment methods (other than the absence of 500 acres for biological control methods), the potential for negative effects associated with the non-biological control treatments does not change under Alternative 3.

4.10.4 General Notes Applicable to Alternatives 2 and 3

As previously noted, all likely potential effects of combined treatments should be taken into account when considering and applying mitigation measures to protect cultural resources. In general, the following protection measures should be used to ensure that effects to historic properties are avoided or minimized: (1) no mechanical treatment within cultural resource site boundaries; (2) no use or staging of heavy mechanized equipment within site boundaries; and (3) allow other treatments within the boundaries of National Register historic properties if NNHPD agrees that the activities will have no adverse effect on the specific historic property. Site protection measures and requirements shall be documented. Sites identified for protection may be monitored by a qualified archaeologist, depending on NNHPD stipulations.

If traditional cultural properties are identified, the BIA shall consult with NNHPD regarding inventory, evaluation, effect, and protection or treatment measures. Previously unrecorded properties that are encountered during the course of a noxious weed control activity shall be protected per the protocols detailed in the NNHPD document entitled *Guidelines for the Treatment of Discovery Situations*. This and other various situations are governed by the Programmatic Agreement for Cultural Resource Protection created for the NNIWMP (Appendix F).

4.11 Environmental Justice

The Environmental Justice Executive Order 12898, released by the White House in 1994, places attention on adverse human health and environmental effects of agency actions that may disproportionately impact minority and low-income populations. Low-income populations are households that live below the subsistence or poverty level as defined by local, State, and Federal Government. The order simultaneously directs Federal agencies to avoid making decisions that discriminate against these communities.

Environmental justice also means that, to the greatest extent practicable and permitted by law, populations are provided the opportunity to comment before decisions are made, are allowed to share in the benefits of, are not excluded from, and are not affected in a disproportionately high and adverse manner by government programs and activities affecting human health or the environment.

In determining the effects related to environmental justice, the following questions should be considered:

1. Would adverse effects be predominantly borne by minority and/or low income populations?
2. Would adverse effects be appreciably more severe and/or greater in magnitude to the disadvantaged populations than the general population?
3. Does the action impact a resource that is especially important to the disadvantaged population (i.e. does the action impact tribal treated rights such as religious, fishing, or hunting grounds), or other land or resources that serve significant social, religious, or cultural functions (WsDOT 2013)?

To determine if the Navajo Nation qualifies as a community of concern for environmental justice analyses, a population analysis is conducted. Low-income populations are identified using poverty thresholds available from the most recent U.S. Census and are compared to the general population. Populations are also compared based on race and ethnicity (**Table 4-11**). For this action, the compared population statistics for neighboring Coconino County and the states of Arizona and New Mexico, the demographics of the Navajo Nation qualify it as an environmental

justice community based on the high percentage of minority populations (i.e. American Indian and Alaska Native) and population living below the poverty level (38%).

Table 4-11. Comparison of Navajo Nation to the surrounding communities to evaluate population and economic characteristics.

Area	Total Population	Race (% of Population)						Total Minority (%)	Below Poverty Level (%)
		White	Black/ African American	Asian	Native American	Hispanic	Other		
Navajo Nation		2	0	0	96	2	0	98	38
Coconino County	134,437	61.7	1.2	1.4	27.3	13.5	0.1	43.5	24.6
Arizona	6,392,310	84	4.6	3.2	5.3	30.3	0.3	43.7	17.9
New Mexico	2,085,572	82.9	2.5	1.6	10.4	47.3	0.2	62	20.4

Notes: 1. The racial and ethnic categories provided are further defined as: White (White Alone, not Hispanic or Latino); Black (Black or African American alone, not Hispanic or Latino); Asian (Asian alone, not Hispanic or Latino); Native American (American Indian and Alaska Native alone, not Hispanic or Latino); Other (Native Hawaiian and Other Pacific Islander, not Hispanic or Latino, Some other race alone, not Hispanic or Latino); Hispanic (Hispanic or Latino, Persons of Hispanic origin may be of any race).
 2. Population with income below established poverty level; the U.S. Census Bureau's established income thresholds define poverty level.
 3. Percentages in **bold** were identified as minority or low-income communities.
Sources: U.S. Census Bureau, Census 2010, AZRPI 2012.

4.11.1 Alternative 1 – No Action

The No Action Alternative would allow existing negative impacts related to the spread and establishment of non-native noxious weeds to continue. Treating weeds through the current ad hoc method would allow weeds to flourish in many of the areas where they cause the most economic damage, such as homesite areas, rangelands, watersheds, and agricultural fields. As discussed in the Economics section, noxious weeds can decrease property values and productivity of lands. For the Navajo people, loss to agricultural and grazing operations could affect the livelihood of many residents. Weeds would also continue to affect human health for many residents who may suffer from allergies or contact dermatitis related to many weed species. Some weeds can alter existing fire regimes, increasing the occurrence of wildfires and the risk for property loss and air pollution in nearby communities.

The continued spread of weeds could also affect cultural significant resources found on the Navajo Nation. Large woody invasives, such as Russian olive and tamarisk, have been known to increase erosion, which could affect some cultural resources found at treatment sites. Artifacts could be unearthed and exposed to the elements. In other areas, the spread of noxious species could replace culturally significant plants that are used in the practice of the Navajo religion.

While such impacts are concerning, they are not likely to represent severe adverse effects to the Navajo Nation. However, they would result in damage to the aesthetics of the community and negative impacts to important economic ventures supported by the Navajo Nation including

ranching, farming, recreation, and forestry. The unsightly spread of weeds would also impact important business enterprises on the Navajo Nation, such as hotels, casinos, and shops.

4.11.2 Alternative 2- Proposed Action

Implementation of an integrated weed management strategy would not result in appreciably more severe or greater in magnitude adverse impacts to residents of the Navajo Nation. Impacts related to chemical and mechanical treatments are likely to have the greatest impacts on communities due to the potential for environmental impacts. Herbicide applications and use of heavy machinery have higher risks for contaminating surface water than other treatments. Prescribed burning would reduce air quality in surrounding communities, with Navajo residents being the most affected. However, many of the potential adverse impacts would be mitigated by measures proposed and outlined below. Such measures include regular public meetings to review weed management activities, notification and consultation with land users and permit holders before, during, and after treatments are implemented, implementation of buffer zones for mechanical and chemical treatments near surface water to limit potential contamination, and buffer zones around home site lease areas. In the end, adverse impacts related to weed control and management are likely to be minimal.

Weed management does have the potential to impact resources that may be important to the Navajo people. The treatment of noxious weeds would impact some culturally significant plants. Some plants may be damaged or destroyed when implementing chemical and/or mechanical treatments. However, surveys of areas prior to treatment would help identify potentially valuable plants and allow them to be marked and avoided to minimize adverse impacts. Some treatments may also take place in or near areas where religious ceremonies or meetings are held. Consultation and coordination with local land users can help identify such areas to avoid treatments during in appropriate times or occasions. If cultural and historic items are present at treatment sites, consultation with the Navajo Historic Preservation Department based on Programmatic Agreement for this project. Implementation of these measures will minimize impacts to resources of cultural, religious, or social importance to the Navajo people.

The use of herbicides must be done in consultation with the Navajo Nation EPA and the U.S. EPA for the protection of surface waters and wellheads. Reporting and monitoring of herbicide use is done by both programs and requires coordination with tribal environmental quality programs and federal agencies. These agencies are responsible for monitoring how use of herbicides may potentially impact water quality for public and environmental health concerns. They also ensure that use of herbicides is done in accordance with the herbicide label.

Nearly all noxious weed management projects are carried out to improve the environmental quality and value of Navajo tribal trust lands. Over the long-term the action is expected to improve land quality and property values in areas where weed treatments are prioritized. Treated areas would improve their economic and environmental value for land users. Positive impacts

from weed control and management include improved site productivity, improved aesthetic values, reduced erosion, improved wildlife habitat, and a reduction of potential allergens.

4.11.3 *Alternative 3 – No Biological Control*

Fewer acres overall would be treated under the No Biological Control Alternative, and would not disproportionately affect the Navajo Nation. Any impacts caused by the removal of vegetation would be temporary and would ultimately result in enhanced tribal lands and communities.

4.12 Climate Change

Climate modeling for the Southwest indicates that the Navajo Nation will experience significant impacts from climate change resulting from elevated greenhouse gas concentrations in the atmosphere. Climate change is expected to alter climate in the Navajo Nation by causing extreme shifts between wet and dry periods. Current climate patterns for the Navajo Nation suggest that such shifts are already taking place.

Analysis of how weed management will impact the effects of climate change is largely focused on the potential for treatments to significantly elevate greenhouse gas emissions above current levels. All weed management alternatives would authorize the use of motor vehicles as part of weed management operations. Vehicles would be used to travel to and from treatment locations, assist in the application of herbicide treatments (i.e. broadcast spraying), and transport equipment and machinery at treatment sites. Such use would not be significantly different than their current use on the Navajo Nation by land managers, residents, and visitors and thus would not contribute to elevated greenhouse gas emissions.

Conversely, climate change is likely to have an impact on the spread and management of weed species on the Navajo Nation. Prolonged periods of drought would give many weed species a competitive advantage over many native species, allowing them to establish and continue to spread throughout the Navajo Nation. Warmer weather will likely result in the expansion of noxious weeds into different latitude and altitudes.

4.12.1 *Alternative 1 – No Action Alternative*

Under the No Action Alternative, weed management projects would be implemented on a case-by-case basis, resulting in fewer acres treated and many exotic weed species left to untreated. Under this alternative, the revegetation of treated sites would not be included as part of a weed management program. The lack of revegetation would result in higher soil carbon emissions from areas where weed infestations have resulted in large monocultures of non-native species. If weeds are removed from such sites without active or passive restoration of native plant communities, such areas would no longer serve as important carbon sinks. Without revegetation, sites can lose some of their ability to store carbon, releasing carbon to the atmosphere as biological processes such as respiration and decomposition continue in soils (Dore et al. 2008). The increase in carbon emissions from such sites could compromise the value of some ecosystems, such as forests and woodlands, to serve as carbon sinks which can counteract the

effects of elevated greenhouse gases. However, on a local level, such changes would be minimal and would not result in any adverse impacts related to climate change.

This alternative would allow weed infestations to increase as a result of climate change. Such increases would likely result in feedback cycles that would allow alterations in vegetation community, composition, and structure. These alterations include the replacement of native vegetation communities with non-native species, increased erosion and loss of topsoil, and reduced resilience to changes in temperature and water availability. For some species, such as cheatgrass and Russian thistle, increased coverage would contribute to more frequent and potentially more severe wildfires, indirectly increasing carbon emissions in weed infested areas. Overall, the No Action Alternative would increase the chance of native species and wildlife habitats from being irreversibly altered.

4.12.2 Alternative 2– Proposed Action

There is no indication that biological, chemical, cultural, or manual treatment methods implemented as part of an integrated weed management program would result in significantly elevated greenhouse gas emissions. Implementation of some of these methods may require the use of vehicles to access and travel within treatment sites. Additionally, the removal of vegetation from treatment sites would temporarily increase carbon emissions to the atmosphere. With revegetation at treatment sites, such losses would be short-lived.

Mechanical treatments would result in the largest releases of greenhouse gases when heavy machinery and prescribed burning are used. These treatment techniques would also increase ground disturbance, resulting in larger carbon emissions from exposed ground. Use of heavy machinery to cut or remove target weeds species would locally increase greenhouse gas emissions at treatment locations from increased fossil fuel use. However, use of these machines would be limited and would represent a short-term localized increase in greenhouse gas emissions, which would not impact climate change. Such releases would also be temporary as revegetation efforts would offset such impacts.

Prescribed burning would increase localized carbon emissions from treatment sites. However, prescribed burning is recommended in many forested systems as a way to reduce the carbon emissions from wildfires. In the Southwest, one study estimated that in forests where prescribed burning is recommended (i.e. ponderosa pine forests), carbon emissions can be reduced significantly in the event of a wildfire. In Arizona, it is estimated that prescribed burning between 2000 and 2009 led to a 52% reduction in carbon emissions during wildfires in treated land types. For New Mexico, emissions decreased by 37% and for Utah the decrease was 54% (Wiedinmyer and Hurteau 2010). Thus, while prescribed burning would increase carbon emissions temporarily, over the long term as part of an integrated approach to weed management, prescribed burning can contribute to reduced carbon releases.

4.12.3 Alternative 3 – No Biological Control

Weed management treatments under this alternative are not expected to result in impacts related to climate change. Since the number of acres treated using the other treatment methods would be the same, the change in greenhouse gas emissions would be similar and would likely not impact climate in the region. The removal of vegetation would also increase carbon emissions temporarily at treatment sites, but revegetation will offset this effect over time.

While Alternative 3 will likely not result in impacts related to climate change, climate change is expected to increase the spread of target weed species that could be treated using biological control agents, such as leafy spurge and Dalmatian toadflax (Nania et al. 2014). The spread of these weed species in response to climate change would require additional treatment methods to control such populations on the Navajo Nation.

4.13 Areas with Special Designation

Under this action, weed management treatments would not be authorized for lands managed by the Bureau of Land Management. Lands managed by the BLM are not under the jurisdiction of the BIA and have separate weed management plans in place to address potentially noxious weed species. While the BLM is a cooperator for this project, weed management activities will be performed in accordance with their guidelines and planning documents. However, the BIA does have a responsibility to manage weeds on areas adjacent to these lands, which would help prevent weeds from spreading into specially protected areas such as wilderness area, national monuments, parks, and recreation areas.

Additionally, weed management projects are not proposed under this action for Biological Preserves or Highly Sensitive Areas as designated by the Biological Resource Land Use Clearance Policies and Procedures set forth by the Navajo Nation Department of Fish & Wildlife. These areas contain habitat for endangered and rare plant, animal, and game species that are of the highest concern for the Navajo Nation. Thus, planning for weed projects in these areas will require additional consultation and coordination with NNDFW beyond what is proposed under this action.

4.13.1 National Park Service

Weed management in Canyon de Chelly and Navajo National Monuments is still the responsibility of the BIA.

4.13.2 Navajo Tribal Parks and Recreation Areas

The mission statement of the Navajo Parks and Recreation Department “is to protect, preserve, and manage tribal parks, monuments and recreation areas for the perpetual enjoyment and benefit of the Navajo Nation – the spectacular landscapes, buttes, canyons, clean air, diversity of plants and wildlife, and areas of beauty and solitude. The accomplishment of this mission is challenged due to the growing pressure from the growing Navajo population, the need to promote economic and social opportunity for the people, and the huge number of visitors that

enjoy these parks. There are no restrictions on vegetation treatments in Navajo Tribal Parks and Recreation Areas. However, the unique characteristics of these areas would be considered when preparing management plans for treatment activities.

4.13.2.1 *Alternative 1 – No Action Alternative*

The No Action Alternative would allow existing negative impacts related to the spread and establishment of non-native noxious weeds to continue. Noxious weeds would continue to expand in Navajo Tribal Parks and Recreation Areas where they would compromise the mission of the Navajo Parks and Recreation Department by degrading the unique qualities of these parks through increased wildfire risk, threats to native plant and wildlife diversity and compromised natural processes. Noxious weeds such as kochia and Russian thistle could cause problems for visitors with hay fever and allergies. Leafy spurge can cause irritation to broken skin or eyes. Weed treatments that do occur in these areas would have similar impacts as discussed in the Alternative 2: Proposed Action.

4.13.2.2 *Alternative 2 – Proposed Action*

Under the Proposed Action, noxious weed treatments would be conducted through an integrated approach within Navajo Tribal Parks and Recreation Areas. In general, weed treatments would have short-term negative effects and long-term positive effects. Treatments would help uphold the mission of the Navajo Parks and Recreation Department by protecting and managing the tribal parks, monuments and recreation areas. Noxious weed treatments would reduce the risk of degrading the unique qualities of these areas through catastrophic wildfire, threats to plant and wildlife diversity, and compromised natural processes. The short-term impacts of weed treatments include temporary closures to areas that are being treated, visual impacts from brown or dead vegetation directly after treatments, increased dust and soil erosion. Temporary closures may lead to lost recreational opportunities, including site seeing, hiking, and photography.

The use of chemical treatments to treat noxious weeds could potentially kill off non-target vegetation through drift or imprecise application. The degree of effects would depend on the application method used. Spot applications would be less likely to cause widespread impacts to non-target vegetation than aerial and vehicle spraying. Implementing mitigation measures would reduce the impacts of noxious weed treatments in these areas. The mitigation measures that would apply to Navajo Tribal Parks and Recreation Areas are associated with human and ecological health and recreation. Please refer to the Vegetation, Wildlife Resources, Recreation, and Human Health and Safety Sections of this chapter.

4.13.2.3 *Alternative 3 – No Biological Control*

Under Alternative 3, more disturbing treatment methods such as chemical, mechanical, manual and cultural methods would be used instead to control target weed species. However, the number of acres treated using such methods would remain the same. In tribal parks and areas, the use of chemical treatments would have an increased risk of overspray or damage to non-target plants and potential impacts to workers and chemically sensitive people. Mechanical, manual, and

target grazing (cultural treatments) would impact soils and potentially trample non-target vegetation from personnel and livestock as the treatments are administered. Also, these treatment methods would require that areas be closed for longer periods of time than with biological control treatments.

4.13.3 Forest Management Units

Forest Management Units are managed under the prescriptions outlined in the “10-Year Forest Management Plan – Navajo Indian Reservation” developed by the Navajo Forestry Department (ref). The purpose of the Navajo Forest Management Plan is to establish management direction for 596,725 acres on the Defiance Plateau-Chuska Mountains, which includes commercial timberland. The regulatory jurisdiction of the FMP is defined by BIA Manual 53, Supplement 2 and implementing regulations of 25 CFR, Part 163 and the National Indian Forest Resources Management Act (P.L. 101-630). The Plan recognizes the need for an integrated weed management approach to control competing vegetation within the Forest Management Units. Water Quality Guidelines were developed by the NNEPA and established in response to the use of herbicide to protect water quality from pesticide residues during all phases of the pesticide use cycle, protect desired vegetation cover, and minimize toxic effects to aquatic organisms. The NNEPA emphasizes that biological, cultural, manual and mechanical control should be used over chemical applications when possible. While the Forest Management Units are not listed under priority sites for weed treatments, weed treatments could be administered in these areas.

4.13.3.1 *Alternative 1 – No Action Alternative*

The No Action Alternative would allow existing negative impacts related to the spread and establishment of non-native noxious weeds to continue. Noxious weeds could be treated under the 10-Year Forest Management Plan, and weed management would continue as it is currently managed. Noxious weeds would continue to expand in Forest Management Units where they would compromise timber health and site accessibility through increased wildfire risk, competing vegetation, and dense monocultures. Under the current ad hoc weed management program more noxious methods such as chemical and mechanical treatments would be utilized. This would increase the risk of contaminating water sources. Weed treatments that do occur in these areas would have similar impacts as discussed in the Alternative 2: Proposed Action.

4.13.3.2 *Alternative 2 – Proposed Action*

Under the Proposed Action, noxious weed treatments would be conducted through an integrated approach. All the methods that are proposed in the 10-Year Forest Management Plan would be available for use. Mechanical, manual, biological and cultural techniques would be prioritized over chemical techniques. In general, weed treatments would have short-term negative effects and long-term positive effects. Noxious weed treatments would reduce the risk of timber loss due to competing noxious vegetation, inaccessible areas due to dense weed infestations, and catastrophic wildfire that would damage important timber resources. The short-term impacts of weed treatments include temporary closures to areas that are being treated, increased dust and

soil erosion. Implementing mitigation measures would minimize the impacts of dust and soil erosion. Revegetating sites with native vegetation would restore timber resources and comply with the 10-Year Forest Plan.

The use of chemical treatments to treat noxious weeds could potentially kill off non-target vegetation through drift or imprecise application and impact water quality in nearby water sources. This method would only be used after determining that all other methods would not be effective in achieving the project objectives. The degree of effects would depend on the application method used. Spot applications would be less likely to cause widespread impacts to non-target vegetation than aerial and vehicle spraying. Implementing mitigation measures would reduce the impacts of noxious weed treatments in these areas. The mitigation measures that would apply to Forest Management Units are associated with human and ecological health. Please refer to the Vegetation, Wildlife Resources, Recreation, and Human Health and Safety Sections of this chapter.

4.13.3.3 *Alternative 3 – No Biological Control*

Under Alternative 3, more disturbing treatment methods such as chemical, mechanical, manual and cultural methods would be instead used to control target weed species. While the number of acres treated by each of these methods would not change from Alternative 2, areas where more passive treatment methods are preferred would need to be treated with these more impactful techniques. Overall, the impacts would be similar to those described in Alternative 2.

4.13.4 Wilderness Areas

As these areas are managed by the Bureau of Land Management, weed treatments conducted or funded by the Bureau of Indian Affairs are not proposed in these areas under any Alternative. Therefore, no impacts are anticipated in designated wilderness areas under this Action.

4.13.5 Biological Preserves

As these areas are managed by the Navajo Nation Department of Fish and Wildlife and the Bureau of Indian Affairs is not proposing to conduct weed treatments in these areas under any Alternative, it is anticipated that these areas will not be impacted under this Action.

4.14 Resource Use

4.14.1 Hunting and Fishing

Navajo Nation Department of Fish and Wildlife is responsible for selling and regulating hunting and fishing permits on the Navajo Nation. Permits are available for several game species, including: mule deer, elk, turkey, pronghorn, black bear, desert bighorn, and mountain lion. Pronghorn, black bear, desert bighorn, and trophy deer and elk permits are limited and are a substantial revenue source. There are many factors that affect big game species population numbers and the resulting numbers that are allowed to be hunted. One factor that has contributed to a decline in big game species on the Navajo Nation includes degraded and fragmented habitat.

Much of the rangeland on the Navajo Nation has been overgrazed and infested with noxious weeds that are less palatable and nutritious to herbivores. Noxious grass species, such as cheatgrass, provides forage to livestock and wildlife when the plant is young and green; however, the forage quality and palatability declines as the plants dry (Cook and Harris 1968, Mayland et al. 1994). Many big game species compete with domestic sheep, cows and horses for limited forage. Limited nutritious forage will reduce the overall health and condition of these species, which will make them more susceptible to disease, predation, and reduced off-spring. Climate change is anticipated to exacerbate the degradation of rangeland health by promoting the expansion of adaptable noxious species. While deer are more adaptable to degraded rangeland health, because they eat a variety of vegetation species and absorb water from their food (Mule Deer Working Group 2004), other species such as bighorn sheep and pronghorn may decline.

All waters on the Navajo Nation are opened to fishing with a permit, however there are several fishing waters that are maintained and stocked with sport fish. Many of the fishing lakes and rivers are lined with noxious plant species which can limit access to fishing areas and reduce habitat conditions for fish.

4.14.1.1 *Alternative 1 – No Action*

The No Action Alternative would allow existing negative impacts related to the spread and establishment of non-native noxious weeds to continue. Noxious weeds would continue to expand in riparian and grasslands, which would promote the expansion of less palatable species such as cheatgrass, red brome and saltcedar. These species would also increase wildfire risk, which would greatly reduce grassland availability to game species. Native grasslands would be reduced and cattle would continue to compete with big game for limited native forage.

4.14.1.2 *Alternative 2- Proposed Action*

Under the Proposed Action, noxious weed treatments would be conducted through an integrated approach. Some of the effects to hunting and fishing would be the same as described under the Wildlife Section. Mechanical, manual and cultural treatments may have short-term localized impacts to vegetation and soil. Increased run-off and soil erosion would cause temporary and localized turbidity to rivers and lakes. Implementing best management practices would minimize runoff and soil erosion into rivers and lakes in treatment areas. Native vegetation, particularly grasses, which are an important food source and habitat for big game species, may be impacted by trampling from work crews or heavy machinery. Also, during treatments game species may be displaced. Biological control would not have impacts to hunting and fishing. The short-term impacts to fishing and hunting would be outweighed by the benefits of habitat improvement from weed removal activities. Weed treatments could be timed outside of the fishing and hunting seasons to create the least amount of impact to these activities.

The use of chemical treatments to manage noxious weeds could result in loss non-target vegetation through drift or imprecise application. This could affect important grazing areas for game species and cause game to be displaced. Aerial applications have the greatest potential to

affect wildlife through direct spraying. Also, some herbicides, including Fluzafop-p-butyl and 2,4-D may provide a slight risk to small and large mammals if contaminated vegetation is consumed. Finally, chemicals could contaminate rivers and lakes and affect sport fishing. Implementing the best management practices and mitigation measures outlined under the Wildlife Section would reduce the potential for chemical contamination.

4.14.1.3 Alternative 3 – No Biological Control

Although this Alternative would have similar impacts to Alternative 2 for mechanical, cultural, manual, and chemical treatments, without the use of biological control, the long-term and large-scale effectiveness of those treatments may be limited. Treatment sites with heavy infestations of species targeted by biological controls would need to be retreated more often using other methods such as chemical or mechanical control.

Without the use of biological control, the cost for vegetation treatments in some areas would likely be higher as these other treatment methods require more manpower, equipment, and monitoring to reduce impacts to native vegetation inside and outside of treatment sites. Sites would also require more intensive retreatments to control re-sprouting weeds and secondary infestations.

4.14.2 Recreation

Recreational opportunities on the Navajo Nation are primarily carried out in the Tribal and National Parks, the Federal Highway Administration's National Scenic Byways, and casinos. The main activities conducted in these recreational areas include site seeing, hiking, photography, gaming, and guided tours. In 2011, it was estimated that 599,862 out-of-region visitors went to the Navajo Nation and were responsible for \$112.8 million of direct expenditures in Navajo and Apache counties, AZ (Arizona Hospitality Research and Resource Center 2012). The Navajo Nation Division of Economic Development recognizes that tourism is increasing on the Navajo Nation and is trying to develop more facilities and opportunities for tourists to increase visitor use and create jobs. Antelope Point Marina and Resort Project and the Navajo Nation Scenic Byway Program are two development projects that were established to promote tourism on the Navajo Nation (NN Division of Economic Development 2010). Scenic byways are roads that are recognized for their archaeological, cultural, historic, natural, recreational, or scenic qualities and can be used to promote tourism and travel through areas.

In a survey conducted by the Arizona Hospitality Research and Resource Center (2012), they found that 66% of the visitors said they came to the Navajo Nation to visit the scenic attractions and 28% wanted to engage in outdoor recreational activities. While many of the scenic attractions include large rock formations located in Monument Valley and other Tribal Parks, noxious weeds have the potential to impact recreational opportunities when visiting these sites. Impacts may include allergic reactions to some weed species, reduced visual appeal, and increased nuisance due to burs and spines that can stick to clothing and skin. Implementing an

integrated weed management approach to treating noxious weeds will have the same impacts on recreation as those discussed above for the Tribal Parks and Access to Vital Services.

4.14.2.1 *Alternative 1 – No Action*

The No Action Alternative would allow existing negative impacts related to the spread and establishment of non-native noxious weeds to continue. Noxious weeds would continue to expand in recreational areas, which would increase wildfire risk, threats to native plant and wildlife diversity, and reduce visual appeal. Noxious weeds such as kochia and Russian thistle could also cause problems for visitors with hay fever and allergies. Leafy spurge can cause irritation to broken skin or eyes. Assuming a steady increase in recreational users on the Navajo Nation, there would be more impacts to lands from human activities with limited weed treatment capability. Increased human activities could spread weeds, start fires, and increase disturbance. Weed treatments that do occur in these areas would have similar impacts as discussed in the Alternative 2: Proposed Action.

4.14.2.2 *Alternative 2 – Proposed Action*

Under Alternative 2, weed treatments would have short-term negative effects and long-term positive effects on recreation. The short-term impacts of weed treatments include temporary closures to areas that are being treated, visual impacts from brown or dead vegetation directly after treatments, increased dust and soil erosion. Temporary closures may lead to lost recreational opportunities, including site seeing, hiking, camping, wildlife viewing and photography. However, benefits from weed treatments include reducing the risk of visitor contact with undesirable plant species and increasing visitor exposure to desirable plants and wildlife. A long-term result would increase the recreation hours spent at a site.

The use of chemical treatments to treat noxious weeds could potentially kill off non-target vegetation through drift or imprecise application. The degree of effects would depend on the application method used. Spot applications would be less likely to cause widespread impacts to non-target vegetation than vehicle spraying. Vehicle spraying would likely be limited to the National Scenic Byways and roads within Tribal Parks. Implementing mitigation measures would reduce the impacts of noxious weed treatments in these areas. Signage and public notifications will be posted and distributed prior to implanting chemical treatments to advise the public. Other mitigation measures that would apply to recreation are associated with human and ecological health and recreation. Refer to the Vegetation, Wildlife Resources, and Human Health and Safety Sections of this chapter.

4.14.2.3 *Alternative 3 – No Biological Control*

Under Alternative 3, other, less passive treatment methods would be used to control weed populations, limiting treatments to the use of chemical, mechanical, manual, and cultural control methods. While the total number of acres treated with these methods would remain the same as those proposed under Alternative 2, use of these more active treatment methods may affect the accessibility of some recreational sites that are treated. Also, these treatment methods would

require that areas be closed for longer periods of time than with biological control treatments. Plants that can be injurious to humans, including: Russian knapweed, Canada and Scotch thistles, and yellow star-thistle would increase. Alternative C could negatively impact recreation activities, particularly hiking, camping and other activities that could increase contact with these invasive, noxious weeds.

4.15 Other Values

4.15.1 Noise and Light

Due to the rural location of the Navajo Nation, ambient noise levels and light pollution are relatively low. The primary contributors of noise and light pollution include the mining operations, casinos and freeways. Vehicle traffic using the travel corridors and facility access contribute noise and light pollution. While the Navajo Nation and the BIA currently do not have specific requirements related to noise and light pollution, adjacent federal agencies and/or projects that include adjacent land may have regulations in place to minimize impacts from additional noise and light.

4.15.1.1 *Alternative 1- No Action*

The no action alternative would have the same minimal noise and light impacts that occur under the current ad-hoc noxious weed treatment program. Mechanized chemical and mechanical treatments using chainsaws are the primary weed treatment methods utilized under the current program. These impacts are the same as those described under Alternative 2. Noise pollution would increase if a wildfire occurs due to the expanding noxious weed populations. Aircraft, vehicles, and heavy equipment that could be part of the control effort would increase noise levels. Such noise levels would most impact those working in field crews to implement treatments. Their proximity to equipment during treatments puts them at risk for increased hearing loss. Use of heavy machinery, aircraft for aerial herbicide applications or wildfire treatments, and vehicle use would increase the potential of noise pollution, especially in remote areas. Those living in remote areas are used to more natural soundscapes and would therefore be more impacted by an increase in noise from such equipment and techniques. Such impacts, however, would be temporary, lasting only for the time period when treatments would be implemented. For more developed parts of the Navajo Nation, the increase in noise from these uses might be an annoyance to local residents, but would not increase the risk of potential harm. Wildfire would also increase light impacts.

4.15.1.2 *Alternative 2- Proposed Action*

All noxious weed treatments proposed under Alternative 2 could increase noise levels temporarily during treatments. Mechanical and mechanized chemical treatments using heavy machinery, aircraft, trucks, ATVs or chainsaws would have the greatest noise level impacts (**Table 3-27**). The use of such equipment would be most impactful in more remote locations where visitors or local residents are used to more natural soundscapes. The use of grazing

animals for cultural control techniques would have increased noise by vehicles transporting animals. The transportation of crews in vehicles to and from a treatment site would also increase noise levels. Biological control methods would have the lowest noise impact and would only involve driving to the site to distribute the insects. Noise impacts from treatments would be temporary and short-lived. Noxious weed treatments will only be applied during the day and will not provide additional light impacts. Use of prescribed burning operations would be done during daytime hours under the supervision of a trained fire crew to assist with control and containment of fire activities. Because prescribed burns tend to be low level ground operations that do not burn as hot as wildfires, impacts to light or additional light pollution is not anticipated.

4.15.1.3 Alternative 3 – No Biological Control

The implementation of Alternative 3 would have the same noise and light impacts as Alternative 2. However, with less noxious weed acres being treated there would be greater risk for catastrophic wildfire. The impacts of wildfire are discussed under Alternative 2.