FINAL ENVIRONMENTAL IMPACT STATEMENT

Navajo Nation Integrated Weed Management Plan

VOLUME I – FINAL PEIS

August 2022

FOR MANAGEMENT OF LANDS ON:
THE NAVAJO NATION

BUREAU OF INDIAN AFFAIRS NAVAJO REGION
NAVAJO NATION
NATURAL RESOURCES CONSERVATION SERVICE - ARIZONA
ANIMAL AND PLANT HEALTH INSPECTION SERVICE
NAVAJO NATION SOIL AND WATER CONSERVATION DISTRICTS
NATIONAL PARK SERVICE
UTAH DEPARTMENT OF TRANSPORTATION
ARIZONA DEPARTMENT OF TRANSPORTATION
BUREAU OF LAND MANAGEMENT - NEW MEXICO
SAN JUAN SOIL AND WATER CONSERVATION DISTRICT

Estimated Lead Agency Total Costs Associated with Development of this EIS: $601,000

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Final Programmatic Environmental Impact Statement for the Navajo Nation Integrated Weed Management Plan

Navajo Trust Land and Navajo Indian Allotments in Arizona, New Mexico, and Utah

Draft () Final (X)

Lead Agency: Bureau of Indian Affairs (BIA), Navajo Regional Office

Cooperating Agencies:
Navajo Nation
Natural Resource Conservation Service (NRCS)
Animal and Plant Health Inspection Services (APHIS)
Navajo Nation Soil Water Conservation District (NNSWCD)
National Park Service (NPS)
Arizona Department of Transportation (ADOT)
Utah Department of Transportation (UDOT)
U.S. Bureau of Land Management (BLM)
San Juan Soil and Water Conservation District

Jurisdiction: Navajo Nation

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All comments should be received by October 4, 2022.

Abstract

The Bureau of Indian Affairs, Navajo Regional Office proposes to implement an integrated weed management program for noxious weeds within the Navajo Nation. The Proposed Action would authorize annual treatments of weed infestations up to 50,000 acres across the Navajo Nation. The various methods analyzed under an integrated weed treatment approach include manual, mechanical, cultural, chemical, and biological control. Initial treatments will focus on areas that have weed inventories completed, including roads, riparian areas, utility and road rights-of-way, designated farmlands or croplands, designated rangeland or range units, and Community Development Areas. This plan will encompass a 10-year period with a project review after five years. The alternatives evaluated in this PEIS include: Alternative 1. No Action; Alternative 2. Proposed Action; and Alternative 3 which is identical to Alternative 2 but does not include biological control weed treatments.

Cover Photo by Renee Benally, BIA Western Navajo Agency, Natural Resource Specialist

APPROVED:

Bureau of Indian Affairs (BIA), Navajo Regional Office

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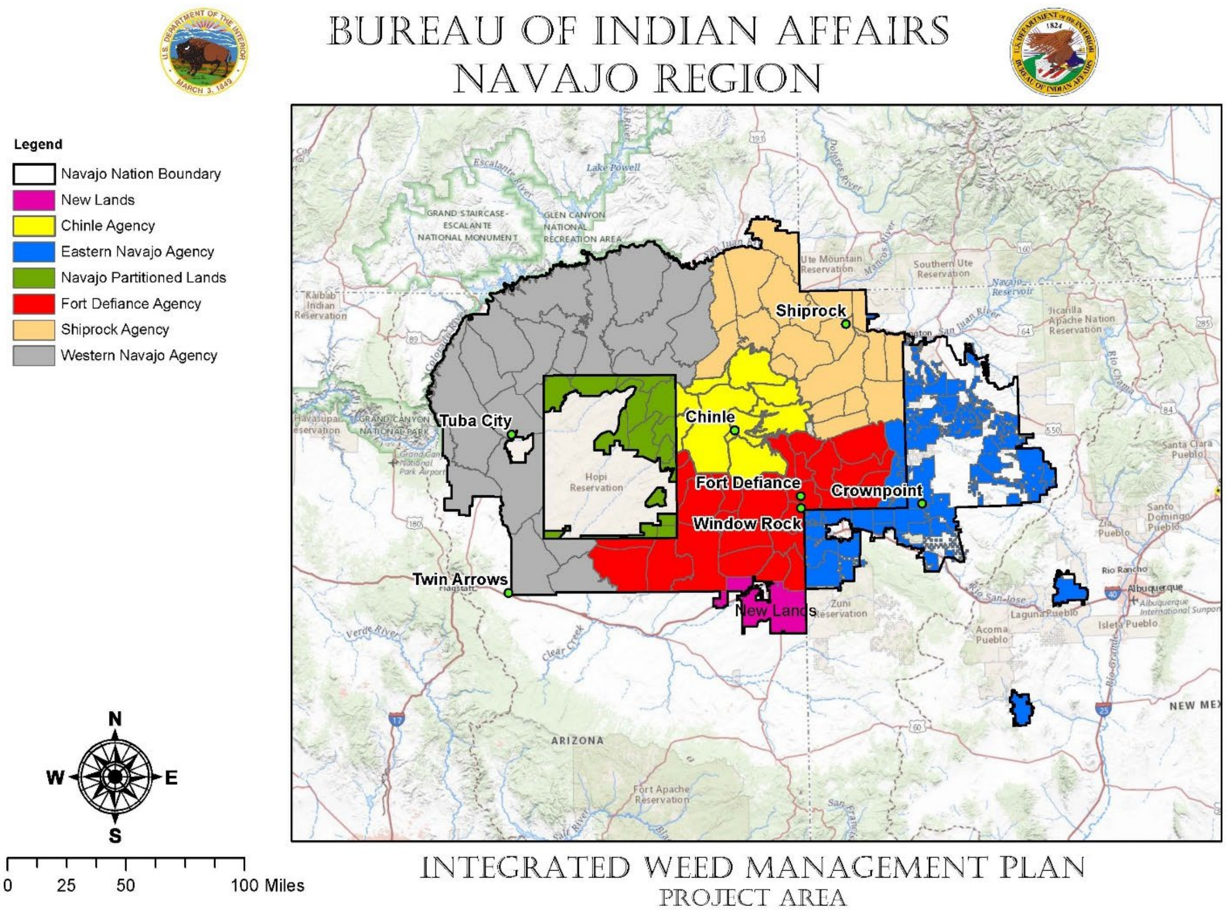
EXECUTIVE SUMMARY

This final Programmatic Environmental Impact Statement (PEIS) analyzes the potential environmental consequences of implementing the Navajo Nation Integrated Weed Management Plan for the Navajo Trust Land and Navajo Indian Allotments in Arizona; New Mexico; and Utah.



Proposed Action

Under the Proposed Action, the BIA would authorize annual treatments of weed infestations for up to 50,000 acres across the Navajo Nation. The methods include manual, mechanical, cultural, chemical, and biological. Initial treatments would focus on areas with complete weed inventories, including roads, riparian areas, Navajo Agricultural Products Industry (NAPI) and Navajo Indian Irrigation Project (NIIP) lands, rights-of-way, designated farmlands, designated rangeland, and Community Development Areas. This plan would encompass a 10-year period with a project review after five years. Weed mapping and inventory would be completed concurrently with weed removal projects. Once inventoried, a site and species prioritization approach would rank projects based on site and priority species. Adaptive management would be used to adjust treatments and improve effectiveness.

Purpose

Manage 45 noxious weed species on the Navajo Nation including the Navajo Indian Allotments and Navajo Partitioned Lands. The control of these noxious plants would improve ecological function by increasing native plant productivity and diversity, preventing further noxious weed spread, and enhancing wildlife habitat.

Need

Based on 54 IAM 7, the BIA has a responsibility to manage noxious weeds on the Navajo Nation. Noxious weeds impact every habitat on the Navajo Nation, affecting the economic, historic, and cultural livelihood of the Navajo people. Noxious weeds can alter soil temperature, soil salinity, water availability, nutrient cycling and availability, native seed germination, water infiltration, and precipitation runoff.

Project Objectives

- Develop the best control techniques for the target weed species in a planned, coordinated, and economically feasible program to limit the impact and spread of noxious weeds.
- Use adaptive management strategies to incorporate successful projects from completed weed projects when developing new initiatives.
- Identify patterns and relationships to prevent the expansion of existing target weed species, and quickly prevent the spread of new high priority weed species through utilization of spatial technology.
- Coordinate weed removal efforts with adjacent landowners, land managers, and/or federal agencies to prevent the further spread of weeds.
- Provide and promote economic opportunities to the Navajo people to improve rangeland and farmland productivity and to remove noxious weeds.
- Develop a public education program focused on weed identification, prevention, and removal techniques for local communities and non-profit organizations.

Decision To Make

The Regional Director of the BIA Navajo Regional Office is the responsible official for this proposal. The Regional Director has discretion to determine whether to implement the proposed action, other action alternatives as defined, or no action pursuant to 59 IAM 3. The Proposed Action (Alternative 2) was developed to meet the purpose and need and to initiate the NEPA process. The Proposed Action is the Agency's recommended course of action to treat weed populations based on the issues identified.

Public Involvement

The Notice of Intent (NOI) to prepare the Programmatic EIS for the Navajo Nation IWMP was published on January 14, 2013 (Vol. 78, No. 9). Public scoping occurred from January 14, 2013, to March 20, 2013. Due to delays in the project, an additional comment period was conducted online from April 29, 2021, to May 29, 2021. The Scoping Report can be found in Appendix D.

Public review of the Draft PEIS occurred from October 29, 2021 to December 13, 2021. The BIA collected public comments and developed responses, which are outlined in the Response to Comment Report in Appendix M.

Cooperating Agencies

Upon approval of this document, the following cooperating agencies will conduct weed removal under the NNIWMP in their area of jurisdiction:

- Navajo Nation
- USDA Natural Resource Conservation Service (NRCS)
- USDA Animal and Plant Health Inspection Service (APHIS)
- Navajo Nation Soil and Water Conservation Districts (SWCD)
- Arizona Department of Transportation (ADOT)
- Utah Department of Transportation (UDOT)
- San Juan Soil and Water Conservation District

BIA will coordinate weed removal projects on adjacent lands managed by these cooperating agencies. Additionally, BIA will coordinate weed removal projects with the Bureau of Land Management (BLM) and National Park Service (NPS), although these agencies will not conduct weed removal under the NNIWMP.

Issues

Scoping resulted in a total of 51 comments. Only one relevant substantive issue was raised during public scoping and was used to develop Alternative 3 for impact analyses. The issue concerned potential impacts from using biological control for weed treatments. Subsequent issues raised after scoping by the public included whether grazing management could sufficiently address weed concerns and whether weed management could be addressed without the use of herbicides. However, it was determined that alternatives developed to address these concerns would not address the purpose and need of the project. No major issues were raised during the public review period of the Draft PEIS.

Alternatives

Alternative 1 – No Action

This alternative is required for analysis and would continue current weed management. Currently, weed projects are site-specific with limited coordination and separate environmental compliance for each. Chemical and mechanical methods are the most common, with occasional use of some cultural or manual methods. Biological control methods are not used (**Table 1**).

Table 1. Estimated acres treated by each noxious weed treatment type for the past 10 years (2010-2020) on the Navajo Nation based on BIA funded projects from 2010 to 2020.

Treatment Type	Estimated Acres Treated 2010-2020
Manual	0
Mechanical	2,782
Cultural	400
Biological	0
Chemical	12,433
TOTAL	**15,615**

Alternative 2 – Proposed Action

The BIA NRO proposes authorizing new weed treatments for up to 50,000 acres annually with repeat treatments over 10 years (**Table 2**) for 45 noxious weed species. The various methods included under an integrated weed treatment approach are a) manual, b) mechanical, c) cultural, d) biological, and e) chemical. Manual methods use hand tools or hand pulling to remove weeds. Mechanical methods include the use of heavy machinery or electric or gas-powered tools, such as chainsaws or mowers, to mow, till, or remove weeds. Cultural methods use agricultural practices to outcompete or replace weeds, such as mulching, cover crops, native plant restoration, or grazing. Biological methods refer to the use of APHIS-approved biological organisms to target specific noxious weeds. Chemical methods use herbicides to kill or suppress noxious weed growth. Prevention, education, annual weed mapping, and early detection and rapid response are also components of this alternative.

Table 2. Estimated annual acres for each noxious weed treatment type under Alternative 2.

Treatment Type	Estimated Acre Treated per Year
Manual	2,000
Mechanical	8,000
Cultural	5,000
Biological	5,000
Chemical	30,000
TOTAL	**50,000**

Alternative 3 – No Biological Control

This action would use the same methods described in Alternative 2, except for biological methods. The treatment acres would be the same for the remaining methods listed in the Preferred Alternative (Alternative 2), less 5,000 acres for biological control (**Table 3**). Alternative 3 was developed to address concern that biological controls could negatively impact endangered species and related native plants. While rare, there are documented cases of biological agents switching host plants from non-native to native species in the same plant family or genus (Louda et al. 2003). Such impacts could indirectly affect endangered species by altering the availability of preferred food or habitat. A separate alternative was proposed at the request of the Navajo Nation Department of Fish and Wildlife to prohibit the use of biological organisms as part of weed management activities conducted by BIA or cooperating agencies. This alternative would treat up to 450,000 weed infested acres with repeated treatments over 10 years.

Table 3. Estimate acres for noxious weed treatments included in Alternative 3.

Treatment Type	Estimated Acreage of Treatment per Year
Manual	2,000
Mechanical	8,000
Cultural	5,000
Biological	-
Chemical	30,000
TOTAL	**45,000**

Summary of Potential Environmental Impacts

Table 4 provides a summary of the potential impacts, by resource, as anticipated by the BIA for the Proposed Action and the other alternatives.

Table 4. A summary comparison of the alternatives and their impacts on the identified resources.

Resource Analyzed	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Biological Control
Paleontological Resources	Increase in noxious weeds. Dense noxious tree roots could damage resources. Would increase wildfire risk that may damage fossils and artifacts.	Ground disturbing mechanical control techniques could damage resources. Cultural controls and biological controls would have minimal effect. Re-planting native vegetation may have ground disturbing impacts. Chemical control may stain, dye, or spall fossils.	The impacts would be the same as Alternative 2.
Soil Resources	Invasive weeds would increase due to uncoordinated and site-specific treatments. Facilitates spread of noxious annual grasses that increase wildfire risk. Annual weeds and riparian trees may increase erosion. Best Management Practices would be used inconsistently, increasing risk of soil contamination	Temporary increase in soil erosion from removing invasive vegetation, but erosion control BMPs would mitigate. Revegetation would stabilize soils. Some herbicides may impact soil organisms. Targeted grazing may disturb soil. Planting native species would improve soil productivity and water holding capacity, increase soil organic content and reduce soil erosion. Biological treatments would have minimal impacts.	Most impacts and benefits would be the same as Alternative 2. Weeds targeted by biological control may spread and increase soil erosion, allelopathic chemicals, and disturbance.
Water Resources and Quality	Fewer treatments would be conducted. Dense riparian noxious trees increase flood energy and disconnect rivers from floodplains. Increased fire frequency and intensity may cause increased turbidity in surface water. Non-coordinated weed treatments may increase chemical contamination to open water. No buffers for chemical treatments near wells.	Short term impacts from increased soil erosion and surface run-off in riparian areas after initial treatments. Passive and active restoration would reduce long-term effects. Risk of groundwater contamination from atrazine, 2,4-D, glyphosate, and picloram treatments in upland sites. Herbicide application buffers adjacent to open water would limit herbicide contamination to surface water. Water quality would be monitored when herbicide treatments occur near wells, with no chemical treatments within 100 ft. No effects from biological controls.	Chemical and mechanical treatments would be used to control knapweeds, field bindweed and leafy spurge, which may increase risk of water contamination. These species would likely increase along riparian corridors, replacing native vegetation and increasing soil erosion, sedimentation, and eutrophication.
Air Quality	This alternative would increase the risk of wildfire from fire prone weeds such as red brome, cheatgrass, kochia, and tamarisk as fewer acres are treated. Large wildfires would likely worsen air quality more than prescribed burns due to increased acreage and uncontrolled fire behavior.	Aerial applications may temporarily increase exposure after treatments. Prescribed fire would result in short-term increases in particulate matter. BMPs would reduce impacts. Effects would be mitigated by burning during optimal weather conditions. Other limited, temporary impacts to air quality include increased dust and emissions from mechanical clearing.	The impacts would be the same as Alternative 2.

Resource Analyzed	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Biological Control
Vegetation	Weed projects would not be prioritized, which would allow several populations to increase. Coordinated weed mapping would not occur. Increased risk of high intensity wildfires, which may threaten protected plants. While roads would be treated, limited coordination would allow new and existing weeds to expand in untreated patches. Treatments may impact plants collected for ceremonial and medicinal purposes.	Special status and non-target vegetation are at highest risk under this alternative. Root systems may be damaged by mechanical treatments. Herbicide drift may impact non-target vegetation. Minor risk of biocontrol agents switching to similar native species. Targeted grazing may consume native species. Trampling may occur during treatments. Buffer zones and mitigation measures would reduce or eliminate negative impacts. Native vegetation and special status species would benefit from the removal of invasive plants.	Similar methods would have the same impacts to Alternative 2. Noxious weeds proposed for biological control would expand and replace native plant communities.
Fish and Aquatic Organisms	Invasive species populations would expand under this alternative which would alter aquatic habitat by increasing erosion and altering food chains. Wildfire frequency would increase as fire-prone weeds expand, which could increase turbidity in surface water. Minimal short-term impacts to critical habitat of existing listed fish species.	Short-term impacts to fish and aquatic habitat from increased soil erosion and surface run-off. Restoration of native plants would reduce long-term impacts. Herbicides used within 25 ft of open water must be an aquatic formulation and those used 25 - 300 ft from open water must be non-toxic to fish and aquatic species. Species conservation measures and BMPs would minimize impacts. Biological control would not affect aquatic organisms and may be an additional food source.	This Alternative would have similar impacts to Alternative 2. More erosive and potentially toxic techniques, such as mechanical and chemical methods, would be used around aquatic habitats which would increase turbidity and toxins and affect fish and aquatic organisms. BMPs would be implemented to mitigate these effects. Management objectives for some weed populations may not be reached.
Terrestrial Wildlife	This alternative has the highest risk of loss to wildlife habitat. Invasive weeds would continue to expand and replace forage and alter habitat. Current weed management does not include planting with native vegetation. There is a higher likelihood of secondary infestations once weeds are removed.	Mechanical, manual, and cultural treatment methods would temporarily displace wildlife. Biological control may affect some nectar plants used by the Great Basin silverspot. However, the species relies on a diverse mix of plants. Aerial applications may impact wildlife, but this method would only use aquatic herbicides. Species conservation measures would minimize impacts. Long-term, this alternative would improve habitat and cover of native plants.	The impacts would be the same as Alternative 2
Hunting and Fishing	Hunting could decline from weeds replacing forage. Elk and bighorn sheep prefer native species and may move or decline as weeds expand. Deer and pronghorn are adapted to degraded rangeland health and would not be as affected if invasive weeds spread. Fishing would be impacted as noxious weeds limit access to fishing sites.	Game may be temporarily displaced during treatments. Treatments near fishing sites may improve access for visitors but would not impact aquatic species. Temporary increases in soil erosion from mechanical and chemical treatments. No impacts expected with biological control. Overall, weed treatments would provide long-term ecological benefits through more palatable, native vegetation and access to fishing areas.	The impacts would be similar to Alternative 2.

Resource Analyzed	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Biological Control
Livestock	While weed treatments would occur, existing weed populations would expand, reducing forage for livestock. Also, may reduce the value of wool if burs and hooks from invasive weeds become entangled. Livestock would continue to transport weeds. Weed treatments would cause secondary weed infestations when cattle are re-introduced to treatment areas.	Some proposed herbicides are slightly to moderately toxic to livestock. Removing animals from treatment areas, mixing herbicides away from animals, and deferring livestock for minimum of 2 growing seasons to allow native plants to regrow would reduce impacts. Planting native species would increase native biodiversity. Biological control would not directly impact livestock. Removal of weeds would benefit rangeland health and livestock over time.	Similar methods would have the same impacts to Alternative 2. However, use of more active treatments could prolong deferment periods because alternative methods may take longer without assive biological control methods.
Farming	Agricultural fields, particularly fallow fields, would not be regularly treated for weeds, which would increase weed expansion to adjacent lands. Use of a few herbicides may encourage herbicide resistant weeds. Mechanical and manual methods would be used, but not cultural. This would increase secondary infestations and soil erosion.	Chemical treatments may impact crops from overspray. Use of integrated methods and several herbicide options will reduce risk of herbicide resistance. Crop rotation and the use of cover crops would improve soil health and production. Biological control would reduce disturbance to soils and crops. Mechanical and manual methods may increase soil disturbance and soil erosion. Weed removal would decrease competition with undesirable plants.	The impacts would be similar to Alternative 2.
Public Health	Uncoordinated efforts may result in overlapping weed treatments, increased public exposure from inconsistent public notification of weed treatments, and contamination of wells. Weed treatments would be lower under this alternative, so there would be less risk for public exposure to treatments. Expansion of weeds, such as kochia and Russian knapweed, would increase allergy risk for some individuals.	Isoxaben, prodiamine, dichlobenil, and pendimethalin are possible human carcinogens. Paraquat, metsulfuron methyl, and triclopyr have some mutagenic and reproductive effects. Posted signs about treatments would reduce impacts. Workers would wear protective clothing and equipment and follow safety measures. Injuries may occur when mounting and dismounting heavy machinery. Dust from heavy equipment may cause respiratory issues. Weed control would reduce allergenic, toxic, and harmful weeds and BMPs would reduce any risk to public health.	The impacts would be similar to Alternative 2.
Socioeconomics	Weeds would reduce land value, livestock forage, crop production, and accessibility to cultural and natural resources. Seasonal employment may occur intermittently. Weed treatments along roads would temporarily limit access to services.	Economic and social impacts would be short-term, including road and recreational site closures and deferment of livestock during treatments. Long-term effects on social and economic resources would be beneficial due to job creation and improved land quality. Access to services may be temporarily limited.	The impacts would be similar to Alternative 2, without low-cost biological control.

Resource Analyzed	Alternative 1 No Action	Alternative 2 Proposed Action	Alternative 3 No Biological Control
Cultural Resources	Weeds pose the same threat to cultural resources as native plants. Roots from dense stands of noxious trees may disturb sites and may pose an increased wildfire risk. Noxious weeds could replace culturally significant plants.	Mitigation measures would be implemented to protect cultural resources by avoiding resources where possible. Manual and mechanical control may affect resources by disturbing shallowly buried artifacts. Targeted grazing is not proposed for cultural sites. Replanting projects that require digging deep holes may impact cultural resources. Biological and chemical controls may impact some plant gathering sites. Most impacts would be minimal.	This Alternative would have similar effects for mechanical, cultural, manual, and chemical treatments as Alternative 2.
Environmental Justice	Weed removal would continue in an uncoordinated way and would increase growth in home sites, rangelands, watersheds, and agricultural fields. This would decrease land values and cause economic hardship for pastoralists and farmers. Weeds could out-compete culturally significant plants.	Chemical and mechanical treatments may have higher risks for contaminating surface water. Prescribed fire may temporarily reduce air quality. BMPs would reduce these risks. Culturally significant plants may be impacted from overspray or trampling. Treatments would improve environmental quality and land values over time. Culturally significant plants may increase as competing weeds are removed.	The impacts would be similar to Alternative 2.
Navajo Tribal Parks and Forest Management Units	Uncoordinated treatments would allow noxious weeds to expand. Some weeds may cause allergies for some visitors. Tamarisk and cheatgrass increase the risk of wildfire, impacting Forest Management Units.	Treatments would cause temporary closures. Visitors could be displaced to other recreational areas, resulting in a loss of revenue. Weed treatment would preserve the natural and cultural heritage of sites by removing weeds that out-compete native vegetation.	The impacts would be similar to the Alternative 2
Recreation	Recreational impacts include temporary site closures, decline in scenic appeal of recreation sites, and potential human and wildlife health effects. Recreational visitors could spread weeds, start fires, and increase disturbance.	Short-term impacts include site and road closures that reduce recreational opportunities, including hiking, tours, horseback riding, and sightseeing. The long-term benefits include reduced visitor contact with noxious weeds and increased visitor contact with native plants and wildlife. Chemical treatments may affect non-target plants. Wildfire risk would be reduced.	The impacts would be similar to the Alternative 2. Active treatment methods (chemical, mechanical, cultural, and manual) would result in longer closures to treated recreational sites, impacting accessibility.

Conservation Measures and Best Management Practices

Table 5 lists the conservation measures and best management practices for analyzed resources. A full list can be found in the Plan (Appendix F).

Table 5. Conservation measures implemented under this plan for the analyzed resources.

Resource	Conservation Measure
Paleontological and Cultural Resources	Pre-treatment field work to identify resources. Resources will be avoided where possible. NNHPD will be consulted if resources are detected and cannot be avoided. No treatments will be used in archeological or cultural sites.
Soil, Air, and Water Resources	BIA will work with NNEPA to protect water quality. WQPZ buffer distance of at least 200 ft will be established for mechanical and aerial and vehicle-based herbicide treatments based on stream category. No herbicides within 100 ft of wellheads. Only aquatic formulations of herbicides within 25 ft of daily high-water mark along rivers and streams; aquatic approved herbicides used from 25-300 ft of daily high-water mark; non-aquatic and moderate to high toxicity herbicides require 300 ft buffer from daily high-water mark. Equipment must be stored in stable upland sites with herbicides and equipment stored in containers. Erosion control measures implemented to limit erosion. Burn plan used for control burning. Chemical applications will not occur in high wind and temperature and low humidity.
Vegetation and Areas with Special Designation	Biological surveys completed prior to treatment to identify plant populations. Listed species populations will be flagged and fenced. Grazing animals will be quarantined after treatment and excrement destroyed. Chemical applications will not occur in high wind and temperature and low humidity. Equipment will be cleaned. Vehicles shall only use established roads and park in disturbed areas. A 200 ft buffer is required around listed species locations for mechanical and cultural treatments. Manual treatments require a 20 ft buffer from identified species locations. Mesa Verde cactus requires a 50 ft buffer for manual treatments. Aerial spraying requires a one-mile buffer around tribally listed species and 300 ft buffer around native habitat, such as cottonwood-willow woodlands and sagebrush communities.
Aquatic Wildlife	Implement erosion control to reduce turbidity in water bodies. Pile burning 300 ft outside of floodplain. Only aquatic formulations of herbicides within 25 ft of daily high-water mark along rivers and streams; aquatic approved herbicides used from 25 -300 ft of daily high-water mark; non-aquatic and moderate to high toxicity herbicides require 300 ft buffer from daily high-water mark. Cut-stump method used to remove trees or shrubs and material piled outside floodplain in Zuni bluehead sucker habitat.
Terrestrial Wildlife	Habitat assessment by a permitted and qualified biologist is required for areas identified as potential habitat. Targeted grazing not permitted in sensitive species habitat. Restrictions during breeding and migration seasons include nest buffers, and herbicide buffers for all treatment methods for listed and sensitive wildlife species.
Agriculture	Remove animals from treatment areas, mix, and prepare herbicides away from project area. Fence livestock in isolated areas for up to 24 hours after treatments to collect feces. Feces gathered, bagged, and incinerated. Plant native species. Avoid chemical spraying in high wind, high temperature, and low humidity. Use crop rotation.
Public Health, Socioeconomics, and Areas with Special Designation	Chemical spraying requires use of personal protective and safety training for workers. Safety buffers, signage, and perimeter marking would be implemented around project areas to prevent injury to the public. Chemical treatments require buffer zones for water bodies and sensitive areas, public notification, and weather condition monitoring.

Preferred Alternative

The BIA preferred alternative is the proposed alternative, Alternative 2.

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ACRONYMS

ACCase	AcetylCoA Carboxylase
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
ALS	acetolactate synthase
APHIS	Animal and Plant Health Inspection Service
APS	Arizona Public Service
ARMP	Agricultural Resource Management Plan
ATV	All-Terrain Vehicle
BEE	Butoxyethyl Ester (refers to Triclopyr-BEE formulation)
BIA	Bureau of Indian Affairs
BIANRBOT	Bureau of Indian Affairs Navajo Region Branch of Transportation
BLM	Bureau of Land Management
BMP	Best Management Practice
BNSF	Burlington Northern Santa Fe Railroad
CAA	Clean Air Act
CDA	Community Development Area
CEQ	Council on Environmental Quality
C.F.R	Code of Federal Regulations
CO_2e	carbon dioxide equivalent greenhouse gas emissions
CWA	U.S. Clean Water Act
DOI	Department of Interior
ERA	Ecological Risk Assessment
ESPS	5-enolpyruvylshikimate-3-phosphate (in reference to herbicide)
FHWA	Federal Highway Administration
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
GHG	greenhouse gas(es)
GIS	Geographic Information Systems
HUC	Hydrologic Unit Code
IAM	Indian Affairs Manual
IHS	Indian Health Service
IRMP	Integrated Resource Management Plan
LD_{50}	lethal dose for 50% of the study population
LRTP	Long-range transportation plan
MCL	Maximum Contaminant Level
MCS	multiple chemical sensitivity
$mTCO_2e/yr$	metric tons of carbon dioxide equivalent gas per year
NAAQS	National Ambient Air Quality Standards

NAPI	Navajo Agricultural Products Industry
NAQCP	Navajo Air Quality Control Program
NEPA	National Environmental Policy Act
NFD	Navajo Forestry Department
NMDOT	New Mexico Department of Transportation
NMFS	National Marine Fisheries Service
NNDA	Navajo Nation Department of Agriculture
NNDED	Navajo Nation Division of Economic
NNDFW	Navajo Nation Department of Fish and Wildlife
Navajo DOT	Navajo Nation Department of Transportation
NNDWR	Navajo Nation Department of Water Resources
NNEPA	Navajo Nation Environmental Protection Agency
NNHPD	Navajo Nation Heritage and Historic Preservation Department
NNHP	Navajo Natural Heritage Program (part of NNDFW)
NNIWMP	Navajo Nation Integrated Weed Management Plan
NNTP	Navajo Nation Parks and Recreation Department or Tribal Parks
NOEL	No Observable Effect Level
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPS	U.S. National Park Service
NRCS	Natural Resources Conservation Service
NRO	BIA Navajo Regional Office
NTMB	Neotropical Migratory Birds
NTUA	Navajo Tribal Utility Authority
OHV	Off-highway Vehicle
PAH	Polynuclear Aromatic Hydrocarbons
PEIS	Programmatic Environmental Impact Statement
PGP	Pesticide General Permit
Pub. L.	Public law
PM	particulate matter
PNM	Public Service Company of New Mexico
POEA	Polyethoxylated Tallow Amine
PPE	Personal Protective Equipment
ppm	Parts Per Million
PWSSP	Public Water Systems Supervision Program
RCP	Biological Resource Land Use Clearance Policies and Procedures
ROW	Right-of-way
RU	range unit
SJLWTP	San Juan Lateral Water Treatment Plant

SJRIP	San Juan River Implementation Program
SRP	Salt River Project
SUYL	Sheep Unit Year Long
SWCD	Soil and Water Conservation Districts
SWEMP	Southwest Exotic Mapping Program
SWEPIC	Southwest Exotic Plant Information Clearinghouse
TCP	Traditional Cultural Properties
TEA	Triethylamine Salt (refers to Triclopyr-TEA formulation)
TEC&S	Threatened, Endangered, Candidate, and Sensitive Species
TEP	Tucson Electric Power
TTP	Tribal Transportation Program
TTIP	Tribal Transportation Improvement Program
UDOT	Utah Department of Transportation
USC	U.S. Code
USBR	USDI Bureau of Reclamation
USCB	U.S. Census Bureau
USDA	US Department of Agriculture
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTDEQ	Utah Department of Environmental Quality
WQPZ	water quality protection zone

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1.0 PURPOSE AND NEED FOR ACTION

1.1 Introduction

The Bureau of Indian Affairs (BIA) Navajo Regional Office has prepared this Programmatic Environmental Impact Statement (PEIS) in compliance with the National Environmental Policy Act (NEPA) to determine the most effective and appropriate methods to treat noxious weeds on the Navajo Nation. While the Council on Environmental Quality (CEQ) published revised NEPA regulations on July 16, 2020 (85 Fed. Reg. 43304), which apply to any NEPA process started after September 14, 2020 (40 CFR 1506.13 (2020)), this action was initiated with the Notice of Intent published on January 14, 2013. Therefore, this PEIS is prepared consistent with the 1978, as amended, NEPA regulations at 40 C.F.R. §§ 1500-1508. This document evaluates the impacts of noxious weed treatments from the Proposed Action and two other alternatives. These treatments provide the BIA with the tools for an integrated approach to treating weeds on Navajo Nation trust and allotment lands.

Because the Navajo Nation Integrated Weed Management Plan would be implemented across the entire Navajo Nation, the BIA Navajo Region determined that a programmatic environmental impact statement (PEIS) would best address its environmental impacts due to the Plan's generalized approach toward weed management and limited information on where, when, and how treatments would be implemented. Thus, a broad analysis of resources and potential impacts from weed treatments was deemed appropriate. A programmatic approach provides the BIA Navajo Regional Office with a strategic way to prioritize projects, species, and treatment methods for project planning and management.

Further, a programmatic approach would allow projects to tier off this effort by incorporating the techniques and analyses for individual weed control projects. Projects that tier from this document would still require project-specific environmental assessments with detailed analyses and information related to the site and each project's proposed methods. Such analyses would be guided by the information provided here to streamline the NEPA process and address weed issues in a comprehensive manner.

1.2 Background

Major federal steps that shaped the BIA's approach to weed management are outlined in **Figure 1-1**.

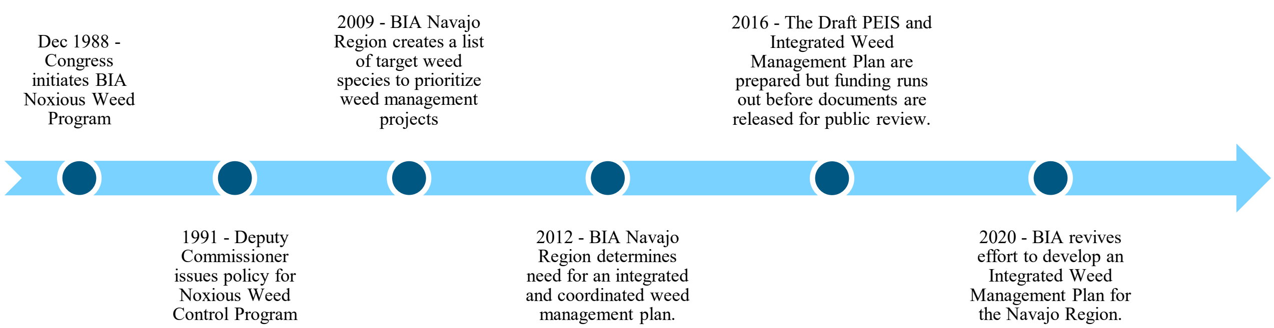

Figure 1-1. Timeline of the development of the BIA Navajo Region's Integrated Weed Management Plan from 1988 to 2012.

The BIA Noxious Weed Program began in December 1988 through congressional directives to improve management of Indian lands, which was followed in 1991 by agency policy to formally create the Program. Through th Program, weed management efforts are managed regionally, while program standards and oversight are provided at the national level.

For the Navajo Nation, efforts to address weed management have been mixed. In 2006, the Tribal Invasive Species Council held a workshop on developing weed management plans. From that workshop, an ad hoc working group led by the Navajo Nation Environmental Protection Agency (NNEPA) led an initial effort to create Cooperative Weed Management Areas. These weed management areas would be based on watershed basins on the Navajo Nation. While the effort was a priority, several of the key partners NNEPA was seeking left and the effort was never completed.

In 2009, the BIA Navajo Regional Office created a list of 21 target noxious weed species to prioritize for its weed management projects. However, most BIA projects focused on treating nine species. While projects provided localized control of species, most BIA Noxious Weed projects were based on individual land user requests. This approach resulted in a patchwork of projects with little coordination between land users and land management agencies and without consideration for broader treatment impacts or native vegetation restoration needs.

Throughout the years, BIA has participated several collaborative partnerships to address weeds, including the Moenkopi Cooperative Weed Management Area, the San Juan Basin Weed Management Cooperative, and San Francisco Peaks Weed Management Area. These location-based partnerships allowed partners to combine resources, information, and educational needs for weed management projects conducted by each entity through cooperative agreements between federal, tribal, and non-profit agencies. While these efforts addressed noxious weeds in their defined areas, weeds outside these management areas were not addressed in a similar fashion. Additionally, each partnership has also been short-lived as none are currently active. However, some are working to restart similar initiatives in the coming years.

Noxious weeds on rangelands, farmlands, community areas, and other riparian areas have created numerous problems for the Navajo people. The current weed treatment approach is driven by consent from the land user with the BIA providing project coordination and negotiating resolutions from local Chapter Houses. This approach treats all weed populations as equally invasive with limited consideration of neighboring agency or landowner concerns. Current weed management also does not adequately prevent weeds from spreading to non-impacted sites, and few projects address the need for native plant restoration after treatment. This leaves many areas of the Navajo Nation vulnerable to infestations, especially along roads and waterways.

In 2012, the BIA Navajo Regional Office (NRO) determined a need for an integrated weed management plan that utilized methodical, science-based strategies to monitor and control noxious weeds. Completing one wholesale environmental compliance effort would allow the BIA to streamline planning, participate in large-scale cooperative projects, and apply for project funds through various organizations. The Plan identifies weed species of concern; details weed removal strategies; consolidates the best management practices available for weed control and applies consistent mitigation measures to address treatment concerns. It uses an integrated approach to allow BIA and cooperating agencies to identify and use the best methods available with adaptive management to improve treatment efficiency and effectiveness.

1.3 Purpose and Need for Action

The purpose of this project is to manage 45 noxious weed species on the Navajo Nation. Noxious weed inventories have documented around 70,000 acres of infestations on the Navajo Nation, with preliminary analysis estimating weeds cover an area 5 to 6 times that size (Appendix L). While weed inventories document a small portion of weed populations on the Navajo Nation, much of the mapping data found weeds cover between 5% to 40% of areas surveyed. Weeds pose a serious threat to biological diversity, livestock production, native grasslands, wildlife habitat, and the overall ecological health of the region. Noxious plants can displace, reduce, or eliminate native plants and animals in habitats within 3 to 10 years of their introduction (Sheley and Petroff 1999, Lesica and Shelly 1991, Tyser and Key 1988, and Rickard and Cline 1980). Noxious weeds impact the environmental, economic, historic, and cultural resources of the Navajo people.

Figure 1-2. Camelthorn growing through the floors of a home on the Navajo Nation. (Photo Credit: BIA Western Navajo Agency).

Ecologically, noxious weeds can alter soil temperature, soil salinity, water availability, nutrient availability, native seed germination, water infiltration, and surface runoff (DiTomaso 2000, Sheley and Petroff 1999, Lacey et al. 1989). Dense weed growth can increase wildfire risk, suppressing the growth of native shrubs and grasses. Some species, such as camelthorn, can damage infrastructure. This species can grow through surfaces impenetrable to most plants, including pavement, concrete, and building foundations (USFS 2012). On the Navajo Nation, camelthorn has penetrated the walls, floors, and water lines of buildings (**Figure 1-2**).

Disturbance, such as overgrazing, fire, and construction, can introduce weeds to new areas and along roads and rights-of-way. Vehicles can carry seeds and plant parts long distances when attached to clothing, vehicles, animals, construction materials, or garbage. Roads can channel weeds into natural, agricultural, or range lands. Right-of-way crossings can introduce weeds to riparian corridors and agricultural land. Riparian areas, which represent prime areas of biodiversity, are regularly disturbed by floods, which can facilitate weed spread. Noxious trees, such as tamarisk and Russian olive, can form dense stands along rivers and streams on the Navajo Nation, limiting biodiversity and increasing flooding and erosion. The impacts to riparian areas include the loss of suitable wildlife habitat, more frequent flooding, and limited access to rivers and streams.

The BIA is required to treat weed infestations on the Navajo Nation under the Federal Noxious Weed Act (Pub. L. 93-629), the Plant Protection Act (Pub. L. 106-224), and the Noxious Weed Control and Eradication Act (Pub. L. 108-412) as outlined in 54 IAM 7 for Indian Affairs. As such, the following objectives have been developed for the NNIWMP:

- Develop the best control techniques for the target weed species in a planned, coordinated, and economically feasible program to limit the impact and spread of noxious weeds.
- Use adaptive management to incorporate project successes and lesson learned from completed weed projects when developing new initiatives.

- Identify and prevent the expansion of existing target weed species, and quickly prevent the spread of new high priority weed species.
- Coordinate weed removal efforts with adjacent landowners, land managers, and/or federal agencies to prevent the further spread of weeds.
- Provide and promote economic opportunities to the Navajo people to improve rangeland productivity and to remove noxious plant species.
- Develop a public education program focused on weed identification, prevention, and removal techniques for local communities and non-profit organizations.

1.3.1 Location

The Navajo Nation covers approximately 16.3 million acres across northeastern Arizona, southeastern Utah, and northwestern New Mexico (**Figure 1-3**). The project covers all tribal trust lands administered by the BIA Navajo Regional Office, including all Navajo Indian Allotments. The BIA Navajo Region is divided into five BIA agencies including (acres indicate total size of areas managed by each agency):

- Western Navajo Agency (Tuba City, Arizona, 5.2 million acres),
- Eastern Navajo Agency (Crownpoint, New Mexico, 2.3 million acres),
- Fort Defiance Agency (3.3 million acres),
- Shiprock / Northern Navajo Agency (2.7 million acres),
- Chinle / Central Navajo Agency (1.4 million acres).

The Navajo Partitioned Lands (Pinon, Arizona, 910,000 acres) and the New Lands Area (310,000 acres) contain an additional 1.2 million acres. At the date of this writing, the New Lands Area is managed by the Office of Hopi and Navajo Indian Relocation but may come under the BIA in the foreseeable future. Thus, the New Lands Area is included in the project area. Additionally, there are approximately a million acres of land that may be in transition to allotment or trust lands on the Navajo Nation as part of land buy backs. For this document, the project area refers to the entire Navajo Nation as defined above, with project sites referring to individual weed project locations.

1.3.1.1 Priority Weed Management Areas

Projects conducted under this effort will focus primarily on priority weed management areas. These areas, which are listed below, were selected because weeds currently cause serious problems in there and BIA Weed Coordinators have planned weed management projects for similar sites. Although weed treatments are prioritized in these areas under the plan, weed treatments may occur on all Navajo Nation trust and allotment lands if the site meets site- and species-specific criteria.

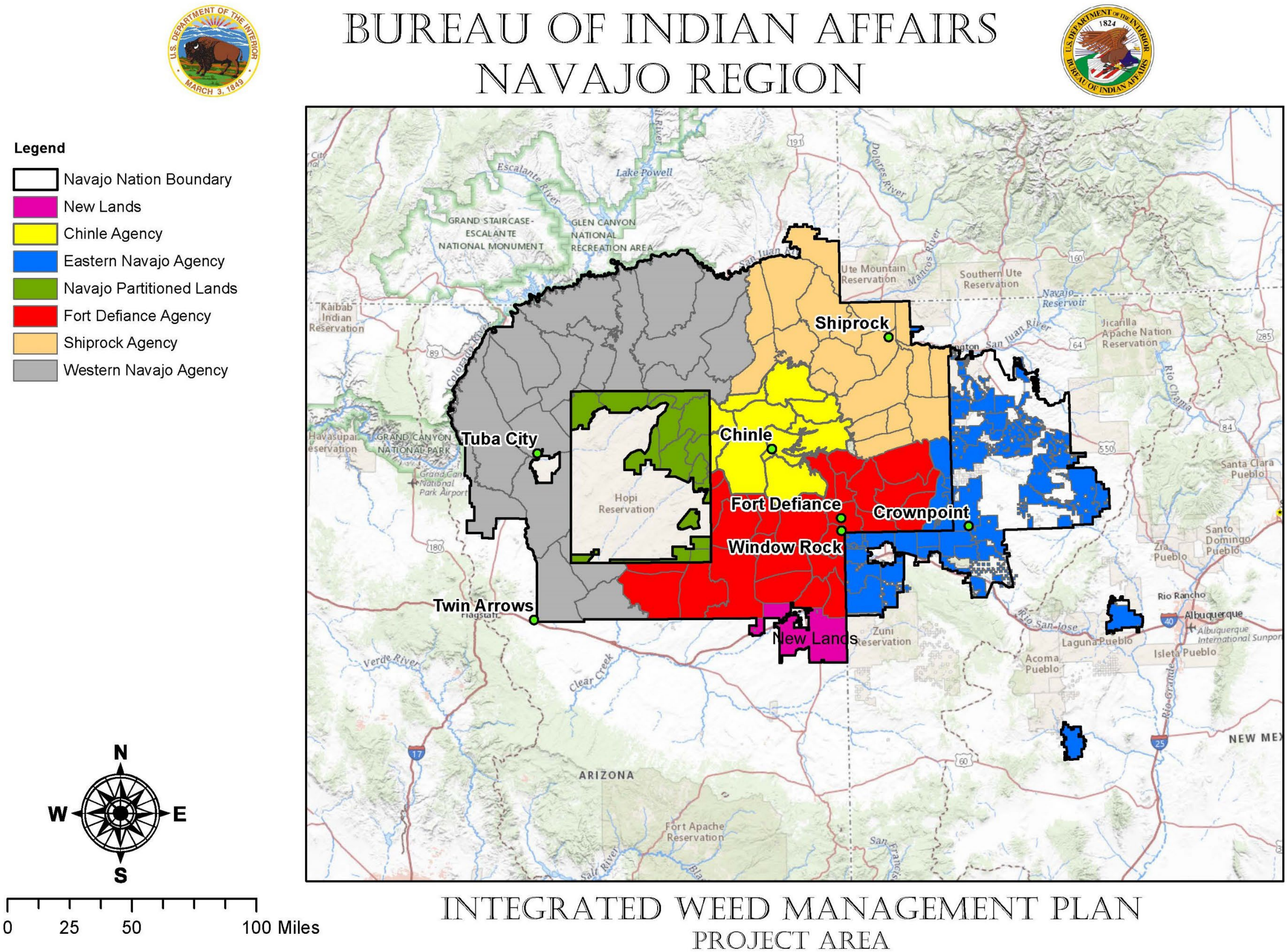

Figure 1-3. Project area of the Navajo Nation divided by BIA Navajo Regional Agencies.

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Priority Weed Management Areas

- Navajo Nation, State, County, and BIA Roads
- Riparian Areas
- Navajo Nation Designated Community Development Areas
- Utility and Road Rights-of-way
- Designated Rangeland
- Designated and commercial farmland

Priority Roads

- Interstate 40
- US Highway: 64, 89, 89A, 191, 163, 160, 491
- State Routes:
  - *Arizona*: 2, 64, 77, 87, 98, 99, 264, 564
  - *New Mexico*: 134, 264, 362, 371, 489, 602
  - *Utah*: 162

Roads are a major focus for weed management. This includes major roads managed by state transportation agencies as well as numerous paved and unpaved public roads managed by the Navajo Nation Department of Transportation (Navajo DOT) and the BIA Navajo Region Branch of Transportation (BIANRBOT). Vegetation is treated along road approximately 300 ft from the center of the road on interstates and between 50-100 ft from the center of the road or the right-of-way fence on highways. Treatments may also occur along tribal forest roads, which requires coordination with Navajo Forestry Department and the BIA Branch of Forestry.

Riparian areas are distinct ecosystems surrounding perennial and intermittent surface water bodies, such as lakes, rivers, springs, and streams, which are hotspots of biodiversity in the region. Water bodies are classified based on the major watershed basin they are located in. Noxious weeds have been mapped in all five major watershed basins on the Navajo Nation.

Community Development Areas (CDAs) are "areas in and around towns with few or no restrictions on development (NNDFW 2008)." CDAs are described in the Navajo Nation Biological Resource Land Clearance Policy (RCP-44-08), which specifies planning and development requirements for six types of wildlife areas. The CDAs are updated periodically by the Navajo Nation Department of Fish and Wildlife based on satellite imagery data on tribally listed species, and big game species habitat and occurrences. These updates are then approved by the Navajo Nation Resource Development Committee. CDAs are deemed unsupportive for Navajo species of concern with few restrictions on development. CDAs can be hotspots for weeds as construction, roads, and development activities spread seeds and plant parts to neighboring communities and natural areas.

Rights-of-way (ROWs) occur along all utility transmission lines, homesite leases, and roads on the Navajo Nation. Utility ROWs on the Navajo Nation are Indian trust lands and maintained by utility companies who manage the lines. These include transmission lines for electricity, water, sewage, internet, phone, and natural gas. Most lines are managed by the Navajo Tribal Utility Authority (NTUA), who provide utility service to residents on the Navajo Nation. BIA Realty currently estimates over 14,000 acres of approved rights-of-way across the Navajo Nation. In addition to NTUA and a few local service providers, Arizona Public Service, Public Service Company of New Mexico, and the Salt River Project also maintain transmission lines on the Navajo Nation but may not provide direct service on the Navajo Nation. Federal law requires grantees to control and prevent weeds as part of their right-of-way terms (25 C.F.R. § 169.125). Land disturbance from installation or repair of utility lines can encourage the growth and introduction of many noxious weed species.

Designated rangeland are areas managed for livestock grazing. These areas could be administered by the Navajo Nation through the Department of Agriculture (NNDA) or the BIA. All range permits and designated range units and range management units are managed by the BIA while NNDA manages enforcement and oversight. These lands encompass roughly 2.6 million acres. The highly disturbed nature of designated rangelands has promoted the growth of many noxious weeds.

Designated farmlands are areas set aside either through land lease agreements or permits by the Navajo Nation and the BIA. Designated farmlands cover approximately 57,900 acres of the Navajo Nation. Farmlands are categorized as either dryland farms or irrigated farms. Irrigated farms are located near open water used to irrigate fields. Dryland farms are located further away from open water and receive water through irrigation, pumping, and seasonal precipitation.

Commercial farmlands cover areas managed by the Navajo Agricultural Products Industry (NAPI) and the Navajo Indian Irrigation Project (NIIP), which provide irrigation and agricultural products for the Navajo Nation. The BIA is responsible for NAPI and NIIP project oversight and ensures they remain in compliance with environmental concerns. The Navajo Nation is responsible for overall management and operations. NAPI lands comprise approximately 110,000 acres between Shiprock / Northern Navajo Agency and Eastern Navajo Agency, south of Farmington, New Mexico.

1.4 Cooperating Agencies

Upon approval of this document, the following cooperating agencies will conduct weed removal efforts under the Plan on the Navajo Nation:

- Navajo Nation
- USDA Natural Resource Conservation Service (NRCS)
- USDA Animal Plant Health Inspection Service (APHIS)
- Navajo Nation Soil and Water Conservation Districts (NNSWCD)
- Arizona Department of Transportation (ADOT)
- Utah Department of Transportation (UDOT)
- San Juan Soil and Water Conservation District

BIA will coordinate weed removal projects on adjacent lands managed by these cooperating agencies. Additionally, BIA will coordinate weed removal projects with the Bureau of Land Management (BLM) and National Park Service (NPS), although these agencies will not conduct weed removal under the NNIWMP.

1.5 Public Involvement

The BIA informed agencies and the public about the development of the Navajo Nation IWMP/PEIS and solicited comments to identify issues and questions to consider when developing the plan. Public scoping was held in the late winter and early spring of 2013. Comments were accepted by mail, phone, email, and fax from January 14 – March 20, 2013. Additionally, the BIA opened an additional public scoping period from April 29, 2021 to May 29, 2021 to update public feedback given the extended time frame for this project. Results from all scoping periods are outlined in the PEIS Scoping Report in Appendix D.

The Draft PEIS was made available to the public during the public review period from October 29, 2021 to December 13, 2021. The BIA held five virtual public hearings to present the Draft PEIS to the public and receive comments. Comments received during the public review period and the BIA's responses are provide in the Response to Comment Report in Appendix M.

Public Scoping	
NOI Published:	Jan 14, 2013 (Vol. 78, No. 9)
Original Scoping Period:	Jan 14, 2013 – Feb 27, 2013
Notice of Extended Scoping Period:	Mar 8, 2013 (Vol. 78, No. 4)
Extended Scoping Period:	Mar 8, 2013 – Mar 20, 2013
Public Scoping Meetings:	Feb 5 -12, 2013 Mar 11 – 15, 2013
Additional Comment Period	April 29 – May 29, 2021
Public Review of Draft PEIS	October 29 – December 13, 2021

The public is invited to comment on the Final PEIS. Information on how to submit public comments on the Final PEIS is outlined below.

Public Review of Final PEIS

Public comments on the Final PEIS can be submitted through the project website until October 4, 2022 and may be sent to:

Leonard Notah, NEPA Coordinator
Environmental Quality Act Compliance Review
Navajo Regional Office
Bureau of Indian Affairs, USDOI
P.O. Box 1060
Gallup, New Mexico 87301
Leonard.Notah@bia.gov

1.6 Issues

Scoping resulted in 51 comments from the public. From the comments received, 97% raised issues previously identified by the BIA. During public scoping, the only relevant issue raised concerned negative impacts to endangered species from the use of biological control agents. This issue was used to develop an additional alternative for analyses. Other issues discussed, but not relevant for analysis are listed in in the Public Scoping Report (Appendix D). No major issues were raised during the public review of the Draft PEIS.

Issue 1. Impacts of using Biological Control to Treat Weeds

The use of biological control agents may negatively impact endangered species and cause unforeseen ecological changes. Biological control agents may affect similar native species and become invasive themselves. Biological control agents may adjust their original range and spread to unintended areas.

The indicators used to measure the environmental consequences of biological control agents include the following:

- Annual acres of the area affected by the biological control agent.
- Density (number/acre) of native plants in the same Genus as the host target plant in and/or near the release site.
- Abundance of native plant species affected by the biological control agent.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Introduction

This chapter describes and compares the alternatives considered by BIA for integrated weed management on the Navajo Nation. Detailed descriptions of the proposed methods and mitigation measures are provided in the Navajo Nation Integrated Weed Management Plan located in Appendix A and Appendix F. This PEIS examines the differences between each alternative to facilitate informed comments from the public and ensure that the decision maker will have the information necessary to issue a Record of Decision (ROD). The alternatives are compared by treatment type and by environmental, social, and economic effects.

2.1.1 Alternatives Considered in Detail

The PEIS fully analyzes three alternatives. Each of the action alternatives (Alternatives 2 and 3) were designed to meet the purpose and need of the project, by implementing an integrated weed management program. All alternatives are focused on treating terrestrial weed species and no alternative includes the treatment of non-native aquatic weed species. The primary difference between the two action alternatives is the use of biological control as a weed control method.

2.1.1.1 Alternative 1 – No Action

This alternative is required by regulation (40 C.F.R. 1502.14) and would continue the current process for weed projects and would only treat weeds covered by the 2009 BIA Noxious Weed List. Currently, individual weed management projects undergo environmental review on a project-specific basis, which would continue. Each project is planned separately and focuses solely on individual project areas, with no prioritization based on species or site. Under this alternative, chemical and mechanical methods would continue to be used the most, with the occasional use of cultural or manual methods. Biological control methods would not be used. The acres treated for each noxious weed treatment type from the past five years are listed in **Table 2-1.** These are provided to estimate how many acres could be treated annually under Alternative 1. No limits are proposed for each method under this alternative. However, each treatment type for Alternative 1 would likely not exceed chemical treatments conducted in previous years and those outlined in **Table 2-1** and **Table 2-2**

Table 2-1. Estimated acres of noxious weed treatments by method for the past 5 years (2015-2019) conducted by the BIA. Acreages for cut stump treatments are counted in both mechanical and chemical treatment acres since both methods are used for this technique. Also, chemical acres include chemically re-treated acres.

Treatment Type	2015	2016	2017	2018	2019
Manual	0	0	0	0	0
Mechanical	76	345	60	110	60
Cultural	0	0	0	0	0
Biological	0	0	0	0	0
Chemical	517	917	560	110	60

Table 2-2. Estimated acres of noxious weed treatments by BIA Navajo Agency for the past ten years. Data are based on weed project reporting and funding. Items with "-" indicate years where data were not available and should not be interpreted as periods where no treatments occurred.

Agency	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Central	156	-	-	-	20	-	-	-	-	130	56
Eastern	360	500	-	-	-	-	560	80	210	80	80
Fort Defiance	-	-	3,125	3,301	-	647	1,661	-	324	-	653
Western	461	2,150	-	443	497	250	-	50	-	33	30
Northern	-	-	-	-	-	-	-	-	-	-	100
TOTAL	**977**	**2,650**	**3,125**	**3,744**	**517**	**897**	**2,221**	**130**	**534**	**243**	**919**

2.1.1.2 Alternative 2 – Proposed Action

Under Alternative 2, the BIA NRO would authorize up to 50,000 acres annually of new weed treatments, for a total of up to 500,000 acres over 10 years. The various methods analyzed under Alternative 2 include:

- Manual
- Mechanical
- Biological
- Cultural
- Chemical

These methods are described in **Table 2-4** and Appendix A. The combination of methods used for each project would vary depending on site conditions and weeds present. Selection would be based on the most effective treatment methods and those that reduce or prioritize non-chemical methods. All projects should include native plant restoration when removing noxious weeds. This alternative would cover a 10-year period, with a review after five years.

Prevention, education, annual weed mapping, early detection, rapid response, and adaptive management are also part of Alternative 2. Prevention is the most effective method to control weeds and may include a weed-free policy adapted by the Navajo Nation, planting native species, cleaning tires, boots, hooves, and equipment. Annual weed mapping would use GPS equipment to determine the presence and distribution of weed species to evaluate spread risk. Early detection involves finding new noxious weed populations that are less than one acre in size and rapidly responding to treat and eliminate the population before it becomes invasive. Alternative 2 would incorporate all mitigation measures outlined in Appendix F for all treatments authorized under this option. The BIA would use adaptive management under this Alternative to promote flexible decision making that can be adjusted as outcomes from management actions and other events are evaluated (Williams et al. 2009). All projects will be conducted by the BIA pending consultation and coordination with the Navajo Nation during project planning and implementation.

Adaptive management would:

- Prioritize treatments for new infestations and weed species in the project area.
- Treat weed species not known to occur on the Navajo Nation or listed as priority weed species.
- Update and evaluate treatment effectiveness to provide current best management options for priority weed species.
- Evaluate and prioritize effective non-chemical treatment alternatives where possible.
- Use approved herbicides, adjuvants, and surfactants not specifically listed in the Proposed Action.

The acreages for each treatment were estimated based on the maximum number of acres treated by a single BIA Navajo Agency in a year based on method and annual funding constraints. Currently, BIA NRO receives funding to treat noxious weeds from the BIA Noxious Weed Program. All BIA Regions compete for project funding through this program, which limits how many acres BIA NRO can treat per year. From 2005 to 2020, the BIA received, on average, $472,112 annually through the Program, which does not include funding from partners or in-kind services. Treatment acres would likely be similar to those completed over the past 10 years with the possibility for more cooperative weed projects with adjacent land and land management agencies. A summary of estimated acres by treatment technique are listed in **Table 2-3** and described in **Table 2-4**. Treatments would be applied across the Navajo Nation in priority weed management areas as defined in the Plan and Chapter 1. The Navajo Nation Integrated Weed Management Plan, in Appendix A, provides a full description of Alternative 2.

Table 2-3. Estimated annual acres for each noxious weed treatment under Alternative 2 - Proposed Action on the entire Navajo Nation. Acres for cut stump treatments are counted in both mechanical and chemical treatment acres since both methods are used for this technique.

Treatment Type	Estimated Treated Acres per Year
Manual	2,000
Mechanical	8,000
Cultural	5,000
Biological	5,000
Chemical	30,000
TOTAL	**50,000**

Under Alternative 2, 45 noxious weed species would be prioritized for control. The priority weed species under Alternative 2 were identified through previous weed mapping efforts by the BIA and the Southwest Exotic Plant Information Clearinghouse (SWEPIC) managed by the U.S. Geological Survey (USGS) Colorado Plateau Research Station. The weeds identified were selected and ranked based on a variety of factors (**Table 2-5**). However, the full extent of each species' population is unknown on the Navajo Nation. To address this knowledge gap, a weed mapping program would assess and monitor weeds on the Navajo Nation. These 45 weed species were prioritized into Category A, B, or C with help from the San Francisco Peaks Weed Management Area Working Group, based on the Invasive Species Assessment Protocol (Randall et al. 2008).

Priority Weed Categories

Category	Distribution	Management Goal	Treatment Emphasis
A	Not currently present Occur in neighboring areas	Prevent new infestations Eradicate existing populations	- Eradication - Prevention - Education - Awareness - Identification - Monitoring
B	Occur on the Navajo Nation in limited areas	Contain existing infestation Stop further spread	- Immediate control - Prevent seed spread - Local eradication
C	Wide-spread populations Well-established on Navajo Nation	Locally contain Monitor populations	- Education - Awareness - Identification - Monitoring

Table 2-4. List of weed control methods including the treatment type, tools used, target weed species, and treatment area and frequency for Alternative 2 - Proposed Action and Alternative 3 – No Biological Control. Alternative 3 would not include Biological Treatment Types.

Treatment Type	Techniques	How Method Is Used	Target Weed Species	Treatment Area and Frequency
Manual	Cutting noxious weeds above ground level; pulling, grubbing, or digging out root systems to prevent sprouting and regrowth by hand or with hand tools.	Use of hand tools, including handsaws, loppers, axes, shovels, rakes, machetes, grubbing hoes, mattocks (combination of cutting edge and grubbing hoe), Pulaskis, brush hooks, weed whackers, and hand clippers.	Annual and biennial weeds with shallow roots that do not re-sprout, and plants growing in sandy or gravelly soils. Also, for smaller populations where native plants will be retained.	Repeated treatments will be necessary. Manual techniques recommended for smaller areas but are not effective or feasible for larger weed infestations.
Cultural	Agricultural methods to control weeds including targeted grazing, seeding and planting of native species, cultivation and crop rotation, use of weed-free hay and seed, and mulching. Most effective when used with biocontrol or chemical methods.	Contain livestock with fencing in an isolated area for up to 24 hours after grazing treatments to isolate and collect defecated seed. Selection of native plants from local sources using BMPs for planting.	Targeted grazing is effective on a several weed species, such as leafy spurge, thistles (except Russian), tall whitetop, knapweeds, perennial pepperweed, kochia, and cheatgrass. Revegetation effective on all weed species following removal.	Targeted grazing will be focused in Community Development Areas and agricultural fields and will be prohibited where federally or tribally listed species occur. Its use in other areas, such as rights-of-way and riparian areas requires additional consultation with NNDFW and NNEPA. All projects will require some level of native plant restoration following removal of noxious weed species.
Biological	USDA-approved insects and pathogens as listed in Appendix A.	Approved list of biological agents provided by APHIS (Appendix A).	Leafy spurge, Dalmatian toadflax, spotted knapweed, diffuse knapweed, Russian knapweed, yellow starthistle, field bindweed, puncturevine	BIA will consult with NNDFW for each project considering the use of biocontrol. Treatments would last until insect populations decline or die off.

Treatment Type	Techniques	How Method Is Used	Target Weed Species	Treatment Area and Frequency
Mechanical	Grubbing, tilling, mowing, and prescribed fire (BLM 2007).	Grubbing - crawler-type tractor and a brush or root rake attachment that removes plants with deep roots. Tilling - a brushland plow, a single axle with an arrangement of angle disks that covers 10-foot swaths, or an offset disk plow. Mowing - rotary mowers or straight-edged cutter bar mowers, chainsaws, wet blade (with herbicide) and power brush saws. Prescribed fire - broadcast burning of debris or vegetative pile burning. Follow guidelines in BIA (2006) and the Programmatic Pile Burn Agreement with the Navajo Nation. Heavy machinery - large chipping equipment, roller chopping tools, feller-bunchers, bulldozers, masticators and extracting equipment.	Grubbing - perennial plants with deep root systems. Tilling – Shrubs and dense monocultures. Mowing – annual and biennial vegetation Prescribed fire - large monocultures of weeds, noxious weeds in the understory, and many grass species. Pile burning effective on piled weed material from mechanical treatments. Heavy machinery - dense invasive woody vegetation or tree species.	Grubbing - clear large areas where weeds are widespread and have dense cover that limits the growth of native vegetation. Tilling - areas with smooth terrain, and deep, rock-free soils. Mowing - along road ROWs and riparian areas. Prescribed fire - broadcast burning in large, predetermined areas where fire behavior is controlled. Pile burning on piles created from mechanical treatments. Heavy machinery – used to thin or remove stands of trees for hazardous fuels.
Chemical	Herbicides are listed in **Table 4-1.** Herbicides would be applied using cut-stump, basal bark, frill or "hack and squirt," foliar spray, pelletized treatment, pre-emergent treatment methods.	Cut stump –cut plant as close to the ground as possible. Apply a systematic herbicide to the cut stump within 30 minutes to prevent re-sprouting. Basal bark - Spray the bottom 12-18 inches of a stem with herbicide. Mix herbicide with a penetrating oil to allows it to pass through the bark. Frill or "Hack and Squirt"- space cuts around the tree trunk with an ax, machete, or hatchet. Apply herbicide to the cuts using a spray bottle or similar tool. Foliar spray – apply herbicide to the leaves of a plant. Pelletized Treatment- Bury herbicides around a plant's base. Pre-Emergent Treatment - Apply herbicide to the soil before the plant germinates or emerges.	Cut stump – trees Basal bark and Frill or "hack and squirt"- dormant and leafless woody plants with stems less than 6 inches in diameter. Foliar spray - plants in full leaf. Pelletized Treatment- shrubs and trees Pre-emergent Treatment –annual weeds	Cut stump, Basal bark, and Frill or "hack and squirt" - sparsely populated trees or in areas where heavy machinery is not feasible. Foliar spray – large areas with weed infestations.

Table 2-5. Noxious weeds of concern and proposed management strategy objectives. Additional information on each species can be found in Appendix L.

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

This is the only alternative that permits the use of biological control agents as a treatment method. The use of biological control would be discussed with NNDFW on a project-by-project basis. Only biological control agents approved by the U.S. Department of Agriculture APHIS would be used. The list of proposed biological control agents is provided in Appendix A. The total number of acres affected by biological control agents depends on the total acres of the host plant available within a reasonable distance from the original release location. This would vary depending on the biocontrol agent used and the target weed species. Biological control would be used in combination with other weed treatment methods. Use of tamarisk leaf beetle (*Diorhabda* sp.) would not be considered for tamarisk (*Tamarix* sp.) under this alternative. APHIS terminated the program in 2010 due to the beetle's negative effects on nesting habitat for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*). Since 2010, the tamarisk leaf beetle has migrated from its introduction site, near Moab, Utah, to the Navajo Nation, where the species now exists in tamarisk inhabited locations.

If approved, treatments would begin in Fiscal Year 2023. Implementation would begin with the Demonstration projects outlined in the "Navajo Nation Integrated Weed Management Plan" (Appendix A). Weed mapping and inventory would occur concurrently with project planning. Treatment of sites would be followed with monitoring to evaluate project success.

2.1.1.3 Alternative 3 – No Biological Control

This action would use the same methods and treat the same species as described in Alternative 2, except for biological control methods. The same treatment acres are estimated for each treatment method outlined in the Proposed Action (Alternative 2), minus 5,000 acres for biological control, resulting in fewer annual treated acres (**Table 2-4** and **Table 2-6**). Alternative 3 was developed to address concern that biological controls could negatively impact endangered species and related native plants. Adaptive management would be a component of this alternative. This alternative was designed to meet the purpose and need of the proposed project. This alternative would treat up to 45,000 acres annually and up to 450,000 acres with repeated treatments over 10 years (**Table 2-6**). Prevention, education, weed mapping, early detection, and rapid response methods are part of this Alternative. Alternative 3 would incorporate all mitigation measures outlined in Appendix F for all treatment methods authorized under this option.

Table 2-6. Estimated annual acres for each weed treatment for Alternative 3. No Biological Control on the Navajo Nation. Acreages for cut stump treatments are implicated in both mechanical and chemical treatment acres since both methods are utilized under this technique.

Treatment Type	Estimated Treated Acres per Year
Manual	2,000
Mechanical	8,000
Cultural	5,000
Biological	-
Chemical	30,000
TOTAL	**45,000**

2.1.2 Alternatives Considered but Eliminated from Detailed Study

Two alternatives were considered but eliminated from detailed study. **Alternative 4** was not suggested during scoping but was requested by the NNDFW Navajo Natural Heritage Program. This alternative would use mechanical, manual, cultural, and biological treatments, but prohibit chemical use. This alternative would decrease the number of acres treated annually and the effectiveness of treatments (**Table 2-7**). The time and cost of current weed infestations on the Navajo Nation without chemical methods make this alternative economically and technically impractical. Chemical treatments can cover large areas in a short period, allowing for greater coverage with fewer resources. Additionally, BIA weed projects are more likely to be funded when chemical treatments are included as part of an integrated management approach. By excluding this treatment, invasive weeds would increase on the Navajo Nation and the objectives of the project would not be met.

Table 2-7. Estimated annual acreage of each noxious weed treatment using Alternative 4 on the entire Navajo Nation.

Treatment Type	Estimated Acreage of Treatment per Year
Manual	2,000
Mechanical	8,000
Cultural	5,000
Biological	5,000
Chemical	-
TOTAL	**20,000**

During public scoping in 2014, BIA received comments that grazing mismanagement and overstocking livestock contributed to increased noxious weed cover. Because of the comments, **Alternative 5** considered using grazing management to control noxious weed populations. Recent rangeland inventories on the Navajo Nation indicated that rangeland carrying capacity and plant production had decreased while permitted livestock numbers remained the same. This led to overgrazing which degraded rangelands and increased noxious weed infestations. While grazing management is an important issue to address on the Navajo Nation, this alternative was eliminated from further analysis because it would not reduce noxious weeds over time, limited the project scope, and did not meet project objectives.

Livestock deferment, when livestock are removed from an area for one to ten years, is recommended to improve rangeland health, ecosystem function, and recovery of native vegetation (Davies et al. 2014). However, studies show that when invasive vegetation, primarily exotic annual grasses, dominate rangelands, short or long-term rest is unlikely to convert these communities back to native dominated ones and does not improve plant and animal production, species composition, and soil function especially when native seedbanks do not exist (Davies et al. 2014, Briske et al. 2011, Young and Mangold 2008, Harris 1967, Melgoza, et al. 1990). With the Navajo Nation experiencing extended drought conditions, overgrazing, and limited native vegetation regrowth, it is unlikely that grazing reduction would reduce noxious weed species even on relatively healthy rangelands. Navajo Nation rangelands have an immediate short-term need to reduce noxious weeds. Established exotic annual species are aggressive and seeds persist for several years in the soil. Therefore, even without grazing pressure, exotic species would continue to expand and outcompete native perennial species.

Also, the NNIWMP is not exclusive to rangeland but identifies riparian habitats, farmlands, roadways, rights-of-way, and Community Development Areas as priority areas for weed treatments. BIA determined that grazing management across the Navajo Nation will be addressed in the Agricultural and Range Resource Management Plan (ARRMP) developed by the Navajo Nation. While the BIA authorizes grazing permits, the Navajo Nation recommends grazing management prescriptions based on the effects of grazing on rangeland health data analyzed in the plan. The ARRMP is funded and will consider impacts from grazing. For these reasons, the BIA has determined that an alternative focused on grazing management would not meet the project objectives and therefore should not be fully analyzed.

3.0 AFFECTED ENVIRONMENT

3.1 Resources Considered but Removed from Analysis

Several resource topics were considered but removed from consideration because the impacts were determined to be non-existent or negligible.

The Navajo Nation lies on the Colorado Plateau, which has a wide array of **geological features**, including canyons, mesas, badlands, and flatlands (Foos 1999). These formations are rich in mineral resources, which have been historically mined for uranium, coal, gas, oil, and construction materials. Vegetation growth and distribution is closely tied to surface geology in the region. Initial analysis of geological resources found these resources would not be impacted by invasive weed treatments. Weed treatments do not alter surface geology as formations are widespread and not affected by changes in vegetation. As a result, none of the proposed alternatives would impact geological resources and materials on the Navajo Nation.

The Navajo Nation is surrounded by and home to several **National Parks, Monuments, and Recreation Areas**. The National Park Service (NPS), under the authority of the U.S. Department of the Interior (DOI), is responsible for managing these areas. For parks on tribal trust land, the Navajo Nation maintains responsibility for managing natural resources. These parks include Canyon de Chelly and Navajo National Monument, which are evaluated. National Parks, Monuments, and Recreation Areas managed solely by NPS are not evaluated.

Two **wilderness areas** are designated on the Navajo Nation: Bisti/De-Na-Zin Wilderness Area and Ah-shi-sle-pah Wilderness Study Area. There are some portions of the Bisti/De-Na-Zin Wilderness Area on the Navajo Nation, but these are managed by the BLM. Since the BLM is responsible for managing weeds in these areas, they have been excluded from analysis.

Finally, **noise and light** were considered for evaluation but impacts from all alternatives would be negligible. All weed treatments would take place during the day, so light pollution would not be a concern. While noise from heavy machinery and traffic to and from treatment sites would occur, this would be minimal with a short duration for all alternatives.

3.2 Paleontological Resources

A variety of paleontological resources occur on the Navajo Nation including vertebrate and invertebrate animal fossils, fossil leaves, palynomorphs, petrified wood, and trace fossils. Some portions of the Navajo Nation are valued as some of the best-preserved botanical, mammalian, and reptilian fossils in North America, which occur in the Triassic, Jurassic, Cretaceous, and Tertiary rock formations that underlie the region. Dinosaurs and other fossils recovered from the Navajo Nation have made valuable contributions to the scientific record. Along the eastern and northern boundaries of the Nation in New Mexico, the BLM has designated special management areas to preserve important paleontological resources for scientific study and other public benefits. These include the Bisti/De-Na-Zin Wilderness and the Ah-Shi-Sle-Pah Wilderness Study Area (respectively west and southwest of Nageezi, New Mexico in lands administered by Eastern Navajo Agency). While Ah-Shi-Sle-Pah occurs solely on BLM lands, approximately 14,000 acres of Bisti/De-Na-Zin is on Navajo Nation lands. However, the BLM is the federal agency responsible for any vegetation treatments in both areas. In Arizona, the Petrified Forest

National Park, well known for its fossilized trees (and to a lesser extent a variety of other fossil types), is bordered to the north and partially on the east by the Navajo Nation.

To date, few areas of the Navajo Nation have been systematically surveyed for paleontological resources. One exception is the Four Corners Power Plant and Navajo Mine southwest of Farmington, New Mexico. Ten locations of significant paleontological resources were confirmed in this area (OSMRE 2015). Immediately adjacent to the Navajo Nation and potentially impacted by this project are the Lybrook and Betonnie Tsosie fossil areas. The Betonnie Tsosie Fossil Area is a type location for early Paleocene North American land mammals (BLM 2003).

The Navajo Nation does not require paleontological resource inventories on their lands. However, if paleontological resources are identified, they are protected under the Nation's rules and regulations. Such encounters are possible during treatments when ground disturbance occurs in areas where fossil deposits are likely. Permits for collecting fossils on the Navajo Nation are issued by the Navajo Nation Minerals Department (Bradley Nesemeier, Navajo Nation Sr. Geologist, personal communication, 5/21/15), and are issued only for scientific research or mitigation. The Indian Affairs Manual Part 59, Chapter 7 on *Environmental and Cultural Resources Management- Paleontological Resources* outlines BIA policy and requirements for protecting and managing paleontological resources on Indian lands. The policy is specific to imbedded fossils (when a fossil cannot be moved without aid of a tool or instrument). Before any person excavates or removes an imbedded fossil from Indian lands that are held in trust or restricted fee status, BIA must issue a permit. Furthermore, BIA-issued permits must comply with the National Environmental Policy Act; National Historic Preservation Act, Section 106; and the Endangered Species Act, Section 7 (per IAM Part 59, Chapter 7).

3.3 Cultural Resources

More than 11,000 years of human existence are represented in the area encompassed by the Navajo Nation. Although archaeologists generally divide the cultural history of the area (and the greater American Southwest) into arbitrary cultural-historical periods (i.e., Paleoindian, Archaic, Formative, Early Contact, and Historic), the Navajo do not recognize these designations, instead asserting that Paleoindian and Archaic hunter-gatherers, in contemporary archaeological terminology, were ancestral to the *Ánaasází* or *Anasazi*, a term that encompasses all ancient peoples, whether related or not to the Navajo (Warburton and Begay 2005). The Navajo (Diné) believe that their people "have been here since time immemorial" (NNHPD 2010), arriving after their migration from the western ocean after entering the Fourth World (Yazzie 1982).

The Diné homeland is bound by four sacred mountains: San Francisco Peaks to the west (known as Dook'o'oosłíid in Navajo) near Flagstaff, Arizona; Blanca Peak to the east (Sisnaajiní in Navajo) near Alamosa, Colorado; Mt. Hesperus to the north (Dibé Ntsaa in Navajo) near Durango, Colorado; and Mt. Taylor to the south (Tsoodził in Navajo) near Grants, New Mexico. The Diné (or Navajo), however, did not confine themselves to the area bounded by the four sacred mountains, but rather traveled outside of this area to hunt and gather thereby acquiring traditions from other people.

3.3.1 Expected Cultural Resources

Data provided by the BIA and the Navajo Nation Historic Preservation Department indicate more than 815,000 acres surveyed for cultural resources across the Navajo Reservation. The HPD estimates this number is likely low because not all their survey reports have been digitized and accounted for. The number of documented cultural resources on the Navajo Nation reservation is not known at this time.

Paleoindian (9500 - 7500 before common era [BCE].) and Archaic peoples (6000 – 500 BCE) were hunter-gatherers who left archaeological sites that are often difficult to identify on the surface and are often buried. Paleoindian and Archaic indigenous peoples were hunter-gatherers during this long period; they are often identified in the archaeological record by their distinctive spear and atlatl projectile points. Cultural resources dated to this period are typically small archaeological sites comprised of artifact scatters and thermal features. Artifacts are limited to stone materials, including projectile points and other tools, and ground stone. Pit house structures were built during this long period but are generally found only in buried contexts. Related features that could be disturbed subsurface include thermal features and burials. Sites are often found buried in sand dune contexts. Rock art depicted on sandstone cliffs and walls begins to proliferate during the Archaic period and this practice continues throughout history. The Navajo hold that many of the “lithic scatters” that are common to this period simply reflect ancestral Diné hunting and gathering sites.

The transition to horticulture (i.e., by the planting of corns, beans, and squash and the domestication of the turkey) around 500 BCE markedly enhances the archaeological visibility of cultural resources. It is the Formative period (500 BCE – 1300 AD) that the term *Anasazi* is typically applied to by archaeologists and to whom the Navajo ascribe cultural affiliation with (also known as the Basketmaker and Puebloan periods by archaeologists). Cultural remains include pithouses, storage bins, and masonry pueblos, evident as rubble mounds and extensive middens that are more visible on the landscape since they are often avoided by modern agricultural practices. The types of artifacts are similar to previous periods but now include ceramics, the bow and arrow, and the proliferation of groundstone technology. Although masonry rubble mounds are easily identified on the surface, buried archaeological deposits will also be present such as pit structures and artifacts. Other kinds of structures include Chacoan road networks, kilns, and ceremonial structures.

The post-1300 abandonment of large parts of the northern Southwest by the Anasazi begins the Early Contact period (AD 1540 – 1650) when Navajo lifeways are generally recognized in the archaeological record. The earliest Navajo forked-stick hogans (habitation structures) were constructed during this time. These structures are extremely rare because of their age and from natural decay and are difficult to identify. Often, these structures are only visible as collapsed poles on the ground with a small scatter of artifacts and thermal features in association, such as fire and roasting pits. Other Navajo structures include ramadas, lean-tos, windbreaks, and sweat lodges.

Navajo lifeways were profoundly changed by the introduction of livestock. Domesticated livestock and horses led the Navajo becoming pastoral sheepherders. Cultural resources changed little during this period, although hogans became larger and more substantial with pastoralism. Masonry redoubts called pueblitos were built in the Dinetah region to provide protection; these structures were typically built on high points and other inaccessible locations.

The Navajo continued to build wooden structures into the historic period; their hogans become larger and more substantial as they became more pastoral than hunter-gatherer. The use of stone tools continued but the Navajo also began to acquire Euro-American manufactured goods such as metal tools. Traditional plant gathering continues to be an important and pervasive cultural practice for the Navajo (see Vegetation for a fuller description of Navajo practices) and is conditioned by the individual and the community. The plants used in traditional practices and the sites from which they are gathered are considered traditional cultural properties (TCPs).

Certain types of vegetation have potential to cause detrimental effects to buried archaeological deposits. 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. Other plants used as food sources or habitat for burrowing animals such as prairie dogs, ground squirrels, and voles can indirectly harm cultural resources by supporting populations that can cause ground-disturbance that may be destructive to buried archaeological deposits. In addition, both noxious weeds and native vegetation can serve as fuel for wildfires that can cause potential harm to several types of combustible archaeological resources such as fork-sticked hogans, sweat lodges, and plant-related TCPs.

3.3.2 Section 106 Process

The Section 106 process includes four steps:

1. Initiate process: establish undertaking, define the area of potential affect (APE), and begin consultation.
2. Identify historic and traditional cultural properties within the APE.
3. Assessment of project effects on historic and/or traditional cultural properties.
4. Resolution of adverse effects, if necessary.

The Section 106 process on the Navajo Nation is governed by a Pub. L. 93-638 contract between the Navajo Nation and the BIA, which allows Navajo HPD to conduct the Section 106 process on behalf of the BIA (Appendix H). However, the BIA still conducts consultation as part of its government-to-government responsibility as a federal agency. The BIA will include the Navajo Nation in consultation with other tribes when an undertaking occurs on trust lands (per 25 C.F.R. 262.8). The potential for individual undertakings to result in adverse effects would be minimized or entirely avoided by mitigation measures stipulated in Appendix F to include, but not limited to avoidance/conservation of traditional resources; identifying alternative locations for traditional resource gathering; timing restrictions on vegetation treatments; transplanting traditional resources to other locations; and negotiation with local communities.

3.4 Soils, Water, and Air

3.4.1 Soil Resources

Soils on the Navajo Nation range from arid, saline soils in low lying deserts and scrublands to productive soils with considerable organic matter in forest habitats. Most soils are formed from sandstone, but soils derived from basalt, limestone, shale, and siltstone are also present. Soils provide important ecosystem services such as water filtration, nutrient exchange between land and water, and carbon storage, which changes with vegetation, land use, disturbance, and climate. Ecologically, soils serve as an important interface for plants, animals, and aquatic resources. Maintaining healthy soils is important for agriculture, wildlife habitat, reservoir recharge, and plant cover. Based on the U.S. General Soils Map, there are an estimated 105 different soil types found on the Navajo Nation (NRCS 2019). Appendix J contains additional information on soil types, locations, and physical properties on the Navajo Nation.

Soil function describes how soils influence plant growth, impact water quality, and support buildings and structures (Soil Quality Institute 2001). Soil function depends on a variety of soil properties, such as the amount of organic content, soil texture, porosity, and microbial diversity. These properties are important for how soils filter, buffer, degrade, transport, and break down materials. Changes in vegetation composition, such as a shift from native perennial to invasive annuals, can increase erosion, reduce organic matter, and decrease soil moisture, making it harder for native plants to re-grow at a site. This can alter the microbial composition of the soil and change decomposition rates, nutrient availability, and create long-term legacy impacts that affect production and facilitate secondary invasions for years after weeds are removed (McLeod et al. 2016).

Erosion and loss of productive soils is a concern on the Navajo Nation. Increased aridity and land use facilitate erosion in some areas, threatening native plant communities, housing and transportation, and grazing capacity. One study estimated that sand dunes on Navajo Nation grow at a rate of 4.5% annually (Redsteer et al. 2011). Increased erosion and reduced topsoil further facilitate weed invasions and reduce the establishment and growth of native plant species, creating a positive feedback loop that can last for decades.

Changes to soils can limit the growth of native vegetation and encourage additional weeds in disturbed sites. These impacts vary depending on landform, hydrology, vegetation, and native plant cover. While erosion is a natural process, it increases when vegetation is cleared (BPA 2000). Vegetation and topsoil dissipate the energy of raindrops and reduce runoff. Plant roots, organic matter, and soil organisms produce chemicals that bind soil particles together. The effects of reduced plant cover and topsoil may be most pronounced on steep slopes. Soil compaction from land use, grazing, or heavy equipment and vehicles at a site can damage cryptobiotic soils. Cryptobiotic soil loss can alter decomposition, native plant growth, and water runoff. Removing vegetation can loosen soils, increasing the risk of topsoil loss and erosion. It can also reduce groundwater storage, which can reduce plant growth and limit decomposition.

Noxious weeds can have varying effects on soils that give them advantages over native plants (Weidenhamer and Callaway 2010). Some produce chemicals that restrict and limit the growth of native species. Tamarisk, for example, can increase the amount of salt in soils, altering soil chemistry and decreasing native grasses and riparian trees growth. Tree of Heaven, diffuse knapweed, Russian knapweed, kochia, yellow nutsedge, and spotted knapweed release allelopathic chemicals in the soil, which inhibit the growth of other nearby plants. When annual grasses invade an area, they can emerge early and limit access to water and nutrients for native species. In many native plant communities, having a variety of plants results in more efficient resource use during the growing season as different plants occupy different portions of soil, creating variations in flowering period, root depth, plant height, and resource use (**Figure 3-1**, Nippert and Knapp, 2007, Guderle et al. 2018).

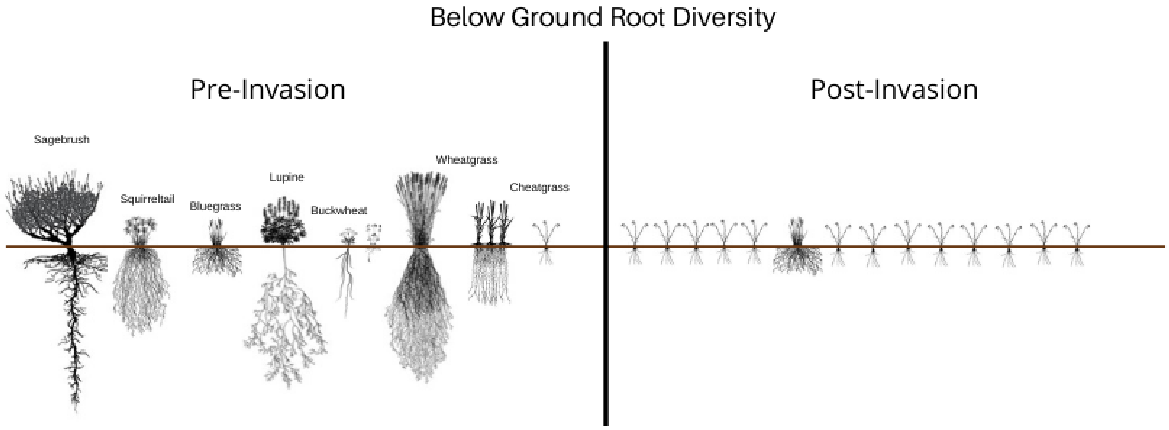

Figure 3-1. Diagram depicting relative variations in root depth for grassland species before and after an invasion of annual grasses, such as cheatgrass. Plant illustrations by Jeremy Maestas, Maja Smith, and the Sage Grouse Initiative.

Lastly, when weeds alter vegetation communities, they can increase soil erosion and limit plant growth. Annual invasive grasses, which emerge in the early spring and die off by summer, increase soil erosion by crowding out perennial grasses with root systems that retain soils and which grow throughout the year. In riparian areas, dense stands of Russian olive and tamarisk can increase erosion along rivers and stream banks, which can change sediment transport and accumulation (Cadol et al. 2011). Weeds that limit the growth of other plants increase bare ground exposure, which makes soils more prone to loss from wind and water.

3.4.1.1 Cryptobiotic Soils

Cryptobiotic soils are common in arid lands, such as the Navajo Nation. These soil crusts occur in exposed areas and are complex associations of cyanobacteria, green algae, lichens, mosses, microfungi, and other microbes that form a stable matrix on soil surfaces over long periods of time (USDOI 2001). Cryptobiotic soils retain soil moisture, fix atmospheric nitrogen, and provide organic matter in arid ecosystems. These crusts reduce wind and water erosion, stabilize sandy soils, and trap soil particles together, increasing their size. Invasive species generally decrease cryptobiotic soils, likely by increasing shade, available soil surface, and fire frequency. The loss of soil crusts can decrease water infiltration, erosion, and the diversity of deep-rooted perennial plants (USDOI 2001).

3.4.2 Water

Five major watershed basins occur on the Navajo Nation and include the Rio Grande (710,367 acres), San Juan (8.54 million acres), Lower Colorado (723,528 acres), Little Colorado (6.67 million acres), and Upper Colorado (980,449 acres). These major watersheds are divided into 31 drainage basins on the Navajo Nation (**Table 3-1**). Average annual precipitation in the area ranges from 12 to 16 inches, which occurs in winter precipitation and summer monsoonal thunderstorms. Precipitation is essential to adequately recharge and refill both surface and ground water reservoirs in the region.

Table 3-1. Watersheds and drainage basins on the Navajo Nation based on USGS Hydrologic Unit Code Number (HUC No.) and total acres of basin on the Navajo Nation.

LITTLE COLORADO WATERSHED				
Surface Drainage Basin	HUC NO.	Total Acres	Acres on Navajo Nation	% of Watershed on Navajo Nation
Moenkopi Wash	15020018	1,685,552	1,199,190	71.1
Dinnebito Wash	15020017	475,416	207,895	43.7
Corn-Oraibi Wash	15020012	547,176	305,664	55.9
Lower Little Colorado River	15020016	1,535,259	783,649	51.0
Polacca Wash	15020013	692,851	324,573	46.8
Upper Puerco River	15020006	1,225,809	1,071,965	87.4
Cottonwood Wash	15020011	1,028,501	896,982	87.2
Jeddito Wash	15020014	665,429	440,772	66.2
Leroux Wash	15020009	516,281	385,579	74.7
Middle Little Colorado River	15020008	1,580,529	326,363	20.6
Lower Puerco River	15020007	715,941	333,537	46.6
Canyon Diablo	15020015	770,708	68,597	8.9
Zuni River	15020004	1,764,468	327,718	18.6
Upper Little Colorado River	15020002	1,032,340	2,216	0.2
LOWER COLORADO WATERSHED				
Surface Drainage Basin	**HUC No.**	**Total Acres**	**Acres on Navajo Nation**	**% of Watershed on Navajo Nation**
Lower Colorado-Marble Canyon	15010001	927,155	272,588	29.4
RIO GRANDE WATERSHED				
Surface Drainage Basin	**HUC No.**	**Total Acres**	**Acres on Navajo Nation**	**% of Watershed on Navajo Nation**
Rio Puerco	13020204	1,356,949	82,749	6.1
Arroyo Chico	13020205	876,642	338,158	38.6
Rio San Jose	13020207	1,689,289	218,417	12.9
Rio Salado	13020209	900,010	60,563	6.7
North Plains	13020206	729,397	10,480	1.4
SAN JUAN WATERSHED				
Surface Drainage Basin	**HUC No.**	**Total Acres**	**Acres on Navajo Nation**	**% of Watershed on Navajo Nation**
Montezuma Creek	14080203	747,121	61,012	8.2
Lower San Juan – Four Corners	14080201	1,283,869	582,240	45.4
Upper San Juan River	14080101	2,206,444	262,308	11.9
Lower San Juan	14080205	1,502,448	1,009,277	67.2
McElmo Creek	14080202	458,010	40,026	8.7
Mancos River	14080107	513,141	37,971	7.4
Middle San Juan River	14080105	1,241,815	685,612	55.2
Chaco Wash	14080106	2,927,155	2,917,013	99.7
Blanco Canyon	14080103	1,097,855	278,642	25.4
Chinle Wash	14080204	2,664,383	2,664,383	100.0
UPPER COLORADO RIVER				
Surface Drainage Basin	**HUC No.**	**Total Acres**	**Acres on Navajo Nation**	**% of Watershed on Navajo Nation**
Lower Lake Powell	14070006	1,910,567	980,449	51.3

The San Juan, Little Colorado, and mainstem of the Colorado River serve as boundaries around the northern, southern, and western borders of the Navajo Nation. Several streams that start on the reservation, such as the Chaco and Rio Puerco, are important headwaters that feed major river systems in the region (NDWR 2011). Noxious weeds have been found in all five watersheds, with large upstream populations distributing seeds that germinate in lands outside the Navajo Nation.

3.4.2.1 Hydrology

Water availability on the Navajo Nation depends on limited annual precipitation to refill surface water and groundwater reservoirs. Groundwater supplies for the Navajo Nation primarily rely on the Colorado Plateau aquifers, composed of sedimentary rocks. These aquifers are heavily used and dependable water sources for most of the Navajo Nation. However, while annual groundwater storage can meet annual water demand through wells or municipal pipelines, some aquifers are less ideal for water use due to poor water quality and limited access (NDWR 2011). A major concern for groundwater is the risk for chemical contamination. A study conducted by the Bureau of Reclamation (Blanchard 2002) estimated that 72% of the Navajo Nation was at risk for groundwater contamination from pesticides, including herbicides (**Figure 3-2**). As a result, the Navajo Nation monitors herbicide use and surface and groundwater quality for domestic, commercial, agricultural, and industrial uses.

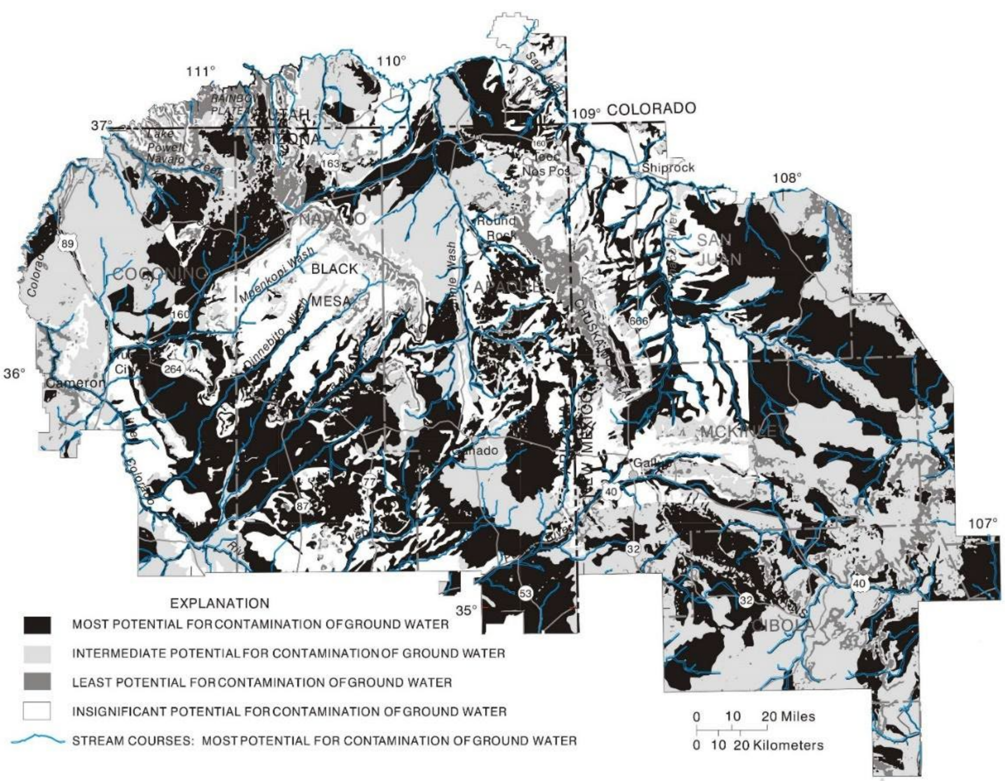

Figure 3-2. Map of the Navajo Nation showing potential risk of groundwater contamination from pesticide use (Blanchard 2002). Risk is based on geology, precipitation rate, slope, and depth to ground water.

Surface water occurs as either streams and rivers or reservoirs. The Navajo Nation uses water from several major rivers, including the Colorado River, the Little Colorado River, and the San Juan River. Use of surface water is highly limited due to various legal and practical restrictions. In recent years, the federal government awarded the Navajo Nation an additional 81,500 acre-feet from water sources in or adjacent to the Navajo Nation boundaries within Utah (U.S. Senate Report 116-79). In New Mexico, the

Navajo Nation was recently granted additional diversions from the San Juan River for agricultural, municipal, and ecological needs as part of the Navajo Mainstem Water Rights settlement in New Mexico (New Mexico CV-75-184, 2013). While these recent settlements do increase available water on the Navajo Nation, reservoirs remain the most important source of surface water for the domestic water supply, wildlife habitat, and recreation. Around 20 reservoirs hold an estimated 100,000 acre-feet of water on the Navajo Nation (NDWR 2011)

Hydrology on the Navajo Nation can change in response to shifts in vegetation cover and density. Changes in plant communities can alter how water recharges groundwater reservoirs, evaporates, or refills lakes and streams. Roots from perennial plants can keep soils intact and increase infiltration of water into soils for groundwater recharge. Trees with deep roots, such as tamarisk and Russian olive, can tap into groundwater and crowd out native trees with shallower root systems, like willows and cottonwoods. Such impacts affect the balance of water resources on the Navajo Nation and alters how water is stored and used across the landscape.

3.4.2.2 Water Use

Water is used in a variety of ways on the Navajo Nation, which could be impacted if sources are contaminated or reduced. Total domestic water use on the Navajo Nation is approximately 12,000 acre-feet annually. Non-domestic use, which accounts for most of the water used, includes commercial, agricultural, and industrial activities (**Table 3-2**). Agricultural use includes irrigation for small, permitted farms, large scale NAPI/NIIP operations, and wells or stock ponds for livestock grazing. Mining and energy development also use large quantities of water on the Navajo Nation (NDWR 2011). These uses are essential for economic productivity on the Navajo Nation.

Table 3-2. Estimated water use for non-domestic activities for the Navajo Nation (NNDWR 2011)

Use Type	Annual Water use (af/yr)
Commercial Use (Businesses, government offices, construction, processing, manufacturing)	6,695
Small Farms	99,560
Rangeland Use – Wells	865
Rangeland Use – Ponds	60,000
NAPI/NIIP	353,000
Large Industrial Use (Mining, Energy)	158,078

The Navajo Nation Department of Water Resources estimates that approximately 25-30% of households, or 7,000 homes do not have direct access to public water and must haul water long distances (NDWR 2011, IHS 2011, Litvak 2019). While the Navajo Nation Department of Water Resources Program has planned several new projects to address water access for residents, largely in response to COVID-19, many rural communities have long-term logistical barriers that limit to access clean, safe water regularly. Many residents must spend considerable time and effort finding, refilling, and hauling water to their homes (Roller et al. 2019).

Protecting water sources from contamination and overuse is vital for many residents. Access to clean water is essential for public health, economic development, and natural resource management. If sources are contaminated, they are not available for domestic or commercial use. NNEPA Public Water Systems Supervision Program (PWSSP) is responsible for water quality monitoring and source water protection. The PWSSP monitors drinking water for contaminants based on the Navajo Nation Primary Drinking Water Regulations (NNEPA 2017). Herbicides are listed as potential contaminants due to health concerns. Specifically, 2,4-D, atrazine, glyphosate, and picloram are monitored and reported if they exceed specified concentrations.

3.4.2.3 Well Management

In areas where water infrastructure is unavailable, Navajo Nation residents use wells for drinking water, especially in rural communities. Permitting and regulation of well drilling and water use is managed by the Navajo Nation Water Department of Water Resources Technical, Construction, and Operations Branch. Water quality studies on wells indicate that livestock grazing or pesticide use near wells may increase the risk of well water contamination, especially in areas where groundwater contamination is high (McGinnis and David 2001, Blanchard 2002, **Figure 3-2**).

Well contamination can occur when elements or chemicals, such as herbicides, infiltrate well water. While some contamination comes from natural sources, such as selenium or arsenic, contamination from human-related activities is of greatest concern. Runoff from rangelands, illegal dumping, chemical spills, waste storage lagoons, sewage, and septic systems can introduce harmful contaminates to well systems. Heavy spraying of pesticides can also contaminate wells and other drinking water sources, depending on the herbicide and its mobility in soils (**Table 4-1**) Contaminated water can impair public water wells, increase the risk of harmful exposures to certain chemicals, and put communities at risk for a variety of health issues.

For these reasons, the Navajo Nation EPA Public Water Systems Supervision Program (PWSSP), through its Wellhead Protection Program established buffer zones around wells, wellfields, springs, and surface water to protect them from contamination from various land management activities (NNEPA 1994), which are incorporated in the NNIWMP. While a default 200-foot buffer zone is used for all wells, consultation with the NNEPA PWSSP is needed to determine each source's status (active vs. inactive), evaluate if the recommended source water protection area may need to be adjusted, and determine if monitoring is needed before and after projects (NNEPA 2001).

While watering points are set-up at border towns and Chapter houses for residents without wells or direct drinking water access, some residents obtain water from unregulated sources, such as livestock ponds, windmills, and abandoned wells, which are not monitored regularly by the PWSSP. Groundwater contamination is a concern for these sources because they are not regularly monitored or designed for domestic use. Use of these sources can put sensitive residents at risk, such as women, children, and individuals with compromised immune systems. Livestock wells are used throughout the Navajo Nation for livestock and can be shallow (20-50 feet in depth) or deep (1,500 feet or greater). Shallow wells can be easily contaminated by livestock waste, pesticides, and runoff since the trough is located next to the well and is often surrounded by animal waste. Windmill-powered wells pump water from underground aquifers and are not tested for contamination. Abandoned wells should be sealed off to prevent their use, but may not be, allowing access. Unregulated wells can be contaminated by uranium, arsenic, and *E. coli* (Garvin et al. 2010) and are commonly located in rural, poor communities where infrastructure costs are a major barrier to installing community water systems. Runoff can introduce pesticides or other harmful contaminants to these wells and the lack of monitoring results in uncertainty regarding their safety and quality. Due to the heavy reliance on wells and groundwater for many remote communities on the Navajo Nation, well contamination remains a primary public health concern. All potential open water sources should be identified in project maps and plans for each weed project under the NNIWMP.

3.4.2.4 Surface Water Quality

Protecting water quality is important for public health, water use, and ecological needs. The Navajo Nation EPA (NNEPA) has developed water quality standards to evaluate contaminants that impair water from safe use (NNEPA 2015). Surface water standards assess rivers, lakes, and streams for human health, wildlife, and the environment. Drinking water standards, which are stricter, use maximum contaminant levels (MCLs) for human consumption. There are several pesticides NNEPA monitors for both 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 (**Table 3-3**). If water is contaminated by these herbicides, it could limit use by local communities for domestic or commercial needs.

Table 3-3. Water Quality standards for herbicides based on use as defined by the Navajo Nation Environmental Protection Agency. MCL refers to maximum contaminant level allowed for each ingredient.

Active Ingredient	Fish Consumption (mg/L)	Human Contact* (mg/L)	Aquatic/Wildlife (mg/L)	Drinking Water MCL (mg/L)
2,4-D	12	9.33	-	0.07
Atrazine	-	32.667	32.667	0.003
Glyphosate	266.667	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 2015.

When waters are impaired, NNEPA documents the causes for impairment and reports the findings to the USEPA. NNEPA then goes through a restoration process to control and reduce contaminants by working with other agencies and land users. In 2015, the NNEPA updated their surface water quality standards to reflect recent federal changes and to add standards for newly identified contaminants. The revised standards include pesticides, including atrazine and technical grade forms of 2-4 D, and glyphosate. The standards set limits for these chemicals' domestic and economic uses (i.e., commercial, natural resources, recreational). The standards are approved and used by the Navajo Nation but are awaiting approval by USEPA. Because the NNEPA water quality standards have not been approved by the USEPA, waterways on the Navajo Nation are not federally listed.

NNEPA water quality assessments have indicated exceedances for some waters. A few instances of elevated uranium and α-radioactivity have been detected at Cove Wash, which is located downstream of historic uranium mining areas (NNEPA 2014). Several testing locations along the San Juan River indicate multiple exceedances for arsenic, lead, selenium, mercury, and other standard analytes for domestic, fish, human, and aquatic and wildlife needs (NNEPA 2016, 2019).

There are also impaired waterways that border or are close to the Navajo Nation, including those impaired by non-point source water pollution. These waterways were evaluated by state agencies and listed by the USEPA. NNEPA works with state agencies to address water quality issues along the border of these watersheds (**Figure 3-3**, **Table 3-4**).

State Water Quality Agencies

- Arizona Department of Environmental Quality
    - Water Quality Division
- New Mexico Environment Department
    - Surface Water Quality Bureau
- Utah Department of Environmental Quality
    - Division of Water Quality

Herbicide use is a major concern for water quality. All pesticides pose a potential risk to human health and the environment and are evaluated by the USEPA for safe use. Chemicals that accumulate and resist degradation pose the most concern for the public. USGS studies of pesticide contamination in the United States, indicate that commonly used herbicides and their breakdown products can occur in high enough concentrations in surface water to cause impairments (Gilliom 2007, Bexfield 2008). Daily sampling studies indicate there may be concerning increases of common herbicides that may not be detected under current sampling protocols but may increase the risk of chronic exposure over time (Norman et a. 2020).

NNEPA manages the Pesticide Tribal Program for the Navajo Nation and ensures pesticides, and their alternatives are used according to USEPA label instructions. Pesticide applicators on the Navajo Nation must obtain a permit if herbicide treatments are conducted near open water. These permits, known as Pesticide General Permits (PGP), are approved by USEPA Region 9 and managed by NNEPA. The permit program covers chemicals used for insects, weed and algae control, animal pest control, and forest canopy pest control. Each BIA Agency maintains its own coverage under the USEPA's PGP permit for herbicide use on the Navajo Nation.

Weeds have varying impacts on hydrology and water quality on the Navajo Nation. Vegetation can affect evaporation, groundwater storage, and surface run-off. Dense stands of noxious weeds with deep tap roots or rhizomatous root systems, such as tamarisk or camelthorn, can access groundwater at greater depths than many native plant species, making them more successful in drought-prone regions. If such weeds replace diverse plant communities, it could reduce soil stability and increase sedimentation, topsoil loss, bank line erosion, and channelization in riparian areas. If dense weed populations are removed, an area may see increased water loss from evaporation, reduced water retention, reduced groundwater recharge, and increased surface run-off. Where infestations are sparse, or where native vegetation is still present, such changes would be less dramatic and removal would result in minor changes to site hydrology. As a result, weed projects conducted under the NNIWMP may require additional consultation and mitigation with NNEPA if they occur near or are connected hydrologically to impaired waters.

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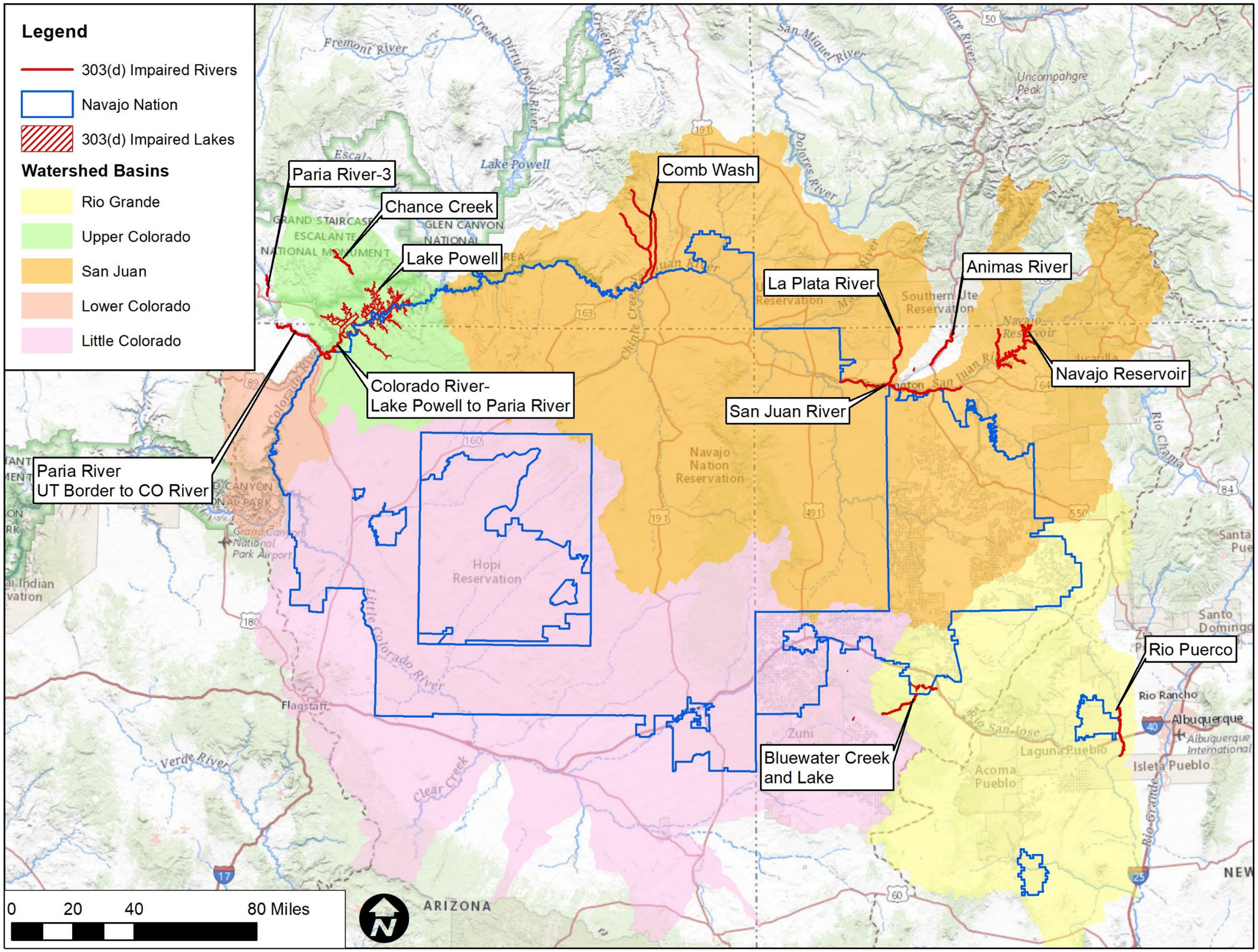

Figure 3-3. Map of impaired waters found on or near the Navajo Nation as listed by state water quality agencies in Utah (2016), Arizona (2016), and New Mexico (2012, 2016) and approved by the USEPA.

Table 3-4. Impaired waters near the Navajo Nation and causes. Impairment data was compiled from the state water quality assessments (ADEQ 2016, 2018, NMED 2016, 2018, UDEQ 2016) and the USEPA WATERS GeoViewer (https://epa.maps.arcgis.com/)

State	Name	AU ID	Class	Size	Cause	Use	Year	Source
UT	Chance Creek	UT14070006-004	River	16.17 mi	Nutrient/Eutrophication	Cold water aquatic life	2016	Unknown
UT	Paria River-3	UT14070007-005	River	9.22 mi	Nutrient/Eutrophication	Aquatic wildlife	2016	Unknown
					Total Dissolved Solids	Agricultural	2016	Unknown
UT	San Juan River	UT14080205-001 UT14080201-009	River	118.8 mi	Heavy Metal	Warm water aquatic life	2016	Unknown
UT	Lake Powell	UT14070006-001	Lake	15,006 ac	pH	Warm water aquatic life	2016	Unknown
AZ	Lake Powell	AZ14070006-1130	Lake	9770 ac	Mercury in Fish	Fisheries	2010	Atmospheric Deposition, Unknown
AZ	Paria River - Utah to Colorado River	AZ14070007-123	River	29.4 mi	Suspended Sediment	Warm water aquatic life	2004	Hydromodification, Natural/Wildlife, Agriculture, Outside boundary source
					E. coli	Recreation	2006	Natural/Wildlife, Agriculture
					Selenium	Warm water aquatic life	2016	Natural sources, Outside state jurisdiction
AZ	Little Colorado River (Silver Creek to Carr Wash)	AZ15020002-004	River	6.07 mi	E coli	Human Contact	2016	Agriculture, Recreation, Urban Runoff
					Sediment	Cold water aquatic life	2016	Agriculture, Recreation, Urban Runoff
NM	Rio Puerco - Rio Grande to Arroyo Chijuilla	NM-2105_20	Stream	147 mi	E. coli	Human Contact, Livestock	2012	Grazing, Irrigation
					Mercury in Fish	Human Contact	2012	Atmospheric Deposition, Unknown
NM	Upper San Juan River - Animas to Cañon Largo)	NM-2401_00	River	34.99 mi	E. coli	Human Contact	2006	Hydromodifications, Municipal Discharge, Agriculture, Natural/Wildlife
					Sedimentation	Cold water aquatic life	2004	Natural/Wildlife, Habitat Modifications, Resource Extraction, Industrial
NM	San Juan River (Hogback to Animas River)	NM-2401_10	River	24.34 mi	E. Coli	Recreation	2006	Natural/Wildlife, Municipal Discharge, Agriculture, Drought
					Sedimentation	Cold water aquatic life	2012	Unknown
					Turbidity	Cold water aquatic life	2012	Unknown

State	Name	AU ID	Class	Size	Cause	Use	Year	Source
NM	Bluewater Creek (Reservoir to Headwaters	NM-2107.A_01	Stream	17.1 mi	Temperature	Cold water aquatic life	1998	Silviculture, Habitat Alterations, Agriculture, Hydromodifications
NM	Bluewater Lake	NM-2107.B	Lake	608.6 ac	Nutrient/Eutrophication	Cold water aquatic life	2014	Unknown
NM	La Plata River - San Juan to McDermott Arroyo	NM-2402A_00	Stream	16.77 mi	Dissolved Oxygen	Wildlife protection	1998	Agriculture, Natural/Wildlife, Hydromodification, Habitat Modifications
					Sedimentation	Cold water aquatic life	2004	Unknown
					E. coli	Recreation	2012	Hydromodification, Stormwater Runoff, Natural/Wildlife, Spills and Dumping, Municipal Discharge, Recreation, Construction.
NM	Animas River - Estes Arroyo to CO Border	NM-2404_00	River	19.6 mi	Temperature	Cold water aquatic life	1998	Agriculture, Natural/Wildlife, Hydromodification, Habitat Modifications
NM	Animas River – San Juan River to Estes Arroyo	NM-2403.A	Stream	16.83 mi	E. coli	Recreation	2012	Hydromodification, Stormwater Runoff, Natural/Wildlife, Spills and Dumping, Municipal Discharge, Recreation, Construction.
					Nutrients	Aquatic Life	2004	Hydromodification, Municipal Discharge, Stormwater Runoff, Natural/Wildlife
					Temperature	Cold water aquatic life	2012	Hydromodification, Stormwater Runoff, Natural/Wildlife, Municipal Discharge
NM	Navajo Reservoir	NM-2406_00	Lake	13,15 ac	Mercury in Fish	Fishery Production	2004	Atmospheric Deposition, Unknown

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3.4.3 Air Resources

Air pollution can negatively impact natural resources and human health and could be impacted by some weed treatments, such as prescribed burning. Air pollution can impact natural resources by injuring tree species and plants, acidifying streams and lakes, and leaching nutrients from soils. Air pollution can impact human health by increasing the incidence of respiratory disease. The harmful effects of air pollution on the visual and recreation experience can also result in economic losses on Navajo lands and surrounding communities as people avoid areas with heavy air pollution.

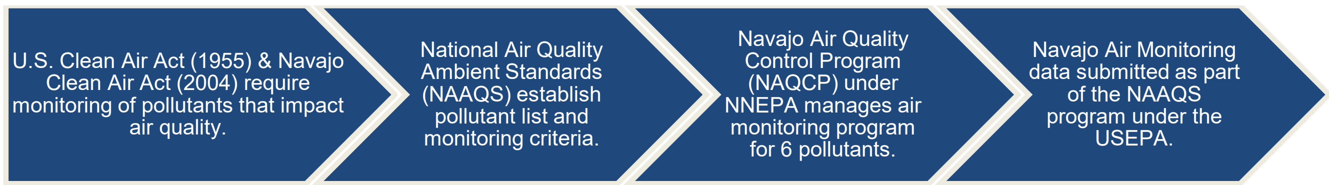

Figure 3-4. How air quality is monitored for public and environmental safety by the Navajo Nation EPA.

Air emissions are monitored by NNEPA Navajo Air Quality Control Program (NAQCP) based on the U.S. Clean Air Act and Navajo Clean Air Act (**Figure 3-4**). The NAQCP monitors these pollutants at two stations (Shiprock, NM and Nazlini, AZ) on the Navajo Nation (**Figure 3-5**) to monitor trends and compliance with federal standards. The Navajo Nation is designated as a Class II airshed under the Clean Air Act and is currently considered in attainment for the five criteria pollutants it monitors. All National Park Service units and designated wilderness areas on the Navajo Nation also have Class II designations under the Prevention of Significant Deterioration provisions of the Clean Air Act.

Air quality is assessed using an air quality index, which measures when air pollutants reach unsafe levels. Ambient air quality on the Navajo Nation is generally good. However, some communities and areas periodically experience impaired air quality, often in the summer and fall when fires are more common. Often, the index values rise as emissions are transported to the Navajo Nation from other urban areas such as Phoenix, Arizona or Albuquerque, New Mexico. The most common air pollutants reported on the Navajo Nation are particulate matter ($PM_{2.5}$ and PM_{10}), ozone (O_3), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2) (NNEPA 2021). These pollutants are commonly from fires, dust storms, and emissions from nearby power plants.

Weed and weed treatments could affect air quality. Wildfires and prescribed fires fueled by noxious weeds can increase particulate matter in the air, along with carbon monoxide and nitrogen oxides. This would mostly affect local communities but could exacerbate air quality regionally. Recent wildfires in the region have transported air pollutants from hundreds of miles away, impacting air quality in distant communities and cities, including on the Navajo Nation.

3.4.3.4 Greenhouse Gas Emissions

The effects from elevated greenhouse gas emissions are evident in some areas of the Navajo Nation through altered temperature and precipitation, hydrology (stream flows and snowmelt), and changes to disturbance regimes (Crimmins et al. 2013, Hoerling et al. 2013, Cozzetto and Nania 2014, NNDFW 2018). However, on the Navajo Nation, concern for greenhouse gas emissions has focused on emissions from power plants located near or adjacent to the Navajo Nation, which tend to be primary emitters (Abasta 2014, McVay 2021). As a rural population, most communities on the Navajo Nation likely have lower emissions rates overall compared to more densely populated or developed areas (Jones and Kammen 2014).

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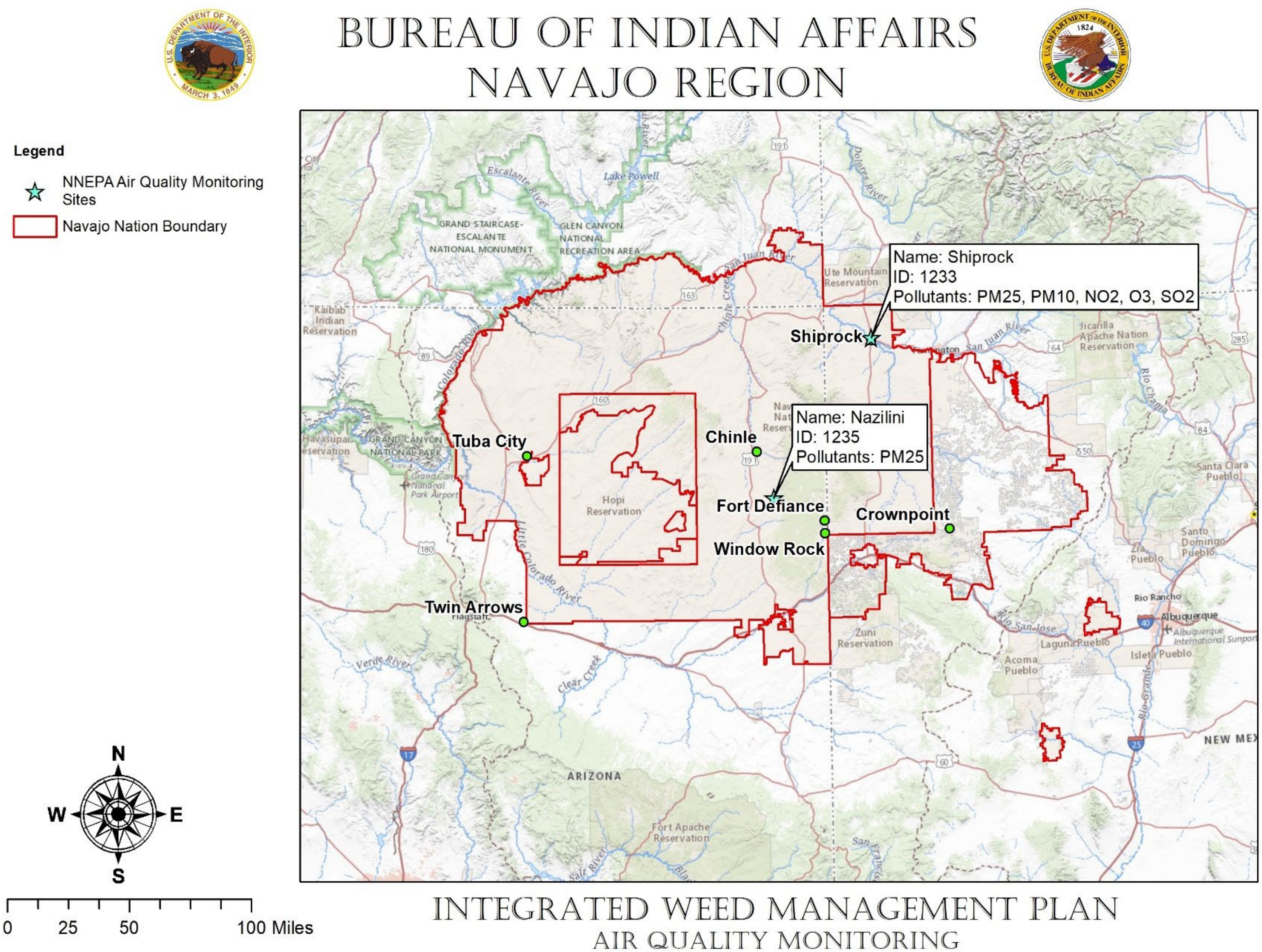

Figure 3-5. Navajo Nation Environmental Protection Agency Air Quality Monitoring Stations and pollutants. Data courtesy of the USEPA AirData program.

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Weed treatments can release greenhouse gases. Mechanical treatments that use gas-powered equipment, such as chainsaws or bulldozers, release small amounts of greenhouse gases (Lijewski et al. 2017, Dimou et al. 2019). Prescribed burning also emits greenhouse gases as dead and removed plant material is burned (CARB 2020). Exhaust from heavy machinery, airplanes and helicopters, and vehicles traveling to projects sites or conducting treatments are another source (USEPA 2018). Herbicides are also a source of GHG emissions, both from how they are produced and how they may be applied (Audsley et al. 2004, BLM 2016). However, weed treatments only minimally contribute to greenhouse gas emissions as any emissions are limited by their size and duration, with some treatments only occurring over a few hours to a few days (ENSR 2005). Additionally, some treatment methods may increase carbon storage at treated sites as native vegetation is restored, such as in forested or woodland areas, which could offset GHG emissions (Cahill et al. 2009, Stephens et al. 2012). Overall, weed management is not considered to be a major source of GHG emissions (BLM 2016)

3.5 Vegetation

3.5.1 Terrestrial Ecosystems

The Navajo Nation covers over 26,500 square miles with elevations ranging from 5,100 ft to above 10,000 ft. This elevation range allows for a wide variety of plant communities. Vegetation for the Navajo Nation was classified based on the National Land Cover Dataset developed for the United States by the USGS (Fry et al. 2011). Cover classes found on the Navajo Nation are outlined in **Table 3-5** and described and mapped in Appendix L. Shrubs/scrub, evergreen forests, and grasslands are the most common land cover classes, which are common in the region due to its arid climate and high elevation.

Table 3-5. Land cover classes on the Navajo Nation based on the National Land Cover Database (Fry et al. 2011).

Class	Estimated Acres	% of Navajo Nation
Open Water	28,078	0.16
Developed, Open Space	77,351	0.45
Developed, Low Intensity	22,002	0.13
Developed, Medium Intensity	5,681	0.03
Developed, High Intensity	751	<0.0001
Barren Land	171,035	0.99
Deciduous Forest	4,321	0.03
Evergreen Forest	2,051,523	11.9
Mixed Forest	271	<0.0001
Shrub/Scrub	13,065,153	75,79
Grassland/Herbaceous	1,674,383	9.71
Pasture/Hay	8,291	0.05
Cultivated Crops	65,186	0.38
Woody Wetlands	44,580	0.26
Emergent Herbaceous Wetlands	19,309	0.11

The Navajo people rely on healthy vegetation to support several economic and cultural activities. Changes in vegetation can indicate major ecological shifts that impact ecological productivity, carrying capacity, wildlife diversity, agriculture, livestock management, and economic development. Healthy and productive rangelands support livestock grazing and wildlife diversity while forests provide valuable forest products and ecosystem services. Diverse riparian woodlands dissipate flood energy and retain soils along streams and rivers, while providing habitat for a wide array of wildlife species. A simple comparison of land cover on the Navajo Nation to pre-European settlement conditions (Appendix L) shows that approximately 18% of the Navajo Nation has experienced conversion of its dominant vegetation communities, with grassland communities showing the most change. Some change is due to construction and the development of communities, roads, and agriculture. However, in less developed areas, where this shift is most prominent, the causes could be related to disturbance events, rangeland management, climate change, or other regional land uses. Further, an estimated 463,000 acres of converted land cover classes were due to exotic weeds. While this estimate is likely high, it does indicate that weeds have impacted vegetation cover on the Navajo Nation (Appendix L, **Figure 3-6**).

Changes in vegetation on the Navajo Nation are a long-standing concern. Studies indicate that native plant communities on the Navajo Nation could be declining in response to overuse and increasing drought conditions (Paruelo and Lauenroth 1995, Draut et al. 2012b, Thomas and Redsteer 2016, El Vilaly et al. 2018). Land use practices, such as overgrazing contribute to shifts in grassland communities from perennial bunchgrasses to shrub species with deep taproots (Jeffries and Klopatek 1987, Draut et al 2012, Thomas and Redsteer 2016, Nauman et al. 2018). Construction and development can also impact vegetation by disturbing soils and introducing non-native plants and organisms to areas. These introductions facilitate sand dune movement, decrease native species and wildlife habitat quality, and reduce suitability for construction and other economic development (Frye 2009, Thomas and Redsteer 2016, Nauman et al. 2018).

3.5.2 Wetlands

Because of the region's arid climate, perennial streams and standing bodies of water are limited on the Navajo Nation. There are intermittent streams and drainages on the Navajo Nation. However, intermittent precipitation restricts wetland vegetation to areas where water is available throughout much of the year. Most wetlands are found near the San Juan and Little Colorado River drainages, the Chuska Mountains, and the bottom of ephemeral and intermittent washes (NNEPA 2009a).

Monocultures of tamarisk (*Tamarix* spp.) and mixed tamarisk stands are the most common riparian vegetation communities in ephemeral washes on the Navajo Nation. Species commonly found with tamarisk include the exotic Russian olive (*Elaeagnus angustifolia*), native cottonwood (*Populus* sp.), and native coyote willow (*Salix exigua*). Like the rest of the Southwest, native riparian vegetation is displaced by exotic tamarisk and Russian olive (Cadol et al. 2011). Seeps and springs, or hanging gardens, are found throughout the Navajo Nation and provide important habitat for a variety of plants and animals, including several endangered and threatened species (NNEPA 2009a, NNDFW 2020). In the Southwest, these ecosystems have high biodiversity and support a variety of plant and animal species, especially migratory birds. Weed populations, such as cheatgrass, Russian olive, and tamarisk, have spread to these areas and threaten valuable habitat for listed and sensitive species (NNDFW 2020).

Emergent wetlands are rare on the Navajo Nation due to a lack of standing water. However, some can be found near stock ponds, in backwater areas of the San Juan, and along the crest of the Chuska Mountains. Emergent wetlands are dominated by rushes (*Juncus* spp.), sedges (*Carex* spp.), cattails (*Typha* spp.), and bulrush (*Scirpus* spp.). The emergent wetlands in the Chuska Mountains are supported by seasonal snowmelt and summer monsoons and are unique due to their high diversity of plant species (NNEPA 2009a). The crest of the Chuska Mountains is flat in some areas, creating depressions that support numerous wetlands. Overall, there are 1,075 acres of emergent wetlands in the Chuska Mountains. This represents about 72% of all emergent wetlands on the Navajo Nation (NNEPA 2009a).

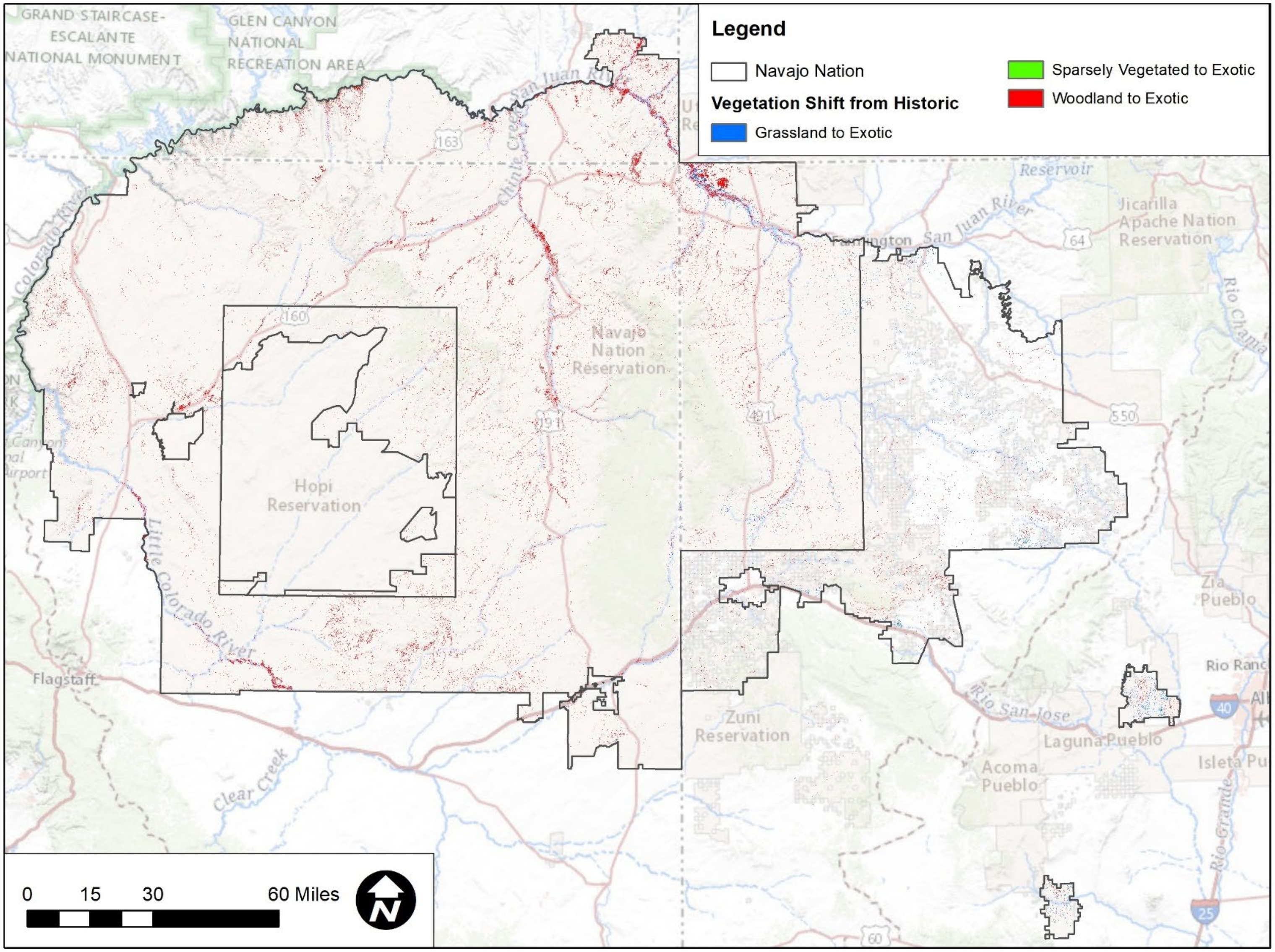

Figure 3-6. Map of areas where vegetation has shifted due to exotic weeds on the Navajo Nation. These shifts were calculated using a vegetation departure analysis comparing pre-European land cover to current LANDFIRE land cover from 2016.

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The San Juan and Little Colorado Rivers both support riparian shrublands and woodlands. Approximately 16,796 acres of riparian shrublands are found on the San Juan River and 14,690 acres are found on the Little Colorado River. These river corridors support close to 86% of riparian shrublands on the Navajo Nation. Additionally, the San Juan River delivers water to approximately 400 acres of emergent wetlands along the river channel (NNEPA 2009a). This represents about 23% of emergent wetlands on the Navajo Nation.

3.5.3 Noxious Weeds

Noxious weeds on the Navajo Nation have ecologically and economically impacted the Navajo Nation. Many are widely dispersed throughout the project area. Currently, documented weed populations exist on over 70,000 acres on the Navajo Nation (**Table 3-6**). Mapping suggests that weed cover and density is substantial in many of these areas. While mapping has mostly focused on areas where land users have requested management and control, which could bias the data, recent systematic mapping on the Navajo Nation estimates that weeds cover between 5 - 40% of surveyed areas. The actual extent of weeds identified in the NNIWMP is unknown but likely widespread. The NNIWMP requires the BIA to conduct comprehensive weed mapping to monitor the extent and cover of noxious weeds. While mapping is a priority for the BIA, funding is limited. Insufficient mapping may allow some weed populations to go undetected, which limits the effectiveness of eradication and prevention measures. Many infestations are in areas used by residents for grazing, farming, travel, or water collection, such as riparian areas. There are likely several thousand acres where weeds have not been formally documented.

Table 3-6. Weed mapping by BIA Navajo Agencies. The acres are compiled from weed inventories conducted by the BIA from 2005 to 2020. The percentage of surveyed areas with weeds is also reported for areas where survey areas are defined.

Agency	Acres of Weeds Mapped	% Weed Cover in Mapped Areas
Western	54,048.93	32.3
Eastern	292.42	53.9
Fort Defiance	6,289.25	67.3
Northern	5,914.44	46.9
Central	10,264.11	52.5
NPL	1,500.29	-
New Lands	226.50	-
ADOT	97.13	71.5
Other Roads	121.94	-
TOTAL	**77,755.01**	**N/A**

3.5.3.1 Priority Weed Species

The Bureau of Indian Affairs has identified 45 noxious weed species through previous weed inventories, and work with the Southwest Exotic Plant Information Clearinghouse Southwest Exotic Mapping Program, or SWEMP (**Table 3-7**). This expands the BIA's 2009 Noxious Weed List by 24 species. Descriptions and characteristics of each species are in Appendix L.

Table 3-7. Acres of priority weed species on the Navajo Nation. Includes weed mapping data compiled by the BIA and estimated acres from SWEMP by weed species. Weed acres documented below represent the most current weed documentation and are expected to change.

Category	Common Name	PLANT Code	Acres Mapped
A	African Rue	PEHA	0.001
	Blue mustard	CHTE2	0.06
	Bull thistle	CIVU	493.63
	Canada thistle	CIAR4	8.38
	Dalmatian toadflax	LIDA	98.55
	Musk thistle	CANU4	173.40
	Perennial pepperweed	LELA2	0.17
	Ravenna grass	SARA3	0.1
	Scotch thistle	ONAC	26.97
	Squarrose knapweed	CEVI	6.34
	Tall whitetop	CADR	1.33
	Tamarisk	TAMAR2	14,469.71
	Tree of Heaven	AIAL	1.50
	Yellow starthistle	CESO3	0.2
B	Camelthorn	ALMA13	3,678.01
	Diffuse knapweed	CEDI3	14.54
	Halogeton	HAGL	1,942.21
	Johnsongrass	SOHA	6.45
	Russian knapweed	ACRE3	901.44
	Russian olive	ELAN	4,723.69
	Siberian elm	ULPU	0.69
C	Bald brome	BRRA2	0.82
	California burclover	MEPO3	0.5
	Cheatgrass	BRTE	980.33
	Field Bindweed	COAR4	451.61
	Field brome	BRAR5	0.3
	Horehound	MAVU	0.81
	Kochia	BASC5	158.218
	Puncturevine	TRTE	301.24
	Red brome	BRRU2	46.24
	Ripgut brome	BRDI3	0.5
	Russian thistle	SAKA	33,297.96
	Smooth brome	BRIN2	0.75
	Spreading wallflower	ERRE4	0.1
NOT IDENTIFIED			16,477.21
TOTAL			**78,263.66**

3.5.4 Plants – Endangered, Threatened, Candidate, and Sensitive Species

There are 35 plant species protected on the Navajo Nation. All are listed tribally through the Navajo Nation Department of Fish and Wildlife and seven are also protected federally by the U.S. Fish and Wildlife Service (**Table 3-8**). Of the federally listed species, three species are endangered, four are threatened, and the Gooding's onion is protected by a Conservation Agreement with the U.S. Forest Service. For tribally listed species, 5 are listed as critically endangered (G2), 15 are endangered (G3), and 14 are sensitive or of concern (G4). Species are listed on the Navajo Nation based on species' populations on the Navajo Nation. Habitat information for all listed plant species is managed by NNDFW.

Table 3-8. Navajo Nation species of concern found as designated by the USFWS and the NNDFW.

Common Name	Scientific Name	Federal Status+	Tribal Status++	Location
Brady pincushion cactus	*Pediocactus bradyi*	E	G2	AZ
Mancos milkvetch	*Astragalus humillimus*	E	G2	AZ, NM
Fickeisen plains cactus	*Pediocactus peeblesianus var. fickeiseniae*	E	G3	AZ
Mesa Verde cactus	*Sclerocactus mesae-verdae*	T	G2	AZ, NM
Zuni/Rhizome fleabane	*Erigeron rhizomatus*	T	G2	AZ, NM
Navajo sedge	*Carex specuicola*	T	G3	AZ, UT
Welsh's milkweed	*Asclepias welshii*	T	G3	AZ, UT
Goodding's onion	*Allium gooddingii*	CA	G3	AZ, NM
Cutler's milkvetch	*Astragalus cutleri*	-	G2	UT
Aztec gilia	*Aliciella formosa*	-	G3	NM
Alcove death camas	*Anticlea vaginatus*	-	G3	AZ, UT
Marble Canyon milkvetch	*Astragalus cremnophylax* var. *hevroni*	-	G3	AZ
Cronquist milkvetch	*Astragalus cronquistii*	-	G3	UT
Naturita milkvetch	*Astragalus naturitensis*	-	G3	NM
Acoma fleabane	*Erigeron acomanus*	-	G3	NM
Round dunebroom	*Errazurizia rotundata*	-	G3	AZ
Navajo penstemon	*Penstemon navajoa*	-	G3	UT
Alcove rock daisy	*Perityle specuicola*	-	G3	UT
Navajo bladderpod	*Physaria navajoensis*	-	G3	AZ, NM
Alcove bog-orchid	*Platanthera zothecina*	-	G3	AZ, UT
Brack's Hardwall cactus	*Sclerocactus cloverae ssp. Brackii*	-	G3	
San Juan milkweed	*Asclepias sanjuanensis*	-	G4	NM
Heil's milkvetch	*Astragalus heilii*	-	G4	NM
Navajo saltbush	*Atriplex garrettii var. navajoensis*	-	G4	AZ
Atwood's camissonia	*Camissonia atwoodii*	-	G4	UT
Rydberg's thistle	*Cirsium rydbergii*	-	G4	AZ, UT
Utah bladder-fern	*Cytsopteris utahensis*	-	G4	AZ, NM
Sivinski's fleabane	*Erigeron sivinskii*	-	G4	AZ, NM
Sarah's buckwheat	*Eriogonum lachnogynum var. sarahiae*	-	G4	AZ, NM
Bluff phacelia	*Phacelia indecora*	-	G4	UT
Cave primrose	*Primula specuicola*	-	G4	AZ, UT
Marble Canyon dalea	*Psorothamnus arborescens var. pubescens*	-	G4	AZ
Parish's alkali grass	*Puccinellla parishii*	-	G4	AZ, NM
Arizona rose sage	*Salvia pachyphylla ssp. eremopictus*	-	G4	AZ
Welsh' American-aster	*Symphyotrichum welshii*	-	G4	AZ, UT

+E=endangered, T=threatened, CA=conservation agreement (precluded listing)

++G2=critically endangered, G3=endangered, G4=sensitive

A recent review of invasive species occurrence in key habitats on the Navajo Nation found that hanging gardens, which provide unique habitat for alcove death camas, Navajo sedge, alcove rock daisy, and the alcove bog-orchid, have been impacted by invasive species. Weed inventory and habitat monitoring indicate that cheatgrass, tamarisk, and Russian olive are the most common weeds in these protected habitats (NNDFW 2020).

3.5.5 Plants with Cultural and Traditional Significance

Numerous plants have traditional and cultural significance to the Navajo people for religious ceremonies, medicines, healing rituals, food, construction, arts and crafts, and dyes and paints. Plants are sacred to the

Navajo, and their collection requires careful consideration of where plants are collected, how much is present at a location, and how the plants will be used. Where plants are gathered may have special significance for different ceremonies or traditions for different communities and families. The importance of gathering places may differ depending on individuals, communities, medicine people, and ceremonialists (Martin 2002). During collection, a portion of the plant usually remains at a site for future use. Plant collection by Navajos for cultural uses does not require a permit.

Traditional healers and users may prefer to use different species or plant parts. Several ethnobotanical studies conducted on the Navajo Nation have identified over 450 culturally and traditionally important plants (Franciscan Fathers 1929, Young 1940, Wyman and Harris 1941, Steggerda and Eckardt 1941, Elmore 1944, Mayes and Rominger 1994, Rainey and Adams 2004). From these studies, it is understood that the Navajo have several plants that may serve the same medicinal or ceremonial purpose which can ensure locally availability of plants throughout the year (Elmore 1944).

Based on a survey conducted by the Navajo Natural Heritage Program (NNHP) in 2018 (Mike et al. 2018), 95 percent of community members use native plants for traditional or cultural purposes, but overgrazing, oil and gas extraction, historic uranium mining, drought, and the spread of invasive species contribute to the decline of these plants on the Navajo Nation.

Noxious weed and weed treatments could affect plants used for traditional purposes. Navajo elders have noticed that important, native medicinal plants have recently disappeared from certain localities, in some instances due to the spread of noxious weed (Mike et al. 2018). In areas where weeds impact plant collection sites, treatments could reduce or harm traditionally valuable plants. In some localities, noxious weeds are substituted for similar plants. Noxious weeds identified for traditional uses include:

- Thistles (*Cirsium* sp.)
- Horehound (*Marribium vulgare*)
- Burclover (*Medicago* sp.)
- Tamarisk (*Tamarix* spp.)
- Russian thistle (*Salsola tragus*)
- Puncturevine (*Tribulus terristris)*
- Cheatgrass (*Bromus tectorum*)
- Field bindweed (*Convolvulus arvensis*)

Thus, weed treatments could affect local traditional practices for communities that use noxious weeds in place of native species. The NNHPD’s Traditional Culture Program maintains a list of traditional plants and gathering sites used by the Navajo in conjunction with the Navajo Natural Heritage Program.

3.6 Wildlife

3.6.1 Terrestrial and Aquatic Wildlife

Wildlife occurs in all habitats across the Navajo Nation. There are a total of 37 reptile species from 8 families, 11 amphibian species from 5 families, 95 mammalian species from 19 families, and 32 fish species from 12 families confirmed on the Navajo Nation (**Table 3-9**) (Mikesic 2008). Of these species, four mammals, two reptiles, one amphibian, and 28 fishes are exotic. There are an additional 25 mammal species, 28 reptiles, 3 amphibians, and one fish that could occur but have not been detected on the Navajo

Nation. Three mammal species that no longer occur on the Navajo Nation and are not included in **Table 3-9**: the black-footed ferret (*Mustela nigripes*), Mexican gray wolf (*Canis lupus baileyi*), and grizzly bear (*Ursus arctos horribilis*). Navajo Nation and USFWS protected species are discussed separately.

Table 3-9. Terrestrial and aquatic wildlife families and number of species on the Navajo Nation.

Amphibians		
Family	**Scientific Name**	**Total Species**
Mole Salamanders	Ambystomatidae	2
True Toad	Bufonidae	4
Tree Frogs	Hylidae	2
True Frogs	Ranidae	1
Spadefoots, Archaic Frogs, and Pelobatids	Pelobatidae	2
Reptiles		
Family	**Scientific Name**	**Total Species**
Pond Turtles	Emydidae	2
Collared Lizards	Crotaphytidae	2
North American Spiny Lizards	Phrynosomatidae	8
Ground Lizards, New World Runners, Racerunners, Whiptails, Ameivas	Teiidae	5
Skinks	Scincidae	3
Slender Blind Snakes, Thread Snakes	Leptotyphlopidae	1
Colubrids	Colubridae	14
Vipers	Viperidae	2
Mammals		
Family	**Scientific Name**	**Total Species**
Shrews	Soricidae	4
Vespertilionid Bats	Vespertilionidae	12
Free-tailed Bats	Molossidae	2
Rabbits, Hares, Pikas	Lagomorpha	5
Squirrels, Marmots, Chipmunks	Sciuridae	15
Pocket Gophers	Geomyidae	3
Kangaroo Rats, Pocket Mice, and Relatives	Heteromyidae	12
Beavers	Castoridae	1
Old World Mice and Rats, Gerbils, Whistling Rats, and Relatives	Muridae	18
New World Porcupines	Erethizontidae	1
Coyotes, Dogs, Foxes, Jackals, and Wolves	Canidae	3
Bears	Ursidae	1
Coatis, Racoons, and Relatives	Procyonidae	2
Badgers, Otters, Weasels, and Relatives	Mustelidae	5
Skunks and Stink Badgers	Mephitidae	2
Cats	Felidae	2
Deer	Cervidae	3
Antelope, Cattle, Goats, Sheep, and Relatives	Bovidae	2
Asses, Horses, and Zebras	Equidae	2
Fishes		

Family	Scientific Name	Total Species
Herrings, Shads, Sardines, and Allies	Clupeidae	2
Carps	Cyprinidae	7
Suckers	Catostomidae	3
North American Freshwater Catfish	Ictaluridae	3
Pikes	Esocidae	1
Salmonids	Salmonidae	5
Killfishes	Cyprinodontidae	1
Poeciliids	Poeciliidae	1
Sculpins	Cottidae	1
Temperate Perches	Percichthyidae	1
Sunfishes	Centrarchidae	5
Perch	Percidae	2

Amphibians and Reptiles

Amphibians such as salamanders, frogs, and toads rely on aquatic habitats including cattle tanks, ponds, lakes, streams, springs, temporary pools, and other water sources which occur across the Navajo Nation. Adult amphibians occur in burrows or under surface objects (downed logs, rocks, etc.), and will exit at night or during humid periods when temporary ponds form. The canyon treefrog is an exception in that it can be observed on rocks, boulders, or cliffs near water sources and sometimes on talus far from water during the day (Brennan and Holycross 2006). Amphibians return to the water to lay eggs, and tadpoles and juvenile amphibians are primarily aquatic. Invertebrates such as insects, spiders, centipedes, and scorpions are the primary food source of amphibians.

Reptiles, including snakes, turtles, and lizards, occupy a diverse number of habitats across the Navajo Nation, including canyons, meadows, ponds, streams, valleys, upland desert scrub, conifer woodland, subalpine conifer, grasslands, shrublands, rolling hills, sand dunes, and bajadas (Brennan and Holycross 2006). Only exotic turtles occur on the Navajo Nation. Turtles, lizards, and skinks are typically active during the day whereas snakes can be active day or night. Lizards and skinks bask during the day on large rocks, trees, the ground, boulder piles, mountainsides, and lava fields and primarily eat insects and vegetation. Snakes occur in burrows, rock or wood piles, or on the open ground and primarily consume reptiles, amphibians, small mammals, birds, and insects.

There is little information of the impacts of noxious weeds on amphibians and reptiles. Riparian weeds, such as tamarisk, Russian olive, camelthorn, and knapweeds may impact the amount of bare ground around aquatic areas available for adult amphibians and dense root systems may impact the ability for amphibians to create burrows. Noxious weeds may impact reptiles by shifting habitats that would typically have more bare ground (native bunch grasses to noxious weed dominated grassland) that would bias toward reptiles that prefer dense vegetation to bare ground. Restored grassland habitats may have indirect negative impacts to reptiles, primarily snakes, when their small mammal food source prefers invasive dominated habitats thereby increasing snake abundance these habitats (Wolf et al. 2017).

Mammals

Larger wildlife species, such as mule deer, have declined on the Navajo Nation due to degraded and fragmented habitat. Much of the rangeland on the Navajo Nation has been overgrazed and infested with noxious weeds such as knapweed, thistles, and cheatgrass (NNDFW 2020) that are less palatable and nutritious to herbivores. Noxious grasses, such as cheatgrass, provide some forage to livestock and wildlife when the plant is young and green; however, the forage quality and palatability decline as the plants mature (Cook and Harris 1968, Mayland et al. 1994). Many native ungulates compete with domestic sheep, cows, and horses for limited forage. Limited nutritious forage reduces the overall health and condition of ungulates, making them more susceptible to disease, predation, and producing smaller offspring. Climate change exacerbates the degradation of rangeland health by promoting the expansion of noxious species. While deer can adapt to degraded rangeland health, because they eat a variety of vegetation species and absorb water from their food (MDWG 2004), other species such as bighorn sheep and pronghorn are not as adaptable, and populations may decline.

Noxious weeds in native plant communities have negative impacts on wildlife species. Weeds displace native forage, reduce forage availability and use; and can modify habitat structure (Duncan et al. 2004). Monocultures of noxious weeds increase the risk for wildfire (Knapp 1996, Link et al. 2006, Racher et al. 2002), which can reduce habitat availability. Some noxious weeds are poisonous to wildlife, which reduces available food resources. The replacement of native grasses with less palatable exotic annual grasses is common in disturbed or overgrazed areas, such as those found on the Navajo Nation. Cheatgrass displaces native perennial grasses and shrubs by germinating early with extensive and fast-growing shoot and root systems (UW and CSU 2013). Zouhar (2003) 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 forest habitats substantially less on sites dominated by knapweed than on sites dominated by native grasses (Sheley et al. 1999). Noxious weed control techniques can increase wildlife forage availability. In Montana, herbicide applications on spotted knapweed increased winter elk forage by 47% at sites with low to moderate weed infestations (Rice et al 1997).

Areas dominated by noxious weeds support lower wildlife diversity and more generalist species than areas with intact native plant communities. As native plant communities were replaced by noxious knapweed small mammal populations were shown to decline (Zouhar 2003). In rangeland habitats wildlife diversity decreased and generalist species dominated when native forbs were replaced by invasive *Bromus* sp. (Germino et al. 2016). A large portion of the Navajo Nation is open rangeland, where wildlife already competes with livestock for limited resources. Since weeds reduce habitat suitable for grazing, their increased spread can put increased pressure on resources needed for the ecological health and wildlife needs in the region.

Pollinators

Pollinators play an important functional role in maintaining wild plant communities and agricultural productivity. Pollinators can be specialists or generalists and, insects including bees, wasps, butterflies, moths, flies, beetles are the primary pollinators; however, small mammals and birds also contribute to pollinating plant communities. They are important for maintaining plant diversity especially in habitats with short and seasonally varied flowering times (Mooney and Zavaleta 2016). Additionally, plant diversity increases pollinator abundance and species richness (Ebeling et al. 2008). Therefore, as noxious weeds dominate sites and reduce plant diversity, pollinators that require a diversity of blooming forb species throughout the season also decline. Often noxious weeds attract invasive pollinators and are responsible for maintaining and expanding noxious weed populations by enhancing reproduction of these species (Gross et al. 2017). As noxious weeds replace native plant community's specialist pollinator populations may decline. Globally pollinators are declining due to loss and fragmentation of habitat, pesticide application, environmental pollution, decreased resource diversity, invasive species, spread of pathogens, and climate change (Potts et al. 2010). These impacts underscore the importance of restoring native plant communities while reducing cover of problematic weeds and vegetation.

3.6.2 Hunting and Fishing

The NNDFW is responsible for selling and regulating hunting and fishing permits on the Navajo Nation. Big game and fishing permits are available to both Navajos and non-Navajos. There are many factors that impact big game species populations and hunting quotas.

Big game populations are monitored and managed to ensure they do not become endangered, diseased, over-populated or cause too many human conflicts (Cole 2014). The big game species managed through hunting permits include deer, elk, turkey, pronghorn, black bear, desert bighorn sheep, and mountain lions. Hunting permits are an economic revenue source for the Navajo Nation, particularly for desert bighorn where non-Navajos will pay between $35,000 and $50,000 for a hunting permit, which provides funds for desert sheep management projects (Cole 2020). The Navajo Nation is divided into 16 Hunting Units with permit numbers based on the presence and population size of each species for each unit. Many years of overgrazing on rangeland across the Navajo Nation have increased noxious weeds and degraded big game habitat.

All waters managed for fish on the Navajo Nation are open to fishing with a permit (**Table 3-10**). Many of the fishing lakes and rivers, including Asaayi Lake, Cow Springs Lake, Ganado Lake, Many Farms Lake, Red Lake, San Juan River, and Wheatfields Lake, are surrounded by noxious plants, which can limit access to fishing areas and degrade habitat for fish. Trout, catfish, and bass have bag limits at Morgan Lake and Whiskey Lake. There are no bag limits on bluegills, sunfish, bullheads, crayfish, and waterdogs. To promote higher quality fishing at Whiskey Lake and Morgan Lake, timing restrictions are used.

Table 3-10. Fishing waters of the Navajo Nation and species of fish.

Fishing Waters	Primary Species
Antelope Lake	Rainbow Trout
Asaayi Lake	Rainbow Trout
Aspen Lake	Rainbow Trout
Berland Lake	Rainbow Trout
Chuska Lake	Rainbow Trout, Brown Trout, Cutthroat Trout
Cutter Dam Reservoir	Rainbow Trout, Brown Trout, Cutthroat Trout, Bullhead
Cow Springs Lake	Channel Catfish, Largemouth Bass, Bluegill
Ganado Lake	Channel Catfish, Largemouth Bass
Many Farms Lake	Channel Catfish, Largemouth Bass, Bluegill
Morgan Lake	Channel Catfish, Largemouth Bass, Bluegill, Carp
Red Lake	Largemouth Bass, Channel Catfish, Bullhead
Round Rock Lake	Channel Catfish, Rainbow Trout
San Juan River	Channel Catfish
Tsaile Lake	Channel Catfish, Rainbow Trout, Brown Trout, Brook Trout, Cutthroat Trout
Trout Lake	Rainbow Trout
Wheatfields Lake	Rainbow Trout, Brown Trout, Brook Trout, Cutthroat Trout
Whiskey Lake	Rainbow Trout, Cutthroat Trout
White Mesa Lake	Rainbow Trout

3.6.3 Terrestrial and Aquatic Wildlife Species – Endangered, Threatened, Proposed, Candidate, and Sensitive Species

There are 39 tribally listed terrestrial wildlife species on the Navajo Nation, four of which are also federally listed. Species listed for tribal designation are based on that species' population on the Navajo Nation. Of the tribally listed species, four are critically endangered (G2), six are endangered (G3), and 29 are sensitive (G4) (NNDFW 2020). Of the federally listed species, two are endangered and two are threatened. The black-footed ferret (G1) has been extirpated from the Navajo Nation, but there are proposed reintroduction efforts for this species adjacent to or on the Navajo Nation. If reintroduction occurs, species conservation measures and species designation would be detailed in the reintroduction plan.

Information on suitable habitat for all listed wildlife species is managed by the Navajo Department of Fish and Wildlife. More information on all federally and tribally listed species can be found in the Biological Assessment (Appendix I) and species potential habitat maps (Appendix E).

Table 3-11 describes the listed species, their federal and tribal status, range, and the known locations of the species or population on the Navajo Nation. Species surveys on the Navajo Nation are limited, and more populations may occur on the Navajo Nation in areas of suitable habitat (NNDFW 2020).

Table 3-11. Terrestrial and aquatic animal species of concern on the Navajo Nation designated by USFWS and NNDFW.

Group 2 (Critically Endangered) – Navajo Endangered Species List				
Birds				
Common Name	**Species Name**	**Federal Status⁺**	**Range**	**Occupied Range on Navajo Nation**
Western yellow-billed cuckoo	*Coccyzus americanus*	T	AZ, NM, UT	Breeds in several sections of the San Juan River. Potential for breeding at Little Colorado and Colorado rivers, Canyon de Chelly, Chinle Valley
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	AZ, NM, UT	Breeds on San Juan and Colorado Rivers. Migrants found in less dense or abundant riparian habitat
Bald Eagle*	*Haliaeetus leucocephalus*	-	AZ, NM, UT	Few nesting records and migrants use lakes, including: Wheatfields, Tsaile, Many Farms, Morgan, Red, Black Lakes, and various lakes in the Chuska Mountains. Winters along the San Juan and Colorado Rivers
Amphibian				
Common Name	**Species Name**	**Federal Status⁺**	**Range**	**Occupied Range on Navajo Nation**
Northern Leopard frog	*Lithobates pipiens*	-	AZ, NM, UT	No current populations. Historic records include Chuska Mountains; Little Colorado, Colorado, and San Juan Rivers; Navajo and Chinle Creeks; Canyon de Chelly; and near Tuba City, Cameron, Thoreau, and Newcomb

Group 3 (Endangered) – Navajo Endangered Species List				
Mammals				
Common Name	**Species Name**	**Federal Status⁺**	**Range**	**Occupied Range on Navajo Nation**
Pronghorn	*Antilocapra americana*	-	AZ, NM, UT	New Lands area, the southwestern portion north of Flagstaff, and checkerboard lands in New Mexico
Birds				
Common Name	**Species Name**	**Federal Status⁺**	**Range**	**Occupied Range on Navajo Nation**
Golden Eagle*	*Aquila chrysaetos*	-	AZ, NM, UT	Nests at nearly all elevations and on nearly all types of cliff substrates including sandstone, limestone, and those of volcanic origin
Ferruginous Hawk*	*Buteo regalis*	-	AZ, NM, UT	Breeds and winters in northwestern New Mexico, but also occur in Chinle Valley and Dilkon area
American dipper	*Cinclus mexicanus*	-	AZ, NM, UT	East and west faces of the Chuska Mountains, upper Canyon de Chelly, the Little Colorado River, and upper Piute Canyon near Navajo Mountain
Mexican spotted owl	*Strix occidentalis lucida*	T	AZ, NM, UT	Chuska Mountain Range, Defiance Plateau, Canyon de Chelly, Black Mesa, and the extensive canyonlands to the north.
Invertebrates				
Common Name	**Species Name**	**Federal Status⁺**	**Range**	**Occupied Range on Navajo Nation**
Great Basin Silverspot	*Speyeria nokomis*	-	AZ, NM, UT	Chuska Mountains and Defiance Plateau: Tsaile, Wheatfields, Whiskey Creeks, and two springs near Washington Pass
Group 4 (Sensitive) – Navajo Endangered Species List				
Mammals				
Common Name	**Species Name**	**Federal Status⁺**	**Range**	**Occupied Range on Navajo Nation**
Townsend's big-eared bat	*Corynorhius townsendii*	-	AZ, NM	Caves and abandoned mines throughout Navajo Nation
Chisel-toothed kangaroo rat	*Dipodomys microps*	-	AZ, UT	Near the Navajo Bridge of Marble Canyon
Banner-tailed kangaroo rat	*Dipodomys spectabilis*	-	AZ, NM, UT	Small remnant populations just west of Chinle and possibly near Navajo Mountain, with patches of desert lands in New Mexico. Potential range includes all desert lands east of the Chuska Mountains, northeast of Black Mesa in Apache Co., Arizona, and San Juan Co., Utah.
Navajo Mountain Vole	*Microtus mogollonensis*	-	AZ, NM, UT	Navajo Mountain, Black Mesa, Defiance Plateau, and Chuska Mountains
Wupatki pocket mouse	*Perognathus amplus cineris*	-	AZ	Narrow swath of the western Navajo Nation from the northern Echo Cliffs south to Wupatki National Monument near Flagstaff, AZ
Kit fox	*Vulpes macrotis*	-	AZ, NM, UT	East of the Chuska Mountains and Chinle Valley in Arizona and Utah

Birds

Common Name	Species Name	Federal Status+	Range	Occupied Range on Navajo Nation
Northern goshawk	*Accipiter gentilis*	-	AZ, NM, UT	Chuska Mountain Range, Defiance Plateau, and Black Mesa
Clark's grebe	*Aechmophorus clarkii*	-	AZ, NM, UT	Morgan Lake
Northern saw-whet owl	*Aegolius acadicus*	-	AZ, NM, UT	No documented breeding on NN, but potential in Chuska Mountains, Defiance Plateau, Black Mesa, and Navajo Mountain
Burrowing owl	*Athene cunicularia*	-	AZ, NM, UT	All low-elevation desert lands to elevations where juniper habitat is found
Belted kingfisher	*Ceryle alcyon*	-	AZ, NM	Chuska Mountains (Tsaile and Asaayi Creeks), Morgan Lake, and the Little Colorado River
Mountain plover	*Charadrius montanus*	-	AZ, NM, UT	New Mexico. Potential breeding in grasslands between the Chuska Mountains, Black Mesa, and southwest of Black Mesa to Little Colorado River
Dusky grouse	*Dendragapus obscurus*	-	AZ, NM, UT	Chuska Mountains
Yellow warbler	*Setophaga petechia*	-	AZ, NM, UT	No current breeding records, but potential exists in areas of the San Juan River and its tributaries
Hammond's flycatcher	*Empidonax hammondii*	-	AZ, NM, UT	Only known nesting site occurs in the Chuska Mountains; potential on Black Mesa and Navajo Mountain
Northern Pygmy owl	*Glaucidium gnoma*	-	AZ, NM, UT	Chuska Mountain Range and Tsegi Canyon
California condor	*Gymnogyps californianus*	E	AZ, NM, UT	Marble Canyon, Grand Canyon, and western Navajo Nation. One nesting attempt on NN
Flammulated owl	*Otus flammeolus*	-	AZ, NM, UT	Chuska Mountain Range, Defiance Plateau, and Black Mesa
Band-tailed pigeon	*Patagioenas fasciata*	-	AZ, NM, UT	Chuska Mountains; potential on the Defiance Plateau, Black Mesa and Navajo Mountain
American three-toed woodpecker	*Picoides dorsalis*	-	AZ, NM, UT	Chuska Mountains
Sora	*Porzana carolina*	-	AZ, NM, UT	Ponds and lakes in the Chuska Mountains, Morgan Lake, and near Tuba City
Tree swallow	*Tachycineta bicolor*	-	AZ, NM, UT	Chuska Mountains
Gray vireo	*Vireo vicinior*	-	AZ, NM, UT	Unknown

Reptiles

Common Name	Species Name	Federal Status+	Range	Occupied Range on Navajo Nation
Milk snake	*Lampropeltis triangulum*	-	AZ, NM, UT	No current records but occurs in bordering areas (Farmington, Cameron, Bluff, Wupatki National Monument, and Petrified Forest National Park)
Chuckwalla	*Sauromalus ater*	-	AZ, UT	Deep canyons and adjacent desert lands of the Little Colorado River, the Marble Canyon area (including Echo Cliffs), and the San Juan River in Utah

Invertebrates				
Common Name	**Species Name**	**Federal Status⁺**	**Range**	**Occupied Range on Navajo Nation**
Rocky Mountainsnail	*Oreohelix strigosa*	-	AZ, NM, UT	One record from south slope of Navajo Mountain, but presently only a few locations in the Chuska Mountains
Yavapai Mountainsnail	*Oreohelix yavapai*	-	AZ, NM, UT	Only known from one location in Canyon de Chelly National Monument
Kanab Ambersnail	*Oxyloma haydeni kanabensis*	-	AZ	No current populations. Potential for species is western NN, including tributaries of the Colorado and Little Colorado Rivers, springs on Echo Cliffs, and creeks north and west of Navajo Mountain

⁺E=endangered, T=threatened, D=delisted

3.6.4 Fish Species – Endangered, Threatened, and Sensitive Species

The Navajo Nation contains populations or suitable habitat for seven tribally listed fish species, five of which are also federally listed as endangered (**Table 3-12**). The Zuni bluehead sucker was recently recognized as a distinct subspecies of bluehead sucker and listed for protection as a sensitive species (G4) by the Navajo Nation, and as a federally endangered species. Information on suitable habitat for all listed fish species is managed by NNDFW.

Five of the seven fish species occur only in the San Juan River, along the northern border of the Navajo Nation. The San Juan River has naturally high turbidity due to high sediment loads from tributaries in Arizona and New Mexico and from highly erodible surrounding geology, agricultural plots, roads, and livestock grazing (USBOR 2002). Organochlorine pesticides are found in low concentrations from agriculture along the San Juan River; however, they are not in high enough concentrations to affect fish and wildlife (USGS 1998). Elevated contaminants that could affect fish reproduction and overall health in the San Juan River include aluminum, arsenic, copper, selenium, zinc and polynuclear aromatic hydrocarbons (PAH) (SJRIP 1999). Most of these contaminants are naturally occurring, except for elevated selenium levels near irrigated farmlands, uranium mining, and oil refineries (USBOR 2002). PAH are byproducts from combustion engines, coal fired generation plants and forest and agricultural fires (USBOR 2002). Zinc comes from mine tailings in the Upper Animas River; and there is no known source for copper (USBOR 2002). After the Gold King Mine wastewater spill on the Animas River in Colorado, fish samples in the San Juan River were screened for 25 metals, which were all below the consumption limits set by the USEPA (Tetra Tech, Inc. 2017).

Zuni bluehead suckers occur in smaller drainages with clean, clear water and abundant riparian vegetation. This species is sensitive to increased sedimentation which impacts reproduction and food availability (USFWS 2014).

Table 3-12. Fish species of concern on the Navajo Nation as designated by USFWS and NNDFW.

Group 1 (Extirpated) – Navajo Endangered Species List				
Common Name	**Scientific Name**	**Federal Status⁺**	**Location**	**Occupied Range on Navajo Nation**
Bonytail chub	*Gila elegans*	E	AZ, NM, UT	Currently no known records.

Group 2 (Critically Endangered) – Navajo Endangered Species List				
Common Name	**Scientific Name**	**Federal Status⁺**	**Location**	**Occupied Range on Navajo Nation**
Zuni bluehead sucker	*Catostomus discobolus yarrow*	E	AZ, NM	Black Soil Wash, Kinlichee Creek, Scattered Willow Wash, and Red Clay Wash. Sensitive to increased sedimentation.
Humpback chub	*Gila cypha*	E	AZ, UT	Colorado River in Grand Canyon National Park
Roundtail chub	*Gila robusta*	-	AZ, NM	San Juan and Mancos Rivers
Colorado Pikeminnow	*Ptychocheilus lucius*	E	AZ, NM, UT	San Juan River, from Shiprock to Lake Powell; the mouth of the Mancos River during spring runoff
Razorback sucker	*Xyrauchen texanus*	E	AZ, NM, UT	No known current populations. Historic record from San Juan River near Bluff, Utah
Group 4 (Sensitive) – Navajo Endangered Species List				
Common Name	**Scientific Name**	**Federal Status⁺**	**Location**	**Occupied Range on Navajo Nation**
Bluehead sucker	*Catostomus discobolus*	-	AZ, NM, UT	San Juan River and major tributaries, Little Colorado River, Kinlichee, Whiskey, Wheatfields, and Tsaile Creeks

⁺E=endangered, C= candidate.

3.6.5 Migratory Birds

The Migratory Bird Treaty Act of 1918 (MBTA) (16 U.S.C. 703-712) was implemented to ensure the sustainability of migratory bird populations and prohibit take (killing, capturing, selling, trading and transport) of migratory birds without authorization by USFWS. Most bird species on the Navajo Nation, except exotic species, are protected under the MBTA. There are 173 species in 52 families with confirmed breeding or wintering on the Navajo Nation, not including NNDFW and USFWS listed or sensitive species (**Table 3-13**). Six species are exotic and not covered under the MBTA. In addition, 82 species were accidental or transient and not included in the table below.

Neotropical migratory birds (NTMBs) are a subset of bird species protected under the MBTA that breed in the United States and winter in Central and South America. These migratory birds are of concern because their populations have been declining, likely due to habitat modification in breeding and wintering habitats (Faaborg et al. 2010). Numerous NTMBs use habitats on the Navajo Nation for breeding, rearing young, or migration at various times of the year. Native riparian and woodland habitats and canyonlands in good ecological condition are important habitat for many of these bird species.

Table 3-13. Bird family and total species occurring on the Navajo Nation. The table does not include accidental or transient species or NNDFW and USFWS listed species.

Family	Scientific Name	Total Species
Coons	Gaviidae	2
Grebes	Podicipedidae	5
Pelicans	Pelecaniidae	1
Cormorants and Shags	Phalacrocoracidae	1
Herons, Egrets, and Bitterns	Ardeidae	5
Ibises and Spoonbills	Threskiornithidae	1
New World Vultures	Cathartidae	1
Ducks, Geese, and Waterfowl	Anatidae	23
Hawks, Eagles, and Kites	Accipitridae	7
Falcons and Caracaras	Falconidae	4
Pheasants, Grouse, and Allies	Phasianidae	3

Family	Scientific Name	Total Species
New World Quail	Odontophoridae	2
Rails, Gallinules, and Coots	Rallidae	2
Plovers and Lapwings	Charadriidae	4
Stilts and Avocets	Recurvirostridae	2
Sandpipers and Allies	Scolopacidae	17
Gulls, Terns, and Skimmers	Laridae	8
Pigeons and Doves	Columbidae	4
Cuckoos	Cuculidae	1
Barn Owls	Tytonidae	1
Owls	Strigidae	4
Nightjars and Allies	Caprimulgidae	2
Swifts	Apodidae	1
Hummingbirds	Trochilidae	3
Woodpeckers	Picidae	8
Tyrant Flycatchers	Tyrannidae	11
Shrikes	Laniidae	2
Vireos, Shrike-Babblers, and Erpornis	Vireonidae	4
Crows, Jays, and Magpies	Corvidae	8
Larks	Alaudidae	1
Swallows	Hirundinidae	6
Tits, Chickadees, and Titmice	Paridae	3
Long-tailed Tits	Aegithalidae	1
Nuthatches	Sittidae	3
Treecreepers	Certhiidae	1
Wrens	Troglodytidae	6
Dippers	Cinclidae	1
Kinglets	Regulidae	2
Sylviid Warblers, Parrotbills, and Allies	Sylviidae	1
Thrushes and Allies	Turdidae	6
Mockingbirds and Thrashers	Mimidae	4
Starlings	Sturnidae	1
Wagtails and Pipits	Motacillidae	1
Silky Flycatchers	Ptilogonatidae	1
New World Warblers	Parulidae	7
Yellow-breasted Chat	Icteriidae	1
Tanagers and Allies	Thraupidae	3
New World Sparrows	Passerellidae	22
Cardinals and Allies	Cardinalidae	5
Troupials and Allies	Icteridae	9
Finches, Euphonias, and Allies	Fringillidae	10
Old World Sparrows	Passeridae	1

Noxious weeds in native plant communities have negative impacts on bird species. Weeds can displace preferred native forage, reduce forage availability; and modify habitat structure (Duncan et al. 2004). Noxious weed dominated habitats reduce the diversity of bird feeding guilds, overall bird abundance, and insects for food (Ellis 1995, Flanders et. al. 2006). Cavity nesting and timber gleaning birds thrive in habitats dominated by native cottonwood forests but are rare or absent in non-native tamarisk patches (Ellis 1995). In another instance, noxious weed dominated grasslands in Texas had 26 to 73 percent less abundance of five grassland bird species than native grasslands (Flanders et. al. 2006). Monocultures of noxious weeds can also increase wildfire risk (Knapp 1996, Link et al. 2006, Racher et al. 2002), which can reduce habitat availability for riparian and forest bird species and decrease the raptor prey base. Even though overall bird diversity declines in noxious weed dominated sites, some bird species have adapted to these conditions and use noxious weed dominated habitats for breeding and foraging. In the southwest United States, 49 bird species use riparian habitats dominated by tamarisk (*Tamarix* sp.) for breeding (Sogge et al. 2008). Completely removing tamarisk monocultures would greatly affect migratory birds if not replaced with native species. A review of effects on migratory birds is discussed in Chapter 4.

3.7 Agriculture

Agriculture is a key part of Navajo society, economy, and culture. Livestock ownership and farming are rooted in the Navajo identity as symbols of resourcefulness, prosperity, and social status. Economically, farming and livestock raising are important ways of life for many Navajo people. These activities provide cultural knowledge, food, and materials for many communities as well as fiber for jewelry making, weaving, and the production of other handicrafts. This agricultural analysis will focus on crop production, livestock management, and commercial agricultural operations. Agriculture on the Navajo Nation is managed by the Navajo Nation Department of Agriculture (NNDA) and the BIA Division of Natural Resources. As part of its trust responsibilities, the BIA issues permits for grazing and farming with tribal government approval. NNDA provides administrative, guidance, enforcement, and support services for all grazing and farming land use.

The Navajo Nation is divided into Land Management Districts (**Figure 3-7**). Each District is managed by a District Grazing Committee. District Grazing Committees provide guidance, coordination, and technical assistance for grazing and agricultural land use permittees. The BIA works closely with them to plan natural resource management projects, including weed management projects. For the Eastern Navajo Agency, instead of Grazing Committees, agricultural activities are managed by the Eastern Navajo Land Board and Farm Boards. The Eastern Navajo Land Board provides grazing management for communities in the Eastern Region and off-reservation permittees, including authority to grant grazing permits. Farm Boards specifically address concerns for irrigated farmlands. In the Navajo Partitioned Lands, all portions of the grazing management districts within the boundary are managed as part of the Joint Navajo Partitioned Lands District Grazing Committee. This impacts parts of Districts 1, 2, 3, 4, 5, 7, and 8, which are divided into Precincts 1 – 3.

3.7.1 Livestock/Grazing Management

Livestock raising is an important economic and cultural activity on the Navajo Nation. Sheep, cattle, goats, llamas, and horses became an integral part of Navajo life after the Spanish introduced them in the fifteenth century (Underhill 1956). Since then, the Navajo have practiced pastoralism, moving their animals to different pastures each season (Weisiger 2004). Sheep are valued as a source for wool and meat. Sheep wool is essential for Navajo textiles, including weavings, blankets, and clothing. Meat from sheep is commonly used for ceremonial purposes and gatherings (Witherspoon 1973). Cattle and goats are raised for their meat and dairy products, while llamas are raised for their wool. Horses were introduced by the Spanish and soon were used for travel and, occasionally, as a food source. While some are permitted, free-roaming horses are common and are occasionally rounded up and sold to reduce overgrazing and erosion. Tally count data from the BIA is used to indicate what kinds of livestock are managed on the Navajo Nation and how the populations may change (**Table 3-14**).

Table 3-14. 2018 Navajo Nation livestock tally count data. Tally counts represent around 10-30% of the livestock on designated rangeland and excludes unpermitted animals. Tally count data estimate composition of livestock. The percentages in the bottom row estimate the portion of the counted livestock population. All animals are presented in sheep units (SU). 1 cow = 4 SU, 1 horse = 5 SU, 1 llama = 3 SU. Sheep and goats equal 1 SU.

Agency	Approved Grazing Permits	No. of Permitted SUYL	Sheep	Cow SU	Horse SU	Goats	Llama SU	Total SUYL
Western Navajo	2,619	137,142	10,277	8,667	1,547	1,034	0	21,525
Northern Navajo	2,004	86,429	5,658	2,614	490	444	0	9,206
Central/Chinle Navajo	1,474	54,009	3,135	1,075	262	168	0	4,640
Fort Defiance	3,727	169,688	8,926	2,298	1,272	468	21	12,975
Eastern Navajo	1,102	57,678	924	-	170	117	-	1,211
New Lands	75	4,346	231	2,948	120	84	2	3,385
Navajo Partitioned Lands	-	-	313	44	65	27	0	449
TOTAL	**11,001**	**509,292**	**29,151**	**17,646**	**392**	**2,332**	**23**	**53,391**
% of tallied animals	**-**	**100**	**55.06**	**33.25**	**7.29**	**4.37**	**0.04**	**10.40**

Both the BIA and the NNDA have jurisdiction over the approval and management of grazing permits on the Navajo Nation. The BIA approves grazing permits assigned to designated range units based on land management district (**Table 3-15, Figure 3-7**). District Grazing Committees and the BIA manage inventories, planning, improvements, and protection of rangelands. Currently, enforcement of grazing regulations is assumed by the District Grazing Committees (or the Eastern Navajo Land Board for districts in Eastern Agency and off reservation lands).

Table 3-15. Navajo grazing permits for 2019 as reported by the BIA Navajo Regional Office.

Agency	Land Management District	# of Grazing Permits
Central (CNA)	4	83
	10	942
	11	458
Eastern (ENA)	15	129
	16	248
	19	83
	20	267
Fort Defiance	7	608
	14	735
	17	1,426
	18	958
Northern (NNA)	9	593
	12	1,200
	13	210
Western (WNA)	1	535
	2	365
	3	661
	5	352
	8	706
Navajo Partitioned Lands	Precinct 1	10
	Precinct 2	0
	Precinct 3	10
TOTAL		**10,621**

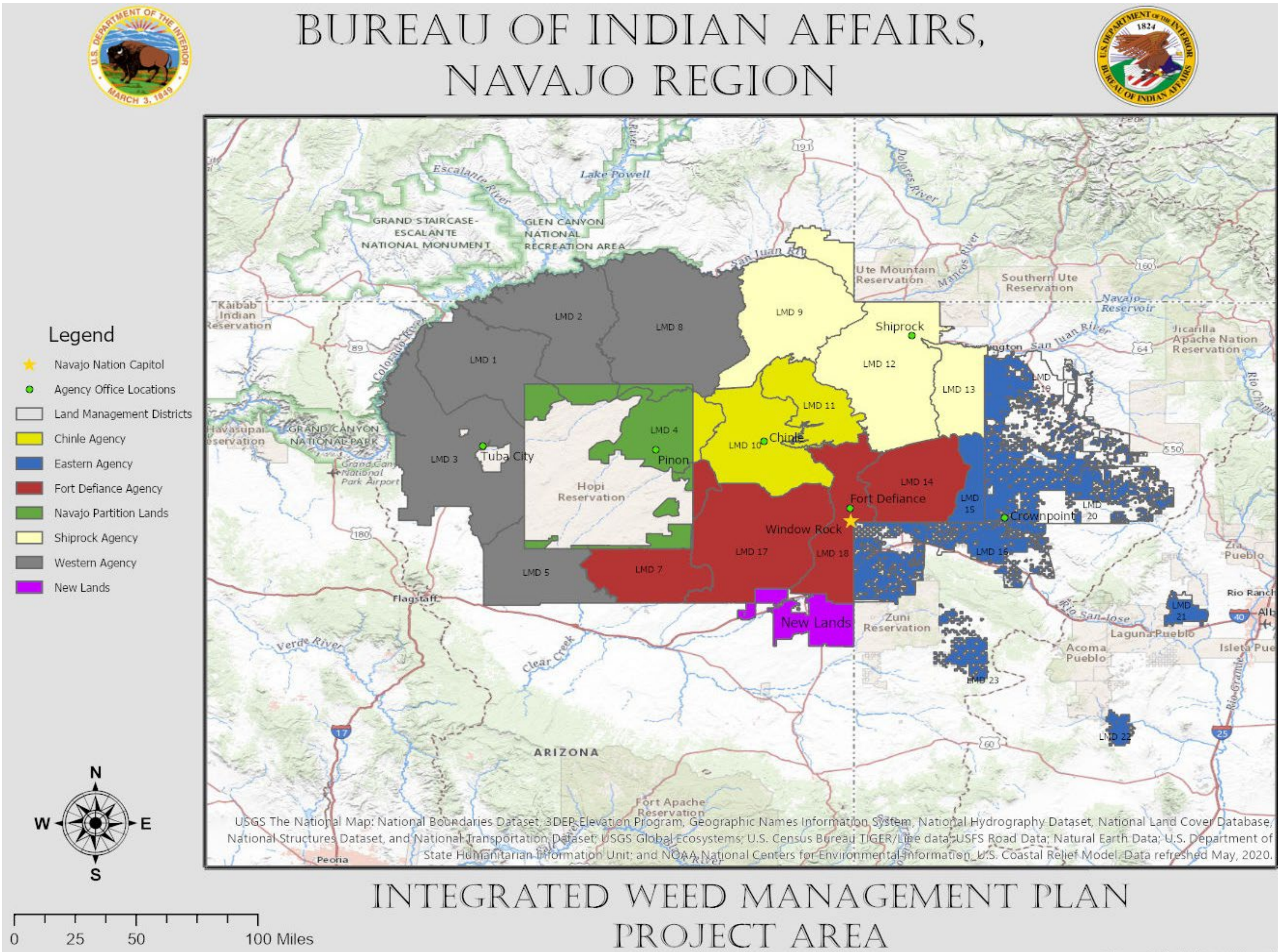

Figure 3-7. Map of the Land Management Districts for the Navajo Nation. Grazing and farming are managed by District.

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Management of Navajo rangelands is complex. When permits were first issued in the 1940s, each grazing district used a set number of animal units to divide between permittees based on the district carrying capacity. These initial permits did not account for the carrying capacity of individual permit areas when allocating animals. In many areas, the number of permitted animals is higher than available forage can sustain, leading to reduced rangeland quality. Recent BIA rangeland inventories indicate that many land management districts (LMD) on the Navajo Nation are considerably degraded, likely from overgrazing. Additionally, understanding the current livestock population is difficult as only 10-30% of permitted annuals are tallied each year, and many others are free-roaming and wild. Aerial surveys by NNDFW estimate total free-range horse populations (permitted and free ranging) at 0.57 horses/km on the Navajo Nation in open rangelands and forests (Wallace et al. 2021). Recent rangeland inventories indicate that permitted and feral livestock and wildlife populations currently exceed the carrying capacity for rangelands in several districts, contributing to their decline. The decline has also been tied to prolonged drought, invasive weeds, and topsoil loss from erosion (Fleischner 1994).

Noxious weeds are a major problem on Navajo Nation rangelands. Unsustainable grazing management practices throughout the West have created conditions that facilitate the spread of many exotic weeds (Abruzzi 1995). Heavy grazing pressure reduces cover of preferred native perennial species and increases erosion. Coupled with drought conditions, grazing pressure facilitates changes to the landscape that increase invasive species and other unpalatable forbs and shrubs. Grazing animals can also spread weeds when eating or traveling through infested areas. Seeds, leaves, and other plant parts can attach to animal coats or be eaten, and then are deposited in other non-infested areas. Annual species can replace perennial species needed for forage, changing vegetative cover and the seasonality of plant communities (Draut et al. 2012). These changes have synergistic effects, contributing to increased erosion and topsoil loss, especially in areas where the number of animals often exceeds current carrying capacity.

Some weeds species may be harmless to livestock for only a short period of time before flower or seed formation increases the production of harmful chemicals. Some weeds produce chemicals that can make livestock sick or result in death. For example, halogeton and kochia plants produce sodium oxalate, which increases as the plant matures. At high doses, oxalates can damage the kidneys and rumen walls, and inhibit 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, 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).

Weeds also impact rangeland economics. Agricultural economists estimate that leafy spurge invasions in North Dakota reduced income for cattle producers by around $9 million with an additional $15 million in losses from reduced livestock production (Beck 1994). In a study of yellow starthistle, economists estimate that infestations resulted in $12.7 million in direct and indirect costs to Idaho rangelands (Juliá et al. 2007). Other economic analyses estimate that problematic rangeland species, such as cheatgrass, exotic knapweeds, and leafy spurge cause an estimated loss of $2 billion annually in the United States (DiTomaso 2000). These losses are from reduced animal and forage production, costs for treating weeds and improving rangeland, and reduced land values.

While there are recent shifts towards sustainable grazing methods on the Navajo Nation, such practices are limited in how they address weed infestations. Sustainable grazing management is recommended on the Navajo Nation, but it does not provide comprehensive management of invasive species. Reduced herd size, rotational grazing, and active weed management in pastures may alleviate grazing pressure and allow native forage to return over time, but they would not address existing weed populations or provide a comprehensive approach to weed management. Grazing management plans are currently limited to customary use areas where grazing is permitted, and they provide limited means for coordinating with neighboring agencies or in priority areas where weeds cause concerning ecological and economic damage. Additionally, grazing management, by design, focuses on animal production with recommendations on how to manage natural resources for livestock. While grazing management supports the sustainable use of natural resources, its primary focus is livestock production with a secondary focus on wildlife, water quality, and soil health. The Navajo Nation has been working on options to address grazing, including an Agricultural Resource Management Plan to provide a sustainable approach for grazing management.

3.7.2 Farming

Farming has been an important part of Navajo culture since before the arrival of Spanish settlers, who observed their farming abilities in the arid Southwest (Weisiger 2004). When the Navajo Indian Reservation was established in 1868, the Navajo were encouraged to continue farming through federal subsidy programs that provided seeds, farming equipment, and consumables. The Navajo were encouraged to plant marketable crops such as corn, squash, wheat, peaches, hay, and beans.

Farming is managed by NNDA and the BIA through an agricultural land use permit system. Agricultural permits are required in customary use areas used for farming. In 2019, there were an estimated 5,000 agricultural permits for small family farms on 57,900 acres (**Table 3-16**). Of these, 948 permits were designated for irrigated farms at Cudei Ditch, Hogback Ditch, and Upper Fruitland Ditch. Other farms use dryland farming. Dryland farming requires water delivery systems to capture and transport water for irrigation. These farms produce commercial and subsistence crops on smaller plots. The crops from dryland farms can subsidize food stores for individual homes, family, and communities.

Table 3-16. Agricultural Land use permits for 2019 as reported by the BIA Navajo Regional Office. Data compiled October 2020.

Agency	Land Management District	# of Agricultural Land Use Permits
Central (CNA)	4	20
	10	181
	11	859
Eastern (ENA)	15	6
	16	23
	19	-
	20	4
Fort Defiance (FDA)	7	14
	14	451
	17	291
	18	616
Northern (NNA)	9	302
	12	917
	13	7
Irrigated areas	Cudei Ditch	52
	Hogback Ditch	543
	Fruitland Ditch	353
Western (WNA)	1	51
	2	79
	3	190
	5	31

Agency	Land Management District	# of Agricultural Land Use Permits
	8	65
TOTAL		5,055

Dryland farming alters the surrounding area by transporting water to active plots. Such modifications can increase erosion and arroyo development, altering groundwater recharge and stream channelization (Jayne 1985). Farming also introduces regular disturbance to the landscape, as plots are tilled and seeded. Sustainable soil management, such as using cover crops and reducing tillage can make inactive fields less prone to invasive weeds, improved soil productivity, and reduced erosion.

3.7.3 Navajo Agricultural Products Industry – Navajo Indian Irrigation Project

Since 1970, the Navajo Nation has managed the Navajo Agricultural Products Industry (NAPI), which produces various commercial crops (**Figure 3-8**). The project is located in the northeastern across the Northern and Eastern Navajo Agency border. NAPI has a managing stake in the Navajo Indian Irrigation Project (NIIP). NIIP is a water diversion project that transports water from the San Juan River to NAPI farmlands. NIIP is about 70% complete with ongoing construction to develop irrigation for remaining 30,000-40,000 acres not currently in production. Major crops include alfalfa, beans, corn, potatoes, and wheat (**Table 3-17)**. Currently, NAPI has between 60,000 and 70,000 acres in active production.

As with most large-scale agriculture enterprises, there are environmental concerns related to NAPI's operations. These concerns include the use of fertilizer and pesticides, selenium leaching, drainage, erosion, and sedimentation (Trujillo 2006). Several weed species occur on NAPI lands. Approximately 1,340 acres of surrounding rangelands have tamarisk, Canada thistle, knapweeds, musk thistle, and perennial pepperweed. While weeds impact only a small portion of the land managed by NAPI, these weeds spread quickly and reduce productivity. NAPI's water resources are limited, and there is concern weeds could reduce water availability. Due to these concerns, NAPI works with the BIA Northern Navajo Agency, NRCS, and the New Mexico Agricultural Extension Agency to address weed management needs. In addition to its active fields, NAPI also manages 30,000-40,000 acres of inactive fields for wildlife, which have been colonized by many priority weed species. These areas are adjacent to BLM lands managed by the Farmington Field Office, which cannot manage weeds on tribal trust lands.

Table 3-17. Estimated acres for various crops grown by NAPI (Roland Becenti, personal communication, July 17, 2020)

Crop	Estimated Acres
Alfalfa	21,405
Corn	13,558
Dry Beans	4,486
Winter Wheat	7,980
Potatoes	3,709
Pop or Orn Corn	4,540
Pumpkins	1,216
Rye	0
Sorghum	0
Barley	0
Other Hay/Non-Alfalfa	3,597
Oats	0

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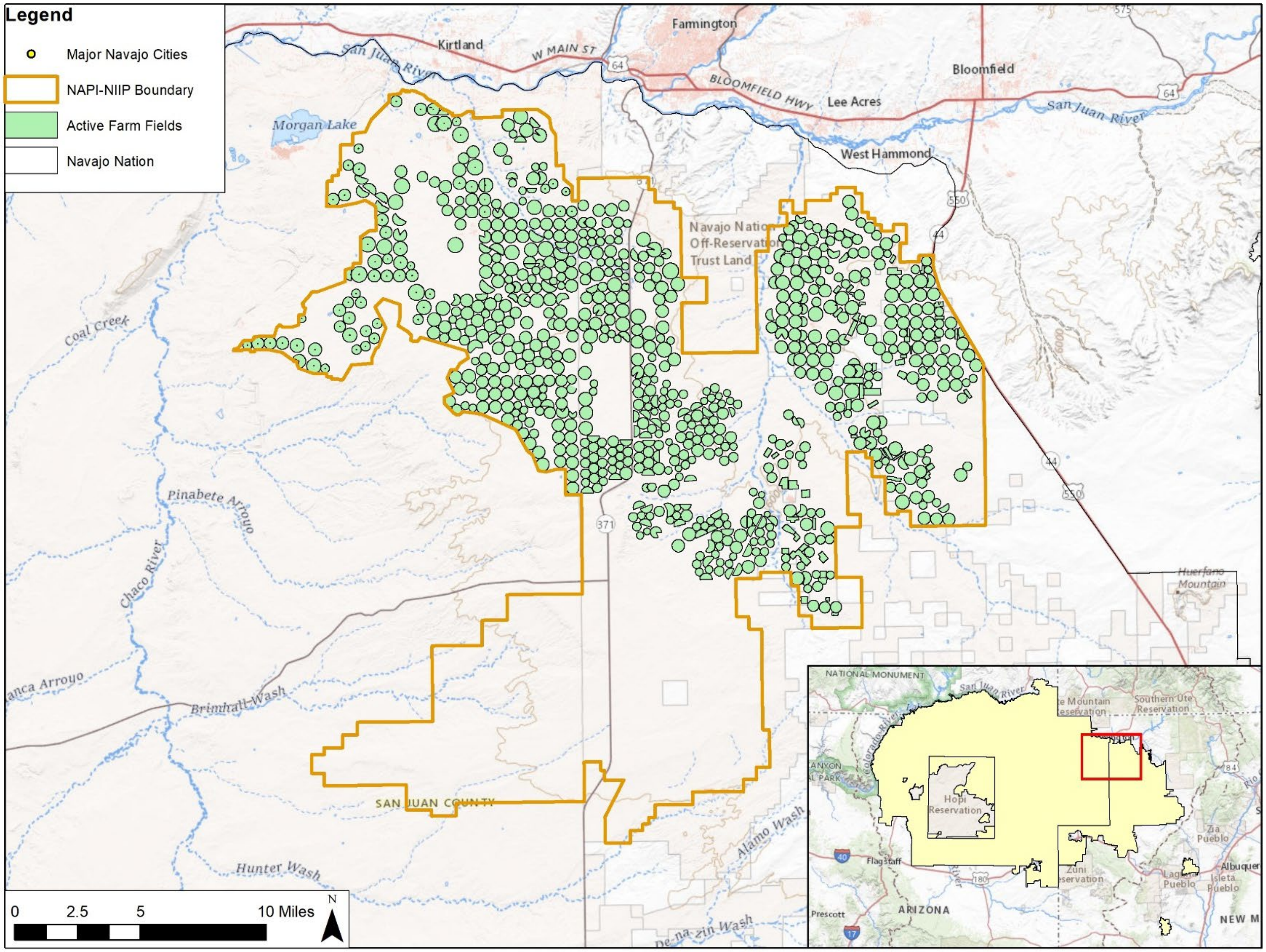

Figure 3-8. Map of the NAPI project area with active fields in green. The project is located across the Northern and Eastern Navajo Agencies.

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Weeds negatively impact farming by decreasing productivity and crop yields, increasing erosion and topsoil loss, reducing land values, decreasing product quality, and increasing maintenance costs. On lands managed by NAPI-NIIP (approximately 110,000 acres), weeds have impacted wildlife habitat and commercial agricultural production. As weeds invade agricultural lands and farm plots, they outcompete desired crops and plants. Crowding, allelopathy, and altered growing seasons are factors that facilitate the spread of noxious weed species on farmlands. One study on the impacts of weeds on North American crops estimated that weeds result in close to $120 billion in annual losses (Pimentel et al. 2005).

While weeds are undesirable, some species may provide beneficial impacts to agricultural operations. Deep-rooted weeds can bring nutrients from the subsoil to the topsoil, making them available for some crops. Weeds also provide habitat for beneficial insects and serve as alternative food sources for pest species, lessening their impacts on desired vegetation. Some noxious plant species can be used as fuel for biogas operations (Pimentel et al. 2005). However, the weed species identified in the Plan have more negative impacts than positive ones on agricultural lands.

3.8 Public Health

Noxious weeds do pose some risks to human health, mostly from cuts or allergies. Weeds can cause physical harm through contact with various plant parts or substances. Weeds with thorns or prickles, like thistles or knapweeds, can cause irritation and scratches as sharp plant parts poke or attach to the skin or clothing. Other species produce harmful skin irritants and poisonous substances. For example, leafy spurge produces a latex substance that can cause minor itching to severe burns and is toxic to humans (Modi et al 2009). The severity of harm depends on the species, the size of the population, and how the plants are encountered.

Some weed species can cause allergic reactions. An allergic reaction occurs when the body overproduces antibodies to a specific foreign substance, resulting in a cascade of symptoms from itching to hay fever to anaphylaxis. Species known to induce allergies include Russian thistle, kochia, Siberian elm, tree of heaven, ripgut brome, and smooth brome (Stallergenes Greer 2020). A plant's ability to induce an allergic reaction depends on its pollen chemistry, how it is pollinated (i.e., wind-pollinated plants), and how widespread it is (Cariñanos et al. 2016, Lo et al. 2019). Some weeds, such as Russian thistle and kochia, can cause severe allergies, while others, like smooth brome, may not. How individuals react to a plant varies widely. Some people may have no reaction at all. Others may only react when in direct contact with a plant or may be especially sensitive when they are near the plant. For these individuals, the health risks can be greater as their allergic response can vary greatly and may include anaphylaxis, which can result in death if not treated immediately. Thus, while some noxious weeds may not pose a major risk to most of the general population, there are individuals who may have severe negative reactions.

Managing weeds also has human health risks, especially to those directly treating them. Some treatment methods can aggravate respiratory conditions by exposing sensitive individuals to allergens. Treatments involving sharp tools or heavy equipment can increase the risk of personal injury if the tools are not used properly. However, the methods that pose the most risk to human health are those using herbicides.

Herbicide use on the Navajo Nation has increased steadily over the past 20 years on roads, rights-of-way, homes, farmland, and rangeland. However, quantifying their overall use is hard as some herbicides are available over the counter, making it difficult to track and monitor their use. Herbicides, such as Round-Up® (glyphosate), Weed-be-Gone® (2,4-D), and BioAdvanced® (2,4-D) are regularly sold directly to the public. In contrast, land management agencies are required to report all herbicide use under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). Use by the public could increase the amount applied in areas and increases possible health risks to local communities and sensitive individuals.

Potential reactions to herbicide exposure include increased allergy sensitivity, dizziness, cardiovascular irregularities, flu-like symptoms, asthma, chronic exhaustion, headaches, mental confusion, and seizures (AZTAP 1996, Felsot 2001). These reactions could result from exposure to a variety of other commonly used substances from air fresheners to construction materials and may indicate allergies, over exposure to higher than permitted amounts, or chemical sensitivity in symptomatic individuals.

Of most concern are individuals who are chemically sensitive and/or allergic to one or more substances. Allergic and sensitivity reactions occur through a different mechanism than toxicity. A toxic reaction occurs when the chemical itself causes physical damage to the body. For chemically sensitive or allergic individuals, these responses are unusual overreactions by certain tissues in the nose or skin. Typical allergic or symptoms include a runny nose, watery eyes, swelling, and/or hives while a chemical sensitivity could present with headaches, asthma attacks or other respiratory issues, cognitive impairments, or other cardiovascular, gastrointestinal, or neurological issues (Felsot 2001, Steinemann 2018). Discerning whether a reaction is due to exposure from a toxic dose or an allergic or sensitivity reaction requires a medical diagnosis.

Toxic reactions occur when chemical doses are high enough to interfere with normal bodily functions (Felsot 2001). For some chemicals, small doses may cause damage, while others may cause a reaction when a person is in contact with large quantities of the chemical. For allergic or sensitive reactions, what may have no apparent effect on one person may have grave consequences for another. For some people, their liver or kidneys have a limited capacity to eliminate toxins, either because of genetics or injury. For others, their neurological or immune systems are especially susceptible (Munson 2004). Chemical sensitivity is defined as an adverse reaction to ambient doses of chemicals, at levels generally accepted as safe (Rea 1994). While the mechanisms for an allergic reaction are well understood, those for chemical sensitivity are less well known and harder to determine. A sensitivity reaction could present with an array of symptoms with a similar onset.

Risk factors for chemical sensitivities can vary by sex, age, genetic predisposition, and prior organ system damage or impairment. Most studies suggest that the disorder may be related to other autonomic, cardiovascular, respiratory, and neuropsychiatric disorders (Rossi & Pitidis 2018). The degree to which a chemical may impact communities depends on how prevalent other related disorders are on the Navajo Nation. Prevalence of chemical sensitivities is estimated from anywhere from 1% to 30% in the general population (Rossi and Pitidis 2018, Steinemann 2018). Population studies indicate the occurrence rate is similar in Native American and other minority communities (Meggs et al. 1996).

While the current rate of chemical sensitivity on the Navajo Nation is unknown, the prevalence of disorders affecting the liver, kidney, respiratory, and circulatory system may indicate that a portion of the population may be chemically sensitive (Rossi and Pitidis 2018). While the general cancer incidence and overall mortality rate on the Navajo Nation is lower than the U.S. population, mortality rates for gallbladder, stomach, kidney, and liver cancers are substantially higher among Navajos, indicating higher incidence of gastrointestinal and endocrine issues in the population (**Table 3-18**, NEC 2018).

Table 3-18. Mortality rates for health disorders related to chemical sensitivity comparing the Navajo Nation and the U.S. General Population (NEC 2016, Kochanek et al. 2019)

Cause of Death	Navajo Nation Rate	U.S. Rate
Cancer	12.7	21.3
Heart Disease	12.2	23.01
Chronic Liver Disease and Cirrhosis	5.6	1.5
Influenza and Pneumonia	4.6	2.0
Renal Failure	1.9	1.3
Chronic Obstructive Pulmonary Disease	1.5	5.7

In terms of respiratory disorders, asthma-related issues account for 10-14 % of hospital admissions on the Navajo Nation compared to 1.2 % among the U.S. general population (Mehal et al. 2014, Lowe et al. 2018, Upson 2018). The higher incidence of asthma on the Navajo Nation could be from increased exposure to indoor pollutants from burning for heating and cooking, fuel exhaust from longer bus rides, and regional dust issues from unpaved roads, allergens, and other local air pollutants (USEPA 2013, Lowe et al. 2018, Upson 2018). What is unknown is whether these existing health concerns increase the potential risk for Navajo communities to develop chemical sensitivities that may affect their quality of life or other health outcomes.

Weeds and weed treatments may indirectly present additional complications for communities with limited access to health services. With a resident population close to 173,000 people (USCB 2020) and a land base of over 16.3 million acres, the population density of the Navajo Nation is less than 7 people per square mile. The Indian Health Service currently has 12 facilities in Chinle, Crownpoint, Gallup, Kayenta, Piñon, and Shiprock (IHS 2021). Additional IHS health facilities are located off the Navajo Nation in Flagstaff, Arizona, Albuquerque, New Mexico, on the Hopi Indian Reservation, and near Blanding, Utah. Tribal health corporations authorized by the Navajo Nation and IHS also operate various health care clinics and facilities in some communities, such as the Utah Navajo Health System, Inc., or Sage Memorial Hospital. There are also various community health and wellness programs that operate in many remote communities to provide basic services, education, and other public health programs (NFV 2021). However, many Navajo do not live close to medical care facilities and must drive or walk long distances when a medical emergency occurs.

3.9 Socioeconomics

3.9.1 Economic Setting

The Navajo Nation is the largest federally recognized tribe in the United States, with around 173,000 people living on Navajo Tribal Trust Lands and Navajo Indian Allotment Lands based on the United States Census Bureau 2020 report (USCB 2020, NNDED 2020). Approximately 96% of residents are members of the Navajo Nation, which currently has over 332,000 recognized members in the United States (USCB 2020a, NNDED 2018).

Economic growth on the Navajo Nation is substantially lower than the rest of the United States due to high unemployment rates, limited employment opportunities, lack of infrastructure, and limited educational opportunities (NNDED 2010). The Navajo Nation has lower household incomes, lower individual incomes, more households below the poverty line, and higher unemployment than the United States overall. (**Table 3-19**).

Table 3-19. American Community Survey Statistics for 2012-2016 comparing economic characteristics for the Navajo Nation and the entire U.S (USCB 2020).

Economic Indicator	Navajo Nation	US
Median Household Income	$ 26,362	$ 55,322
Mean Household Income	$ 37,801	$ 77,866
Per Capita Income	$ 11,237	$ 29,829
Below Poverty Line (All People)	39.5 %	15.1 %
Not in Labor Force	55.9 %	36.5 %

Employment is concentrated in public service sectors, such as education and health care (40.5%), public administration (9.5%), and hospitality-related industries, such as arts, entertainment, and tourism (10.3%). Other informal economic activities, such as flea markets, artisanal sales, and bartering for goods, may also contribute a considerable portion of economic support to Navajo residents but their contributions are often understudied, and their size of such contributions are unknown (Diné Policy Institute 2018). Weed management is considered part of the natural resource industry, which accounts for 13.8% of jobs on the Navajo Nation and provides work for skilled and unskilled workers, including positions for seasonal field crews, researchers, natural resource specialists, agricultural specialists, and data analysts in both government and private organizations. Jobs in this industry also include those in agriculture, forestry, scientific research, education, and public outreach.

3.9.2 Agricultural Economy

Agriculture is a substantial part of the Navajo economy. In 2017, farms on the Navajo Nation sold an estimated $87,652,600 of product with 79.1% from plant production and 20.8% from livestock sales (USDA 2017). While large production operations, like NAPI, generate a considerable portion of agricultural products, small family farms are still the most common with just under 75% generating less than $1,000 in sales per farm annually (USDA 2017). These farms likely provide additional resources to families and communities to supplement wage earnings (Diné Policy Institute 2018). As discussed in Agriculture, weed management on agricultural land represents a major cost on farms and rangelands. However, prevention, eradication, and native plant restoration can alleviate some of the economic costs for managing weeds in agricultural areas (Patel and Kumbhar 2016).

3.9.3 Recreation and Tourism

Developing a growing and sustainable tourism industry has been a long-term goal for the Navajo Nation. Tourists and visitors directly spend an estimated $212 million on the Navajo Nation and an additional $8.9 million in job support and sales (ASU 2018). Tourism includes revenues from casinos, visits to Navajo Nation Tribal Parks and Recreation sites, spending at restaurants and hotels, visits to facilities such as the Navajo Zoo, and permit fees for hunting, fishing, backcountry camping, and filming. Recreation sites are managed by the Navajo Nation Tribal Parks and Recreation Department and the Navajo Nation Division of Natural Resources. Casinos are operated by the Navajo Nation Gaming Enterprise. Information on recreation sites can be found in Areas with Special Designation.

The Navajo Nation has strived to develop tribally based tourism to promote cultural sovereignty and decolonization. The remote and largely underdeveloped landscape is vulnerable to pressure from outside investors promising large financial benefits (Buzinde et al., 2017). However, the focus of the Navajo Nation on community-based development has reframed development efforts to empower and organize recreation development based on Navajo values and needs (Buzinde et al., 2017, NNDED 2018).

Weeds indirectly affect the tourism industry. Widespread populations may negatively impact scenic vistas and views. Visitors may also encounter weeds along hiking trails or campsites, which they could inadvertently carry to other locations. Thick weed infestations can make it difficult to access popular recreation sites, such as lakes or streams used for fishing. The direct and indirect costs for treating and managing weeds in these areas is uncertain as treatments are often incorporated into other resource management activities, such as landscaping and vegetation removal projects.

3.9.4 Community Infrastructure

3.9.4.1 Utilities

Navajo Tribal Utility Authority (NTUA) manages and operates most utility services on the Navajo Nation with technical assistance from Indian Health Services for water and sewer lines and a few local companies providing service to nearby communities. NTUA provides electricity, fiber optic, cellular service, wireless service, natural gas, water, and wastewater services to residents and businesses on the Navajo Nation. Gas, water, wastewater, and some electricity transmission lines require underground installations. From the substations, primary lines deliver power to communities, while secondary and underground lines deliver services to individual residences and businesses (NTUA 2012). Delivery of water and management of sewage is the responsibility of IHS, with NTUA contracted to construct and install lines.

Other utility companies manage utility lines that run through the Navajo Nation but may not provide service directly to residents. APS, Salt River Project, and PNM, for example, do not provide utility services on the Navajo Nation but maintain service lines in the area. These lines are often used to transmit power from generating stations to their main service areas. Utility lines on the Navajo Nation are granted a utility right-of-way (ROW) easement as part of their agreements. Utility ROWs are approved by the Navajo Nation and /or the BIA and include provisions that the Grantee holder controls and manages weeds in the permit area. Based on current BIA Realty data, approved ROWs comprise around 20% of the Navajo Nation, representing a substantial portion of the area.

ROW corridors serve as a major source of weeds on the Navajo Nation. Construction and installation of utility lines can introduce weeds in the ROW corridor, which can spread to neighboring areas. While managing weeds are the responsibility of the lease holder, the BIA offers guidance to utility companies on the best approach for managing problematic populations and occasionally conduct treatments along ROWs that intersect rangelands or other treatment sites.

Tribally owned Companies must apply for a Tribal Authorize Access (RDCJN-17-20) lease from the Navajo Nation. Companies not owned by the tribe must apply for a ROW from the BIA on trust and allotment lands, to construct and maintain transmission lines and access roads across tribal trust lands (25 C.F.R. 169). While Navajo Nation approves TAA leases on tribal trust lands, these approvals must comply with BIA stipulations regarding vegetation and noxious weed management. Construction of roads and utility lines can disturb soils and provide ideal conditions for weed seed germination and colonization. Currently many utility companies completely remove vegetation from the ROW corridor during construction, replace the soil, and sometimes plant seeds. However, companies may not perform follow-up treatments or inspections for weeds after projects are complete.

3.9.4.2 Transportation

Transportation includes the management of roads, air travel, and railroads. Road maintenance on the Navajo Nation is the responsibility of state, federal, and tribal agencies. Arizona, New Mexico, and Utah transportation departments manage and maintain state and federal roads, including U.S. highways and interstates (**Table 3-20**). BIA and Navajo DOT manage the remaining road networks that provide access to rural communities, businesses, and services. In 2012 and 2013, the Federal Highway Administration (FHWA) transferred full responsibility for the Tribal Transportation Program (TTP) to the Navajo Nation. Since that transfer, the Navajo Nation is responsible for administering and managing the program, which includes planning regular maintenance such as vegetation removal.

Table 3-20. Roads inventoried for the Navajo Nation Indian Reservation Road System in 2020.

Agency	BIA	Tribe	State	County	Other BIA	Other Fed	Other	Total
New Lands	88.6	0.0	98.4	0.0	0.0	0.0	0.0	187.0
Northern	1,228.1	684.5	225.7	146.6	3.5	0.0	1.5	2,289.9
Western	1,470.2	1,636.6	532.5	106	10.9	2.0	5.7	3,763.9
Eastern	654.7	695.5	480.9	814.3	0.0	12.4	1.4	2,659.2
Chinle	995.8	587.7	60.8	287	5.9	15.8	0.0	1953
Ft. Defiance	1,350.5	1,569.3	267	140.1	7.5	0.4	5	3,339.8
NIIP	298	0.0	15.2	18	0.0	0.0	0.0	331.2
TOTAL	**6,085.9**	**5,173.6**	**1,680.5**	**1,512**	**27.8**	**30.6**	**13.6**	**14,524**

Navajo DOT is responsible for managing and annually updating the road inventory while developing the long-range transportation plan (LRTP) and the Tribal Transportation Improvement Program (TTIP), which prioritizes projects on the Navajo Nation using TTP funds. This includes road improvements and regular maintenance needs. Paved roads on the Navajo Nation (**Table 3-20**) have a designated right-of-way maintained by its managing agency. The width of the right-of-way is determined by the type of road (e.g., one lane, multiple lanes, paved, unpaved, etc.), with wider paved roads having larger rights-of-way and unpaved roads often having no right-of-way.

Weed management is part of regular road maintenance. Roads are a major vector for weed introductions as seeds and plant parts can attach to vehicles and traffic can create pockets that accelerate air, increasing pollination and spread. Because members of the Navajo Nation often travel great distances for errands and work, roads can spread weeds to remote communities.

The Navajo Nation owns and maintains several airports on the Navajo Nation (**Figure 3-9**). Navajo DOT operates eight primary airports. Except for the Window Rock and Kayenta Airports, all primary airports are operated by the Navajo DOT's Department of Airport Maintenance with funding from BIA for emergency maintenance. The Navajo Nation airport system also includes 20 secondary airports, which are unpaved/dirt runways with no support facilities (Navajo DOT 2015). There are also five privately owned and maintained airports on the Navajo Nation: Goulding's Airport, Thoreau Airport, Lake Valley, Klagetoh Airport, and Black Mesa Airport.

Weeds are a concern at airports. Heavy winds from air traffic can pollinate and spread weeds. In rural areas where runways are only a strip of cleared land, weeds can invade quickly. Camelthorn, for example, can grow in cracks in the pavement, which impacts landing and take-off safety by creating additional obstacles. Weeds in thick clusters and clumps can also block signs and information on the ground.

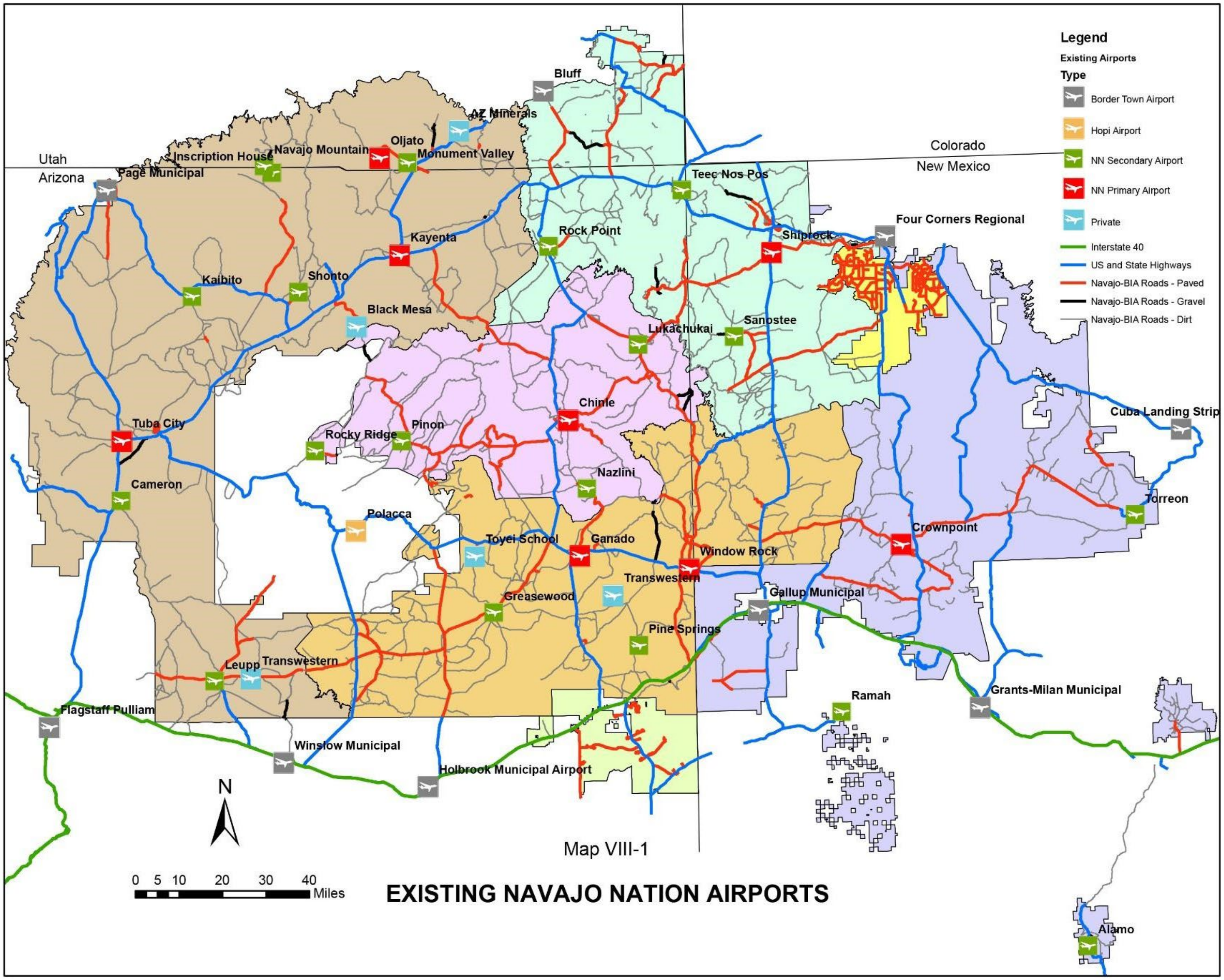

Figure 3-9. Airport locations on the Navajo Nation (Navajo DOT 2009).

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Two major railroad companies manage lines on the Navajo Nation: Burlington Northern Santa Fe Railroad (BNSF) and Amtrak Passenger Rail Service. The BNSF railway runs from Los Angeles, CA to Chicago, Illinois and crosses the southern portion of the Navajo Nation in Arizona and New Mexico through the New Lands, Church Rock, and the checkerboard area of the Eastern Navajo Agency. BNSF operates a freight rail service along its railway (Navajo DOT 2009). Amtrak provides passenger rail services along the BNSF railway with stations in Gallup, New Mexico and Winslow and Flagstaff, Arizona. Railroads can spread noxious weeds. The standard ROW corridors for railway lines are 100 ft on most public land, but authorization for the ROW on Navajo trust lands is granted by the BIA, which may adjust the size of the railway ROW depending on its use (25 C.F.R. 169). BNSF has a vegetation control plan to remove all vegetation along their rail lines, in coordination with state and county officials using an integrated system to address state-listed noxious species. Weed control along railways is important to maintain safety and rail bed quality, and to prevent fires (Nyberg 2001).

3.9.5 Weed Management Costs

From 2010 through 2020, the BIA Noxious Weed Program spent over $7.1 million on weed projects for the Navajo Nation. These funds paid for equipment, staff, materials (such as herbicide), contractors, and administrative costs. They cover costs for project planning, weed inventories, treatments, monitoring, and reporting and do not include costs for in-kind services from project partners and land users. Specific project costs can vary based on the project site, species treated, methods used, and the project timeline. For example, aerial herbicide applications are more expensive in total due to costs for contractors, aerial equipment use, bulk herbicide purchases, and additional permitting and compliance needs. However, they often treat hundreds of acres versus manual treatments, which require more labor, equipment (i.e., gloves, hand tools, bags), and travel costs and treat only small areas. Matching funds for projects, which is required for all BIA weed projects, come from the land user, non-profit organizations, or grants. In-kind services include donated time from land users, volunteers, Navajo Nation tribal agencies, other federal agencies, supplies, and development of tribal support for projects.

Across the US, noxious species impact the economy, costing billions of dollars every year (Pimentel et al. 2005). Economic losses from noxious weeds include the direct costs from reduced productivity for agriculture and forestry, as native vegetation and agricultural crops compete with noxious weeds for light, nutrients, and water. Recreation and tourism may suffer as landscapes become degraded, reducing the visual quality and safety at popular travel destinations. Noxious weeds also reduce land values and increase the risk of damage to private property. On farm and rangeland, weeds reduce carrying capacity for livestock and wildlife and lowers capacity for plant production, recreation, and development.

Some of the most damaging and widespread noxious weeds on the Navajo Nation include camelthorn, Russian thistle, and annual brome species. Camelthorn can grow into buildings and structures, degrading their integrity and reducing property values. Other species are fire prone, such as Russian thistle, bromes, and kochia, and can increase the frequency and intensity of wildfires, which can increase property damage and reduce land value. Economic experts estimate that, in general, for every year weeds are not addressed, the costs of controlling noxious weeds can increase two- to three-fold (BIA 2014).

3.10 Environmental Justice

Environmental Justice, as defined by the USEPA, is "the fair treatment and meaningful involvement of all people regardless of race, color, sex, national origin, or income with respect to the development, implementation and enforcement of environmental laws, regulations, and policies." Environmental injustice describes the negative impact of projects on underserved ethnic or population groups. Modification of land, water, energy, and air; unresponsive, unaccountable government policies and regulation; and lack of resources and power in affected communities contribute to environmental injustice (Rasmussen 2004).

The Navajo Nation qualifies as a community of concern based on its demographics and economic indicators. According to the U.S. Census Bureau, more than 96% of residents identify as American Indian or Alaskan Native and approximately 39.5% of residents live below the poverty line, with more than 48.1% of children living in poverty (USCB 2020). Many residents live in remote areas, where access to health services, in-home water, and electricity is limited. It is estimated that a third of homes do not have running water, requiring many to haul water for drinking, cooking, and bathing, often from unregulated sources where water quality is not monitored (Litvak 2019) The Navajo Nation Department of Water Resource estimates of 25-30% of households are without direct access to public water (NNDWR 2011, IHS 2011). Other studies estimate that 30-50% of some communities lack access to water and electricity (NNDWR 2011, USBOR 2015). Because houses can be spread out, costs for installing electrical connections can be around $40,000 per home (Lapastora 2019). These factors disproportionately impact the health, economic livelihood, and culture of residents on the Navajo Nation.

Pollution is a critical environmental concern for the Navajo Nation. The USEPA established a National Tribal Toxics Committee with the goal to empower tribal communities to protect themselves from toxic chemicals. This committee established several initiatives to increase pesticide safety on Indian lands, reduce exposure to toxic chemicals, and prevent pollution (Tribal Law and Policy Institute, May 2011). For the Navajo Nation, the USEPA manages the federal Pesticide Applicator certification program for applicators working on trust and allotment lands while NNEPA manages enforcement and compliance assistance. The major aim of this program is to give tribal governments the ability to manage, track, and enforce responsible chemical use for the safety of communities and residents.

As discussed in Soil, Air, and Water, weeds can increase sedimentation and impact water quality in some areas. Weed treatments, especially those involving chemical treatments, do pose risks for water contamination. Contamination creates an undue burden on many residents, as safe drinking can be scarce in some parts of the Navajo Nation. These concerns emphasize the need for careful planning and consultation with Navajo Nation Programs and communities when developing weed projects, so communities are aware of the risks and benefits of different weed treatment methods and how to implement reasonable safety measures to protect sensitive individuals.

As discussed in Public Health, the Navajo Nation does have a higher incidence of respiratory, liver, and gastrointestinal diseases due to numerous factors unrelated to weed treatments. For example, widespread uranium mining from the 1940's through the mid-1980's resulted in hundreds of undocumented abandoned mines on the Navajo Nation. These activities left many communities dealing with the clean-up along with identifying numerous contamination sites, remediating water and soils from illegal dumping practices, and treating numerous health disorders stemming from radioactive exposure (USEPA 2013). Additionally, indoor air pollution from burning fuel for cooking and heating has contributed to the rise of asthma and other related respiratory conditions in many households (Bunnell et al. 2010). There is concern that some communities, where such practices or needs are high, may be more sensitive to health impacts from weed treatments, especially given the uncertainty surrounding disorders such as chemical sensitivity.

The cultural importance of the land and vegetation to the Navajo people is also a critical concern for weed treatments. As discussed in Vegetation, numerous plants have cultural and ceremonial importance to the Navajo people. Such plants can be used for religious ceremonies, medicines, healing rituals, food, construction, arts and crafts, and dyes and paints. Weeds and weed treatments have the potential to impact gathering sites for culturally important plants, which can vary between communities and practitioners. Local communities should be involved in identifying culturally significant plants and collection sites to ensure that valued species are available for future generations.

3.11 Areas with Special Designations and Uses

The Navajo Nation offers many recreational opportunities for its members and the general public. National Parks, National Monuments, and Tribal Parks on the Navajo Nation include rivers, canyons, scenic vistas, mountains and mesas for hiking, photography, wildlife viewing, fishing, and guided tours. Campgrounds at National and Tribal Parks offer car camping and numerous backcountry trails. Several scenic byways, including Diné Bíítah; Kayenta-Monument Valley; Naat'tsis'aan (Navajo Mountain); Tse'nikani (Flat Mesa Rock); Trail of the Ancients; and Vermillion Cliffs, provide driving options to experience the geology, geography, photography, wildlife viewing and cultural values of the Navajo Nation. The San Juan River is used for remote, multi-day river rafting trips for private and commercial outfitters.

There are three casinos and one casino resort on the Navajo Nation. Twin Arrows Navajo Casino Resort is a full-service destination casino resort that offers gaming tables, a hotel, conference center, entertainment amphitheater, and several restaurants. Northern Edge Navajo Casino, Fire Rock Navajo Casino, and Flowing Water Navajo Casino offer gaming and restaurants.

In 2018, a study estimated the Navajo Nation received over one million visitors during an eight-month period and the tribal government received over $212 million of direct spending from out-of-region visitors (ASU 2018). Tourism is recognized as the third highest key economic priority for the Navajo Nation, with needs to develop more facilities and opportunities for tourists and jobs (NNDED 2018).

3.11.1 National Parks

The National Park Service (NPS), Navajo Nation, and BIA collectively manage national monuments located on tribal trust lands on the Navajo Nation, which include Canyon de Chelly, Hubbell Trading Post, and Navajo National Monument as part of the Southern Four Corners Management Group, to maintain their unique value (**Figure 3-10**). NPS is tasked with managing cultural resources in the area, while the Navajo Nation with assistance from the BIA manages natural resources. Navajo Nation Law (Title 5, Navajo Nation Code Chap 13. §2501 et seq.) regulates tour operations and guide services on the Navajo Nation. This law gives the Navajo Nation Tribal Parks and Recreation Department (NNTP) authority to issue rules and regulations for these areas. Along with tour services, the NNTP and local communities work with the NPS to develop cooperative management plans to better manage resources and clearly define agency responsibilities. NPS is responsible for controlling noxious weeds on NPS managed land, but contracts with BIA to complete weed treatments. NPS supports efforts to control noxious weeds on properties adjacent to NPS lands through financial contributions, technical assistance, access, and personnel. At Hubbell Trading Post, a National Historic Site, NPS and Navajo Nation worked with BIA, NRCS, and NTUA to control weeds.

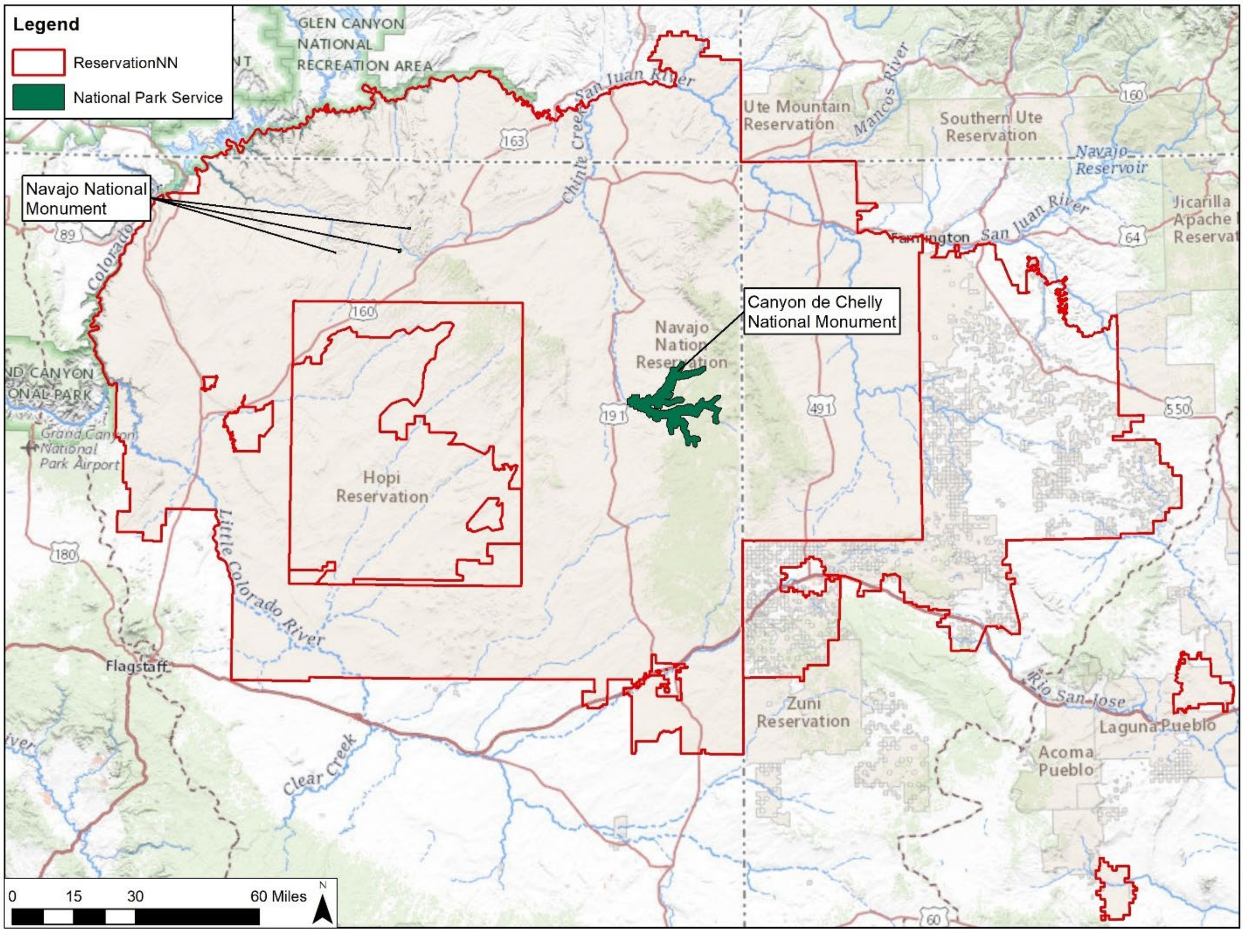

Figure 3-10. Map of National Park Service areas where the Navajo Nation manages natural resources.

Canyon de Chelly National Monument is located in the northeastern corner of Arizona near the town of Chinle. There are approximately 40 grazing permits and over 200 agricultural permits to farm the canyon floor of the Monument. NPS manages the cultural resources, park administration, and visitor services, while the Navajo Nation retains control of the land and minerals and manages surface and sub-surface land use (NPS 2005). Aggressive infestations of tamarisk and Russian olive, along with intensive historic grazing and tour operations in riparian corridors of the monument, prompted the creation of a cooperative watershed restoration project in 2005. Infestations of noxious trees altered stream processes and led to channel incision and harmful erosion, threatening ancestral farmlands, archeological sites, and biodiversity in the monument (NPS 2005, Cadol et al. 2011). As part of the Southern Four Corners Management Group, NPS contracted BIA’s Chinle Navajo Agency to control tamarisk and Russian olive north of the park boundary in Chinle Wash. Through this agreement, NPS and the BIA have cleared 100 acres of weed species using the cut stump method. Canyon de Chelly has also made efforts to control Russian knapweed at dispersed sites throughout the park. This volunteer effort was done as infestations were identified.

3.11.2 Navajo Tribal Parks and Recreation Areas

The Navajo Nation Tribal Parks and Recreation Department (NNTP) was established in 1962 to steward the Navajo Nation's tribal parks. The department has the primary responsibility to protect and preserve areas of scenic and recreational significance (NNTP 2006). Currently, the NNTP is the custodian of five tribal parks, one monument, and one veteran's memorial. NNTP is tasked with protecting these lands for future generations. Currently, noxious weed management is only directly addressed at Canyon de Chelly, where the park is co-managed with NPS. Weed management on Navajo tribal parks occurs on an ad hoc basis as part of other landscape management projects, primarily using hand tools. Weeds have been observed in parking lots and along hiking trails. While projects will continue in this manner, NNTP is interested in coordinating weed treatments with the BIA under the NNIWMP (Martin Begaye, NNTP, personal communication, February 9, 2021).

Monument Valley Navajo Tribal Park is northeast of Kayenta on the Arizona/Utah border. The park covers 91,696 acres of Great Basin Desert surrounding massive sandstone buttes, towering up to 1,000 feet above the desert floor. The Park offers a visitor center, campground, scenic driving route, hiking trails, and guided tours (NNTP 2020). The Park operates under a General Management Plan, which addresses land management activities (NNTP 2020)

Lake Powell Navajo Tribal Park manages five areas just east of Page, Arizona in the LeChee Chapter of the Navajo Nation. These areas include Upper Antelope Canyon, Lower Antelope Canyon, Upper Part of East Waterholes, Lower Part of East Waterholes, and Rainbow Bridge Trail. Upper Antelope Canyon is called *Tse' bighanilini,* which translates to "the place where water runs through rocks", aptly describing this 120-foot-deep slot canyon that attracts thousands of tourists each year. Lower Antelope Canyon, called *Hasdestwazi* or "spiraling arches," consists of more sculpted sandstone slot canyons, but is deeper and slightly less accessible. Both the Upper and Lower East Waterholes are bisected by Highway 89, are located near Antelope Canyon, and offer visitors access to more slot canyons that drain into Lake Powell (NNTP 2020a and Crossley 2014). The Rainbow Bridge Trail is a 13-mile backcountry trail that traverses the Navajo Nation to Navajo Bridge National Monument (Clark 2014).

The San Juan River flows along the northern border of the Navajo Nation and is a popular recreation designation for rafting and fishing. One of the major launch points for the river is Montezuma Creek, which is on the Navajo Nation. Additionally, the south bank of the river, from Mexican Hat to Lake Powell, is part of Lake Powell Navajo Tribal Park. Visitors must have a permit to hike and camp on the south bank of the river.

Little Colorado River Gorge Navajo Tribal Park comprises three park areas near Cameron, Arizona. The park includes two viewpoints overlooking the Little Colorado River Gorge off SR 64, the east side of Marble Canyon outside Grand Canyon National Park (including trails along the East Rim of the Grand Canyon), and Grand Falls northeast of Flagstaff in the Painted Desert. Marble Canyon includes the Colorado River from Lee's Ferry to the confluence with the Little Colorado River. The sculpted limestone walls of Marble Canyon mark the beginning of the Grand Canyon, and, while Marble Canyon itself is part of Grand Canyon National Park, the lands east of the canyon are part of the Navajo Nation. NNTP manages trails along this East Rim of the Grand Canyon from Cameron to Page, Arizona. Grand Falls is a natural cascade in the Little Colorado River formed by lava flows blocking the river. Management of these areas is coordinated out of the tribal Park Office/Visitor Center in Cameron, AZ (Navajo Tourism Department 2020).

Four Corners Monument is the only location in the United States where four states intersect: Arizona, Colorado, Utah, and New Mexico. The Park offers a granite and brass plaza that celebrates the intersection of the four states (NNTP 2020b).

Window Rock Navajo Tribal Park and Veteran's Memorial is near the Navajo Nation Administrative Center in Window Rock, Arizona. The Park protects the large sandstone arch, which is Window Rock's namesake. It is also the location of a Veteran's Memorial, constructed at the base of the Window Rock Arch. The memorial was designed and constructed to recognize the Navajo Code Talkers who used the Navajo language as a form of encryption during WWII (NTD 2020a).

Bowl Canyon Recreation Area is in the Chuska Mountains near Crystal, New Mexico. The Park manages camping sites, the Camp Asááyi lodge, and access to the 36-acre Asááyi Lake. Popular activities at the park include canoeing, fishing, hiking, picnicking, and camping.

3.11.3 Biological Preserves

Biological Preserves contain excellent, or potentially excellent, wildlife habitat and are protected from development by NNDFW to protect listed species and habitat (Title 17 § 507). Biological Preserves are designated by the Resources and Development Committee of the Navajo Nation Council in accordance with NNDFW's Biological Resource Land Use Clearance Policies and Procedures (RCP). These areas contain populations of one or more Navajo, and often federal, listed endangered or threatened species. In 2008, 19 Biological Preserves were designated; however, NNHP is proposing to remove four preserves and add four preserves in the updated 2021 RCP based on species presence or absence (**Table 3-21**). An additional two preserves may be removed due to species absence which will be confirmed after biological surveys are conducted in Spring 2021.

Biological Preserves are required to have a conservation or management plan identifying management needs and recovery efforts. Despite this requirement, only two Biological Preserves have them: Shiprock Mesa Verde Cactus (NNDFW, 2021) and Little Colorado River (Hazelton and Smith 2011). Both plans indicate noxious weeds as a threat to protected species, and BIA has several proposed weed management projects that overlap with or are adjacent to these preserves (**Table 3-21**). NNHP has identified several Navajo Nation listed species, including those within Biological Preserves, that are threatened by noxious weeds and are prioritized for weed treatments (NNDFW 2020). NNHP would like to partner with BIA to control noxious weeds occurring in Biological Preserves with close consultation with NNHP.

Table 3-21. List of the Biological Preserves, acres, and intended species to project designated by NNDFW in 2008 and proposed for 2021. The table includes proposed weed projects adjacent to or within these Biological Preserves and the noxious weed of focus. * indicates that the preserve may change shape, move locations or be eliminated based on results of biological surveys conducted in Spring 2021.

Navajo Nation Biological Preserves	Acres	Protected Species	2008 RCP	2021 RCP	Proposed BIA Weed Project and Target weeds
Crystal Conservation Area	636	*Allium gooddingii* and *Speyeria nokomis*		X	
Copper Canyon Conservation Area	7,438	*Astragalus cutleri*		X	
Comb Ridge Welsh's Milkweed Conservation Area	2,159	*Asclepias welshii*	X	X	

Navajo Nation Biological Preserves	Acres	Protected Species	2008 RCP	2021 RCP	Proposed BIA Weed Project and Target weeds
San Juan River Conservation Area	728	*Empidonax traillii extimus*	X	X	San Juan River Project - Tamarisk and Russian Olive
Many Farms Bald Eagle Conservation Area	4,548	*Haliaeetus leucocephalus*	X		Many Farms Project Area
Black Lake Bald Eagle Conservation Area	640	*Haliaeetus leucocephalus*	X		
Red Lake Conservation Area	1,892	*Haliaeetus leucocephalus*	X		
Laguna Creek Conservation Area	1,466	None listed	X		Dennehotso Farms Project - Tamarisk, Russian knapweed, and Russian olive
Hosteen Tso Leopard Frog Conservation Area	460	*Lithobates pipiens, Carex specuicola,* and *Platanthera zothecina*	X	X	
Navajo Mountain Conservation Area	6,065	*Penstemon navajoa*	X	X	Paiute Creek – Tamarisk, Russian olive
Many Devils Wash Conservation Area	1,893	*Sclerocactus mesae-verdae*	X	X	
Red Wash Conservation Area*	3,804	*Sclerocactus mesae-verdae*		X	Red Wash Project - Tamarisk and Russian olive
Many Devils Wash Conservation Area	40	*Sclerocactus mesae-verdae*	X	X	San Juan River Project - Tamarisk and Russian Olive
Malpais Conservation Area	7,530	*Sclerocactus mesae-verdae*	X	X	San Juan River Project - Tamarisk and Russian Olive
Monument Rocks Conservation Area	475	*Sclerocactus mesae-verdae*	X	X	
Monument Rocks Conservation Area	1,752	*Sclerocactus mesae-verdae*	X	X	Salt Creek Project - Tamarisk, Russian olive, and Russian knapweed
Rattlesnake Conservation Area	1,651	*Sclerocactus mesae-verdae*	X	X	San Juan River Project - Tamarisk and Russian Olive
Narbona Pass Silverspot Conservation Area	2,627	*Speyeria nokomis and Lithobates pipiens*	X	X	
Wheatfields Silverspot Conservation Area*	129	*Speyeria nokomis*	X	X	Upper Wheatfields
Little Whiskey Creek Silverspot Conservation Area	205	*Speyeria nokomis*	X	X	
Bowl Canyon Creek Conservation Area	4,295	*Strix occidentalis lucida* and *Rhinichthys osculus*	X	X	
LCR Conservation Area	89,164	Multiple (Hazelton and Smith 2011)	X	X	LCR Cameron/ Grand Falls Project - Tamarisk
LCR Conservation Area Extension	9,830	Farm/Preserve Area		X	

3.11.4 Forest Lands

The Navajo Nation forest lands are managed by the BIA Navajo Region Branch of Forestry and the Navajo Forestry Department (NFD). This includes timberlands and woodlands as defined by the BIA and Navajo Nation. The NFD manages forests on tribal trust lands, while BIA is responsible for managing forests on allotted lands. Currently, the NFD has documented timberlands, including the commercial forest, and pinyon juniper woodlands on the Navajo Nation (**Figure 3-11**). Other forest types, such as riparian woodlands, are also present but have not been inventoried at the time of this effort. The commercial forest includes Defiance Plateau and Chuska Mountains (NFD 2018). The satellite forests include Navajo Mountain, Mount Powell, and Carrizo Mountain. The Defiance Plateau contains the most productive forest on the Navajo Nation and is mostly ponderosa pine. The Chuska Mountains are the largest forestlands on the Navajo Nation. Lower elevations are piñon-juniper woodlands and mid to high elevations are ponderosa pine and spruce-fir on north facing slopes (NFD 2018). Navajo Mountain, Mount Powell, and Carrizo Mountain primarily consist of ponderosa pine forests and piñon-juniper.

Forests are managed under the "10-Year Forest Management Plan – Navajo Indian Reservation" developed by the Navajo Forestry Department (2006). The purpose of the Navajo Forest Management Plan is to establish management direction the Defiance Plateau-Chuska Mountains. In 2018, the "Draft Navajo Forestlands Integrated Resource Management Plan" was developed by Navajo Nation staff, coordinating agencies, and the public to provide a comprehensive management strategy for forestland areas on the Navajo Nation.

Noxious, non-native plants jeopardize the health of forest ecosystems (USFS 2014) and can reduce silvicultural yields (Stokes and Willoughby 2013). Recent weed inventories documented close to 325 acres of noxious weeds, with cheatgrass and field bindweed being the most common (BIA 2015, 2017, 2020). Timber harvesting practices, such the construction of haul roads, operation of heavy equipment, and the removal of overstory habitat, create disturbance that can spread noxious weeds.

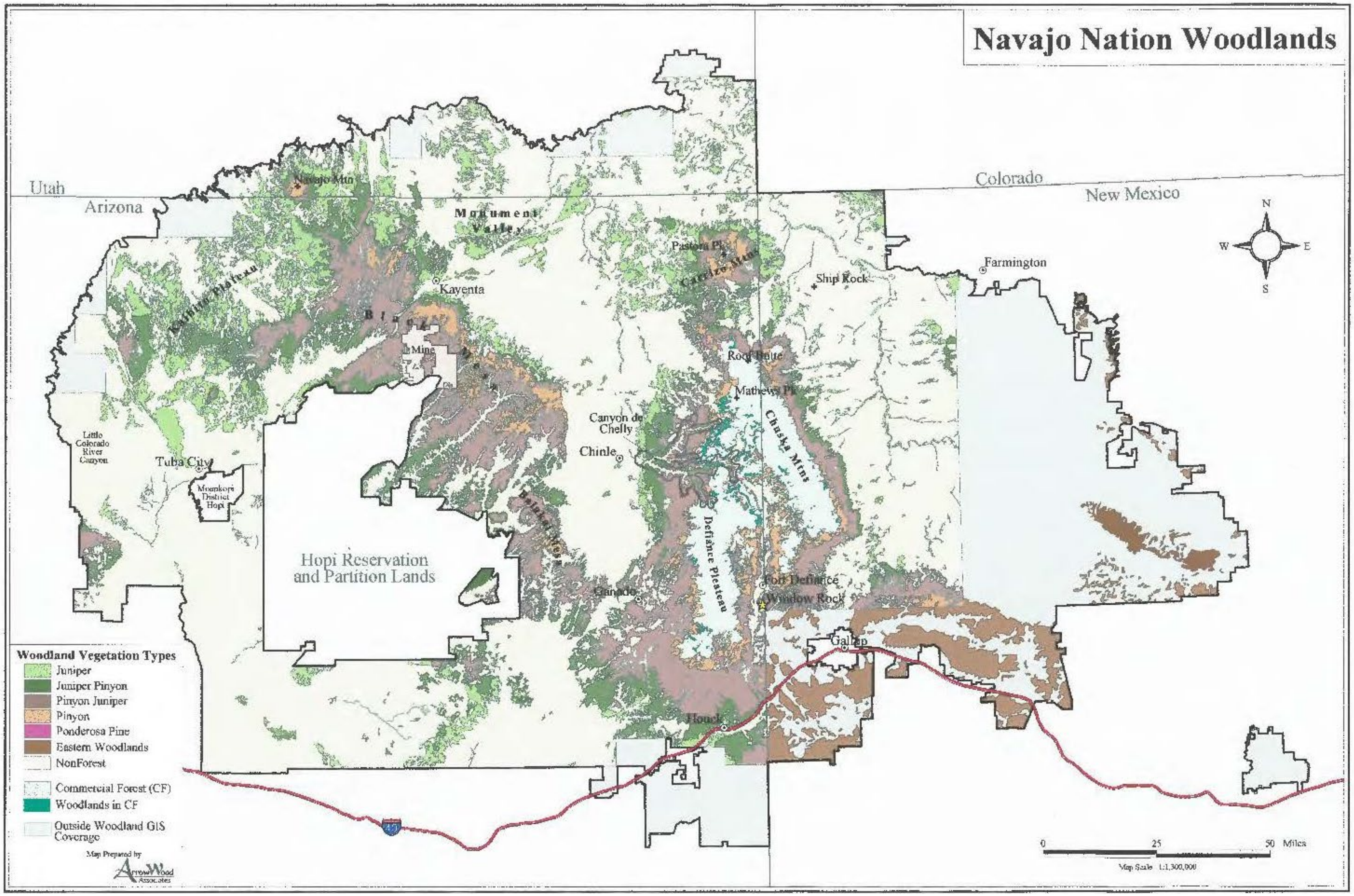

Figure 3-11. Map of designated Navajo Nation Forests, including woodlands and commercial forest, as reported in the 1998 Woodland Inventory and Assessment Report (NFD).

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4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Paleontological Resources

4.1.1 Alternative 1 – No Action

The No Action Alternative has the potential to increase noxious weeds. Certain types of vegetation have potential to detrimentally affect fossils. 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. The ability of some noxious weed species to create dense monocultures can increase the risk of damage to fossils. For example, dense communities of cheat grass or Russian thistle can increase the risk of fire damage to fossils that occur near the surface. When weed with deep or rhizomatous roots form dense populations, the below ground structures can increase the potential of damaging fossils during removal efforts. Several of these noxious woody species (e.g., tamarisk) have been targeted by the Noxious Weed Program through ad hoc weed management projects. Consequently, the No Action Alternative would likely result in treating fewer of these noxious weeds than the other Alternatives. The proliferation of these plants increases the possibility of damage to paleontological resources from root growth and other indirect effects, such as increased fire risk.

There is potential for negative impacts to paleontological resources (i.e., fossils) from noxious weed treatments. Treatments involving ground disturbance present the greatest threat as paleontological resources could be exposed and adversely affected. Vehicular off-road travel could damage paleontological resources, and chemical treatment could result in effects if applied directly to resources. Furthermore, erosion caused by the removal of vegetation or treatment activities could impact previously buried paleontological resources by exposing them to the aboveground environment. However, if paleontological resources are encountered, a permit to collect or mitigate damage to the fossils must be obtained from the Navajo Nation Minerals Department. These impacts and measures would apply to all alternatives.

In addition, 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.

In summary, the No Action Alternative would pose a higher risk of damage to paleontological resources. Under this Alternative several weed species would continue to expand, especially woody species, causing further damage and risk to fossils either by physically growing into or around fossils or by indirectly increasing the rate and frequency of disturbance in the region. The lack of consistent mitigations during mechanical or chemical treatments under this Alternative may also pose a risk to resources as they would increase the risks for potential exposure or damage.

4.1.2 Alternative 2 – Proposed Action

Chemical Control

Chemical methods could impact paleontological resources. Some herbicides and application solutions contain salts which can cause spalling in sandstone. Dyes and other ingredients can stain or change the color of materials. However, several herbicide application methods can be used to minimize the chance of chemicals depositing on fossils. Methods such as cut stump, basal bark, and frill or "hack and squirt" target individual plants; these methods are the least likely to cause chemical contamination issues. In addition to the negative effects of chemicals being accidentally applied directly to fossils, some application methods have potential to damage paleontological resources. For example, using wheeled equipment for spraying or driving off road to reach application sites could damage exposed or shallowly buried fossils if they are driven over. For these reasons, treatment areas should be evaluated for paleontological resources and the chemical methods being considered should be fully assessed for possible negative impacts prior to implementation.

Cultural Control
Cultural treatments, such as target grazing and active native vegetation reseeding or replanting, can result in ground disturbance and could damage or destroy paleontological resources. For example, livestock can damage fossils by trampling and defecating on them. Broadcast reseeding by hand or by mechanical sprayer mounted on a vehicle with rubber tires is likely to have little to no impact on most paleontological resources unless a fossil is driven on 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 damage fossils. Comparatively, others (e.g., mulching) pose little or no threat to paleontological resources.

Manual Control
Manual methods, except for hand-cutting plants above ground level, cause some level of subsurface disturbance and thus could impact paleontological resources by uncovering or dislodging subsurface fossils. If manual treatments are performed directly in the vicinity of such resources or in fossil-bearing strata with observed fossils present, a collection permit would be required to mitigate and allow the resources to be removed and evaluated, thus limiting potential impacts to them.

Mechanical Control
Mechanical treatments 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 on the surface. Treatment methods like mowing, though considered to have low to moderate levels of ground disturbance, can cause damage to fossils if driven or mowed over. The effects of prescribed burning 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 break and crack.

Biological Control
Biological methods have almost no risk of impacting paleontological resources other than indirect effects, such as increased erosion from damaged or dying noxious weeds that no longer anchor the soil.

4.1.3 Alternative 3 – No Biological Control
Impacts from treatments under Alternative 3 are the same as those under the Proposed Action (Alternative 2), except for biological control techniques. However, because there is no change in the estimated

treatment acres for the remaining methods, the potential for negative effects would not change under Alternative 3.

4.2 Cultural Resources

4.2.1 Alternative 1 – No Action

The No Action alternative has potential to increase noxious weeds by continuing to treat noxious weeds in an uncoordinated manner. The preferential use of chemical and mechanical treatment over cultural and manual treatment would continue under Alternative 1. Over the last five years, no manual or cultural treatments have occurred, although manual treatment is a treatment option available under the No Action alternative. Mitigation measures under the No Action are implemented on a project-by-project basis. Under the No Action alternative, there is less coordination among weed management project proponents and fewer weed species treated.

Although untreated noxious weeds may reduce the quantity of some culturally significant native plants available for spiritual ceremonies, medicinal use, or other traditional use by replacing native species, some plants classified as noxious and subject to treatment have traditional uses, which would continue to proliferate under the No Action alternative. However, it has also been shown that noxious weeds have become a substitute for the loss of other, nonnative plants used in traditional practices. The proliferation of noxious weeds can also reduce the overall quality of traditional gathering sites by inhibiting access from dense weed thickets or brush.

Treatment methods under Alternative 1 have potential to affect archaeological resources and other cultural resources (particularly culturally important native plants used for medicine, spiritual practices, or other traditional purposes). The following subsections evaluate the potential effects of each weed control technique used under the No Action alternative.

Chemical Control

Chemical control methods use herbicides to control noxious weeds, which may affect cultural resources from chemical reaction or from the method used to apply the herbicides. Some herbicides and treatment solutions contain salts which can act as desiccants that can damage old, fragile wood, such as historical Navajo structures, and cause spalling in sandstone that could affect rock art from drift. Chemicals may cause corrosion in metals, and some corrosion inhibitors may 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 buried perishable materials. Adjuvants and surfactants added to herbicides, including mineral oil, vegetable oil, and methylated seed oil, are organic substances that have some potential 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 exposure risk may affect those 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 plant materials being used, this poses a health risk to weavers. Research indicates that nearly half of the plant materials used by Native American basket weavers in treatment areas contained herbicide residue. Even outside of treated areas, 3 percent of the potentially used plant materials contained residue, and the residue was present for several months after the application (Segawa et al. 1997).

There are several herbicide application methods that can be used 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, large-scale foliar herbicide application using a boom or boomless sprayer mounted on an ATV or truck, fixed-wing airplane, or helicopter has greater potential for drift and contamination than foliar spraying with smaller applicators like a backpack sprayer or spray bottle. Similarly, widespread pre-emergence treatments have more possibility of affecting culturally important plants or archaeological resources than pelletized treatments. Given that the cut stump, basal bark, and frill methods target individual plants one at a time, these methods are the least likely to cause chemical contamination issues. Accordingly, any chemical application methods being considered for any given treatment area should be fully assessed for potential negative impacts prior to implementation.

In addition to possible effects on archaeological materials from the chemicals themselves, some methods have potential to cause direct effects on archaeological resources from the type of application. Potential effects on archaeological resources from the application of herbicide using wheeled vehicles may cause direct effects on archaeological resources from artifact breakage or feature displacement. The use of wheeled vehicles can also exacerbate erosion from the loss of vegetation and could lead to the loss of desirable plants from trampling; potential effects on archaeological resources from erosion is detailed below under Mechanical Control.

Mechanical Control

Mechanical control treatment methods such as grubbing, tillage, and use of heavy machinery cause direct ground-disturbing effects on cultural resources if not avoided through survey and identification efforts. Grubbing causes surface and near surface effects while tillage affects subsurface archaeological deposits. The use of heavy machinery can cause direct effects to archaeological sites through compaction of archaeological deposits and destruction of surface artifacts and features. Vegetation mowing has the least ground disturbance and would have negligible effect to surface archaeological sites (Odess and Robertson 2007). The loss of some vegetation cover may increase the potential for indirect effects from surface erosion and displacement of surface archaeological materials and the subsequent loss of integrity and interpretive value of archaeological resources.

Effects of fire from prescribed burns to cultural resources depend on several factors including archaeological 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). Fire can have negligible to extreme effects on archaeological materials and other physical cultural resources on (or above) the surface, depending on the severity and duration of the fire and the nature of the archaeological materials. The use of fire affects perishable materials and structures such as hogans, sweat lodges, culturally modified trees, and brush structures. 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 provides a conduit for heat penetration to subsurface cultural deposits (Oster et al. 2012). Fire also can substantially affect intangible cultural resources such as certain TCPs based on conceptual, oral, and behavioral traditions tied to a particular geographic location. In addition to the fire itself, fire control and suppression techniques have potential to cause direct effects to archaeological resources from 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 have been extensively addressed by Ryan et al. (2012).

Overall, mechanical control has the most potential to cause effects on archaeological resources and TCPs from the use of heavy machinery and potential indirect effects from fire control and suppression. The use of fire on rangelands, however, typically do not reach temperatures and duration to adversely affect surface artifact assemblages other than the obvious effects to perishable structures and materials identified in Chapter 3.

Manual Control

Manual control methods could impact archaeological resources by disturbing subsurface archaeological deposits when roots are pulled from the ground. When weeds are pulled from the ground, surface artifacts may be displaced from the ground surface and enter the subsurface through exposed root cavities. However, the effect to archaeological resources would be limited to near surface archaeological deposits unless root systems have substantial depth. Indirect effects may occur to archaeological resources from cutting non-native vegetation, increasing artifact visibility and their potential for looting or illicit artifact collection.

Overall, manual control measures may cause minor adverse effects on archaeological resources from disturbance to surface artifacts and shallowly buried archaeological deposits. However, these effects would be minimized from regulatory efforts to identify archaeological resources prior to treatment.

4.2.2 Alternative 2 – Proposed Action

Under Alternative 2, chemical, mechanical, and manual treatment would continue, with the addition of cultural and biological control methods. Projects would be implemented in a more coordinated manner to better control the potential effects of treatment on resources and to expand the number of acres treated. Coordinated mitigation measures implemented under the IWMP would minimize or avoid potential effects to archaeological and TCPs identified under Alternative 1 (see Appendix F for mitigation measures).

Chemical Control

Potential effects from chemical control would be similar under Alternative 1 but minimized by implementing coordinated mitigation measures (Appendix F). Ethnographic interviews, community engagement, and traditional plant surveys would identify traditional plant resources and gathering sites and would identify alternative locations for traditional plant gathering. Community engagement would educate traditional plant gatherers of the potential health risks from processing plant resources affected by chemical treatments (i.e., drift). As a result, some traditional plant gathering sites may become temporarily inaccessible during chemical treatment to avoid the effects of drift on gatherers. Consequently, any areas being considered for chemical weed control methods would be fully evaluated for plant gathering before proceeding with treatments.

Mechanical Control

Potential effects from mechanical control would be similar under Alternative 1 but minimized by implementing coordinated mitigation measures (Appendix F). The Section 106 process outlined under the

IWMP (also see Appendix H) would provide the process to identify and implement minimalization and avoidance measures prior to mechanical treatment.

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. Livestock grazing and active native vegetation reseeding or replanting may cause direct effects to archaeological resources. Livestock cause direct effects to archaeological resources from trampling, which may lead to erosion from sediment compaction and the loss of vegetation (Robbins 2015). Livestock could cause effects on traditional plant resources from grazing desirable species that may otherwise be collected by gatherers during traditional practices. However, all treatments, including targeted grazing, require an ethnographic study of community resources to identify potential TCP resources. Coordinating project-specific mitigations to protect TCP resources would reduce potential impacts and loss to local communities. Broadcast reseeding by hand would have no effect on archaeological resources. Reseeding methods that cause direct effects to archaeological resources include seed injection or tilling. Similarly, replanting with plant cuttings, deep potted plants, containerized plants, and bundled native vegetation “poles” require deep augured holes to reach suitable depths for soil moisture. This method could adversely affect archaeological resources by impacting subsurface archaeological deposits and features, similar to manual treatment discussed above. Erosion control techniques, such as installing erosion blankets, brush layering, mulching, and brush revetment, would have a negligible effect on surface archaeological resources.

Overall, cultural control may cause adverse effects on archaeological resources, primarily from methods that utilize deep plantings; otherwise, effects on archaeological resources would be negligible to minor and generally not adverse. The Section 106 process outlined under the IWMP would provide the process to identify and implement minimalization and avoidance measures prior to mechanical treatment.

Biological Control

It is unlikely that authorized biological control treatments would damage most cultural resources due to the rigorous testing and small size of insect pathogens. Overall, biological control would have no effect on archaeological resources.

4.2.3 Alternative 3 – No Biological Control

Noxious 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 used. The potential effects of each proposed weed control treatment under Alternative 3 are the same as described under Alternative 2.

4.3 Soil, Air, and Water Resources

4.3.1 Soil Resources

4.3.1.1 Alternative 1 – No Action

Under the No Action Alternative, noxious weed treatments would continue through ad hoc, individual management efforts, resulting in an expansion of untreated weed infestations on the Navajo Nation. This would allow noxious weeds to displace native vegetation. In areas where perennial species are replaced with annual exotics, annual plants would be less effective at stabilizing sandy or loose soils, increasing the risk of topsoil loss and reducing water-holding capacity (Draut et al. 2012). Native grasses could be replaced with tap-rooted weeds, such as knapweeds and thistle, which can increase erosion and water loss in invaded areas. These factors could result in a loss of soil productivity and an increase in erosion. The No Action Alternative would allow for the continued spread of exotic annual grasses, which could increase fire risk in in local communities, forests and woodlands, and grasslands. This could lead to a decrease in ground cover, increasing erosion and reducing soil productivity.

Current treatment methods have different effects on soil resources. Treatments that increase the amount of soil exposed to rain and wind energy, reduce soil structure, remove organic topsoil, and compact soils run a higher risk of damaging soils over the long term.

Manual treatment methods are highly selective to the target species. Use of manual methods would reduce impacts to soil resources by treating small areas and limiting ground disturbance. This would reduce erosion or sediment loss at the site and maintain the water holding capacity of soils.

Mechanical treatments are not selective. Many mechanical treatments, such as tilling or grubbing, would remove all vegetation from large areas. Soils in treated areas would experience compaction, vegetation loss, and turnover. However, mowing would have minimal impacts on soil resources, as below ground roots and a portion of the above ground plant would remain. There may be a reduction in belowground storage, however, such impacts would be minimal overall as plants regrow. Prescribed burning could remove cryptobiotic soils and could increase sediment transport of both soils and burn residues through erosion or surface runoff.

Herbicides range in their selectivity of target species based on their chemical composition and have varying effects on soils. The most important factors in determining the impacts of an herbicide on soil are its mobility, persistence, and how it breaks down or degrades. These factors are determined by each herbicide's chemical properties, such as adsorption to soil particles, solubility, chemical half-life, and volatilization. Soil properties that influence the fate of herbicides in soils include organic matter content, pH, temperature, moisture content, soil texture and composition, climate, and microbial activity. Most herbicides degrade over time due to physical and chemical processes in soil and water. Herbicide degradation generally decreases with soil depth, as light, water, and microorganisms become less available. Persistence and mobility of herbicides may also be influenced by the formulation of the active ingredient. The overall impacts of herbicides on soil resources would depend on which herbicides are selected for a given project, the proposed application rates, and the frequency of retreatments. Under the No Action Alternative, such considerations would be inconsistently addressed, as buffers and mitigation measures for the use of herbicides may vary between projects.

Chemical treatments for weed species would continue on an ad hoc project basis, resulting in fewer acres being treated and less concerted herbicide use. Since any herbicide could be used under the No Action Alternative, impacts would vary substantially between projects. This approach could increase herbicide residues in soils in some areas, increasing the risk of water contamination through runoff or leaching. A lack of project coordination would prevent the BIA from considering the cumulative impacts of using some herbicides and how they may interact with each other. Projects that use picloram, thifensulfuron methyl, and prodiamine would be most concerning as these herbicides are highly mobile and persist a long time in soils. Additionally, fluazifop-P-butyl can be rendered inactive 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.

4.3.1.2 Alternative 2 – Proposed Action

Under the Proposed Action, noxious weed treatments would be done using an integrated approach, combining different methods to best control the target weed species. These treatments would be applied to priority weed treatment areas. As such, any impacts to soil resources would be most pronounced in these areas. The Proposed Action includes methods that would reduce erosion, such as cultural treatments that replant native vegetation or seeded in treatment areas or measures to reduce erosion on streambanks near waterways.

Chemical Control

Herbicides can impact soils based on their ability to bind to soil particles, breakdown, and persist at treated sites, and if environmental factors change their chemical properties. The chemical characteristics of the 21 proposed herbicides are summarized in **Table 4-1**. Some of the herbicides under Alternative 2 come in different chemical forms, which can vary how they move and persist in soils. For example, triclopyr butoxyethyl ester (BEE) has lower mobility and solubility in soils, while triclopyr triethlamine (TEA) salt has higher solubility and a higher potential to move through soils.

How herbicides bind or adsorb to soil particles determines whether they will remain on the soil surface, or if they will be able to move through the soil profile and potentially beyond. Herbicides that bind weakly to soil, such as 2,4-D, clopyralid, metribuzin, picloram, and atrazine, are likely to move through soils and impact plants with deep roots. For many herbicides, soil mobility may change with differences in soil moisture, temperature, and organic matter. For example, dichlobenil has higher mobility in soils with organic matter when soil moisture and temperatures are low, conditions that occur frequently on the Navajo Nation. Some herbicides have active ingredients that allow them to bind strongly to soils, but their byproducts may have higher mobility. Thifensulfuron methyl, for instance, does not persist for long in soils. Its degradate, triazine amine, however, is highly mobile and persistent, increasing its risk of moving through the soil profile and remaining on sites for long periods of time. The glyphosate byproduct, aminomethylphosphic acid (AMPA), binds less to soils, allowing it to move through the soil profile (Battaglin et al. 2014). Mobility in soils may also result in secondary effects to water quality, as herbicides with high mobility are more likely to impact groundwater.

Aside from soil-binding capacity, persistence in soils also depends on the active ingredients chemical half-life and how it degrades. Herbicide persistence can determine if there is a risk of an herbicide impacting other plants, nearby water sources, and wildlife in the area, as the soil could act as a reservoir for the herbicide. Herbicides that degrade by light, or photolysis, may not persist for long on the soil surface after spraying. However, if the herbicide binds weakly to soils, such as picloram, its movement through the soil profile may hinder its breakdown at treated sites, allowing it to persist longer than expected. Some herbicides, such as glyphosate and triclopyr, breakdown through a variety of mechanisms, reducing how long it can remain on site.

Studies on the impact of herbicides on soil organisms show that some can cause temporary shifts in soil microbes that reduce the biodiversity and relative biomass (USFS 1997). Some herbicides may inhibit the growth of some microbial species, which could impact decomposition or plant growth if frequently used. Studies are mixed on the effects of glyphosate on soil microbes (Van Bruggen et al. 2018). Some suggest that glyphosate could increase activity of some fungi while others suggest that glyphosate could interfere with symbiotic microorganisms, such as mycorrhizae, which facilitate plant growth (Kremer and Means 2009, Van Bruggen et al. 2018), Picloram can be toxic to soil microorganisms, which is likely due to its longevity in soils. Overall, these effects are expected to last for a short period of time and populations generally recover after a few days or weeks as herbicides degrade (SERA 2011, 2011b). Alternative 2 provides a variety of herbicides to limit the long-term impacts of any single one at treated sites. Additionally, the use of herbicide as part of an integrated approach along with the proposed mitigation measures would reduce long-term herbicide use in any one area.

Cultural Control

Cultural treatments under the Proposed Action are generally selective to the target species. Targeted grazing could cause soil disturbance but would be short-lived and grazed areas would recover following treatments. Other cultural methods would restore native vegetative cover, creating beneficial impacts to soil resources. The use of perennial native plants to replace annual invasive species could reduce the risks of erosion and topsoil loss, increase water holding capacity, and increase soil organic content at treated sites. Cover crops would improve soils by reducing water loss, increasing organic matter, reducing erosion, and improving overall soil health. Reestablishing native vegetation at treated site and maintaining organic matter on the soil surface (e.g. plant litter, mulch) could prevent long-term soil losses. BMPs would be implemented to minimize soil erosion and runoff from treatment areas.

Mechanical Control

Some mechanical treatments proposed under Alternative 2, such as grubbing, tilling, and the use of heavy machinery, would require the use of water trucks to keep bare soils wet, reduce dust, stabilize sandy or loose soils, and decrease the risk of topsoil loss. Treatments would use the lightest/smallest off-road vehicles or tractors possible, and no heavy equipment would be used on wet, solid or cryptobiotic crusts. Mowing would have minimal impacts to soils. Prescribed fire, implemented under an approved burn plan, would temporarily increase soil erosion and sediment transport. However, sites should be seeded and restored immediately after treatments if native plant cover is less than 50%.

Biological Control

The use of biological treatments would have minimal impacts to soils as most damage is done to specific parts of the plant and is limited to seasons when the organisms are most active, typically in the spring and/or summer. As plants die or weaken from biological control, their roots are left in place, which reduces erosion in treated areas. Maintaining vegetation cover in these areas would reduce negative impacts to soils until additional follow-up treatments can restore native plants.

Overall, chemical and mechanical control methods would pose the most risk to soils. Some of the herbicides proposed can persist at treated sites for days to months after applications. However, mitigation measures that restrict the use of herbicides near water, plants, and high value habitat would limit those impacts. The proposed mitigation measures, such as the use of water trucks, development of a burn plan, use of erosion control measures, using the lightest vehicles, and avoiding cryptobiotic soils would decrease those risks. Other control measures, such as replanting native species and the use of biological control agents, would reduce such impacts and likely improve soils in treated areas over time.

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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 Method	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	Moderate	16 to 241 days	Microbial	Low due to high soil adsorption, but degradants can have a higher risk.	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 increase risks	Low due to high soil adsorption but high use can increase 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

Herbicide	Water Solubility (ppm)	Adsorption	Half-Life	Degradation Method	Groundwater Contamination	Surface Water Contamination
Indaziflam	2.8 to 4.4	Moderate to Weak	9.3 to 69.3 days	Microbial, Aqueous Photolysis	Moderate to low based on persistence in the environment.	Moderate with higher persistence in aquatic environment but low in shallow clear water.
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	Moderate to 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
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
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
Prodiamine	0.013	Strong	19 to 120 days	Photolysis	Low due to low solubility and strong soil adsorption	Low due to photodegradation and strong soil adsorption
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 persist for longer

Sources: BLM 2007, BPA 2000, Tu et al. 2001; SERA 2000 – 2016a, USFS 2020; Vogue et al. 1994

4.3.1.3 Alternative 3 – No Biological Control

Under Alternative 3, fewer total acres would be treated compared to Alternative 2. The prohibition on biocontrol agents to treat weeds such as knapweeds and thistles could increase their risk of spreading in certain areas. The anticipated spread of knapweeds and other proposed target weed species would continue to increase soil erosion, release of allelopathic chemicals, and altered disturbance regimes.

4.3.2 Water Resources

4.3.2.1 Alternative 1 - No Action

The No Action Alternative would allow several species to continue to spread in riparian corridors and near open water sources. Weeds, such as perennial pepperweed, Ravenna grass, and leafy spurge would not be treated under the No Action Alternative and could spread in riparian areas especially those downstream of current infestations. These infestations could impact water quality and increase streambank erosion.

Untreated weeds in riparian corridors could reduce streambank stability, increase turbidity, and alter stream temperatures and nutrient exchange between land and water. Noxious weeds tend to form monocultures, replacing more diverse native plant communities. Such changes can change sediment concentrations in streams, rivers, and lakes, which can alter nutrient inputs and flooding regimes. For example, dense stands of tamarisk are effective at trapping large amounts of sediment along riparian corridors, interfering with nutrient inputs, increasing flood intensity, and disconnecting rivers from their floodplains (Shafroth et al. 2005). Such impacts can accumulate, resulting in floods that further erode streambanks and make river channels unstable and vulnerable to flash flooding.

Some noxious grasses can reduce runoff to watersheds by establishing ground cover early in the season and using early seasonal moisture. However, this cover is often short lived as many annual grasses die off in early summer, allowing for more surface runoff, erosion, and sedimentation during monsoonal storms in the late summer. Additionally, they can interfere with the regeneration of cottonwoods and willows (two desirable native species that stabilize streambanks).

The continued spread of some noxious weeds would contribute to indirect effects as well. For example, cheatgrass may increase fire frequency and size in infested areas, which could result in a higher risk of erosion and sedimentation, increased turbidity, and increased nutrient loading, which can cause toxic microbial activity in open water, or eutrophication.

Weed treatments could impact hydrology, water use, and water quality, which may limit some communities' access to water for domestic or commercial needs. For example, increased erosion from mechanical treatments could increase turbidity or particulate contaminants and temporarily limit access in streams and reservoirs. Weed treatments that disturb soils, remove large quantities of vegetation, or use chemicals in and around watersheds could impact water quality by increasing temperature, salinity, toxic organics, and turbidity. While most watersheds around Navajo Nation have not been impaired by pesticides, impairments from *E. coli*, selenium, sedimentation, toxic microbial activity or eutrophication, 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). Some pesticides, like glyphosate, could exacerbate existing issues by increasing microbial activity (Van Bruggen et al. 2018).

Chemical treatments could contaminate water if there are accidental spills, overspray or drift of herbicides to non-treated areas, heavy use of herbicides beyond label instructions, and/or use of non-aquatic herbicides in or near open water. When in the water system, some herbicides can create cascading effects that can impact vegetative, animal, and human health.

The impacts of herbicides on water quality depend on an herbicide's chemical properties (**Table 4-1**), application method, environmental factors, and application rate. These factors affect how an herbicide is transported from an application site to water sources and whether they can alter water quality, wildlife, and other plants. Herbicide applications of non-aquatic formulations near open waters can also increase the risk of contamination, especially where herbicides are applied aerially. Some herbicides are highly soluble in water (i.e., greater than 1,000 parts per million (ppm). High solubility can increase how much herbicide moves from dry ground to open water during heavy precipitation and runoff events, especially in areas where large amounts of herbicide are applied. Some herbicides could potentially impact groundwater reservoirs. Herbicides that persist for long periods of time and have a limited ability to breakdown in soils and water or adhere to soil particles pose the most concern. These herbicides, such as 2,4-D, picloram, and atrazine, have a greater potential of moving from treatment sites to surface water or groundwater. If a water source is contaminated by these herbicides, use of that source for commercial and domestic activities would be restricted, potentially limiting water availability for some communities. Thus, an analysis of the environmental fate of herbicides is important for determining the risks associated with their use.

There could be indirect impacts of herbicide applications as some can increase nutrient content to surface and ground water, leading to algal blooms that can reduce oxygen for aquatic organisms. Herbicides with high solubility and long half-lives are more likely to negatively impact water. For example, glyphosate can reduce growth and density of some photosynthetic microorganisms (Rodriguez-Gil et al. 2017, Van Bruggen et al. 2018). These microorganisms are important food sources for other aquatic organisms and their presence can inhibit the growth and density of more toxic microorganisms (Vera et al. 2012, Van Bruggen et al. 2018).

Since weed treatments could have limited coordination with other land users or adjacent landowners, overuse of herbicides could result in increased herbicide runoff. Concern about non-native plants can prompt non-judicial use of herbicides by individual land users, increasing the amount applied to treated sites. This is largely a concern for herbicides available over the counter to local land users, such as glyphosate. Areas with large weed populations located near the boundaries of the Navajo Nation or that neighbor other federal or tribal lands would not be managed in a coherent fashion. Such scenarios could increase the amount of herbicide applied in an area and potentially impact water quality in nearby waters.

Mechanical methods under this Alternative have the potential to negatively impact water quality on the Navajo Nation. In riparian areas, the removal of vegetation near streambanks would increase erosion, which can increase sedimentation and turbidity in surface waters. Without an integrated and coordinated approach, widespread weed infestations, especially those along riparian corridors would likely increase channelization of waterways and expand to important streams and water sources far from their current locations. Channelization would compound issues related to flood events, where dense stands of trees could be uprooted and cause property and infrastructure damage. Additionally, increased sedimentation, turbidity, and nutrient loading from erosion events could impair nearby water sources, limiting their use for commercial and domestic needs.

4.3.2.2 Alternative 2 – Proposed Action

The proposed action may have small impacts to hydrology by changing the water balance in large treatment sites. Short term impacts from clearing large stands of noxious species would result in an increase of 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 revegetate, resulting in short-term differences in water balance. They would likely not impact overall water availability and use.

The removal of large woody noxious weeds, such as tamarisk or Russian olive, may increase short-term water loss from evaporation, which would be mitigated if sites are restored with native species. Studies comparing evaporation of large woody noxious with native vegetation show mixed results (Nagler et al. 2003, 2005, 2007; Hultine et al. 2010; Gaddis 2008). Most results suggest that replacement of exotic woody species with native vegetation would not result in a difference in regional evaporation rates. Thus, overall changes in water loss may be mixed depending on how treatment methods adjust the density of vegetation and the amount of exposed bare ground.

Noxious species with deep taproots, such as tamarisk or camelthorn, would impact groundwater availability, especially in areas where groundwater is shallow. Removal of these species may increase groundwater storage as native plant communities often do not form dense deep root systems, especially in active floodplains (Nagler et al. 2010). However, removal in areas that are far from major surface water are not likely to result in gains to groundwater. Removal may actually decrease water interception from plants as more bare ground is exposed, especially after large-scale clearing treatments. Loss of living vegetation from sites may temporarily increase surface water run-off. These impacts would be most pronounced immediately after treatments for any of the proposed methods. Restoration of native vegetation from cultural treatments may affect long-term water balance based on variations in plant density and coverage. However, these impacts are likely to be small in scale, with little difference across the landscape. This is because native vegetation can reduce overall plant density from dense thickets or monocultures to a diverse cover of grasses, trees, and shrubs. This transition may decrease water interception by plants, allowing for more infiltration to groundwater aquifers.

Of the proposed herbicides, 2,4-D, glyphosate, and atrazine have water quality standards for surface and drinking water (**Table 3-3**). Of these, 2,4-D and glyphosate have aquatic formulations which break down rapidly in water. Selection of herbicides should consider impacts to nearby water sources, with consideration for their solubility, persistence, and method of degradation.

2,4-D can cause nerve system damage from unsafe short-term exposures. Drinking water levels of 2,4-D considered "safe" for short-term exposures are 1mg/L per day for a small child or 0.3mg/L over 10 days. NNEPA's drinking water standard for 2,4-D is 0.07 mg/L, well below the safe exposure limit. While 2,4-D has a relatively short half-life, it can drift off sites, impacting non-target species and increasing the risk of short-term exposure. This pesticide is monitored due to heavy use in agricultural and urban areas, increasing its risk for contamination. The water quality standards do not affect the aquatic formulations for 2,4-D, which breaks down easily in water, reducing its potential for contamination.

Glyphosate can cause lung congestion and increased breathing rates at its higher application rate, and its widespread use has increased concerns about its long-term exposure risks (Benbrook 2016). Drinking water levels considered "safe" for short-term exposure are 20mg/L daily for a 10-day period for children or 1mg/L daily over a 7-year period. NNEPA's drinking water standard for glyphosate is 0.7 mg/L.

Glyphosate strongly adsorbs to soil, remains in upper soil layers, and exhibits a low propensity for leaching, but it may enter aquatic ecosystems and open water via runoff. While aquatic and non-aquatic glyphosate breakdown quickly in water, widespread and intensive use of the herbicide in agriculture and by the general public increases its prevalence in the environment, especially in surface water (Battaglin etal. 2014, Benbrook 2016, Medalie et al. 2020). These findings raise concerns about exposure rates for applicators and the general public. For these reasons, NNEPA developed standards for glyphosate to monitor its use and its potential impacts to water quality and human health.

Atrazine is a known endocrine disruptor that can alter hormones in animals and humans and is known to cause reproductive and cardiovascular issues. Drinking water levels of atrazine considered "safe" for short term exposures are 0.1mg/L daily or 0.05mg/l daily for long-term exposure in children. NNEPA's drinking water standard for atrazine is 0.003 mg/L. Atrazine has relatively high mobility and can persist for a long time since it is not easily broken down by light or water. There are no aquatic formulations of atrazine and, under Alternative 2, it must be applied at least 300 feet away from any open water sources to reduce the risks of contamination.

Picloram can cause damage to the central nervous system, weakness, weight loss, and diarrhea in people exposed to harmful levels. Safe exposure rates for short-term exposure are 20 mg/L in children or up to 0.7 mg/L for a 7-year exposure rate. NNEPA's drinking water standard for picloram is 0.5 mg/L. In soils, picloram does not bind strongly to soils and may leach into groundwater where it can remain for years. There is no aquatic formulation for picloram, which would limit its use under Alternative 2 to at least 300 feet away from open water sources.

Under Alternative 2, the BIA would work with the NNEPA to ensure treatments comply with the Safe Drinking Water Act and other water quality laws and regulations. These include mitigation measures outlined in Appendix F**.** While herbicides can be used around wellheads, manual or cultural methods would be preferred within 100 feet of wellheads. To protect water quality, only aquatic-formulated herbicides, which are designed to breakdown quickly in water, would be used within 25 feet of surface water and for aerial applications (**Figure 4-1**). Additionally, herbicides that are non-toxic to fish and other aquatic herbicides would only be used within 25 to 300 feet of surface water, and all other herbicides must be applied at least 300 feet away from open water, limiting their ability to move off-site. Other measures, such as restricting applications before precipitation events, during windy conditions, and keeping herbicide storage areas away from open water would also limit or reduce the potential for accidental spills or drift that could contaminate open water.

Targeted grazing near wellheads could raise nitrate levels in the water, so manual treatments would be preferred. If herbicides must be used, treatments should be timed during dry periods to prevent leaching into the wellhead. Targeted grazing would increase surface runoff from trampling and soil compaction. Heavily grazed sites could increase runoff up to nine times that of lightly grazed systems. However, grazing is a short-term treatment and treated areas can recover quickly from high-impact, short-term grazing. Targeted grazing treatments would impact water quality from increased animal waste, which can increase nutrient loading and fecal coliform levels. Excess nutrients can cause algal blooms and reduced oxygen levels, harming aquatic organisms. The severity of such impacts would depend on the number of animals used, the intensity and duration of treatments, and distance to open water.

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

Overall, Alternative 2 would provide several mitigation measures to limit potential impacts to water quality, hydrology, and water use. Limitations on which herbicides can be applied near open water should reduce the potential for harmful herbicides to impair water quality. The restoration of native plants and the use of less impactful methods, such as biological controls, through an integrated approach would also reduce the risk of erosion and water loss.

4.3.2.3 Alternative 3 – No Biological Control

This method would limit weed treatments to cultural, mechanical, chemical, and manual treatments. Treatment of some species, such as knapweeds, leafy spurge, and field bindweed, would be limited to chemical and mechanical methods, which could increase the risks for water contamination. This is a major concern in irrigated farms, which are near rivers and streams. Chemical treatments for these species often require herbicides known to impact water quality standards. While some could be controlled through targeted grazing, the use of livestock would increase soil erosion and topsoil loss in treated locations. Without the use of biological treatments, leafy spurge, which is known to impact riparian areas, would spread in riparian corridors, replacing valuable riparian plant species. This expansion may increase erosion, sedimentation, and nutrient inputs in these areas.

4.3.3 Air Quality

All alternatives could impact air resources. In addition to the treatment of weeds, indirect impacts to air quality from traveling to and from worksites are possible, but likely negligible. Large-scale vegetation removal or travel to treatment sites could increase dust, while prescribed burning could increase particulate matter and air pollutants in nearby areas. However, prescribe burns require NNEPA notification and additional permitting and planning to mitigate potential impacts.

Gaseous emissions – including sulfur dioxide, carbon monoxide, nitrogen oxides, and volatile organic compounds – would result from the combustion of gas and diesel in vehicles used to transport workers or from using heavy machinery. The size of these emissions would depend upon the size, type, age, fuel efficiency and loads hauled during treatments. Emissions from newer, more efficient engines would be less than those of older models, but even the emissions from older, less efficient engines would constitute minor sources of air pollution. However, such emissions are likely to be less than for large-scale construction projects and would only last for short periods of time.

Road dust would occur during travel to and from worksites and during treatments which use motor vehicles. However, vehicles used during treatments are operated at slower speeds which would reduce road dust. Depending on the mileage driven on dirt or gravel roads accessing project sites, the speed driven while traveling, the number of vehicles traveling, and the weight of the materials carried from sites, there could be a detectable amount of dust generated during travel to and from worksites along roads and at treatment sites. These impacts would be temporary and have a short duration, and not expected to have long-term impacts.

During ground applications of herbicides some spray drift would occur. This drift is not expected to produce any ambient air quality impacts since drift does not last long and is limited to areas immediately adjacent to sprayed areas. The quantity of the herbicide released into the atmosphere is not expected to have any long-term impact on air quality.

The use of prescribed burning would have the most impacts to air quality due to increased smoke. The most common air pollutants in smoke are carbon monoxide (CO), carbon dioxide (CO_2), and particulate matter (PM_{10} and $PM_{2.5}$). The BLM Vegetation Treatment EIS (BLM 2007), 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 for air quality standards for PM_{10} and $PM_{2.5}$. Fine particulate matter ($PM_{2.5}$) can travel especially far and has more potential negative health effects than the coarser PM_{10} size fraction. Burning would be used by all alternatives and must follow the BIA's current protocols to reduce impacts from smoke and impacted air quality, including development of a burn plan in compliance with NNEPA and the BIA's Wildfire Prevention 10-Year Plan for the Navajo Region (BIA 2018). This includes smoke modeling, coordination with regional fire support programs, and restricted seasons for when fire treatments can occur.

4.3.3.1 Alternative 1 – No Action

Under the No Action Alternative, limited weed management would be conducted without integrated and coordinated efforts to address major weed issues on the Navajo Nation. Noxious weeds could continue to indirectly contribute to reduced air quality by increasing the frequency and duration 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 increase in proportion to the number of acres burned. The No Action Alternative could indirectly increase total air pollutant emissions over time due to increases in wildfire acres from having more acres of untreated weeds.

4.3.3.2 Alternative 2 – Proposed Action

Air quality impacts common to both the Proposed Alternative and the No Biological Control Alternative are from aerial spraying and prescribed burning. Aerial spraying has the potential for greater spray drift than ground applications. 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 in dust or powder form are more likely to drift into non-treatment areas than herbicides in liquid or pellet forms. The size of the spray droplets can increase the potential for drift, as small droplets can travel longer distances than large droplets. Weather conditions can influence the volatility and drift of herbicides. For example, 2,4-D volatility can triple when temperatures increase from 60 to 80ºF. This effect is exacerbated during periods of low relative humidity.

Aerial herbicide applications may also increase the risk of drift. Aerial applications applied by a fixed wing aircraft can result in more off-site movement than those applied by helicopter. Applications that minimize the distance between the nozzle or applicator and the target area can minimize the potential for drift. Wind direction, velocity, and herbicide stability can also affect drift. Applicators should monitor weather for windy conditions, which increase the potential for herbicides to move into non-target areas. Lastly, the configuration of the application nozzles can influence herbicides 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 would permit aerial herbicide applications. This would increase local exposure to volatilized herbicides immediately after spraying treatments, which could impact those who have sensitivities to herbicides. However, the impacts would be short-term and would dissipate once applications were done. Additionally, BMPs and mitigation measures for aerial spraying would reduce these impacts by prohibiting applications during weather conditions that increase the chances of evaporation or sublimation of herbicide. Under Alternative 2, only aquatic herbicides would be used for aerial treatments, such as 2,4-D, glyphosate, imazapyr, and triclopyr, which reduce potential impacts to air quality due to the lower risk of health impacts form these formulations. Also, aerial applications require a 300-foot. buffer around cottonwood-willow and native sagebrush vegetation communities to further protect native wildlife species.

4.3.3.3 Alternative 3 – No Biological Control

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

4.3.3.4 Greenhouse Gas Emissions

All the alternatives have the potential to release some greenhouse gases (GHG) during implementation However, the magnitude of GHG emissions depends on the methods used and how they are applied. In its analysis of GHG emissions for herbicide use, the BLM estimated that treatments (which include aerial and vehicle-based broadcast spraying), would emit around 3,350 $mTCO_2e$ annually on an estimated 935,000 acres (BLM 2016). Based on the BIA's proposed annual treatment area of 50,000 acres, similar herbicide treatments would emit an estimated 179 $mTCO_2e$/yr or lower as the BIA would likely not conduct herbicide treatments at the same frequency as the BLM and would abide by much more restrictive mitigations for aerial applications. By comparison, mechanical treatments that use gas-powered equipment (i.e. chainsaws and weed whackers) and heavy machinery emit GHGs as they burn fuel, emitting an estimated 10,180g of CO_2e per gallon of diesel fuel (USEPA 2018). A 310-horsepower tractor, which uses an estimated 13.6 gallons of diesel fuel an hour (Schnitkey and Lattz 2017), releases an estimated 1.1$mTCO_2e$ in an 8-hour workday. Emissions for biological control, on the other hand, only occur when vehicles travel to and from treatment sites to transfer organisms. If organisms were transferred from sites 50 miles apart, a vehicle might release an estimated 0.04 $mTCO_2e$ during the round trip, assuming with a fuel efficiency of 20 MPG. In addition, all treatments would be time limited, from 1 day to a few weeks, which further limits how long any emissions would be released. By comparison, GHG emissions inventory for the region are in the millions of metric tons of carbon dioxide each year, with Arizona emitting an estimated 90.4 million $mTCO_2e$/yr and New Mexico emitting an estimated 45.5 million $mTCO_2e$/year as reported in 2018 with a total of 6,677 million $mTCO_2e$/year nationally (USEIA 2020). This indicates that the potential impact of mechanical treatments represents less than 0.00001% of emissions in either state or less than 0.0000027% of total U.S. emissions.

Controlled or prescribed burning would be the most substantial source of GHG emissions under the NNIWMP. Burning emissions, whether from prescribed burning or wildfires, are considered part of ecosystem emissions from land use changes that remove or dramatically alter carbon stored in the ecosystem (USGS 2018). Recent inventories of carbon emissions on federal lands estimate that wildfires result in 21 million $mTCO_2e$/yr nationally, and 0.7 million $mTCO_2e$ in annual emissions each for Arizona and New Mexico (USGS 2018). This indicates that wildfire account for 0.3% of emissions nationally, 0.7% of annual emissions for Arizona, and 1.5% of annual emissions for New Mexico.

However, it is not anticipated that prescribed burning would be used frequently under any alternative as prescribed burning requires a high degree of planning and coordination with the BIA Branch of Forestry, Navajo Forestry Department, BIA Branch of Fire and Aviation Management, and Navajo Nation EPA and can only be applied during specific periods of the year due to air quality and safety concerns. As a result, the BIA anticipates that prescribed burning would be used at a similar rate for all alternatives, but with the added objective of addressing noxious weeds for Alternatives 2 and 3, amounting to less than 500 acres treated on the Navajo Nation each year. The magnitude of GHG emissions from prescribed burns largely depends on the composition of the fuel being burned, the burn duration, and the size of the area being treated (CARB 2020). Prescribed burns also burn at a lower intensity, releasing fewer particulates and GHGs in the air. These variables make it difficult to estimate GHG emissions as it is unknown where prescribed burning may occur, what fuels may be involved, and how large of an area could be impacted under the IWMP. Indirectly, prescribed burning can also be an effective long-term treatment method to reduce the risk of frequent high severity wildfires, which can lower regional emission rates from wildfires by 18 – 25% and improve carbon storage in treated areas (Wiedinmyer and Hurteau 2010, Stephens et al. 2012). This would indicate that prescribed burning could reduce ecosystem emissions from wildfire in the region.

Native plant restoration could counter many GHG emissions by increasing carbon storage at treated sites. The outcomes depend on if and when existing weed populations are replaced with native plant communities. In rangelands, for example, noxious weed treatments could increase carbon storage as exotic annuals are replaced with perennial native species. This is because perennial plants maintain above and belowground structures year-round, which increases their capacity for storing carbon, while exotic annuals do not (Koteen et al. 2011). In riparian ecosystems, however, the results could be mixed. Areas with dense tamarisk or Russian olive, with perennial woody structures, store large amounts of carbon above and below ground. If they are replaced with a mosaic of native cottonwood and willow trees and grasses, which tend to be less dense, treatments could reduce carbon storage as trees are replaced with grasses and shrubs, which have less above and below ground mass. Other factors, such as changes to soil microbial communities and soil respiration rates add additional uncertainty to ecosystem-based assessments (Cahill et al. 2009).

Overall, emission rates may be slightly higher under Alternatives 2 and 3 when compared to the No Action Alternative, Alternative 1, as more acres are treated. However, even high-end estimates of emissions, as noted above, would not be significant enough to result in higher GHG emission rates for the region. Further the use of less impactful methods such as biological control, native plant restoration, and livestock deferment after treatments would lower emission rates for a given project. Due to the variations between projects, each project will undergo a site-specific environmental analysis, which will allow for analyses of GHG emissions for each project based on the proposed treatment methods.

4.4 Vegetation

4.4.1 Noxious Weeds and Native Vegetation Impacts

All weed management alternatives would impact vegetation. Minor impacts would include uprooting small native plants, damage from herbicides, and trampling from increased traffic at project sites. Major impacts to native vegetation may include die-off from herbicide drift, damage to roots or stems from heavy machinery, or a total loss of native vegetation at sites where vegetation is completely cleared. The degree to which desirable vegetation is impacted is largely a factor of how treatments are planned and implemented.

Some of the noxious weeds targeted for control under all the alternatives have been incorporated into Navajo cultural practices, and consequently weed control could impact these resources. Species like field bindweed, cheatgrass, puncturevine, Russian thistle, and tamarisk have documented medicinal and/or ceremonial uses (Mayes and Lacy 1989). These species, however, are well established across the Navajo Nation (and surrounding public lands), and it is unlikely that successful weed control would completely eradicate weeds with cultural significance. Therefore, it is likely that these weeds would persist regardless of the Alternative chosen. It is possible that noxious weeds are utilized for cultural purposes because native species are no longer available. Public education workshops on traditional uses of native plants would reinforce the use of native species and may reduce cultural use of noxious weeds. Under Alternatives 2 and 3, consultation with NNHPD and local communities on weed management projects would address potential impacts to plants used in cultural practices, which would reduce potential impacts to sensitive or culturally valuable populations.

How vegetation is impacted will differ between Alternatives. These variations are based on differences in planning, implementation, and methods proposed for each alternative (**Table 4-2**). For Alternative 1, management efforts would solely focus on plants listed in the 2009 BIA Priority Weed Management list. Other weed species proposed for control would not be treated and would likely expand in size and cover. For species with permitted biological control agents, there would be a greater reliance on direct control methods under Alternatives 1 and 3, which are often expensive and require additional funding to implement. Control of these weeds would be limited under Alternatives 1 and 3, especially for weeds where eradication is desired or where populations are widespread. Alternative 1 would manage fewer weed species, which would affect how resources are allocated for weed management projects.

Table 4-2. Target species meeting treatment objectives by alternative.

Category	Common Name	Objective	Alt 1	Alt 2	Alt 3
A	African rue	Prevent	No	Yes	Yes
	Blue mustard	Eradicate	No	Yes	Yes
	Bull thistle	Eradicate	No	Yes	No
	Canada thistle	Eradicate	Yes	Yes	Yes
	Common Mediterranean grass	Eradicate	No	Yes	Yes
	Dalmatian toadflax	Eradicate	Yes	Yes	Yes
	Fountaingrass	Prevent	No	Yes	Yes
	Leafy spurge	Prevent	Yes	Yes	Yes
	Musk thistle	Eradicate	No	Yes	No
	Perennial pepperweed	Eradicate	Yes	Yes	Yes
	Ravenna grass	Eradicate	No	Yes	Yes
	Sahara mustard	Eradicate	No	Yes	Yes
	Scotch thistle	Eradicate	Yes	Yes	Yes
	Spotted knapweed	Eradicate	No	Yes	No
	Squarrose knapweed	Prevent	No	Yes	Yes
	Sulphur cinquefoil	Eradicate	No	Yes	Yes
	Tall whitetop	Eradicate	Yes	Yes	Yes
	Tamarisk, Saltcedar	Eradicate	Yes	Yes	Yes
	Tree of Heaven	Prevent	No	Yes	Yes
	Yellow starthistle	Eradicate	Yes	Yes	Yes
	Uruguyan pampas grass	Eradicate	No	Yes	Yes
	Yellow nutsedge	Eradicate	No	Yes	Yes
B	Camelthorn	Control/Eradicate	No	Yes	Yes
	Diffuse knapweed	Control/Eradicate	No	Yes	No
	Johnsongrass	Control/Eradicate	No	Yes	Yes
	Halogeton	Control/Eradicate	Yes	Yes	Yes
	Russian knapweed	Control/Eradicate	No	Yes	No

Category	Common Name	Objective	Alt 1	Alt 2	Alt 3
	Russian olive	Control/Eradicate	No	Yes	Yes
	Siberian Elm	Control/Eradicate	No	Yes	Yes
	Tamarisk	Control/Eradicate	Yes	Yes	Yes
C	Bald brome	Local Control/Monitor	No	Yes	Yes
	California burclover	Local Control/Monitor	No	Yes	Yes
	Cheatgrass	Local Control/Monitor	Yes	Yes	Yes
	Field bindweed	Local Control/Monitor	Yes	Yes	No
	Field brome	Local Control/Monitor	No	Yes	Yes
	Horehound	Local Control/Monitor	No	Yes	Yes
	Jointed goatgrass	Local Control/Monitor	Yes	Yes	Yes
	Kochia	Local Control/Monitor	No	Yes	Yes
	Puncturevine	Local Control/Monitor	Yes	Yes	No
	Red brome	Local Control/Monitor	No	Yes	Yes
	Rescuegrass	Local Control/Monitor	No	Yes	Yes
	Ripgut brome	Local Control/Monitor	No	Yes	Yes
	Russian thistle	Local Control/Monitor	No	Yes	Yes
	Smooth brome	Local Control/Monitor	No	Yes	Yes
	Spreading wallflower	Local Control/Monitor	No	Yes	Yes

4.4.1.1 Alternative 1 – No Action

Under the No Action alternative, weed treatments would be implemented under the BIA Noxious Weed Program. However, several widespread weed species, such as diffuse knapweed, kochia, Russian thistle, and several brome grasses would not be addressed or managed. Inaction would increase their spread and cause further degradation to rangeland, farmlands, roads, and riparian areas. Indirectly, weeds identified as Category A priority species are often found in areas just outside of the Navajo Nation or on other federal lands. Species such as squarrose knapweed and Ravenna grass have been detected in small populations on the Navajo Nation. Without management or treatment of these weeds, they would spread to the Navajo Nation and impact biodiversity, grazing, and habitat quality.

Species currently treated under Alternative 1 would not be treated in an integrated and coordinated manner, which could allow large populations to propagate. Under the No Action Alternative, projects would not be prioritized, limiting treatments to large populations, and reducing efforts to monitor for small populations that may become problematic in the future. Populations of several target weeds addressed under the current program, such as knapweeds, thistles, camelthorn, and halogeton would be treated with limited coordination to prevent populations from spreading.

4.4.1.2 Alternative 2 – Proposed Action

Under the Proposed Action, the best management practices would reduce the impacts from weed treatments on non-target vegetation. Best management practices include establishing buffers around large native plant populations, following pesticide label instructions, and training field crews to identify and avoid desirable native vegetation versus target weed species. In the long-term, native vegetation would likely increase in coverage at treatment sites, increasing biodiversity and ecological health at treatment sites. The removal of noxious weed species would restore native plant communities and preserve biodiversity, forage quality, and wildlife habitat in the region. An integrated approach would use multiple methods implemented at different times based on the biology of the target weed.

Biological Control

The proposed action would authorize the use of biological control agents. Each of the species treated with this method has multiple biological agents that have been tested and approved for use. The use of more than one agent for a single species provides a greater means of control. Some agents may impact the target species by destroying seeds or the reproductive capacity of a plant, such as the seed head feeding weevils for knapweeds (*Bangasternus fausti, B. orientalis, or Larinus minutus*). Other agents may form galls in roots or stems, preventing the plant from flowering or growing, such as the starthistle gall fly (*Urophora sirunaseva*). Successful use of biological controls depends on the size and density of existing populations. In general, populations that are continuous, dense, and occupy a large area (1 acre or more) show greater success using this method. Typically, insects crawl, jump, or fly from one plant to the next, so scattered, less dense populations reduce the reproductive success of organisms and their ability to achieve treatment objectives.

Vallentine (1989) noted that before introductions, insects must be highly damaging to the target plants while virtually harmless to native plants. All the biological control agents proposed for use under Alternative 2 (see Appendix A, Table 9-2) 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 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 under testing, it did damage several native species during some initial releases (Louda et al. 2003). Such impacts are not expected when using biological agents and site-based testing near target areas as recommended by APHIS and the BIA to determine feasibility and specificity. Additionally, a list of related native species is provided in Appendix L for each of the weed species proposed for biological control. If biocontrol is planned, crews should monitor treatment sites for related native plants to determine potential risks to those species. As with all treatments, there are unknown risks with the use of these agents on different vegetation communities.

Cultural Control

Targeted grazing would be limited to areas where noxious weeds contribute more than 50% of total cover, are common, and where the use of herbicides or other treatments may be a concern. Targeted grazing would cause direct impacts to non-target vegetation from browsing or trampling plants. The extent of these impacts would depend on the animals used and the condition of the site prior to grazing. For example, while sheep and goats prefer forbs, sheep tend to consume more grass than goats (Walker et al. 1994). Disturbance at grazed sites may encourage the recolonization of other weed species. Grazing animals can also spread weeds to non-infested areas by transporting seeds or plant parts on their fur or in their dung. These impacts would be minimized by quarantining grazing animals after treatments and collecting and burning their excrement to reduce the spread to other areas.

Timing of grazing treatments is important as some weed species lose their palatability over time as they develop toxins, spines, or distasteful compounds, which can cause grazing animals to select native plants over target weed species. The effectiveness of grazing is greatest when treatments are done before plants produce seed, during times of drought, or when implemented repeatedly over time. Overall, grazing provides a method of control for areas where other methods may not be feasible or reasonable.

Manual Control

Manual techniques are very selective and generally only impact vegetation targeted for treatment. Surrounding vegetation could be crushed or damaged by workers or debris. Cutting treatments, such as clipping or use of brush cutters, could encourage resprouting of noxious tree species. To kill 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 incorporate the use of chemical treatments for better control and eradication. Manual treatments for low-growing species, such as pulling young plants or mowing noxious grasses, would have little impact on non-target vegetation except for the removal of some nearby plants.

Mechanical Control

Mechanical treatments are often non-selective as they clear or cut large areas of dense vegetation. Many mechanical methods remove vegetation with little ability to avoid or select specific plants in the treatment area. The exception is the use of feller-bunchers which can select and cut individual trees from a site. Heavy machinery (e.g., tillers, bulldozers, grubbers, etc.) can disturb the ground by rutting and compacting soils when machines are transported and used at project sites. Larger machines increase soil compaction which could alter plant growth of native vegetation and encourage the growth of noxious weeds. Mowers and mulchers that cut vegetation above the surface, would reduce impacts to plant growth by reducing soil disturbance, but may still cause some soil compaction and resprouting. To address compaction, buffer zones would be used to protect federally and tribally listed species. These include parking 20 feet from native plant populations, flagging and establishing buffers around sensitive populations with specific buffer distances based on treatment method. These are outlined in Appendix F (Mitigation Measures).

Additionally, some mechanical treatments have limited effectiveness for noxious weed control. Use of some machines, such as mowers or mulchers, could facilitate the spread of seeds and plant parts in treatment sites. Thus, mechanical treatments should be combined with selective herbicide treatments to prevent recolonization of target weed species and encourage the growth of native vegetation.

Chemical Control

Because herbicides are designed to kill plants, damage to non-target plant species is likely despite cautious planning and implementation. Broadcast spraying, whether by ground or aerial applications, has the greatest chance of damaging non-target plants in and close to the application site. The level and extent of damage from broadcast applications depends on site-specific conditions, including wind speed and foliar interception of herbicides. Non-target and sensitive plant species could be indirectly impacted from off-site drift, surface runoff, or wind erosion. The level of impact would depend on the selectivity of the herbicide, its mobility in the environment, the amount applied, and the exposure level needed to damage non-target plant species.

How herbicides impact native plants depends on how the chemical works to prevent growth or cause damage. The Weed Science Society of America has developed a classification system for herbicides based on the mechanism of action (2011). The classification system groups herbicides based on the biochemical pathways the herbicides impact to control plant growth and development. These mechanisms provide a variety of means to control target populations and aid in herbicide selection.

To assess the potential impacts of herbicides on non-target plants, the BIA reviewed Ecological Risk Assessments (ERAs) from the BLM and the U.S. Forest Service, and USEPA Registration Eligibility Decision assessments for the proposed herbicides. These assessments use modeling to estimate the probability of herbicides movement from off-site drift, surface runoff, and wind erosion based on application method, chemical composition, environmental properties, and toxicology information. 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 used to assess the impacts of herbicides on non-target weed species.

Risk assessments developed by the BLM (2007, 2016) and the USFS (2005, 2006, 2020, SERA 2000 – 2016a) are incorporated by reference. However, six herbicides proposed in Alternative 2 were not covered by these assessments and are examined here based on USEPA registration data and independent studies. These include dichlobenil, metribuzin, paraquat, pendimethalin, prodiamine, and thifensulfuron methyl. Vegetation risk assessments for these herbicides are described in Appendix K. Risk assessments for all proposed herbicides are summarized in **Table 4-3**.

4.4.1.3 Alternative 3 – No Biological Control

Alternative 3 would have similar impacts to Alternative 2 for mechanical, cultural, manual, and chemical treatments. However, the lack of biological control would limit the long-term and large-scale effectiveness of those treatments. Treatment sites with heavy weed infestations that could be treated by biological controls would need to be retreated more often with other methods, such as chemical or mechanical control.

It is important to note that some agencies adjacent to the Navajo Nation already use biological controls on their lands, such as the USFS and the City of Flagstaff. These releases suggest that biological control agents may already exist on the Navajo Nation (D. Murray, APHIS Biology Specialist, personal communication). Thus, the No Biological Control Alternative does not guarantee that these organisms would not be present in the region. However, the BIA could not authorize releases, monitor populations, or manage agents for the purposes of weed control. This would include monitoring related native species for impacts or moving agents to areas where they may be more effective at controlling target weed populations.

Without the use of biological control, many of the proposed weeds that could be controlled with permitted biological control agents would spread on the Navajo Nation, which may require the BIA to redirect projects toward these problem populations. Since this passive method of control would not be available, there may be higher project costs from increased mechanical and/or chemical treatments in these sites.

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Table 4-3. Herbicide selectivity, mode of action, and site impacts. Selectivity indicates the specific types of plants the herbicide targets. Pre-emergent herbicides are applied to sites before plants emerge. Post-emergent herbicides are applied after plants emerge and are actively growing. Refer to the herbicide label for specific timing instructions. For impacts analysis, risk of damage is based on a comparison of the modeled hazards and the USEPA toxicity levels for plants.

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 100-300 ft from treated area with distance increasing at higher application rates (0.5 – 4 lbs / 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 2006
Aminopyralid	Broadleaf Weeds	Synthetic Auxin	Growth regulator		X	High to slight risk to sensitive plants 50-300 ft from application area. Not likely to impact tolerant plants	Not Likely	Slight risk for sensitive plants in clay soils with 15" of annual rainfall. Not likely to impact tolerant plants.	SERA 2007
Atrazine	Broadleaf weeds and grasses	Synthetic Auxin	Growth regulator	X	X	Moderate to low risk to sensitive plant species 66 ft from treated areas at all application rates. Risk of damage up to 1000 ft for ground and 1 mile for aerial treatments at high application rates. Highest risk for seedlings and aquatic vegetation	Risk of damage to trees, shrubs, and forbs in windy conditions.	Risk of damage for sensitive plants due to long-term persistence in soils and weak soil adsorption.	BLM 2016 USEPA 2003
Chlorsulfuron	Perennial broadleaf weeds and grasses	ALS Inhibitor	Blocks protein synthesis	X	X	Sensitive plants have a risk of impact at all application rates up to 900 ft from the application site. Higher risks 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 treated areas.	BLM 2007 SERA 2016a
Clopyralid	Broadleaf weeds	Synthetic Auxin	Growth regulator		X	High to slight risk to sensitive plants up to 500 ft from application area. Risk increases with decreasing distance to application area and increasing application rates. 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.	SERA 2004
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. Ground broadcast applications only.	Not Examined	Potential for damage to sensitive plants in surface waters. Estimated 2% of dichlobenil runs off site following applications. Potentially high to low risk of damage to sensitive species based on applied concentration.	USEPA 1998
Fluroxypyr	Broadleaf weeds	Synthetic Auxin	Growth regulator		X	Moderate to low risk to sensitive plants up to 900 ft for high boom ground applications and 500 ft for low boom applications at traditional application rates. Low risk to sensitive plants during backpack applications up to 100 ft. Low risk to tolerant plant species in treated area.	Not Likely	Not Likely	BLM 2016 SERA 2009

Herbicide	Selectivity	Mode of Action*	How it Works	Pre-emergent	Post-emergent	Off-Site Drift Impacts	Wind Erosion Impacts	Surface Runoff Impacts	Source
Fluazifop-P-butyl	Annual and perennial grasses	ACCase Inhibitor	Growth regulator		X	Low risk to sensitive plant species at traditional application rates, up to 300 ft for aerial applications with fine droplets and 100 ft 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	SERA 2014
Glyphosate	Non-selective	EPSP Synthase Inhibitor	Blocks protein synthesis		X	High to moderate risk of damage to sensitive plant species at 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	Not Likely	SERA 2011**
Imazapic	Broadleaf weeds	ALS Inhibitor	Blocks protein synthesis	X	X	Low risk to sensitive plant species at a range of application rates up to 100 ft from application area for aerial applications. Very low risk up to 50 ft 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 in areas with clay soils and 50-150" of annual rainfall.	BLM 2007 SERA 2004a
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 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 in application areas. Not likely to impact outside of the area.	Potential for damage to sensitive plant species from contaminated dust during major 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 2007 SERA 2011a
Indaziflam	Annual and broadleaf weeds, grasses, and vines.	Cellulose Inhibitor	Inhibits cellulose production in roots.	X		High risk to aquatic plants and sensitive plant species.	Not likely	Moderate risk to sensitive and tolerant plant species with higher application rates.	USFS 2020
Isoxaben	Broadleaf weeds, grasses, and vines	Cellulose Inhibitor	Inhibits cellulose production	X		Low risk to sensitive plants species within 25 ft of application area for ground broadcast treatments. At higher application rates, sensitive species may be impacted within 250 ft 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. Risks decreases with lower annual rainfall and lower application rates.	SERA 2000 USEPA 2010
Metsulfuron methyl	Annual, biennial, and perennial broadleaf weeds and brush	ALS Inhibitor	Blocks protein synthesis		X	Moderate to low damage risk to sensitive plant species within 500 ft of treated areas from aerial applications. For ground applications, low risk of damage to sensitive plants within 500 ft of treated areas at all application rates. Some damage to tolerant plants in the area for ground applications.	Risk of damage to sensitive plant species from contaminated soil during major 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.	SERA 2005 BLM 2007

Herbicide	Selectivity	Mode of Action*	How it Works	Pre-emergent	Post-emergent	Off-Site Drift Impacts	Wind Erosion Impacts	Surface Runoff Impacts	Source
Metribuzin	Broadleaf weeds and grasses	Synthetic Auxin	Growth regulator	X	X	Off-site drift studies indicate a risk of damage to plants anywhere from 112 to 282 ft away from treated areas during aerial and ground broadcast applications. Risk of damage to sensitive plants within 15 ft of treated areas.	Risk of damage to sensitive species during wind events for up to 3 weeks after treatments.	Risk of damage to sensitive species due to high mobility in soils for metribuzin and its metabolites.	USEPA 2012
Paraquat	Annual broadleaf weeds and grasses	Photosynthesis I electron diverter	Cell membrane disruptor	X	X	Off-site drift is likely to affect non-target plants within 20 ft of treatment areas for broadcast applications.	Not Likely	Not Likely	USEPA 1997
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 at 1% of applied spray volume from ground applications.	Not Likely	Potential for damage to sensitive plant species during runoff events. Damage most likely during heavy rainfall immediately after applications.	USEPA 1997a
Picloram	Annual and perennial broadleaf weeds and brush	Synthetic Auxin	Growth regulator		X	Moderate to high risk of damage to sensitive plants up to 900 ft of application area for ground broadcast treatments. Low risk of damage to tolerant species in application area for both broadcast treatments	Potential for damage to sensitive plant species from contaminated soil during major 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 2007 SERA 2011b
Prodiamine	Broadleaf weeds and grasses	Mitosis Inhibitor	Interferes with new plant growth	X		Use of liquid forms posed risks to sensitive and non-target plant species for all uses, while granular forms only posed risks to semi-aquatic plants. Risks are low to moderate.	Not Examined	Not examined	USEPA 1992
Thifensulfuron methyl	Broadleaf weeds	ALS Inhibitor	Blocks protein synthesis		X	Moderate risk of damage to sensitive and non-target plant species from aerial and ground broadcast applications within 1000 ft of treated sites.	Not Examined.	Increased risk of damage due to weak adsorption to soils. Risks are highest in clay soils with moderate annual rainfall. However, such risks are short-lived.	USEPA 2011
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 rates, damage could occur within 300 ft of application site. At maximum rate, damage could occur within 900 ft of application site.	Low risk to sensitive plant species up to 50 ft. from treated sites with ground applications, with higher risk of damage following major wind erosion events after applications.	Low risk of damage to sensitive plant species. Potential damage in areas with clay soils and heavy rainfall. Risk of damage is higher for triclopyr BEE.	BLM 2007 SERA 2016

**Assessment for higher toxicity formulations

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

As discussed in Chapter 3, the Navajo Nation supports 35 special status plant species based on their rarity and sensitivity. Special status plants include seven federally listed species that are threatened or endangered. The remaining 28 special status species are tribally listed by the NNDFW. Many of these species are threatened by competition with non-native plants and other noxious species. Weed control has the potential to improve habitat for listed plant species. Herbicides, biological control agents, and other weed control treatments, however, may adversely impact some sensitive plants. The potential impacts of each alternative on listed plant species are discussed below.

4.4.2.1 Alternative 1 – No Action

Under the No Action alternative, some weed treatments would have similar impacts to those described for the Proposed Alternative. However, not all the weed species listed in the plan would be targeted, and thus some could continue to expand and invade native plant communities, potentially degrading habitat for listed plant species. Moreover, weed treatments on the Navajo Nation would continue in a piecemeal fashion rather than as part of coordinated, integrated efforts. Attempting to control weeds in this manner reduces the overall effectiveness of treatments and allows for the continued degradation of native plant communities.

Additionally, as described earlier in this document, several weed species including Russian thistle, red brome, and cheatgrass can increase the frequency of wildfires. Wildfires can kill listed plant species and cause indirect effects by altering hydrologic dynamics and other key habitat features that support their growth and reproduction. Finally, there is a greater risk for listed species impacts from weed treatments because consistent species conservation measures would not be implemented.

4.4.2.2 Alternative 2 – Proposed Action

All weed control techniques considered for use under Alternative 2 could impact listed plant species. However, the mitigation measures described along with the treatment buffers for listed plant species by the USFWS and/or the NNDFW should minimize the potential for harm. Two control methods, biological and chemical, could impact listed plant species despite these measures, as impacts from both methods can spread beyond their intended taxonomic or geographic targets.

As described above and in Chapter 2, biological controls are organisms which target specific weed species through predation or parasitism, reducing the ability of the weed to thrive. Thus, there should be no direct effect on listed plant species from the use of biological controls. There may, however, be indirect effects of biological control agents on native species, including listed species, if the target weed species is well established in the vegetation community, and has come to serve an important ecological role (Pearson and Callaway 2003). Therefore, it is important to study the possible unintended consequences of biological control before it is used.

Despite the rigorous testing of potential biological control agents for host-specificity, there have been cases where a released biological control agent has directly impacted native species, particularly when those species are closely related to the weed species being targeted. For example, the flowerhead weevil (*Rhinocyllus conicus*) was used to control exotic thistles. Despite being tested by APHIS for host-specificity before its release, the weevil did damage native thistles (Louda et al. 1997). Several noxious thistle species are related to the NNDFW listed Rydberg's thistle. While this species of flowerhead weevil is not being considered under this plan, the potential for negative impacts should be carefully considered before utilizing any biological control agent on exotic thistles.

Herbicides have the potential to impact listed plant species, particularly through spray drift during aerial applications. Due to the large number of herbicides considered in Alternative 2 (21) and the number of listed plant species in the study area (34), it is not feasible to discuss all potential impacts of each herbicide on each species here. Instead, a general discussion of general herbicide classes on different categories of listed plant species is 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 group(s) (broadleaf dicots, grasses, shrubs, etc.). See **Table 4-3** for the selectivity of the proposed herbicides. Broad spectrum herbicides, such as glyphosate, imazapyr, paraquat, picloram, thifensulfuron methyl, and triclopyr have the most potential, if used inappropriately, to impact listed species on the Navajo Nation as they damage all plants regardless of growth form and type.

The remainder of the herbicides considered in the plan are selective to one degree or another. Herbicides that are selective for grasses and/or sedges could impact any of the five listed monocot species, such as Navajo sedge or Gooding’s onion. Several herbicides are selective for annual grasses and could impact Parish’s alkali grass (the only listed annual grass on the Navajo Nation). Most of the herbicides target broadleaf weeds and could impact any of the 20 listed broadleaf dicots, and the Utah bladder fern. A few herbicides are selective for woody species, including fluroxypyr, glyphosate, and metsulfuron methyl. These herbicides could impact woody species on the federal and Navajo Nation lists, which include round dunebroom, Navajo saltbush, and Arizona rose sage. Cacti have some resistance to foliar herbicides due to their thick, waxy cuticle, but the three listed cacti in the study area may be impacted by herbicides that work through the roots, such as atrazine, fluroxypyr, and imazapyr.

Unintended impacts to listed plant species, while always a possibility when using herbicides, would be minimized by following the Recommended Protection Measures for Pesticide Applications in Region 2 of the U.S. Fish and Wildlife Service (White 2007), the mitigation measures listed in Appendix F, and using the required or recommended buffer zones around listed species when planning treatments.

4.4.2.3 Alternative 3 – No Biological Control

This Alternative would result in similar impacts to those described above for the Proposed Alternative, without potential impacts from biological control agents. However, without biological control agents, land managers would use other control techniques more often, such as pesticides and mechanical removal, and could increase negative impacts from those techniques under this Alternative.

4.4.3 Wetlands

Impacts from weeds and weed treatments on water quality are assessed in the Water Resources section. Weed infestations can impact riparian areas and emergent wetlands by lowering the water table, increasing bank erosion and channelization, outcompeting native species, and degrading wetland habitat for native plants and animal species. As discussed in Soils, Water, and Air, weed treatments can increase sedimentation and turbidity. These impacts could increase potential damage to riparian and wetland vegetation, as described below.

4.4.3.1 Alternative 1 – No Action

Under the No Action Alternative, weed treatments would have similar impacts as described below for Alternative 2. These impacts, however, would be weaker as treatments would not be as widespread across the Navajo Nation. Moreover, without a coherent, integrated weed management strategy, the negative impacts of weeds on native species, including riparian and emergent wetland species, would be greater under No the Action Alternatives.

4.4.3.2 Alternative 2 – Proposed Action

Under this Alternative, weed control treatments could temporarily increase surface runoff from cleared areas, which could increase sedimentation and turbidity in riparian areas and emergent wetlands. Although increased sedimentation and turbidity primarily impact wetland fauna, they can result in decreased macrophyte growth and diversity as less light penetrates the water column (Henley et al. 2000). However, any increases in sedimentation and turbidity from clearing weeds would be short-term, as plant regrowth and restoration after treatments would replace soil-retaining vegetation in treated riparian areas or emergent wetlands, returning them to their pre-treatment condition.

Herbicides have the potential to impact riparian areas and emergent wetlands directly through spray drift and indirectly via groundwater transport 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. Careful application based on label instructions along with buffer zones and mitigation measures outlined in Appendix F should minimize negative impacts from herbicide treatments. Only USEPA aquatic approved herbicides would be used near wetlands. Non-aquatic herbicides with high aquatic toxicity, such as picloram, would require a 300-foot buffer away from the daily high-water mark.

Overall, impacts to riparian and emergent wetland plants from treatments under this alternative are likely to be minimal, and short-term. The long-term benefits of removing or minimizing the presence of noxious, non-native species would likely outweigh potential negative effects.

4.4.3.3 Alternative 3 – No Biological Control

Impacts from this Alternative would be similar to those for the Proposed Alternative. However, without the use of biological control treatments, there would be increased use of mechanical and/or herbicide treatments, resulting in increased negative impacts compared to the Proposed Alternative. Fewer acres would also be treated under this alternative. However, positive impacts from removing weed species and restoring native plant communities would be similar.

4.5 Wildlife

4.5.1 Terrestrial and Aquatic Wildlife Species

Noxious weed treatments would have short-term impacts on wildlife species. Most of these impacts are due to changes in habitat and food for grazing species. For aquatic species, impacts to water quality have the greatest potential for harm. Since most fish on the Navajo Nation are exotic and fished or are protected by NNDFW or USFWS, the impacts are discussed in Section 4.5.2 Hunting and Fishing and 4.5.4 Threatened, Endangered, and Sensitive Fish Species and Designated Critical Habitat.

4.5.1.1 Alternative 1 – No Action

This alternative has the potential for the highest loss of wildlife habitat. Minimal, uncoordinated noxious weed treatments would continue under the current management strategy. Noxious weed infestations would expand, which could lead to long-term degradation of wildlife habitat. As weed infestations expand, there would be high losses of available forage for ungulates such as elk, mule deer, and pronghorn during the next 10-year period. Livestock would continue the spread of the noxious weeds and compete with wildlife for native forage. Leafy spurge, Russian knapweed, cheatgrass, and yellow starthistle would also expand and invade previously uninfested grasslands due to limited number of treatments, replacing palatable, nutritious food for elk, deer, and pronghorn. Species such as Sahara mustard, brome grasses and Russian thistle would remain untreated as they are not covered by the 2009 BIA Noxious Weed List. The expansion of non-native grasses, such as cheatgrass, would increase wildfire risk in these areas. Wildfires would reduce habitat availability for small mammals and butterfly species, and forage for ungulates. Also, cheatgrass awns can imbed themselves in the throat, ears, and noses of native mammals causing infections. There was one confirmed case of mortality in a bighorn ram due to an infection caused by an imbedded cheatgrass awn in its throat (Pam Kyselka, Wildlife Biologist at NNDFW, personal communication, August 18, 2020).

Noxious weeds in riparian areas would continue to spread and out-compete native vegetation. Native riparian habitats may be replaced with dense stands of noxious tamarisk and Russian olive. Invasive plants could impact development and metamorphosis of amphibians by changing the nutrient quality of plant materials that tadpoles feed on and changing the chemistry and water temperature of riparian ecosystems (Bucciarelli et al. 2014). This alternative would result in the greatest expansion of weeds in the project area. Under Alternative 1, noxious weeds would be largely controlled by chemical methods which could increase herbicide in wildlife habitat because best management practices and species conservation measures would be implemented inconsistently. Despite the increased use of herbicide, this alternative would have minimal, short-term impacts to wildlife diversity and population trends in the project area.

4.5.1.2 Alternative 2 – Proposed Action

Repeat treatments using various methods would be necessary for most weed species because seeds can be viable for years. Therefore, reoccurring treatments would be authorized until the desired control objective is reached. The combination of methods used would vary based on specific site conditions.

Chemical Control

Wildlife could be exposed to herbicides through direct spray, consumption of contaminated items (vegetation, prey species, or water), grooming activities, or indirect contact with contaminated vegetation. To determine the toxicity of herbicides on wildlife (mammals and birds), different scenarios are evaluated, including acute exposure (direct spray), subacute exposure (ingestion of contaminated media and grooming activities), and chronic exposure (indirect contact over a long duration) of low to high herbicide doses. Aerial applications have the greatest potential to impact wildlife because they typically cover the largest treatment area; however, these impacts would be minimized when implementing mitigation measures. Fluazuifop-P-butyl and 2,4-D may carry a slight risk to small and large mammals if they consume contaminated vegetation. Fluazuifop-P-butyl also may adversely impact wildlife reproduction. Atrazine could exhibit endocrine-disrupting effects in mammals, amphibians, and reptiles (Rohr et al. 2006).

Currently, the BIA uses around 11 herbicides (**Table 4-5**), and mainly use imazapyr, metsulfuron-methyl, 2,4-D, and triclopyr, with over 80% of treatments using imazapyr. These herbicides would likely continue as the preferred herbicides for most BIA treatments. Under Alternative 2, the BIA would permit the use of 10 additional herbicides to allow projects more options in using herbicides that best match treatment goals and application conditions and are less toxic reduce health risks for wildlife species.

New information on glyphosate and its adjuvants indicates that when exposed to a single dose there is a minimal impact on mammals, however mammals may have long-term effects when glyphosate accumulates in the environment. Some impacts of glyphosate on mammals include infertility and malformation when glyphosate accumulates to detectable concentrations in the liver and kidneys from residues found in food (Van Bruggen et al. 2018). Other long-term impacts include impaired neural cell development and depressive-like behavior in rats.

Of the herbicides proposed under Alternative 2, fifteen are discussed in detail in risk assessments prepared by USFS (2005, 2006, 2020, SERA 2000 – 2016a) and BLM (2007, 2016), and are incorporated by reference. Six herbicides proposed for use are evaluated here, as they were not covered by these assessments, and include dichlobenil, metribuzin, paraquat dichloride, pendimethalin, prodiamine, and thifensulfuron methyl. Their impacts on wildlife are summarized below. More detailed information on the toxic effects of short, moderate, and long-term exposure of these herbicides and all herbicides proposed for use by the BIA are discussed in Appendix K.

Dichlobenil – Dichlobenil is slightly to moderately toxic to mammals when consumed. Small and medium sized mammals can show liver and kidney damage. Neurotoxic effects of dichlobenil, such as depression and muscle weakness, were observed in small mammals (USEPA 1998).

Metribuzin - When ingested, metribuzin can be slightly toxic to mammals (USEPA 1998b). Exposure to low concentrations show short term liver toxicity to rabbits and their fetuses (Samir et al. 2018). Multiple applications have a higher risk to endangered small herbivorous and insectivorous mammals. Broadcast application of nongranular product over long-term consumption is toxic for small mammals. Metribuzin is moderately toxic to bird reproduction when directly consumed and practically non-toxic to birds when minimal amounts are consumed over time (USEPA 1998a).

Paraquat– Medium to high application rates produce long-term risk for mammals. Consumption of grass with herbicide residues present a high risk of for herbivores and small insectivorous mammals. Birds are at risk when directly sprayed. At high application rates, paraquat can reduce hatchability, produce high mortality, and reduced growth to eggs (USEPA 1997). However, when paraquat is in dry powered form, its registered form, there are no long-term risks to mammals or birds.

Pendimethalin - Pendimethalin is slightly toxic to birds and small mammals from direct consumption and consuming contaminated vegetation over time (USEPA 1997a).

Prodiamine - Prodiamine is practically nontoxic to slightly toxic to small mammals from direct contact spray and inhalation (USEPA 1992). It is practically nontoxic to birds when consumed directly or consumed as residues on food; however long-term consumption can negatively influence reproduction (USEPA 1991).

Thifensulfuron methyl - Thifensulfuron methyl is practically nontoxic to mammals when directly consumed (USEPA 2011). However, exposure through drinking water is a potential concern for short-term toxicity in mammals and birds and long-term exposure in birds. When directly consumed by birds it causes a slight reduction in egg production and hatchlings (USEPA 2011).

Overall herbicide treatments and their impacts will be temporary and will only impact wildlife in the short-term minimizing the chronic exposure impacts. The long-term positive impacts on wildlife communities under this alternative include improvements to habitat, forage production, and overall ecosystem health. All herbicide applications would adhere to the buffer requirements and mitigation measures listed for special status species and riparian and wetland areas. Overall, the impacts to wildlife under this treatment method would be minimal.

Cultural, Manual, and Mechanical Control

Hand pulling, mowing, and heavy machinery may be implemented under the proposed action and would require up to 30 people in areas where it is difficult to use other methods. This method is not as effective for long-term treatment against large infestations of weeds. Short-term disturbance impacts on wildlife could occur from hand-pulling and mowing treatments. Wildlife may be temporarily displaced, but disturbance would be limited in extent and duration. Vehicles and other ground-based mechanized gear used for treatments would generate noise. However, these impacts are expected to have a short duration and with minimal impacts to wildlife. Heavy machinery may impact ground dwelling or burrowing wildlife by causing burrows to collapse. Restrictions for breeding and migrating seasons and nest buffer restrictions required in the mitigation measures would reduce the likelihood of disturbing birds and wildlife during more sensitive periods. The short-term impacts to wildlife would be outweighed by the benefits of habitat improvement from weed removal activities. Also, the relative size of sites proposed for treatment on an annual basis compared to the amount of habitat available for wildlife species makes these impacts minimal on a population level for most species.

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 mitigation measures for species of concern. Mitigation measures and BMPs would be applied to minimize effects to species habitat. These measures were developed in consultation with the USFWS and the NNDFW specifically for the Proposed Alternative (Appendix F).

When vegetation is removed, bare soil would be exposed, which could cause topsoil erosion. Native plant revegetation in treated areas, particularly in riparian areas, where pollinators are common, along roadsides and on cut banks or slopes, would be important to stabilize soils and improve wildlife habitat. The use of appropriate seed mixes for treated areas would restore the native habitat. This includes the addition of native forbs to site that were almost exclusively grasses, which increases habitat for pollinators. Impacts from these control measures would be short-term and would be outweighed by the long-term benefits.

Biological Control

The release of approved biological control agents could reduce the reliance on herbicides. There are no expected impacts to fish and wildlife across the Navajo Nation from the introduction of the proposed biological control agents.

There is concern that a biological agent could switch hosts from noxious to native species in the same genius or family if the noxious resource becomes limited. This could cause indirect impacts to species of concern by reducing food availability or habitat. One wildlife species of concern is the Great Basin silverspot butterfly (*Speyeria nokomis*), a NNFWS Group 3 listed species that uses an array of plants as nectar sources, including introduced thistles, horsemint (*Monarda* sp.), and joe pye weed (*Eutrochium* sp.) (Selby 2007). Selby (2007) emphasized the need for diverse nectar sources during adult flight time to increase reproduction rates. If Canada thistle and leafy spurge are left unchecked, they can replace diverse native plant communities with dense monocultures, compromising this species' habitat (Selby 2007).

Introducing biological control agents in this species habitat would eliminate potential deleterious impacts from other treatment methods, including erosion from mechanical methods and herbicide overspray that could impact this species' host plant and native nectar resources. Further, native forbs could be planted to provide a native nectar source for the butterfly in conjunction with biological control releases. Many native plants have specialized pollinators which would not be visited by biological control agents, therefore no effects from biological control agents on pollinators are anticipated (Wäckers and Van Rijn 2012).

Additionally, some biological agents may indirectly increase small mammal populations by providing a new food source. In one case, two gall fly species (*Urophora affinis* and *U. quadrifasciata*) provided limited control of diffuse and spotted knapweeds. However, deer mice, which feed on the fly larvae, increased by 2 to 3 times in areas where the flies were released, which indirectly impacted humans and predators (Pearson and Calloway 2003).[1] Overall impacts from this treatment method on wildlife would be minimal especially when mitigation measures are implemented.

Effects of Treatments on Amphibians

Amphibians may be the most herbicide-sensitive wildlife group 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 an indicator species for environmental and ecological impacts related to land management.

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 free of endocrine-disrupting effects until proven otherwise." Hayes et al. (2002) found that atrazine at concentrations much lower than USEPA drinking water standards could cause hermaphrodites and reduced laryngeal size in frogs. Herbicides used with surfactants may also increase the risk to amphibians and reptiles. Studies show that using the surfactant POEA with glyphosate-based herbicides is three times more toxic than glyphosate alone (Perkins et al. 2000, Relyea 2012). Also, the use of non-aquatic approved glyphosate is a concern in areas with amphibians, with studies showing glyphosate killing 90 to 100% of tadpole species when applied at above average rates, and 79% of amphibians died within one day after direct spraying with recommended application rates (Relyea 2005, 2005a). Other effects of glyphosate-based herbicides on amphibians include osmotic instability, delayed or accelerated development, reduced size at metamorphosis, malformations, stress, and death (Wagner et al. 2013). The use of paraquat on farm fields

[1] Increases in deer mouse populations raised concerns about hantavirus transmission and potential impacts to associated predators (Pearson and Calloway 2003). Gall fly larvae should not be introduced as biological controls close to human development to prevent the risk of hantavirus.

showed direct toxic effects on the survival, reproduction, and growth of California red legged frog and reduction of the prey base (Office of Pesticide Programs 2009). Amphibians can be indirectly affected by herbicides through the elimination of food resources, competitors, or predators. Atrazine use reduced algal food resources which impaired growth in amphibians (Mann et al. 2009).

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

Effects of Treatments on Reptiles

Reptiles that bask during the day on rocks, trees, logs, or bare ground are the most at risk for negative impacts from weed treatments. Herbicides may pose the greatest threat as environmental contaminants have been identified as one of the main factors driving global reptile decline (Böhm et al. 2013). The herbicides proposed for use under the integrated weed management plan are all rated as being either slightly to moderately toxic to reptile species or non-toxic (White 2007). However, few studies have been conducted observing the effects of herbicide application on reptiles. Reptile studies that have been conducted found little effect of herbicides on reptiles, and in some causes increased reptile richness (Greenberg et al. 2016, Wier et al. 2016, Lindenmayer et al. 2017). One study found that when exposed to glyphosate skinks selected warmer temperatures, which may indicate impaired thermoregulation (Carpenter et al. 2016). Glyphosate has shown to be toxic to reptiles, but it is thought that this is due to the surfactant POEA (Howe et al. 2004). A study showed that there was an increase to reptile species richness to glyphosate spraying after a control burn to control an invasive weed (Lindenmayer et al. 2017). Also, at the highest acceptable application rate of triclopyr western fence lizard showed acute toxicity when orally exposed, however it is unlikely this concentration would be used in the field (Weir et al. 2016). Therefore, it is unlikely that herbicides listed in the Proposed Action will impact reptiles.

Mechanical treatments may impact reptile habitat, specifically those that may move or dig up large quantities of earth while removing vegetation. They could be trampled or run over by a vehicle or mower, but such events would be rare. Reptiles may retreat to burrows that are impacted by heavy machinery. Impacts to reptiles and their habitat will be minimal and short-term and have beneficial effects to habitat in the long-term.

Effects of Treatments on Pollinators

Noxious weeds provide nectar resources for pollinators, and their removal would reduce these resources. However, pollinator diversity has shown to increase with flowering plant diversity, and by removing weed monocultures and replanting treated areas with diverse native seed would increase pollinator diversity (Garibaldi et al. 2011, Miller 2018, Dale et al. 2020). Biological control agents, particularly bud herbivores, reduce the number of inflorescences a noxious weed produces and indirectly reduce flower visitation of pollinators (Swope and Parker 2012). While biocontrol agents reduce available nectar resources for pollinators in the short-term, they reduce the spread of noxious weeds and provide opportunity for diverse native species planting and increased pollinator diversity. Pollinators, primarily insects, are active throughout the day and have a high chance of being impacted by noxious weed treatments. Manual, mechanical, and cultural treatments would provide short-term disturbance to an area; however, the long-term effects of planting native plants and seeds would provide more diverse nectar resources.

Pollinators can be exposed to herbicides through direct spraying, contact with plant parts, consuming contaminated vegetation, and interactions with the soil. Aerial applications have the greatest potential to impact pollinators because they typically cover the largest treatment area and may drift for longer distances; however, these impacts would be minimized when implementing mitigation measures. Dichlobenil, prodiamine, pendimethalin, thifensulfuron methyl, and indaziflam are practically non-toxic to honeybees when directly contacted (USEPA 1991, 1998a, 2003, 2011). Triclopyr, pendimethalin, and prodiamine are moderately toxic to terrestrial arthropods. Honeybees are at risk when directly sprayed with paraquat <u>and even at low doses paraquat can alter larval development </u>(USEPA 1997, Cousin et al. 2013).

Glyphosate, triclopyr, and imazapyr have shown to have deleterious effects on pollinators. Honeybees and native bees displayed high mortality when exposed to vegetation that had recently been sprayed with above recommended concentrations of glyphosate (Abraham et al. 2018). Additionally, one study found that glyphosate altered bee gut bacteria, which reduced their ability to fight off infections (Motta et al. 2018). Monarch butterfly declines have been attributed to indirect effects of reducing their host plant (milkweed) abundance from glyphosate spraying (Pleasants and Oberhauser 2013 and Pleasants 2017). Monarch butterflies showed no developmental impacts when directly exposed to atrazine throughout development (Olaya-Arenas et al. 2020). Behr's metalmark butterfly experienced reduced number of pupae produced and subsequent adult emergence when directly exposed to triclopyr and imazapyr over time (Stark et al. 2012).

Soil litter invertebrates (which are prey for a range of vertebrate species in this study) also appear to be relatively unaffected by herbicide spraying (Lindenmayer et al. 2017). Since pollinators use a large area for obtaining nectar resources, there may be synergistic effects if herbicides or other pesticides are sprayed in adjacent agricultural or resource areas. While one-time direct exposure to herbicides may be practically non-toxic, herbicides accumulating over time may have negative effects (Main et al. 2020). Atrazine has shown to bioaccumulate in honeybees when exposed to sprayed vegetation over time (Hladik et al. 2016). Using the proposed mitigation measures will reduce long-term effects to pollinators and planting native species will increase flowering plant and pollinator diversity.

Overall herbicide treatments and their impacts will be temporary and will only impact pollinators in the short-term minimizing chronic exposure impacts. The long-term positive impacts on pollinator communities under this alternative include improvements to habitat, nectar resource diversity, and overall ecosystem health. The impacts to pollinators under this treatment method would be minimal.

4.5.1.3 Alternative 3 – No Biological Control

This alternative would limit the 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 be treated over multiple applications using other methods such as chemical or mechanical control, which pose a greater risk to wildlife.

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

4.5.2 Hunting and Fishing

4.5.2.1 Alternative 1 – No Action

The No Action Alternative would allow existing negative impacts related to the spread and establishment of noxious weeds to continue. Less palatable noxious weeds, like cheatgrass, red brome, and tamarisk, would continue to expand in riparian areas and grasslands. These species would also increase wildfire risk, which would reduce grassland availability to game species. Native grasslands would be reduced, and cattle would continue to compete with big game for limited native forage.

4.5.2.2 Alternative 2 – Proposed Action

Under the Proposed Action, noxious weed treatments would be conducted through an integrated approach. Some of the impacts to hunting and fishing would be the same as described in 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 for big game species, may be impacted from trampling by work crews or heavy machinery. Also, game species may be temporarily displaced during treatments. 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 proposed action would have limited effect on hunting and fishing especially when best management practices are used.

4.5.2.3 Alternative 3 – No Biological Control

This Alternative would have similar impacts to Alternative 2 for mechanical, cultural, manual, and chemical treatments, without the use of biological control, and 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 be retreated more often using other methods such as chemical or mechanical control.

4.5.3 Terrestrial and Aquatic Wildlife Species - Endangered, Threatened, Proposed, Candidate, and Sensitive Species.

As discussed in Chapter 3, the Navajo Nation supports 39 special status terrestrial wildlife species based on their rarity or sensitivity. Many listed species are threatened by competition from livestock, habitat degradation, and limited distribution (see the discussion under Terrestrial Wildlife Species). Noxious weeds can reduce the suitability of some habitats that support special status species. Some species, such as butterflies, require specific host plants for their larval stage. For other species, it is the structure rather than the species composition of the habitat that makes it suitable. For example, the southwestern willow flycatcher lives in riparian areas with dense deciduous shrubs and trees and kangaroo rats require open, grassland conditions (USFWS 1995). Noxious weeds can alter the structure of habitats making them less suitable for sensitive wildlife species. Weed treatments can improve habitats for these species. The potential impacts of each alternative on special status species are discussed in **Table 4-4**.

Table 4-4. Treatment effects on threatened (T), endangered (E), and Navajo Nation Department of Fish and Wildlife (NNDFW) G3 and G4 species on the Navajo Nation by Alternative. Conservation measures were recommended by NNDFW and USFWS. Conservation measures for G4 species are recommended but not required (NNDFW 2020).

Common Name	Federal Status	Tribal Status	Impacts from Alternative 1	Impacts from Alternatives 2 and 3
Western yellow-billed cuckoo (YBCU)	T	[illegible]	Negative - Long-term risk of losing limited riparian habitat. Weeds could reduce native plants used for nesting.	Breeding season timing restrictions and buffers around nesting areas would make disturbance or chemical impacts to the YBCU from weed treatments unlikely.
Southwestern willow flycatcher (SWFL)	E	G2	Neutral - nests in tamarisk and Russian olive. The tamarisk leaf beetle has reduced tamarisk dominated nesting habitat making it unsustainable.	Conservation measures maintain current nest stands. No biological control. Breeding season and migratory timing restrictions and buffers around nest patches would reduce disturbance to nesting SWFL. Native species planting would improve habitat.
Bald Eagle	-	G2	Neutral - terrestrial weeds should not impact prey or physical habitat.	Conservation measures include a 1/3 mi. buffer from an active nest for brief activities (spot spraying or manual treatments); 0.5 mi. for light activities (mechanical and mechanized ground chemical treatments); and 3/4 mi. for heavy activities (prescribed fire, aerial spraying) to eliminate impacts.
Northern leopard frog	–	G2	Negative - tamarisk and Russian olive, if large enough, may compete with cattails, sedges, and rushes for sunlight and nutrients. Unlikely the frog would be impacted by noxious sedges and grasses.	No treatments in aquatic habitat. Mechanical and manual treatments would require a 200 ft buffer from open water habitat. No applications of herbicides in occupied/potentially occupied habitat. Native vegetation planting required after weed removal. No target grazing in its habitat.
Pronghorn	–	G3	Negative - loss of forage. Long-term risk of reducing available native plant forage and reducing population size. Some weeds provide predator cover, increasing predation and reducing fawn survival.	Treatments require a 1-mile buffer from potential lambing areas during breeding season. Indirect impacts limited to treated sites with no measurable impact and no impact on broader population found on the NN.
Golden Eagle	–	G3	Negative – noxious weeds can reduce prey habitat for small to medium mammals which could reduce eagle population size.	Conservation measures include 3/8 mi buffer from active nest for brief activities (spot spraying or manual treatments); 1/2 mi. for light activities (mechanical and mechanized ground chemical treatments); and 3/4 mi. for heavy activities (prescribed fire, aerial spraying).
Ferruginous hawk	–	G3	Negative - weeds can reduce prey habitat for small and medium mammals. Long-term risk of weeds reducing or replacing native vegetation, reducing hawk prey habitat and population size.	Conservation measures include a 0.5 mi. buffer from active nest for brief activities (spot spraying or manual treatments); 5/8 mi. for light activities (mechanical and mechanized ground chemical treatments); and 3/4 mi. for heavy activities (prescribed fire, aerial spraying) to eliminate disturbance impacts.

Common Name	Federal Status	Tribal Status	Impacts from Alternative 1	Impacts from Alternatives 2 and 3
American dipper	–	G3	Neutral - weeds do not impact food or physical habitat.	Conservation measures include a 50-200 ft buffer from occupied nesting habitat outside of breeding season for mechanical treatments; no mechanical, mechanized ground or aerial chemical treatments within 1/8 mi. of active nest; and a 328 ft buffer for spot spraying or manual treatments from active nest will remove disturbance impacts.
Mexican spotted owl (MSO)	T	G3	Negative - Long-term risk of weeds increasing and reducing or replacing native vegetation and reducing availability of MSO prey (small mammals and passerine birds) habitat and reduce population size.	Conservation measures requires ¼-mile buffer from the edge of the PAC and potential nesting habitat for mechanical, prescribed fires, and aerial and mechanized chemical spraying to reduce disturbance or chemical impacts. No impacts to population size.
Great Basin silverspot	–	G3	Negative - Weeds can outcompete larval host plants. Long-term risk of weeds reducing or replacing native plants and outcompeting host plants and reducing population size. Some noxious species are used for nectar plants.	Conservation measures require no chemical or mechanical treatments permitted within 200 ft of occupied habitat year-round and no target grazing in wet areas containing host plants during the mating season.
Townsend's big-eared bat	–	G4	Neutral - weeds do not impact food or physical habitat.	Conservation measures require a 200 ft buffer from occupied roost sites during breeding period for all treatments to remove disturbance impacts during breeding.
Chisel-toothed kangaroo rat	–	G4	Negative - this species prefers undisturbed and sparsely vegetated habitats. Long-term risk of weeds to reduce available native plant habitat and reduce local populations.	Proposed treatments not likely to impact species as they do not occur in areas dominated by noxious weeds. Conservation measures require a 200 ft buffer for mechanical and target grazing treatments from occupied habitats year-round. Long-term impacts include possible increase in habitat quantity and quality.
Banner-tailed kangaroo rat	–	G4	Negative - species prefers grasses, but avoids dense, tall vegetation, which is created by monocultures of noxious weeds. Long-term risk of weeds decreasing habitat suitability and reducing the population.	Conservation measures require a 200 ft buffer for mechanical and target grazing treatments from occupied habitats year-round. Populations may be impacted if fluazuifop-p-butyl and 2,4-D are used for herbicide treatments. Long-term impacts include improved habitat quality and quantity.
Navajo mountain vole	–	G4	Neutral - species can survive in noxious tamarisk stands.	Conservation measures require a 200 ft buffer for mechanical and target grazing treatments from occupied habitats year-round. Populations may be impacted if fluazuifop-p-butyl and 2,4-D are used for herbicide treatments. Long-term impacts include improved habitat quality and quantity.

Common Name	Federal Status	Tribal Status	Impacts from Alternative 1	Impacts from Alternatives 2 and 3
Wupatki (Arizona) pocket mouse	–	G4	Negative - species prefers sparsely vegetated habitats. Long-term risk of weeds reducing available native plant habitat and reducing local populations.	Treatments not likely to impact species as they do not occur in areas dominated by noxious weeds. Conservation measures require a 200 ft buffer from occupied habitats year-round for mechanical and target grazing treatments. Long-term impacts include improved habitat quantity and quality.
Kit fox	–	G4	Negative - species prefers sparse shrub and grass vegetation for creating dens. Long-term risk of dense noxious grass populations to change habitat structure and impact local populations.	Conservation measures include a 200 ft buffer from occupied habitats year-round for mechanical and target grazing methods and all treatments require a 1/8-mile buffer from active dens during breeding season.
Northern goshawk	–	G4	Neutral - weeds do not impact food or physical habitat	Conservation measures require a buffer of 1/4 mi. from nest sites year-round for all treatments. Measures would remove disturbance impacts.
Clark's grebe	–	G4	Neutral - species not impacted by terrestrial weeds.	Conservation measures require a 200 ft 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 mi. from active nest during breeding season. Chemical spot and manual treatments require 330 ft from active nest during breeding season.
Northern saw-whet owl	–	G4	Negative - weeds can reduce prey habitat for small mammals. Long-term risk for weeds to reduce or replace native vegetation, reduce owl prey habitat and reduce populations.	Conservation measures require a 1/8-mile buffer from active nests for all treatments during breeding season.
Burrowing owl	–	G4	Negative - Long-term risk of weeds to reduce or replace native vegetation, reduce owl prey habitat and reduce population size.	Conservation measures require a ¼-mi. buffer from active nest sites for all treatments during breeding season. Mechanical treatments require 1/8-mi. buffer from nest site year-round.
Belted kingfisher	–	G4	Negative - non-native trees would create dense monocultures on bank habitat required for belted kingfisher nests. Long-term risk of weeds to reduce nesting habitat and negatively impact population trends.	Conservation measures require no treatments in nesting habitat year-round. Prescribed fire, target livestock grazing, and mechanized ground and aerial chemical spraying require 1/8-mi. buffer from active nest during breeding season. Chemical spot and manual treatments require 330 ft buffer from active nests during breeding season. Long-term treatments would protect species habitat.
Mountain plover	–	G4	Negative - species prefers sparsely vegetated habitats. Long-term risk of weeds may create dense monocultures and reduce local populations.	No treatments in nesting habitat year-round. Prescribed fire, target livestock grazing, and mechanized ground and aerial chemical spraying require 1/8-mi. buffer from active nest during breeding season. Chemical spot and manual treatments require 330 ft buffer from active nest during breeding season. Long-term, treatments would protect habitat.

Common Name	Federal Status	Tribal Status	Impacts from Alternative 1	Impacts from Alternatives 2 and 3
Dusky grouse	–	G4	Neutral - weeds do not impact food or physical habitat	Conservation measures require 1/8-mi. 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-mi. buffer from active nest during breeding season. Chemical spot and manual treatments require 330 ft buffer from active nest during breeding season.
Yellow warbler	–	G4	Negative - noxious trees can replace willow or early successional species. Long-term risk of reducing limited riparian habitat. Weed populations can reduce the plants used for nesting.	Conservation measures require a 1/8-mi. buffer from active nests during breeding season. Mechanical, mechanized ground and aerial spraying require 1/8-mi. buffer from habitat patches for breeding and potential habitat year-round.
Hammond's flycatcher	–	G4	Neutral - weeds do not impact nesting habitat in dense old growth forests.	Conservation measures require a 1/8-mi. buffer from active nest year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 330 ft buffer from active nest during breeding season.
Northern pygmy-owl	–	G4	Negative - weeds can reduce prey habitat for small mammals and passerine birds. Long-term risk of weeds to reduce native vegetation used for nesting and prey habitat which could reduce populations.	Conservation measures require 1/8-mi. buffer from nest year-round for mechanical, prescribed fire, mechanized ground, and aerial spraying. Chemical spot and manual treatments require a 1/8-mi. buffer from active nest during breeding season.
California Condor	E	G4	Neutral - weeds do not impact food or physical habitat	Conservation measures include 1 mi buffer for mechanical, prescribed fire, and ground application of herbicides and 1.5 mi. buffer from suitable nesting sites, known as roosting sites, for aerial application of herbicides. Dispose of trash. If condors detected, stop treatment and call NNDFW.
Flammulated owl	_	G4	Neutral - weeds do not impact nesting habitat in old-growth forest conifer or aspen forests. Flammulated owls eat diverse and common insect species.	Conservation measures require a 1/8-mi. buffer from nest site year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 1/8-mi. buffer from active nest during breeding season.
Band-tailed pigeon	–	G4	Neutral - weeds do not impact nesting habitat in mixed-conifer forests. Band-tailed pigeons travel long distances to feed and eat a variety of plants.	Conservation measures require a 1/8-mi. buffer from nest site year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 330 ft buffer from active nest during breeding season.

Common Name	Federal Status	Tribal Status	Impacts from Alternative 1	Impacts from Alternatives 2 and 3
American three-toed woodpecker	–	G4	Neutral - weeds do not impact nesting habitat in forests. Primary food source (bark beetles) would not be impacted by weeds.	Conservation measures require a 1/8-mi. buffer from nest site year-round for mechanical, prescribed fire, mechanized ground and aerial spraying. Chemical spot and manual treatments require a 330 ft buffer from active nest during breeding season.
Tree swallow	–	G4	Neutral - weeds do not impact nesting habitat in existing cavities in forests. Swallows eat diverse and common insect species.	Conservation measures require a 1/8-mi. buffer from nest site year-round for mechanical, prescribed fire, mechanized ground, and aerial spraying. Chemical spot and manual treatments require a 330 ft buffer from active nest during breeding season.
Sora	–	G4	Negative -Prefers native cattails and bulrushes for breeding and avoids tamarisk. Long-term risk of weeds to reduce or replace native vegetation and reduce populations.	Conservation measures require a 200 ft buffer from lakes and 150 ft from Category I wetlands. Prescribed fire, target grazing, and mechanized ground and aerial spraying require 1/8-mi. buffer from active nest during breeding season. Chemical spot and manual treatments require 330 ft buffer from active nest during breeding season.
Gray vireo	–	G4	Neutral - weeds do not impact nesting habitat in pinyon-juniper and juniper-sagebrush. Gray vireos eat diverse and common arthropods and fruit.	Conservation measures require a 1/8-mi. buffer from nest site during breeding season for mechanical, prescribed fire, target grazing, and mechanized ground and aerial spraying. Chemical spot and manual treatments require 330 ft buffer from active nest during breeding season.
Milk snake	–	G4	Neutral - weeds do not impact habitats where species occurs. Milk snakes eat diverse prey.	Conservation measures require no mechanical treatments in occupied habitats, which would remove impacts from disturbance.
Chuckwalla	–	G4	Neutral - species has a wide distribution in drought-tolerant habitats. Eats a varied diet including plants and insects.	Conservation measures require no mechanical treatments in occupied habitats, which would remove impacts from disturbance.
Rocky mountainsnail	–	G4	Neutral - plant community composition not required for potential habitat. Physical factors such as cool, moist microclimate and leaf mold are more important.	Conservation measures require ground-disturbing treatments (mechanical and manual) establish a 200 ft buffer from occupied habitat year-round.
Yavapai mountainsnail	–	G4	Neutral – weeds not likely in the required habitat of this species.	Conservation measures require ground-disturbing treatments (mechanical and manual) establish a 200 ft buffer from occupied habitat year-round.
Kanab ambersnail	E	G4	Negative - tamarisk may reduce native aquatic vegetation required by the species. Long-term risk of losing limited riparian habitat to expanding weed populations.	No treatments would occur in aquatic habitat. Mechanized, manual and chemical spot treatments require a 200 ft buffer from suitable habitat. Low aerial spraying requires a 150 ft buffer and high aerial spraying requires a 1/8-mi. buffer from suitable habitat.

4.5.4 Threatened, Endangered, and Sensitive Fish Species and Designated Critical Habitat

There are seven fish species with special status based on their sensitivity, rarity, and restricted ranges on the Navajo Nation. Five species are federally listed as endangered (E). Two species are tribally listed (G2 and G4) by the NNDFW. The G2 listed species is considered critically endangered and the G4 species is considered sensitive because of insufficient information. Impacts from treatments are analyzed based on their impacts to the following E, G2&G4 species and/or their designated or proposed critical habitat: Colorado pikeminnow (E), humpback chub (E), razorback sucker (E), bonytail chub (E), Zuni bluehead sucker (E), roundtail chub (G2) and bluehead sucker (G4). There would be no direct effects to E and G2 & G4 fish species because treatments are not proposed for weeds in aquatic habitats. However, treatments may occur adjacent to critical habitat for Colorado pikeminnow, humpback chub, and razorback sucker.

4.5.4.1 Alternative 1 – No Action

Minimal, uncoordinated non-native weed treatments would continue 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 areas. The expansion of weeds in riparian areas would result in long-term alteration of aquatic habitats by interrupting biological, geomorphological, and hydrological processes. Some of these processes and features include the geomorphology of stream banks, channel morphology (i.e. width and depth), natural dissipation of flood energy, sediment transport, ground water recharge, aquatic and riparian food chains, and water temperature regulation. These changes would compromise the invertebrate food base and limit species to only those able to persist in noxious vegetation.

Monocultures of tamarisk and Russian olive in riparian areas increase wildfire risk which would directly and indirectly impact fish species. An indirect impact from weed infested areas includes faster expansion of fires in areas with high cover of fire-adapted species. The impacts to listed fish species and/or critical habitat in a fire event include a reduction in local populations and adverse changes to aquatic habitat due to mortality or indirectly from increased sedimentation, nutrients, and ash input into streams. Turbidity would increase and prevent beneficial algal production for benthic feeding fish.

The expansion of fire-adapted noxious weeds in upland areas, such as cheatgrass, would increase wildfire risk. Wildfires in upland areas would cause increased erosion, runoff, and ash that would directly or indirectly impact the aquatic habitat. Turbidity would increase and prevent beneficial algal production for benthic feeding fish. The impacts to listed fish species and/or critical habitat include a reduction in aquatic habitat quality and food supply.

This action would result in the greatest expansion of weeds throughout the project area, including riparian corridors. Non-native weed treatments under this alternative would primarily be chemical treatments and have similar impacts as the other alternatives. This alternative would have minimal, short-term impacts to critical habitat and existing fish species composition and population trends of listed fish species in the project area.

4.5.4.2 Alternative 2 – Proposed Action

There would be no direct impacts to the listed fish species because aquatic treatments would not occur. Weed treatments are proposed for riparian and upland habitat used by all fish species and critical habitat for the Colorado pikeminnow, humpback chub, and razorback sucker. Repeated treatments in riparian areas would be necessary for most weed species because seeds in the soil can be viable for several years. The annual combination of methods used is expected to vary depending on specific site conditions.

Mechanical, manual, and cultural treatments in upland and riparian areas would have short-term, localized impacts to vegetation and soil. When vegetation is removed using these methods, bare soil would be exposed, which could temporarily increase localized turbidity in nearby water sources. BMPs and mitigation measures would minimize runoff and soil erosion from treatment areas to reduce sediment moving into species' habitat, resulting in minimal impact 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 300 ft outside of the floodplain. Conservation measures and BMPs would be applied to minimize impacts to species' habitat. These measures were developed in consultation with the USFWS and the NNDFW specifically for the Proposed Action. The use of biological treatments would have no direct effects to listed 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 minimal erosion. Biological controls typically decrease vigor in host plants; leaving the root system intact to hold the soil in place.

Chemical Control

There are 21 herbicides proposed, however only herbicides that are practically non-toxic to fish species will be used in the riparian zone. The best available information on the toxicity of the herbicides and adjuvants proposed for use by the BIA on aquatic organisms are incorporated by reference from USFS (2005, 2006, 2020, SERA 2000 – 2016a) and BLM (2007, 2016). However, six herbicides are not covered by these documents and required additional analysis based on USEPA registration data and independent studies. Appendix K discusses this analysis, which applies to dichlobenil, metribuzin, paraquat, pendimethalin, prodiamine, and thifensulfuron methyl. These herbicides do not have USEPA-approved aquatic formulations and will require over 300-foot buffer, except for thifensulfuron methyl which requires a 25-foot buffer. It is unlikely that direct or long-term exposure to these herbicides will impact aquatic species since they will not be used aquatically. All herbicide applications would follow required protection measures (**Figure 4-1**). Only aquatic formulations of 2,4-D, glyphosate, triclopyr and imazapyr would be used within 25 feet of the daily high-water mark. Herbicides that are practically non-toxic to fish require a 25-foot (7.6 meters) buffer from the daily high-water mark (White 2007). These include aminopyralid, chlorsulfuron, clopyralid, imazapic, and thifensulfuron-methyl. Accidental spray or spill of these herbicides into aquatic habitats have no risk to aquatic invertebrates and fish (BLM 2007). All other herbicides require a 300-foot (91 meters) buffer from the daily high-water mark as they are moderately to highly toxic to aquatic organisms and do not have aquatic formulations (White 2007). Only USEPA-approved aquatic herbicides would be used for aerial applications by either fixed wing or rotary aircraft in riparian areas. Implementing these measures would minimize herbicide exposure to such small levels that species or habitat impacts would be diminished. The long-term benefits to the floodplain and riparian habitat include improved function, reduced erosion, and an improved invertebrate food base due to the return of the native riparian vegetation.

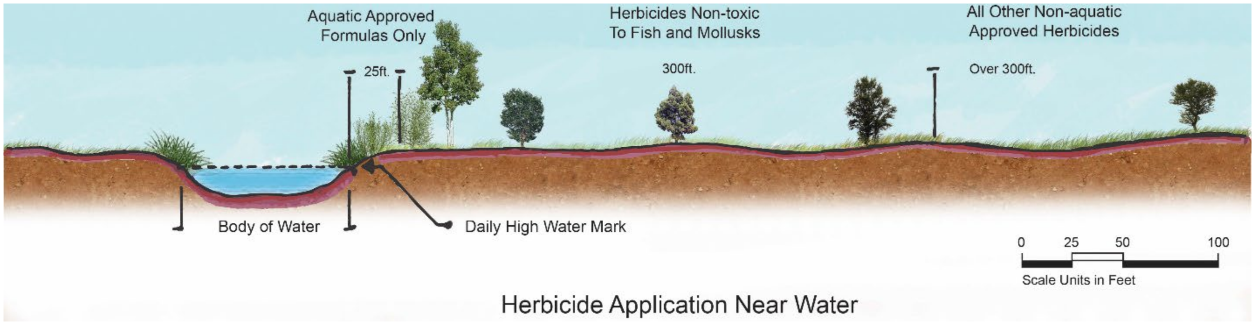

Figure 4-1. Herbicide application zones based on toxicity and formulation to protect aquatic wildlife.

4.5.4.3 Alternative 3 – No Biological Control

Alternative 3 would use all the proposed methods under Alternative 2, except for 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 those described under Alternative 2.

4.5.5 Migratory Birds

Noxious weed treatments would impact migratory birds in the short-term when treatments are conducted and over the long-term as monocultures of noxious weed trees, such as tamarisk or Russian olive, are removed. Some migratory birds use these monocultures for foraging and nesting habitat, but migratory birds would benefit from native species restoration by having more diverse habitat.

4.5.5.1 Alternative 1 – No Action

Alternative 1 would have the greatest impact on migratory birds due to weed expansion, habitat loss, and increased chemical exposure. Coordination of treatments is not required under Alternative 1, which would result in less habitat treated, and the continued spread noxious weeds that can out-compete native vegetation. Dense stands of noxious tamarisk and Russian olive may replace native riparian forests. This habitat replacement would reduce nest and forage areas for migratory and riparian dependent bird species, such as yellow-billed cuckoo, yellow warbler, Lucy's warbler, and Bell's vireo. Additionally, noxious grasses would continue to replace native grassland habitats, which would decrease migratory bird abundance. Under Alternative 1 best management practices, such as native species planting after treatments and implementing soil stabilization during treatments, would not be implemented which would decrease habitat quality for migratory birds. If monocultures of tamarisk and Russian olive are removed and not replanted with native species, migratory birds that depend on those habitats would be negatively impacted. Under Alternative 1, noxious weeds would be primarily controlled by chemical methods and, since best management practices and species conservation measures would not be implemented, herbicides and other methods would have greater direct and indirect impacts to migratory birds. This alternative would have short-term impacts on migratory birds during treatments from disturbance. Also, there would be long-term impacts on migratory birds and habitat from soil erosion, decreased habitat from increased noxious weed populations and limited native plant restoration after treatments and increased direct effects from treatment methods as best management practices would not be implemented. Alternative 1 would have the greatest impact to wildlife diversity and population trends on the Navajo Nation.

4.5.5.2 Alternative 2 – Proposed Action

Under the Proposed Action, noxious weed treatments would be conducted through an integrated approach.

Chemical Control

Currently, the BIA uses 11 USEPA approved herbicides, with most projects using imazapyr, metsulfuron-methyl, 2,4-D, and triclopyr and over 80% of treatments using imazapyr. These herbicides will likely continue as the preferred herbicides for most BIA treatments. Under Alternative 2, the BIA would permit the use of 10 additional herbicides to allow BIA managers to choose herbicides that best match the treatment goals and application conditions, and are less toxic, reducing the risks to migratory birds. The long-term positive impacts on migratory birds under this alternative would include improvements to habitat, forage production, and overall ecosystem function. All herbicide applications would require buffers and other species conservation measures for special status species and riparian and wetland areas. Aerial applications of herbicides would follow the mitigation measures developed for species of concern located near the project area.

The BIA is proposing the use of 21 herbicides. Fifteen of the herbicides were discussed in detail in risk assessments prepared by USFS (2005, 2006, 2020, SERA 2000 – 2016a) and BLM (2007, 2016) and incorporated by reference here. The remaining six herbicides proposed for use by the BIA, including dichlobenil, metribuzin, paraquat, pendimethalin, prodiamine, and thifensulfuron methyl and their impacts on migratory birds are summarized below with additional information in Appendix K.

Migratory birds can be exposed to herbicides through direct spray, consumption of contaminated items (vegetation, prey species, or water), grooming activities, or indirect contact with contaminated vegetation. Toxic effects to birds from atrazine include weakness, hyperexcitability, muscle incoordination, tremors, and weight loss (USEPA 2003). Metribuzin is moderately toxic to birds when consumed, practically non-toxic when consumed from contaminated food, and can decrease a bird's body weight when consumed over time (USEPA 1998a). Paraquat presents a high risk for young birds by reducing hatchability, increasing mortality, and reducing growth when ingested. But if used according to the label, the risk of harmful exposure is reduced with no long-term effects (USEPA 1997). Prodiamine is non-toxic to birds when directly exposed, however bird reproduction can be affected if exposed over a long period of time (USEPA 1992). Thifensulfuron is toxic to birds when exposed over a long period of time and can cause reductions in egg and hatchling production (USEPA 2011). Pendimethalin is slightly toxic to birds when directly consumed and when consumed from contaminated vegetation over time (USEPA 1997a). Several herbicides such as dichlobenil and isoxaben are practically non-toxic or slightly toxic to birds (USEPA 1998, BPA 2000, USEPA 2003). Most of the toxic effects of herbicides occur over a long period of time. Treatments conducted under the proposed action will be short term and will not have long-term effects on migratory birds. Also, best management practices and species conservation measures will be implemented to limit negative effects to migratory birds. Overall, migratory birds will benefit from the reduction of weeds and native species planting that would provide a more diverse habitat.

Cultural, Manual, and Mechanical Control

Hand pulling, mowing, and heavy machinery may be used under the proposed action and would require up to 30 people in areas where it is difficult to use other methods. These methods are not as effective for long-term control of large infestations of weeds. Migratory birds may be temporarily displaced during hand-pulling and mowing treatments, but this would be limited in extent and duration. Vehicles and other ground-based mechanical equipment would generate noise that displaces birds. However, these impacts are expected to be short in duration and with minimal impacts to migrating birds. Heavy machinery may impact ground dwelling or burrowing birds by causing burrows to collapse. Restrictions for breeding and migrating seasons and nest buffer restrictions required in the mitigation measures would reduce the likelihood of disturbance to birds during these more sensitive periods. The relatively small areas proposed for treatment on an annual basis in relation to the entire habitat available for migratory birds makes these impacts minimal on a population level for most species.

Prescribed burns would create ash and smoke, which would temporarily and locally reduce visibility and impact migratory birds. Pile burning and prescribed burns would require a site-specific burn plan and must follow species conservation measures, which would minimize impacts to migratory birds.

When vegetation is removed using these methods, the increase in exposed bare soil would increase the risk of topsoil erosion. Replanting native vegetation in these areas, particularly in riparian areas, roadsides and cut banks or slopes, would stabilize soils, and improve migratory bird habitat.

Biological Control

The release of approved biological control agents could reduce the reliance on herbicides. There is no expected impact on migratory birds across the Navajo Nation from the introduction of the biological control agents.

4.5.5.3 Alternative 3 – No Biological Control

Alternative 3 would use all the methods proposed under Alternative 2, except for biological control. Without the use of biological control, some weed populations may not meet the management objectives. Many of the biocontrol agents proposed under Alternative 2 would treat weeds that have invaded and reduced the suitability of native grasslands that are used by several migratory bird species. The impacts from cultural, manual, mechanical, and chemical treatments are similar to those proposed under Alternative 2.

4.6 Agriculture

4.6.1 Rangeland Management

Weed treatments have varying impacts on rangeland management. Most will require deferment of livestock during treatments and for a period after as sites recover. The extent and duration of such impacts will vary by Alternative and the methods used at each site.

4.6.1.1 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. Impacts from these treatment methods would be similar to those described for the Proposed Action for individual treatment sites. However, treatments would allow limited control and management of noxious species and would not consistently track or monitor treatments and species across the Navajo Nation. This Alternative would not require coordination of weed management with neighboring agencies or the use of additional weed control methods on rangelands. It would not address many species that impact rangeland health, including Russian thistle, kochia, and several exotic brome species. The No Action Alternative would not provide region-wide monitoring or prevent infestations in new areas. Biological control would not be used as there would be no agreement with NNDFW for its use on the Navajo Nation.

There may be some projects that use targeted grazing on a provisional basis, however they would not consistently use established guidelines and mitigation measures to prevent damage to high value habitats or to protect livestock species during implementation. If targeted grazing is improperly implemented, the risk for adverse impacts increases. Improper timing may lead animals to graze when weeds produce harmful chemicals or plant parts. Grazing during these times would increase the risk of animal poisoning or harm. 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, allowing undesirable weeds to spread. Mismatching the grazing animal with the species being treated would result in similar impacts. Without standard guidance or mitigations, the risks for these impacts would be highest under the No Action Alternative.

Weed species would continue to spread on the Navajo Nation, where they would impact livestock production. In addition to reducing native forage, some toxic species, such as kochia, Russian knapweed, yellow starthistle, or Russian thistle, could increase poisoning risks to livestock as they replace preferred native forage. Seeds, burrs, and hooked plant parts could become tangled on animal coats, reducing the value of the wool for handicrafts and textiles. Thus, under the No Action Alternative, the expansion of weeds would negatively impact the health of livestock on the Navajo Nation. As weeds continue to spread on the Navajo Nation, ranchers and grazing permit holders would see increased costs for livestock management in their customary use areas, as they provide more supplemental feed to replace palatable forage and increased costs for weed removal and control. Loss of quality forage may 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.

Lastly, the No Action Alternative would not prioritize follow-up treatments or native plant restoration. Treatment of weeds, especially in areas where infestations may be large, could increase erosion and topsoil loss as belowground roots are removed. After the treatment of an area, land users may decide to place cattle immediately back on pastures due to a lack of consistent deferment recommendations. Grazing recently treated areas can reduce treatment effectiveness, expose cattle to herbicides too early, and result in secondary infestations or the reintroduction of previously eradicated weeds. Further, the lack of mitigation and avoidance measures can cause livestock to be sprayed during aerial or ground broadcast treatments, increasing the risks of harmful exposure. These impacts would perpetuate increased erosion, decreased biodiversity, decreased vegetative cover, damage to livestock, and poor forage production and impact the overall value and use of rangelands.

4.6.1.2 Alternative 2 – Proposed Action

Under the Proposed Alternative, rangelands would be prioritized and treated for weed infestations through an integrated approach using the best means of control based on species and location. Projects would be closely coordinated with other land management agencies, permittees, and Navajo Nation programs. 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 with the most impact on rangelands include mechanical methods, chemical methods, biological control agents, targeted grazing, and native plant restoration.

Mechanical Control

Mechanical methods that use heavy machinery could impact rangelands by compacting soils, removing valuable forage, and causing prolonged deferment periods. Mechanical methods are typically implemented when large weed populations need to be removed from treatment sites. Directly, these treatments would compact soils and remove both noxious and palatable plants, which may lengthen the amount of time needed to restore forage in treated areas. These treatments would require the removal of livestock until sites have recovered and forage is available. Indirectly, if sites take a long period of time to recover after treatments, it may increase costs for producers who would need to provide additional supplemental feed to animals and could limit the amount of rangeland available for livestock production. These impacts may be reduced when coupled with native plant restoration, which would reduce the deferment period and improve forage production.

Chemical Control

Some of the chemicals proposed under the Proposed Alternative would impact livestock. Many of these impacts are described in the Wildlife section for each herbicide. However, some herbicides proposed could have impacts that specifically impact sheep, goats, or cows. This analysis incorporates by reference herbicide risk assessments prepared by the BLM (2007, 2016) and the USFS (2005, 2020, SERA 2000, 2004a-b, 2005, 2007, 2009, 2011a-c, 2014, 2016, 2016a). Of the six new herbicides included in the Proposed Action, paraquat is the only one evaluated by the USEPA for livestock species as part of its registration process at this time. In its initial findings, paraquat was found to be moderately toxic to large mammals when ingested. It can pose a risk to mammals when moderate to high concentrations leave residues on grasses. Some studies indicate the herbicide can be found in the milk, fat, and meat of cattle, goats, horses, and sheep of animals that graze on treated vegetation (USEPA 1997).

Overall, herbicide use on rangelands should have minimal impacts to livestock species. The herbicides proposed are slightly to moderately toxic to large mammals, with the most serious impacts related to accidental spills or direct spraying. The risks of exposure would be reduced by the Best Management Practices, which include removing animals from treatment areas prior to and during treatments, mixing and preparing herbicides away from the main project area to prevent spills, deferring cattle to prevent animals from grazing treated forage, and allowing native plants to reestablish.

Cultural Control

Weed projects that restore native vegetation will positively impact treated sites. Restoring native plants would improve forage production in areas where weeds may have replaced native vegetation. Temporary impacts from native plant restoration include increased foot traffic at planting sites, which can increase erosion, soil compaction, and sedimentation near streams. These impacts would be short-term and not likely to negatively impact rangelands.

Native plant restoration would benefit rangeland health in the long-term by increasing diverse plant communities and improving forage quality in many areas. Diverse native plant communities would maximize the overall productivity of sites and allow for longer grazing seasons (Pellant 1996). An increase in plant biodiversity would increase carrying capacity at some sites and allow for more sustainable grazing by animals with varying grazing habits. For example, cattle tend to eat younger shoots and leaves of plant, leaving a portion of the plant close to the ground. Horses, on the other hand, tend to eat the entire plant, pulling up even portions of the plant’s roots when grazing. Higher plant diversity would also help sustain wildlife populations in these units.

Weed Species for Targeted Grazing

- Leafy spurge
- Bull thistle
- Cheatgrass
- Perennial pepperweed
- Spotted knapweed
- Diffuse knapweed
- Kochia
- Yellow starthistle
- Canada thistle
- Musk thistle
- Scotch thistle
- Tall whitetop
- Russian knapweed
- Tamarisk/saltcedar

Proper use of targeted grazing would positively impact treatment sites if projects train and monitor animals. Treating weeds with livestock requires attention to the timing of treatments, the cover and density of species being treated, and the size of the treatment area to control weed infestations. They should consider the animal being used and the growth stage of the weed being treated to protect the health of the animal (Davison et al. 2005). While livestock can contribute to the spread of noxious weeds, grazing management experts note that proper application of targeted grazing can provide competition and reduced cover of several noxious species (Frost and Launchbaugh 2003, Mosley and Roselle 2006). Some land managers and federal agencies have found that proper use of targeted grazing can increase perennial grass and forb cover while reducing non-native annual grasses (Mosley and Roselle 2006). Thus, using proper Best Management Practices and training for animals for targeted grazing would be required.

However, even with proper implementation, targeted grazing could increase site-specific impacts as treatments are concentrated in small areas. This method can increase erosion and sedimentation as animals trample areas and vegetation is removed. Such impacts, however, would be short-term, especially if native plants are restored in treated areas.

Biological Control

Many of the biological control agents proposed under this alternative would treat species that impact rangeland health. Biological agents would not impact livestock or wildlife species directly and can be used to treat weeds in a less intrusive manner. The method would save land users time and money as livestock would only be removed from treatment sites when agents are first placed on sites and when they are collected for distribution, which would only last a few hours or days. Once the agents are placed, cattle would only be moved occasionally as workers come to sites to check the biological agents and collect them for other treatment sites. As weeds are reduced, other native species may return to sites, improving forage and species diversity.

4.6.1.3 Alternative 3 – No Biological Control

Under this Alternative, weed treatments would be limited to cultural, mechanical, manual, and chemical treatment methods. Many of the proposed biological control agents target species that impact rangelands. Under this alternative, use of chemical, manual, or mechanical treatments would be used instead to treat these populations. These treatments could prolong deferment periods, as moderately toxic herbicides may be used more heavily and for longer periods. Use of mechanical treatments on designated rangelands would increase erosion and soil compaction in treated areas. Treatments would require livestock deferment from treated sites for extended periods of time to limit their exposure. Deferment can increase the cost of managing livestock and can reduce the productivity of some livestock species.

4.6.2 Farming

4.6.2.1 Alternative 1 – No Action

Under the No Action Alternative, treatments would not be conducted in a coordinated fashion in an integrated approach. This alternative would permit weeds to spread and would not treat major agricultural weeds, such as Sahara mustard, kochia, and several noxious bromes.

Under the No Action Alternative, while any number of herbicides may be used on agricultural fields, most projects use a select few for BIA and NAPI weed management projects (**Table 4-5**). Long-term use of a limited number of herbicides on agricultural sites, where herbicide use is highest, may result in herbicide resistance. If a weed develops herbicide resistance, it is possible that other herbicides with the same mechanism of action may also be ineffective, limiting potential treatment options for control. Several species currently managed and proposed for management under Alternative 2 have shown signs of herbicide resistance (**Table 4-6**).

Table 4-5. Herbicides used by the BIA and NAPI, including product names and method of action.

Active Ingredient	Product Name(s)	Method of Action
2,4-D	Weedmaster Curtail	Synthetic Auxin
Aminopyralid	Milestone	Synthetic Auxin
Chlosulfuron methyl	Telar	ALS Inhibitor
Clopyralid	Curtail	Synthetic Auxin
Fluazifop-p-butyl	Fusilade	ACCase Inhibitor
Glyphosate	Roundup Polaris	ESPS Synthase Inhibitor
Imazapic	Habitat	ALS Inhibitor
Imazapyr	Habitat Arsenal Hardball	ALS Inhibitor
Metsulfuron methyl	Escort	ALS Inhibitor
Picloram	Tordon 22K	Synthetic Auxin
Triclopyr	Garlon Element 3a Element 4 Remedy	Synthetic Auxin

Increased herbicide use may increase herbicide residues on crops or nearby forage, which could be consumed by humans or animals. This is a major concern on the NAPI-NIIP site, where most weed infestations occur in rangelands surrounding the main agricultural fields. These inactive fields provide habitat and forage for wildlife species. Herbicides may also increase the risk of surface water contamination by either directly spraying fields that near open water or through surface runoff. Herbicides, by design, may also impact crops based on their method of action and selectivity. An in-depth discussion of herbicide impacts is provided in the Alternative 2 analysis.

Mechanical and manual methods would be heavily used on agricultural lands under the No Action Alternative as they are often used to prepare fields for crop production and harvest. Use of these methods could increase erosion and negatively impact topsoil. Vegetation would be removed from larger sites but native plant restoration or the use of cover crops would not be a priority. Absent an integrated approach, treated areas have an increased risk of topsoil loss, soil moisture loss, and secondary weed invasions.

Some weeds would increase fire risk in infested areas. Species like cheatgrass alter existing fire regimes, resulting in more frequent fires. While fires can be beneficial for agricultural operations by recycling important nutrients back into soils and removing dead plant material, weeds could facilitate fires at inopportune times, impacting crop production and increasing the potential for property damage.

4.6.2.2 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.

Chemical Control

Agricultural areas experience more frequent herbicide applications than other land use types, which increases the risks associated with elevated herbicide applications and chronic exposure. While it is assumed herbicides will impact non-target plant species, the sensitivity of plants differs by plant form, family, or application rate. Since herbicides are designed to kill plants, the USEPA requires they undergo phytotoxicity testing. This testing is done on a few common agricultural species to determine how plants respond to different application rates.

The most popular crops cultivated on the Navajo Nation include corn, wheat, peaches, hay, beans, and squash. Because the USEPA only requires testing on a few crop species during its product registration process, many herbicides are not tested against all potential crops and some analyses may assume that impacts to one species in a family translate to impacts to all species in that family. For example, impacts to squash, which are part of the cucurbit family, can indicate potential toxicity for cucumbers or melons; and soybeans can be used to determine the sensitivity of other legumes. As hay is a mix of different grass, legumes, and other herbaceous species, alfalfa and ryegrass are used as surrogates. No information, however, is available for peaches or other stone fruits. Stone fruits are not a standard test crop evaluated by the USEPA and none of the proposed herbicides have reported this information.

The toxicity of an herbicide on specific crops is based on differences in application rates and methods. Some plants may show greater sensitivity to an herbicide than others, which may require limited use of that herbicide near that crop. **Table 4-7** outlines the reported phytotoxic rates of the proposed herbicides to various agricultural species. For this analysis, the sensitivity of a plant to an herbicide is relative to the other plants tested, unlike animal toxicity, which is defined by a specific dose (i.e., non-toxic vs. highly toxic; see Wildlife and Public Health). When examining plant phytotoxicity, the relative concentrations must be compared with the standard and maximum herbicide application rates recommended by the product label instructions. However, application rates can vary considerably based on manufacturers, product formulations, and application methods. To assess if an herbicide could impact crops, the phytotoxicity rates should be compared using the most closely related crop species to a product's application rate and application method.

Based on **Table 4-7**, some crops vary in their sensitivity to the proposed herbicides. Some herbicides can damage all plants, such as glyphosate and fluroxypyr, while others only target a select few, such as paraquat or metribuzin. Thifensulfuron methyl is more toxic to squash plants than ryegrass, corn, or soybeans. Some have greater sensitivity at different stages of growth. For example, corn has higher phytotoxicity to 2,4-D ester during the juvenile growing phase than during seedling emergence. Thus, herbicide formulation, herbicide mode of action, and crop growth form are important variables to consider in evaluating potential impacts of herbicides used to control weeds in a particular crop.

As previously noted, some weeds may develop herbicide resistance if they are treated repeatedly with the same herbicide over time. Herbicide resistance can occur through natural selection, mutation, or genetic engineering and has been documented for several priority weed species (**Table 4-6**, Heap 2020). To reduce the risks of herbicide resistance, land users should vary which herbicides they use for subsequent treatments, while pairing chemical treatments with mechanical and cultural techniques over time to reduce their overall use. The concern of herbicide resistance is most pertinent for crop production, as herbicides are more heavily used to control weeds in these areas than any other priority treatment areas.

Table 4-6. Target weed species with documented evidence of resistance to herbicides proposed in Alternative 2 (Heap 2020). Only weeds with documented herbicide resistance are listed. * indicates species currently managed by the BIA per the 2009 Noxious Weed List.

CATEGORY A - HIGH		
Common Name	**Scientific Name**	**Documented Herbicide Resistance**
Canada thistle*	*Cirsium arvense*	2,4-D
Field brome	*Bromus arvensis*	ALS inhibitor
Musk thistle*	*Carduus nutans*	2,4-D
Sahara mustard	*Brassica tournefortii*	Chlorsulfuron, imazapyr
Spotted knapweed*	*Centaurea maculosa*	Clopyralid, picloram
Yellow nutsedge	*Cyperus esculentus*	ALS Inhibitors
Yellow starthistle*	*Centaurea solstitialis*	Picloram
CATEGORY B - MEDIUM		
Common Name	**Scientific Name**	**Documented Herbicide Resistance**
Johnsongrass	*Sorghum halepense*	Glyphosate, fluazifop-p-butyl, pendimethalin
CATEGORY C - LOW		
Common Name	**Scientific Name**	**Documented Herbicide Resistance**
Cheatgrass*	*Bromus tectorum*	Atrazine, fluazifop-p-butyl
Field bindweed*	*Convolvulus arvensis*	Paraquat
Kochia	*Bassia scoparia*	Atrazine, chlorsulfuron, fluroxypyr, glyphosate, imazapyr, metsulfuron metyl, thifensulfuron methyl
Rescuegrass	*Bromus catharticus*	Glyphosate
Ripgut brome	*Bromus diandrus*	Glyphosate, fluazifop-p-butyl
Red brome	*Bromus rubens*	Glyphosate
Russian thistle	*Salsola collina, S. paulsenii, S. tragus*	Chlorsulfuron, metsulfuron methyl, glyphosate
Spreading wallflower	*Erysimum repandum*	Chlorsulfuron, metsulfuron methyl

Herbicides can also indirectly impact agricultural lands and operations. Some herbicides can interfere with beneficial insects, such as honeybees and other pollinators (see Wildlife). Paraquat, for example, can alter larval development of some insects at low concentrations despite being labeled as non-toxic at low doses by the USEPA (USEPA 1997, Cousin et al. 2013). Glyphosate could directly and indirectly harm bee populations as one study found it altered their gut bacteria, reducing their ability to fight off infections (Motta et al. 2018). Such interactions could indirectly impact crop production. In the case of honeybees and other pollinators, heavy use may reduce the production of certain crops. In some instances, natural predators of agricultural pests may be harmed, increasing crop damage and loss. Using an integrated approach would reduce such risks by combining herbicides with biological controls and native plant restoration.

Table 4-7. Phytotoxicity rates, or EC_{25} values, for proposed herbicides on major crops and related species. The EC_{25} value is the amount that causes damage to at least 25% of plants. All values are reported as pounds of active ingredient per acre (lbs a.i./ac). Application rates depend on label instructions and application method.

Herbicide	Application Rate	Corn		Wheat		Hay*		Beans^		Squash°		References
		Seedling	Vegetative	Seedling	Vegetative	Seedling	Vegetative	Seedling	Vegetative	Seedling	Vegetative	
2,4-D Acid	Varies	>4.2	>4.2	2.1^{+}	0.2		2.07	1.71	0.008	0.53	0.015	
2,4-D Amine	Varies	>4.0		0.0054	0.32	>4.0	>2.07	0.26	0.0093			USEPA 2000, 2009
2,4-D Esters	Varies	3.4	0.17	>4.0	0.34	>4.0	>2.03	0.036	0.058			
Aminopyralid	0.03 – 0.11	>230.8	>230.8	>230.8	>230.8	>230.8	>230.8	2.7	0.75	>57.7	12	USEPA 2005, BLM 2016
Atrazine	1 – 4	>4.0	>4.0			0.004+	>4.0	0.19	0.026	0.013	0.008	USEPA 2003
Chlorsulfuron	0.047 – 0.062	0.0048	0.0031	0.022	0.93			0.014	0.00031	0.004	0.098	McKelvey and Kuratle. 2003.
Clopyralid	0.35 – 1			>0.037	>0.27			0.0046	0.0053			UESPA. 2000.
Dichlobenil	4 - 66	<1.14		<1.14		>0.25		<1.14		<1.14		USEPA. 2000.
Fluroxypyr	0.12 – 0.5	0.178	>0.25	0.079	>0.25	>0.25	>0.25	0.072	0.00042	0.075	0.01	USEPA 2000.
Fluazifop-P-butyl[1]	0.1 – 0.375		0.0071		0.13	0.45	0.018		0.5		0.5	USEPA 2000., SERA 2014
Glyphosate acid	0.5 - 4		0.43		0.176		0.98	>10	0.32		0.46	Chetram R.S. 1994.
Imazapic	0.0313 – 0.1875	0.0076	0.019			0.014	0.0046	0.041	0.036	0.0014	0.0032	USEPA. 2000.
Imazapyr	0.45 -1.5	0.025	>0.0156	0.0046	0.012			0.012	0.034	0.0043	0.0009	USEPA 2000.
Indaziflam	0.046 – 0.091					0.00016	0.031		0.0043			USFS 2020
Isoxaben	0.66 – 1.33			>0.888	>0.888	>0.888	0.014	0.29	>0.888	>0.888	0.089	USEPA 2010
Metsulfuron methyl	0.0125 – 0.15	0.00091	0.00303					0.00041	0.000018			USEPA 2000.
Metribuzin	0.17 – 3			0.024	0.37					0.029		Burge, C.L. 1992.
Paraquat dichloride	0.07 – 1		0.16	>0.86	0.061							USEPA 2000, USEPA 1997
Pendimethalin	1.485 – 1.98	0.02	0.035			0.03	0.1	0.02	0.035	2.4		USEPA 1997a
Picloram	0.125 – 1	>1.0	0.25	0.02	0.032			0.00001	0.0003		0.0011	USEPA 2000.
Prodiamine	0.75 – 1.5	>1.5	>1.5			0.026	>1.5	1.135	>1.5	0.08	0.061	USEPA 2000.
Thifensulfuron methyl	0.0023 – 0.028	>0.0311				0.0069*		>0.0311		<0.00027		USEPA. 2000.
Triclopyr-BEE	1 – 8	>2	0.46	>2	0.8	0.036	0.037	0.17	0.038			SERA 2011
Triclopyr-TEA	0.5 - 8	>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.
[1]EC_{50} values reported

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Some herbicides may increase the risk of humans and wildlife consuming herbicide-contaminated produce and a higher risk of herbicide runoff to nearby water sources (see Public Health). Agricultural workers and people living near or downstream from treatment areas would also be at increased risk of herbicide exposure. Adherence to BMPs and mitigation measure would reduce the risks of these impacts by limiting herbicide use through an integrated approach, notifying communities when herbicides are used, and proper use of PPE to minimize exposure risk to workers. Overall, by reducing problematic weed populations in designated farmlands, agricultural production should improve and the costs for managing weeds would decrease over time.

Cultural Control

On the Navajo Nation, cultural treatments under Alternative 2 include crop rotation and planting cover or forage crops to limit weed growth. Crop rotation is an agricultural tool used to control weeds by limiting the area available for weed growth. In a crop rotation system, different crops are grown in systematic and varying sequences, replacing crop monocultures. These variations provide temporal and spatial diversity based on how different plants use nutrients and space during the growing season. Under temporal rotation systems, a farmer may grow corn one year and soybeans the next, followed by alfalfa. For spatial systems, squash, beans, and corn may be grown together in a distinct spatial pattern, providing a synergistic relationship that improves the growth of each plant (Liebman and Dyck 1993, Postma and Lynch 2012). Crop rotation can control weeds by altering how plants use growing space and limiting how weeds establish and grow in an area (Liebman and Dyck 1993, Shrestha et al. 2004). Crop rotation systems reduce the reliance of farmers on herbicides and more disruptive weed control methods.

Cover and forage crops can be used in a crop rotation system, or if a field needs to rest after extensive use. Cover crops limit the spread of weeds in fallow areas and provide additional benefits including improved soil quality, reduced erosion, and better nutrient management (Shrestha et al. 2004). They can include native plants and grasses or other desirable vegetation species, such as wildlife forage. Selection and use of cover crops should be done in consultation with local Cooperative Extension agents or NRCS specialists to ensure that selected species will not result in unintended issues for farmers. Currently, NAPI coordinates events featuring agronomists and seed producers, to educate farmers on planting methods, weed control, and crop rotation to improve yields and limit weed infestations.

Finally, different fertilization methods can reduce weed cover on farms. Similar to crop rotation, fertilizers may provide a competitive advantage to preferred crop species, allowing them to outcompete non-native weeds. Some studies indicate that reducing nitrogen fertilizers can alter weed competition in agricultural settings, reducing cover while not impacting crop yields (Blackshaw et al. 2002). Selecting and modifying fertilizers should be done in consultation with an agricultural specialist such as Cooperative Extension agent or an NRCS specialist. Use of fertilizer to reduce weed cover may alter nutrient availability but should not change crop productivity or yields.

Mechanical and Manual Treatments

Agricultural areas are often subject to burning, tilling, plowing, and other mechanical methods used to improve crop growth, which may also control weeds. In the short-term, additional mechanical and manual treatments for weed control would increase localized erosion and soil turnover. If treatments are done during the growing season, some crops may be damaged, which would reduce their productivity. If treated areas are not replanted with either native plants or a cover crop, some weed species may return or secondary infestations can occur. If tilling or plowing is used as a weed control method, care must be taken to ensure that the treatment does not facilitate weed growth. Some weeds can propagate from remaining plant parts and seeds. Plowing would disturb soils and could distribute seeds and propagating plant parts. (McCarty 2011). BMPs would reduce many of these adverse impacts (Appendix F). In the long-term, weed treatments would improve agricultural fields and would economically benefit farmers.

Prescribed burning would be used as a management technique under the Proposed Alternative. Fire is used in croplands to remove dead plant material after harvesting to facilitate soil turnover, suppress overwintering pathogenic fungi, and reduce seed banks of crop competitors. Cropland fuels are typically dried crop stubble and weeds, which can keep the fire on the surface, reducing their risk of large-scale damage to the landscape. Prescribed burning would not create additional impacts to farmlands as used in the Proposed Alternative.

Biological Control

Some land users may not use chemicals to treat and control weeds. Biological control has been used to provide cost-effective long-term control of different weed species. Conventional pesticide treatments are not always practical and alternative methods may be used to protect agriculture, the economy, human health, and the natural environment. Using natural enemies of noxious weeds can provide a permanent reduction in weed populations, substantially reducing their economic impact (California Department of Agriculture 2001).

Use of biological control agents on farms would reduce the need for more disturbing control methods such as mechanical or chemical treatments. While biological control would not eradicate or kill noxious weeds, they would provide a competitive advantage to crops. Many of the biological agents proposed were tested for impacts on important agricultural crops, so the risk of cross-species impacts would be minimal. Biological treatments would temporarily close fields to release agents or to conduct site-specific testing prior to full implementation. Closures may reduce productivity or yields in these areas, but the overall impact would be minimal. Over the long-term, biological agents would improve agricultural production as less time and money would be needed to address problematic weeds.

4.6.2.3 Alternative 3 – No Biological Control

Impacts under the No Biological Control Alternative would be similar to those described under the Proposed Alternative. Without the use of biological controls, projects would use other methods to control weeds at treatment sites. Passive methods such crop rotation, cover crops, fertilizer use, and chemical and mechanical methods could be used. Overall, these would not result in significantly different impacts to agricultural areas than those described under the Proposed Alternative.

4.7 Public Health

All alternatives would use herbicides, mechanical, and manual treatments to varying degrees, which pose some level of risk to human health. The human health impacts for each alternative are similar but differ based on the use of mitigation measures and the level of project coordination. Below is a discussion of impacts for each method and how these impacts may differ by alternative.

4.7.1.1 Alternative 1 – No Action

Under the No Action Alternative, workers may receive inconsistent training on PPE, equipment handling, and safety protocols. While some projects may implement them to address known risks, some projects may not adequately address all risks. This may result in inconsistent safety measures to protect workers and the public during treatments, which may increase the risk of harm during mechanical and chemical treatments. 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 from harmful plant parts (spines, awns, and chemical irritants) or allergies among sensitive individuals.

Chemical use under this alternative may increase exposure risks to the public and workers. Without an integrated approach, the overall use of pesticides would likely be heavier under the No Action Alternative as they may not consider combining other control methods to improve weed control. Under the No Action alternative, other herbicides not examined in the PEIS may be used to manage weed populations. These chemicals may have synergistic effects with certain herbicides that may render them ineffective or may exacerbate negative impacts to the environment or human health. While the chemicals examined are safe for use when applied based on the label instructions, non-judicious applications, or a lack of planning for chemical treatments may increase risks for the public.

The No Action Alternative would have a higher risk of exposing the public to higher concentrations of herbicides. Under this Alternative, weed projects may not coordinate treatments with other agencies and the community. Since projects would not consistently notify adjacent land users, other land management agencies near the project area, or the public, those who may want to avoid herbicides may not have clear guidance on how to do so. Additionally, this could result in sites treated by different agencies to apply herbicide in a manner that may exceed the label's instructions. These treatments could increase the presence of certain herbicides in the environment, increasing the risk to the public.

4.7.1.2 Alternative 2 – Proposed Action

Under the Proposed Action, safety training would be required for all projects to educate workers on known health risks associated with different treatment methods, proper use of PPE, proper equipment handling, and emergency safety protocols. These include regular on-site briefings to remind participants of necessary safety information. Alternative 2 would provide consistent safety measures that would decrease the risk of harm and enforce safe use of mechanical and manual treatment methods.

Cultural Control

Cultural methods would not impose a risk to the human health of workers or the public. There is a risk of indirect impacts from grazing animals for intensive vegetation treatments. If many animals are concentrated in a small area for feeding, feces could spread harmful bacteria to nearby water sources. Such spread could occur if animals are close to open water before or during precipitation events.

Biological Control

APHIS has studied and tested all biological control organisms for potential risks to the public. None of the agents proposed under this plan are known to impact human health. Minor injuries could occur when trapping and transporting organisms from treatment sites (USFS 2005, BLM 2007). These impacts would be limited to workers and would not affect the public.

Chemical Control

Health risks associated with herbicides depend on the toxicity of the herbicide used, how a person is exposed to the herbicide, and the duration of their exposure. All alternatives would use herbicides and could expose workers or the public. The public may be exposed to herbicide by contacting treated vegetation, consuming contaminated vegetation or water, or through herbicide drift. Drift occurs when herbicide is inadvertently carried to untreated sites by air movement. It can occur during broadcast treatments, where herbicide is applied broadly to area. However, drift can be reduced by prohibiting treatments during windy conditions, adjusting the droplet size of applicators, and where possible, using more direct application methods, all of which are advised under Alternative 2. Any exposures are not expected to exceed levels determined as safe by the USEPA over a 70-year lifetime of daily exposure.

The BIA may only use herbicides approved by the USEPA per the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA, 7 USC § 136 [1996]), which states that manufacturers must demonstrate that a pesticide does not have unreasonable adverse impacts on the environment and human health. To enforce this, all pesticides must have chemical labels that provide strict limitations on how herbicides can be used, with which federal and tribal pesticide applicators must comply. The health risks to workers from herbicide is a function of the amount of chemical handled and the length of time they are exposed. The time needed each field season to apply herbicides is substantial. Of the herbicide application methods used, backpack applications have the greatest potential for worker exposure, as workers are in direct contact with an herbicide's active ingredients for extended periods of time (USFS 2005).

All synthetic herbicides have the potential to impact human health (**Table 4-8**). Herbicides can cause temporary or permanent damage or make pre-existing conditions worse. Herbicides can damage skin, eyes, lungs, liver, kidneys, muscles, the nervous system (including the brain and behavioral changes), hormone systems, the immune system, and the digestive system. Some can have impact reproduction and cause genetic damage, increasing the risk of cancer for exposed individuals. Many of these risks largely depend on each chemical's toxicity, an individual's personal health, and how long a person is exposed. When used as labeled, herbicides are generally considered safe for humans and the environment.

Herbicides that persist in the environment for long periods of time do have a higher risk of impacting human health than herbicides that break down quickly once applied. Herbicides like atrazine and picloram can travel through water and soil where they could affect people miles away from where they were applied. Some herbicides, such as paraquat and picloram, can remain in areas for substantial amounts of time after they are applied (sometimes for over a year), which increases the potential for exposure (see **Table 4-1**). While such impacts decrease with time and distance, some people, especially chemically sensitive individuals, may be affected without having visited a recently treated site and without knowing herbicide is the cause. For these reasons, the use of other weed management techniques besides chemical applications or prescribed burning is preferred where feasible. When herbicides or burning are used, advance public notice, detours around treated sites, and signs would mitigate the impacts for the most vulnerable.

Herbicide Risk Assessments

To analyze human health risks associated with herbicide use, risk assessments developed by the BLM (2007, 2016) and the USFS (2005, 2020, SERA 2000, 2004a-b, 2005, 2007, 2009, 2011-c, 2014, 2016, 2016a) have been incorporated by reference. However, six herbicides proposed under Alternative 2 were not covered by these assessments and require additional analysis based on USEPA registration data and independent studies. Appendix K discusses this analysis, which applies to dichlobenil, metribuzin, paraquat, pendimethalin, prodiamine, and thifensulfuron methyl. Environmental risk assessments for all proposed herbicides are summarized in **Table 4-3** in the Vegetation analysis. The potential impacts to human health are summarized for all herbicides in **Table 4-8** below.

Synergistic Effects of Herbicides

Synergistic effects are interactions wherein combining two or more herbicides could result in greater negative impacts than for the individual herbicides. There are few studies on the synergistic effects of herbicides. Many herbicides, however, are sold in combined formulas. There is evidence that simultaneous exposure to 2,4-D and picloram may induce impacts not associated with exposure to 2,4-D or picloram alone (EXTOXNET 1993). Another study indicates that the combined use of 2,4-D and glyphosate can increase the risk of rhinitis (Slager et al. 2009). Similarly, there may be synergistic interactions between herbicides and/or other chemicals that workers or the public may be exposed to. 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). However, such analysis is outside the scope of this document.

Under the Proposed Action Alternative, 21 herbicides would be permitted for use on the Navajo Nation. Several mitigation measures would be implemented for ground treatments such as buffer zones around water bodies and sensitive areas, public notification prior to application, and weather condition monitoring to reduce exposure risks. Safety training and use to mitigation measures would also reduce risks to workers.

Of the herbicides proposed under Alternative 2, isoxaben, prodiamine, dichlobenil, and pendimethalin have been classified by the USEPA as possible human carcinogens based on animal studies. Other studies suggest a possible link between 2,4-D and cervical cancer and non-Hodgkin's lymphoma. However, a review of relevant studies could not determine a cause-effect relationship between 2,4-D exposure and human cancer (Tu et al. 2000). Paraquat, metsulfuron methyl, and triclopyr have some mutagenic properties and reproductive effects. Under Alternative 2, the use of BMPs, mitigation measures, and integrated methods would reduce these risks to the public from harmful exposures. If the public is exposed, it would probably be a few minutes (for those traveling through treatment areas) to a few days (for those living near treatment sites) at fairly low concentrations. However, applicators may be exposed to harmful doses if they spill concentrated herbicide while mixing or if they apply the same herbicide in large areas for extended periods of time. The BIA would reduce such risks by training staff, using required protective clothing and equipment, and following each project's safety and spill plan and the mitigation measures (Appendix F). The BIA would also use adaptive management to adjust treatments, as necessary. Information obtained from monitoring and new information on herbicides would be incorporated to reduce negative impacts.

The BIA predicts that the use of herbicides, as required by their label instructions and the BIA, will not cause adverse human health impacts. The reasons for this conclusion are: (1) the amount of area treated covers at most 50,000 acres or less than 0.1 percent of the Navajo Nation; (2) scheduled work will be under the control of a certified pesticide applicator and PPE will be worn by all workers; and (3) only approved herbicides for each specific set of environmental conditions will be used. In addition, treatment sites would be closed for a set time when herbicide labeling recommends limiting exposure for humans, livestock, and pets. This will prevent individuals from receiving a harmful dose and reduces the risks of long-term health issues.

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

During the production of some pesticides, byproducts can be produced and carried over into the final products. Occasionally byproducts or impurities are considered toxicologically hazardous, and their concentrations are limited so that exposures do not exceed levels of concern (Felsot 2001). Other formulations may also contain inert ingredients. Some inert ingredients are proprietary, limiting the amount of information on their potential toxicity or impacts to human health. Finally, some formulations add surfactants to improve the mixing and adsorption of their products by plants. These include various dyes, foaming agents, and other ingredients. Like inert ingredients, many surfactants may be proprietary or not part of the active ingredients, and thus not disclosed or analyzed for toxicity. Known impurities, inert ingredients, surfactants, and adjuvants in the proposed herbicides and their effects are discussed in detail in Appendix K. Based on this analysis and the proposed mitigation measures (Appendix F), the risks of adverse impacts are considered low for both workers and the public.

Mechanical and Manual Control

Potential health risks to workers from manual and mechanical noxious weed control measures include cuts, burns, allergies, and skin irritations. The direct impacts on human health would be greatest for allergy and contact dermatitis sufferers who are sensitive to noxious weeds or other terrestrial plants. Skin irritations may occur after general contact with some species, such as spotted knapweed and leafy spurge, or from specific parts of the plant itself, such as spines on thistles and awns from brome grasses. Each alternative would implement safety measures for workers to reduce potential health risks. Gloves, long-sleeved shirts, pants, and boots would reduce injuries or irritations. In the long term, the removal of target weed species would reduce allergens and hazardous contact with weed species for the public.

Workers could be injured by cutting blades such as those on saws, mulchers, shredders, and drills which can cause major 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. These risks are reduced as most project areas would use mechanized equipment along roads or in agricultural fields, where they are currently used. Rocks and debris may be kicked up during operations. Noise from heavy machinery or power tools could cause hearing impairment. These impacts can be reduced through use of personal protective equipment (PPE) such as ear plugs, gloves, hard hats, and boots. Safety training would reduce the risk of injury by instructing workers on how to safely operate heavy machinery. Equipment operators should also avoid contact with electrical power lines, which could result in serious injury or death.

Safety buffers, signs, and perimeter marking would be placed around project areas to prevent injuries from debris. Accidental fuel and oil spills could contaminate water supplies and operators would avoid operating vehicles near open water when possible and would never refuel near water bodies. Project staging areas would be outside of riparian areas.

All proposed alternatives would make use of prescribed burning to treat certain 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 would 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 injured during treatments and the public can be at risk if the fire escapes. Any prescribed burning treatments would require a site-specific burn plan that includes restrictions on the timing and environmental conditions of the site to reduce such risks.

Table 4-8. Toxicity of herbicides proposed under Alternative 2 and adverse human health impacts from harmful doses. LD_{50} corresponds to the dose at which 50% of tested animals died and are reported by the USEPA as part of the pesticide registration process. Herbicides are listed from least toxic to most toxic based on oral ingestion. The order can be used to prioritize herbicide selection, with a preference for less toxic herbicides.

Herbicide	Application Rates (lbs a.i./acre)	Oral LD_{50} (mg/kg)	Dermal LD_{50}	Inhalation LD_{50} (mg/L)	Adverse Human Health Effects
Chlorsulfuron	0.047 – 0.062	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	0.03 – 0.11	>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	0.0313 – 0.1875	>5,000	>5,000	>2.38	Can cause moderate skin and eye irritation. Not a known carcinogen or mutagen.
Imazapyr	0.45 – 1.5	>5,000	>2,000	>1.3	Can cause moderate skin and eye irritation. Not a known carcinogen or mutagen.
Isoxaben	0.66 – 1.33	>5,000	>2,000	>2.68	Can cause eye irritation and corneal damage. The additive, crystalline silica, is a listed carcinogen. can cause birth defects and adverse effects on reproduction. Classified as a possible human carcinogen and mutagen.
Metsulfuron methyl	0.0125 – 0.15	>5,000	>5,000	>5.3	Mild to moderate skin and eye irritant. Not classed as a carcinogen or mutagen. Not known to impact or inhibit reproduction or development.
Prodiamine	0.75 – 1.5	>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	0.0023 – 0.028	>5,000	>2,000	>5.03	Mild eye irritant. Not carcinogenic or mutagenic. Has little to no effect on reproduction, development, or fertility.
Glyphosate	0.5 – 4	4,320	>2,000	1.6 - 5.63	Possible alteration of intestinal microbial community. Some evidence of endocrine disruption. Linked to increased risk of Non-Hodgkin's Lymphoma for workers.
Clopyralid	0.35 – 1	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.

Herbicide	**Application Rates (lbs a.i./acre)**	**Oral LD_{50} (mg/kg)**	**Dermal LD_{50}**	**Inhalation LD_{50} (mg/L)**	**Adverse Human Health Effects**
Dichlobenil	4 -6	4,250	>2,000	>3.3	Impacts to liver and kidneys with acute exposure. Classed as a possible human carcinogen. Potential endocrine disruptor.
Picloram*	0.125 – 1	4,012	>2,000	>8.11	Acute poisoning can lead to nervous system damage, weakness, and diarrhea. Chronic exposure can cause liver damage. Mild to moderate skin and eye irritant. Chronic exposure can lead to developmental effects. Not a known carcinogen or mutagen.
Fluroxypyr	0.12 – 0.5	2,405	>2,000	>6.2	Can cause damage to the liver at high doses. Potential effects if swimming in or drinking contaminated water. Not likely to be carcinogenic or mutagenic.
Metribuzin	0.17 - 3	2,300	>5,000	0.72	Sub-chronic exposure linked to abnormal liver function and adverse impacts to reproduction. Known endocrine disruptor. Not a known carcinogen or mutagen.
Fluazifop –p-butyl	0.1 – 0.375	>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 to the public from long-term consumption of contaminated vegetation. Not likely to be carcinogenic or mutagenic.
Indaziflam	0.046 – 0.091	>2,000	>2,000	>2.3	Can cause degenerative neuropathology and damage to kidneys, liver, and thyroid with chronic exposure. No evidence of carcinogenicity or genotoxicity.
Atrazine	1-4	1869	>2,000	5.8	Causes endocrine disruption. Most impacts affect 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. Potential endocrine disruptor.
Pendimethalin	1.485 – 1.98	>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.

Herbicide	Application Rates (lbs a.i./acre)	Oral LD_{50} (mg/kg)	Dermal LD_{50}	Inhalation LD_{50} (mg/L)	Adverse Human Health Effects
Triclopyr	0.5 - 8	630	>2000	>4.8	Mildly toxic to developing embryos. High doses can cause adverse birth defects and maternal toxicity. Not classified as a human carcinogen. Can cause mutations but with no adverse effects.
2,4-D	0.23 - 9	579 - 1646	>2,000	0.78 – 5.4	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. Potential endocrine disrupter.
Paraquat	0.07 - 1	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.

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

Smoke from prescribed burning is a major concern for fire crews and residents. Particulate matter can affect lung function and aggravate sensitive individuals. Studies on the long-term effects of smoke exposure on firefighters show evidence that cardiopulmonary disease and premature death is higher for firefighters than in the general population (Gabbert 2010, Broyles 2013, Adetona et al. 2016, Navarro et al. 2019).

Gases in smoke include carbon dioxide (CO_2), carbon monoxide (CO), and nitrogen oxides (NOx). Most gases will diffuse into the atmosphere and would have lower concentrations during prescribed burns than wildfires, but firefighters may be exposed to higher levels of these gases. Wood smoke also contains polynuclear aromatic hydrocarbons (PAH), which contain several carcinogenic compounds. Recent studies indicate that higher exposure to PAHs, which could occur for burns targeting woody riparian species such as tamarisk or Russian olive, may increase the risk for multiple health issues including cancers, respiratory disease, and cardiovascular disease (Aisbett et al. 2007, Booze et al. 2004, Reinhardt and Ottmar 2004, Wolfe et al. 2004, Edwards et al. 2005, Leonard et al. 2007, Naeher et al. 2007, Tak et al. 2007, Swiston et al. 2008, Gabbert 2010, Adetona et al. 2011, Broyles 2013). To reduce the risks of exposure, respirators are recommended to protect wildfire staff during burning operations (Barboni et al. 2010) along with limited shift times and crew rotations (Broyles 2013).

Smoke can reduce visibility and haze in areas, reducing air quality in nearby communities. Removing flammable weeds (i.e., cheatgrass and tamarisk) would decrease the risk and severity of unplanned wildfires over time. Because all prescribed burning treatments require separate planning and environmental analysis for all alternatives per the BIA Wildland Fire Management Plan (BIA 2006), all impacts from burning activities would be similar and require adherence to measures such as public notifications, timing burns based on environmental conditions, and reducing nearby vegetation to reduce wildfire risk.

4.7.1.3 Alternative 3 – No Biological Control

Under Alternative 3 (No Biological Control), public health impacts would be similar to those described for Alternative 2.

4.8 Socioeconomics

A goal of the BIA Noxious Weed Management Program is to maintain the sustainability and economic viability of Indian agricultural lands and to restore degraded lands. This goal should be done while minimizing negative impacts to local communities. Reducing the spread of noxious weeds can improve the productivity of rangeland and farmlands, economically benefiting ranchers, farmers and hunting guides who make their living off the land. However, removal efforts do require funds and can vary in costs depending on the methods used, the effectiveness of treatments, and indirect impacts from site closures and access issues.

4.8.1 Economic Loss

Across the US, noxious species impact the economy, costing billions of dollars every year (Pimentel et al. 2005). Economic losses from noxious weeds include direct costs from reduced productivity for agriculture and forestry, as native vegetation and agricultural crops compete with noxious weeds for light, nutrients, and water. Recreation and tourism may suffer as landscapes become degraded, reducing the visual quality and safety at popular travel destinations. Noxious weeds also reduce land values and increase the risk of damage to private property. On farm and rangeland, weeds reduce carrying capacity for livestock and wildlife and lowers capacity for plant production, recreation, and development.

Some of the most damaging and widespread noxious weeds on the Navajo Nation include camelthorn, Russian thistle, and annual brome species. Camelthorn can grow into buildings and structures, degrading their integrity and reducing property values. Other species are fire prone, such as Russian thistle, bromes, and kochia, and can increase the frequency and intensity of wildfires, which can increase property damage and reduce land value. Economic experts estimate that, in general, for every year weeds are not addressed, the costs of controlling them can increase by two- to three-fold (BIA 2014).

4.8.1.1 Alternative 1 – No Action

Costs and economic losses for treating weeds under Alternative 1 would be higher due to a lack of coordination between projects and treatment of fewer weed species. Limited coordination between neighboring projects would reduce the ability of the BIA to leverage resources from other partner agencies, which could increase direct costs for projects. This could include the need for increased manpower, specialized equipment, funding, and supplies for projects. While BIA projects require an in-kind match, many land users are limited in the resources they can provide, which can limit the kinds of projects they can fund.

Under Alternative 1, only species on the BIA's 2009 Noxious Weed List would be treated, with no treatment for annual brome species, kochia, and Russian thistle, which are prominent on agricultural lands. Failure to treat these species further degrades rangelands, reducing carrying capacity and animal production. On farmlands, these weeds increase competition and require additional treatments, such as herbicide applications, to limit their growth in favor of agricultural crops.

Costs for treating weeds on a per acre basis would remain the same, if not slightly higher, as the BIA primarily uses mechanical and chemical methods. The per acre costs can vary substantially between projects and agencies based on a variety of factors, such as project goals, staff expertise, methods used, and whether additional contracting is needed. The current cost for BIA weed management projects ranges from $17 to $4,700 an acre. Variations in costs are largely due to differences in in-kind contributions from partners, the amount of herbicide used, personnel needs, and how treatments are applied (ground broadcast vs. cut stump treatments). In terms of long-term costs, the No Action Alternative would have higher costs as weed infestations continue to expand, increasing the need for treatment with limited returns or improvement.

4.8.1.2 Alternative 2 – Proposed Action

Weed control projects along roads or in communities may temporarily limit access to treated areas, which could impact commerce, recreation, and travel. These disruptions would be most common during chemical treatments. Chemical treatments near recreational areas, such as Navajo tribal parks or national parks and monuments, may reduce visitation and travel within the area. However, herbicide treatments would be short-lived, lasting a few days to a few weeks. Treatments could be timed during periods when tourism is slower to reduce potential economic losses. Additionally, travelers would also be given alternative routes around treatments areas so they can avoid them if necessary.

Treatments on rangeland may cause some short-term losses during deferment. Deferment could increase the costs for raising livestock as ranchers supplement forage with hay or other grains for extended periods of time. If animals are transferred to a different location during deferment, there may be additional costs for rent and forage at the new location. Such costs depend on where animals are housed and if there are special agreements to transfer the costs for deferment from the permit holder to the Navajo Nation, such as Navajo Nation Ranches. Deferment for weed treatments, however, would be short lived as treatments would improve rangelands by reducing competition with preferred native forage.

4.8.1.3 Alternative 3 – No Biological Control

Under the No Biological Control Alternative, fewer acres would be treated for a similar cost. Use of other weed management techniques would result in higher direct costs for equipment, supplies, and personnel. Such costs generally make these methods more expensive and have the potential for greater impacts to sites. Sites would also require more retreatment as passive control through biological control would not be available. This would potentially increase costs for eradication on a per acre basis.

4.8.2 Economic Opportunities

4.8.2.1 Alternative 1 – No Action

Under the No Action Alternative, the BIA would provide funding for weed projects that meet the planning and cost-sharing requirements for the agency through the existing BIA Noxious Weed Program. The No Action Alternative would provide some job opportunities for skilled and unskilled labor on the Navajo Nation for projects. Jobs may be created either by specific BIA project teams or local contractors. However, these positions would be temporary, as longer-term positions for monitoring, treatment evaluation, and retreatment would not be a priority. As a result, this action would likely only support seasonal employment.

4.8.2.2 Alternative 2 – Proposed Action

Funding for weeds may allow the Navajo Nation to hire additional staff to carry out projects. BIA funding and other government grants for weed control could facilitate the purchase of weed control equipment BIA Agencies at a minimal cost. A large portion of the funds from the BIA are spent on contractors who carry out the work. which could increase small business investment for local and Native American natural resource firms.

Implementing an integrated approach would provide economic opportunities through job creation and improved land quality. Similar to Alternative 1, the BIA Noxious Weed Program would fund projects that provide opportunities for skilled and unskilled laborers to conduct weed mapping and inventories, implement weed control and removal projects, and conduct monitoring and scientific studies on treatment effectiveness either through the BIA, partner organizations, or local contractors. For private organizations, contracting jobs could create additional opportunities for environmental planning, landscape maintenance, natural resource management, and scientific research. In addition to federal funding, the Proposed Action could leverage funds from cooperating agencies and the BIA through grant programs for non-profits or other funding opportunities.

The integrated approach outlined in the Proposed Action would lower per acre treatment costs. The use of biological agents, in coordination with USDA APHIS, has lower costs than many of the other methods proposed. Through APHIS, agencies can obtain biological agents for free under the agency's permits. Thus, direct costs for biological control projects would include those for labor and travel to distribute and monitor populations. Biological controls would increase the number of acres treated on the Navajo Nation so resources and funds could be used on other projects.

Monitoring and adaptive management would improve the effectiveness of weed treatments on the Navajo Nation. Adaptive management of projects controls costs by preventing the long-term use of ineffective treatments. Reestablishing native vegetation at treated areas would reduce the costs associated with retreatment by increasing competition with target weed species and improving land productivity. Projects under Alternative 2 would have increased costs for long-term monitoring and retreatment than Alternative 1. However, such activities improve the overall success of projects, improving the BIA's ability to prioritize and effectively control problematic populations. By prioritizing areas and techniques, agencies would implement the most effective treatments while improving land values and ecosystem functions.

4.8.2.3 Alternative 3 – No Biological Control

The No Biological Control Alternative would create jobs and economic opportunities on the Navajo Nation in the same way as Alternatives 1 and 2. Weed projects would increase the need for seasonal staff and equipment. This alternative would restore degraded lands and improve rangeland and agricultural productivity. Costs for retreatment and monitoring would be similar to Alternative 2, as such measures would also be implemented.

However, this alternative would use more labor-intensive and costly methods, such as mechanical and chemical treatments since biological control would not be permitted. Thus, projects requiring such treatments would be more expensive than those proposed under Alternative 2. Per acre costs under this Alternative would be slightly higher than the Proposed Alternative due to the reliance on other methods.

4.8.3 Access to Vital Services, Recreation Sites, and Customary Use

4.8.3.1 Alternative 1 – No Action

The No Action Alternative would have limited coordination along roadsides or rights of way. The BIA, Navajo Nation, county, and state departments of transportation all currently do roadside herbicide and mechanical treatments in the project area. However, treatments are only coordinated on a case-by-case basis. Limited coordination would increase herbicide exposure risk along roadways as multiple areas may be treated. The number of people affected however would depend on how many people travel through treated sites, which is likely to be limited on Navajo DOT roads and in rural areas.

As discussed previously, weed treatments can limit access to recreation or customary use areas. Trails, campgrounds, and open areas may require closures during treatments for a short period of time once completed. As recreation is strongly tied to the service industry (i.e., hotels, restaurants) on the Navajo Nation, there may be some small economic losses as visitors avoid treatment areas or opt to visit alternative locations to reduce their exposure to herbicides or increased dust and noise from mechanical treatments.

Access to customary use areas may be restricted depending on the project and the ability of land users to establish alternative locations for cattle or farming. Projects in these areas would limit access while treatments are implemented. Land users may restrict access to sites after treatments to allow native vegetation to re-establish and to reduce harm to livestock, however the length of any closure depends on the methods used.

4.8.3.2 Alternative 2 – Proposed Action

There is potential for treatments to limit access to sites used for recreation, religious ceremonies, customary use areas such as ranching or farming, especially along roads. Given the remote nature of the Navajo Nation, treatments along roads could hinder residents who may use specific sites in 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 would be treated at any given time (less than 1% for federal, state, county, and tribal roads). Therefore, identifying alternative routes or treatment windows should be feasible to avoid travel through treated sites.

Treatments could occur near recreational sites, such as tribal parks and federal lands (i.e. BLM and NPS areas). These treatments could impact activities, such as hiking or camping, affecting those with herbicide sensitivities. Treatments would be done in coordination with other agencies to improve treatment coverage and timing, which is important in the patchwork areas of Eastern Navajo Agency. Coordination between agencies would allow treatments to be timed simultaneously to reduce confusion and allow for consistent notifications for those wishing to avoid treated sites.

Customary use areas used for grazing and traditional farming on the Navajo Nation would be impacted by weed treatments. Impacts to customary use areas used for farming and grazing are discussed in more detail in the Agriculture section. Customary use areas not used for grazing or farming, would likely not be impacted by weed treatments unless land users seek assistance from the BIA for weed control. Treatments could impact access to ceremonial sites. However, as part of its project planning requirements, the BIA and its cooperators would identify alternative areas for ceremonial needs prior to treatments (Appendix H). Practitioners and those who use these areas would also identify alternative use areas to reduce access issues related to recreation, plant collection, and ceremonial use in project areas.

4.8.3.3 Alternative 3 – No Biological Control

Impacts would be similar to those described for Alternative 2. However, sites that may have been treated with biological controls would now be treated with chemical or mechanical methods under this Alternative. This shift in methods may limit access to vital services, customary use areas, and/or recreational site. Those wishing to avoid herbicides may have limited options, but it will likely not result in significant differences than under Alternative 2.

4.9 Environmental Justice

Weed management would carry the most risks for Navajo residents. These impacts would vary by alternative and would result in both negative and positive effects for residents. Reducing negative impacts to communities will require the BIA and other agencies to work with local communities to understand their concerns, existing needs, concerns, and factors that may affect their support of a project, and reasonable mitigation measures to protect residents without causing an undue burden.

4.9.1 Alternative 1 – No Action

The No Action Alternative would negatively impact Navajo communities as current treatments only provide communities with limited input on treatments or management needs. Treating weeds on a case-by-case basis would allow weeds to spread to areas where they can cause economic damage to homesites, rangelands, watersheds, and agricultural fields. As discussed in the Economics section, noxious weeds can decrease property values and land productivity by reducing the cover and production of crops and/or forage resources. For the Navajo people, reduced farming and livestock productivity could impact the livelihood of many residents. Some weeds can increase wildfire risk, which could increase property damage and air pollution in nearby communities. The unsightly spread of weeds could impact valuable business enterprises on the Navajo Nation, such as hotels, casinos, and shops which may need to spend more to treat and reduce weeds.

Under the No Action Alternative, community involvement to provide input on weed projects would be inconsistent. Projects are currently done on a case-by-case basis in response to weed issues reported by land users. They are often planned based on limited land user knowledge. While the local Chapter House and grazing officials are contacted, planning can be ad hoc and may have limited or no communication with neighboring permit holders or land management agencies, residents, or Navajo Nation agencies. As a result, mitigation measures to protect sensitive plants, surface water and wells, plant collection areas, residences, and other customary use areas may be inconsistent or non-existent. Projects may not be planned in collaboration with other agencies to reduce cumulative impacts and result in increased risks for herbicide exposure, surface and drinking water contamination, and soil erosion. These impacts can increase environmental injustice in local communities.

4.9.2 Alternative 2 – Proposed Action

An integrated weed management strategy would not result in adverse impacts to residents of the Navajo Nation. Chemical and mechanical treatments are likely to have the greatest impacts on local communities. Herbicide applications and heavy machinery have higher risks for contaminating surface water than other treatments. Prescribed burning would impact air quality in surrounding communities. However, mitigation measures proposed under the plan would reduce or eliminate these risks.

A key difference between Alternative 1 and Alternative 2 is the requirement for consultation and coordination with tribal agencies, federal landowners, and local communities to plan and develop weed management projects. Measures include regular public meetings, notification and consultation with neighboring land users and permit holders, and buffer zones near water sources and around homesite lease areas. Local Chapter Houses must be involved in planning to provide input about project concerns and risks. Consistent mitigation measures, buffer zones, and avoidance measures are required to protect sensitive plant and animal species, surface water and wells, cultural resources, plant collection areas, and residents. Herbicide use must be done in consultation with the NNEPA and the USEPA to protect surface water and wells. These agencies are responsible for reporting and monitoring herbicide use to protect local communities and reduce the risk of harmful exposures.

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 treated areas. Positive impacts from weed control and management include improved site productivity, improved aesthetic values, reduced erosion, improved wildlife habitat, and a reduction in weed allergens.

4.9.3 Alternative 3 – No Biological Control

The No Biological Control Alternative would not disproportionately impact the Navajo Nation. Alternative 3 would incorporate the same level of community consultation and notification to ensure that projects are planned and implemented in a way that will not disproportionately impact local residents.

4.10 Areas with Special Designation

4.10.1 National Park Service, Navajo Tribal Parks, and Recreation

Within Canyon de Chelly and Navajo National Monuments, weed management is the joint responsibility of the BIA, Navajo Nation, and NPS. Weed treatments in these parks are developed in cooperation with Navajo Nation Parks and Recreation Department or tribal parks (NNTP) and NPS through cooperative management plans. The unique characteristics of these areas should be considered when developing weed treatment projects. Priority areas for weed treatments include the National Scenic Byways to reduce weed spread along linear corridors.

4.10.1.1 Alternative 1 – No Action Alternative

The No Action Alternative would allow existing impacts from the spread and establishment of noxious weeds to continue. Noxious weeds would expand in Navajo tribal parks and recreation areas where they would degrade the unique qualities of these parks, increase wildfire risk, threaten native plant and wildlife diversity, and compromise natural processes. Noxious weeds, such as kochia and Russian thistle, could cause problems for visitors with hay fever and allergies. Weed treatments occur in these areas would have similar impacts for manual, mechanical, and chemical treatments in the Proposed Action.

4.10.1.2 Alternative 2 – Proposed Action

Under the Proposed Action, noxious weed treatments would be conducted using an integrated approach in Navajo Tribal Parks and Recreation Areas. In general, weed treatments would have short-term negative impacts and long-term positive impacts. Treatments would uphold the mission of the Navajo Tribal 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. The short-term impacts of weed treatments include temporary closures to treated areas, visual impacts from brown or dead vegetation directly after treatments, and increased dust and soil erosion, which would vary depending on the size of the treated area. Temporary closures may lead to lost recreational opportunities, including site seeing, hiking, and photography.

The use of chemical treatments to treat noxious weeds could damage or kill non-target vegetation through drift or imprecise application, however mitigation measures would reduce this risk. The degree of impact would depend on the application method used. Spot applications would be less likely to cause widespread impacts to non-target vegetation than aerial and ground broadcast spraying. Mitigation measures would reduce the impacts of noxious weed treatments in these areas. The mitigation measures associated with human and ecological health and recreation would apply to Navajo Tribal Parks and Recreation Areas. Signs and public notices would be posted and distributed prior to chemical treatments to inform the public. Please refer to the 4.4 Vegetation, 4.5 Wildlife, and 4.7 Public Health sections of this chapter for specific details.

4.10.1.3 Alternative 3 – No Biological Control

Under Alternative 3, more impactful treatment methods, such as chemical, mechanical, manual, and cultural, would be used more frequently to control target weed species. However, the number of acres treated for each method would be the same as the Proposed Action. In Tribal Parks, 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 damage to non-target vegetation from personnel, equipment, 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.

4.10.2 Forest Lands

4.10.2.1 Alternative 1 – No Action Alternative

The No Action Alternative would allow existing negative impacts related to the spread and establishment of noxious weeds to continue. Noxious weeds could be treated under the 10-Year Forest Management Plan and continue as it is currently managed. However, the Integrated Resource Management Plan for the forests recommends development of a separate comprehensive noxious weed management plan and to provide consistent weed management throughout the Navajo Nation. Noxious weeds would continue to expand in forest lands where they would compromise timber health and site accessibility through increased wildfire risk, competing vegetation, and dense monocultures. Under the BIA's Noxious Weed Program more direct methods such as chemical and mechanical treatments would be utilized with ad hoc mitigations or limitations on their use. This would increase the risk of contaminating water sources. Weed treatments that do occur in these areas would have similar impacts as discussed in Alternative 2: Proposed Action.

4.10.2.2 Alternative 2 – Proposed Action

Under the Proposed Action, noxious weed treatments would be conducted through an integrated approach. The methods proposed in the 10-Year Forest Management Plan would be available for use. In general, weed treatments would have short-term negative impacts and long-term positive impacts. Noxious weed treatments would reduce the risks of timber loss due to competing noxious vegetation, area closures from dense weed infestations, and wildfire that damage important timber resources. The short-term impacts of weed treatments include temporary closures to treated sites, increased dust, and soil erosion. Mitigation measures would minimize impacts from dust and soil erosion. Revegetating sites with native vegetation would restore timber resources and comply with the 10-Year Forest Management Plan.

Chemical treatments could damage non-target vegetation through drift or imprecise application along with impacts to water quality, however mitigation measures would reduce these risks. This method would only be used if other methods are not as effective toward achieving the project objectives. The degree of impact 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 impacts from weed treatments in these sites. The mitigation measures associated with human and ecological health would apply to forest lands. Refer to the 4.4 Vegetation, 4.5 Wildlife, and 4.7 Public Health sections of this chapter.

4.10.2.3 Alternative 3 – No Biological Control

Under Alternative 3, more disturbing treatment methods such as chemical, mechanical, and cultural, would be used to control target weed species. While the number of acres treated by each of these methods would be the same as Alternative 2, areas where more passive treatment methods are preferred would instead be treated with these more impactful techniques. Also, re-treatment using these techniques may result in cumulative impacts over time. Overall, the impacts would be the same as those for Alternative 2.

4.11 Cumulative Impacts

Many activities on the Navajo Nation have the potential to increase noxious weed populations either by introducing seeds or plant parts into non-infested areas, creating conditions favorable for germination or spread, or out-competing native plants. This section analyzes the cumulative impacts of the alternatives. Under the applicable CEQ NEPA regulations, a cumulative impact is defined in 40 C.F.R. Section 1508.7 as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." As noted earlier the Agency is proceeding under regulations in effect prior to September 14, 2020. Accordingly, cumulative impacts are analyzed below.

4.11.1 Roads and Rights-of-Way Management

This category includes road construction, reconstruction, installation of above and below ground infrastructure, and road maintenance. Rights-of-way projects include the installation of utility lines and maintenance along railroad tracks. Also, the Navajo-Gallup Water Supply Project is under construction and will convey municipal and industrial water supply from the San Juan River to the eastern section of the Navajo Nation. Ditch reshaping and culvert replacement does create ground disturbance in the project area. These projects could bring weed seed from existing populations to non-infested areas. Soil disturbance creates ideal germination conditions for many noxious weed species, making disturbed sites hotspots for weed spread. Current contract clauses for road management and rights-of-way construction direct operators to clean their equipment between jobsites.

BNSF would be exempt from the proposed action because they implement their own weed treatment program along their railroad lines using mechanical removal and annual broadcast herbicide spraying with helicopters and vehicles (Nyberg 2001). BNSF uses pre-emergent herbicides in the spring to treat prevent weed growth. Target species are based on state noxious weed lists, which are identified on an annual basis and change if new species are listed or new populations are detected. Railroad tracks are a vector for spreading weeds as seeds and plant parts can attach to train cars and equipment and travel great distances. The BNSF program relies on the use of herbicide applications and mechanical removal, with biological controls in areas where spraying may not be permitted or where there is a high risk to other resources. There is a risk of increased herbicides use along BNSF railroads and in adjacent areas treated under the IWMP that may present cumulative effects to soils, vegetation, and wildlife.

Bureau of Reclamation is responsible for managing weeds along water lines for the Navajo-Gallup Water Line Project. Water line construction disturbs soils and provides a platform for noxious weed invasion. Treatments include removing weeds and planting/seeding native vegetation.

Short-term impacts related to the construction along rights-of-ways include increased compaction and disturbance to soils during treatments, and erosion when weeds are cleared and native species have not recolonized. Cumulative impacts would be reduced under the Proposed Action as coordination between projects would occur between agencies/land managers and best management practices and species conservation measures would be implemented. Under Alternative 1 the cumulative impacts to soil, wildlife, terrestrial, and water resources would be greater as weed projects would be uncoordinated providing a greater risk for synergistic effects from herbicides on non-target plants and soils. Additionally, under Alternative 1 best management practices and species conservation measures would not be implemented. Fewer treatments would occur under Alternative 1 which would increase noxious weed expansion from rights-of-ways onto adjacent lands.

4.11.2 Vegetation Management

4.11.2.1 Forest Management

Forest management is planned in five forestland areas, including but not limited to the Chuska Mountains, Defiance Plateau, Carrizo Mountain, Mount Powell, and Navajo Mountain under the 10-Year Navajo Nation Forest Management Plan. Forest management includes commercial and non-commercial harvesting as well as a multitude of silvicultural treatments. Harvest operations can provide vectors for weed infestation as equipment is transported between sites. Ground disturbance is common and can increase the risk for seed germination. Other impacts include increased erosion, damage to native plants, and loss of topsoil.

Firewood harvesting can also transport weeds into forests since owners are not required to clean private vehicles before entering the forest. Weed seed and materials may also be introduced by fire fighting vehicles and crews.

Mechanical treatments implemented under the Proposed Action near forest lands may cumulatively increase erosion, impact native vegetation, and increase disturbance that would increase noxious weed germination. Under Alternative 2, communication protocols and best management practices would reduce these impacts by coordinating treatments near managed forests, using soil stabilization techniques, and replanting native species to prevent weed germination. Under Alternative 1, there would be a greater potential for cumulative impacts to native vegetation, soils, and wildlife since best management practices and species conservation measures would be implemented inconsistently. There would be a higher likelihood for noxious weed spread and increased soil erosion through ground disturbance from roads and mechanical weed treatments occurring together.

4.11.2.2 Cooperative Agency Weed Management Programs

Many cooperating agencies, including state and federal agencies, actively employ integrated weed management programs similar to the Proposed Action for their lands. Chemical and mechanical treatments would increase the potential for water quality issues, increased erosion, and disturbance at project sites, however mitigation measures and project coordination would reduce these impacts. Cooperative noxious weed projects would provide a long-term benefit. Weed treatments conducted by agencies adjacent to or within the Navajo Nation, such as the NPS and BLM, would result in larger treatment sites. Herbicide treatments applied by either agency have the potential to increase the amount of the herbicide applied to a landscape, which would increase the risks for water contamination, herbicide drift, exposure to chemicals for chemically sensitive individuals, and consumption of contaminated vegetation by wildlife or livestock. Both these agencies currently consult with BIA and Navajo Nation for weed treatments, therefore there would not be a significant and cumulative increase in herbicide use under any of the alternatives. Mechanical treatments would increase ground disturbance, which increases the risk of soil erosion, soil compaction, and damage to native plant communities. Under Alternative 2, cooperative implementation of weed management projects with the use of best management practices and conservation measures would help reduce the severity of these impacts for both agencies. Without the cooperation of agencies implementing weed projects, best management practices, and species conservation measures under Alternative 1, there would be a greater cumulative risk for soil erosion, damage to native plant communities, and spread of noxious weeds.

4.11.3 Community Development

Each chapter on the Navajo Nation has developed a Land Use Plan. The Navajo Nation Division of Community Development certifies these plans under the Navajo Nation Local Governance Act to provide the chapters with decision making power and the ability to manage land development at a local level. As Chapters develop and construct new facilities and infrastructure or repair existing ones, such activities impact soils, vegetation, and wildlife. Construction activities remove vegetation, disturb soils, and have temporary noise impacts that could disturb wildlife. If weed treatments are conducted adjacent to community development there may be cumulative impacts from mechanical methods that increase soil erosion and compaction, removal of native vegetation, and noise effects on wildlife. Under Alternative 2 and Alternative 3, cumulative impacts would be minor when best management practices and conservation measures are implemented to reduce soil impacts and planting native vegetation. Wildlife impacts would still occur; however, they would be short-term. There would be greater cumulative impacts when community development occurs with weed treatments conducted under Alternative 1 where best management practices are not implemented. Soil erosion and compaction would increase as soil control measures would not be implemented and there would be greater impacts to native vegetation since replanting would not be implemented. There is also a greater risk for noxious weed spread from community development to adjacent lands treated with mechanical methods under Alternative 1.

4.11.4 Mining Operations

The disturbance created through mining creates conditions conducive to the spread and establishment of weeds by removing native vegetation and introducing weed seed. While mining and power generation once represented one of the biggest sources of income for the Navajo Nation, three major coal power plants have closed in the past 20 years. All mining operations are subject to the Surface Mining Control and Reclamation Act of 1977 (P.L. 95-87), which requires mines to operate in an environmentally responsible manner and reclaim mines during and after operations to the same or better condition. Currently, Navajo Mine is the only active coal mine on the Navajo Nation. In 2014, the Office of Surface Mining and Reclamation and Enforcement (OSMRE) approved the Pinabete Permit Area to expand coal mining in approximately 5,600 acres on the Navajo Mine property. As part of the management of the Navajo Mine, revegetation of disturbed sites is required, with seeds and plant materials coming from certified weed-free suppliers. The other two mines, Kayenta and Black Mesa Mine, are being reclaimed after mining operations ceased. Those activities are overseen by OSMRE, the Navajo Nation, and the BIA until they are returned to the Navajo Nation.

Additionally, there are two approved active leases for sand and gravel mining on Indian trust lands at Emma Brown Pit and Wheatfield, AZ. Two more proposed sand and gravel leases are under consideration for the Teec Nos Pos Gravel Pit and Greasewood Spring, AZ. As part of the permit application, mining companies submit a Mining and Reclamation Plan that includes how weed management will be addressed on sand and gravel mines. This plan requires approval from BIA and BLM.

BIA NRO, in cooperation with BLM, proposes development of oil and gas leases on approximately 900,000 surface and mineral estate acres on tribal trust lands and individual Indian Allotments through the Farmington Mancos-Gallup Draft Resource Management Plan Amendment and EIS (BLM and BIA 2020). Mining includes primarily subsurface mining (horizontal drilling and multistage hydraulic fracturing), but drill stations and rights-of-way will impact the surface. While BIA is a co-author of this plan, BLM is responsible for overseeing reclamation after the oil and gas operation is complete.

Mining operations, in general, create large amounts of ground disturbance as topsoil is removed from mining sites to access soil and mineral resources beneath the earth's surface. Adjacent areas are also cleared for spoil areas. Active mines are often devoid of vegetation due to heavy ground disturbance and modifications. The topsoil is removed, making them poor sites for native vegetation establishment. Vegetation analysis for the Pinabete Mine indicates that noxious species such as Russian olive, Russian thistle, tamarisk, cheatgrass, musk thistle, and Canada thistle are present in the main project site (OSMRE 2015). While federal mine permits require restoration work to use weed-free seeds and vegetation, without follow-up treatments, disturbed sites would create conditions that facilitate the spread of weeds.

Additionally, mining exposes minerals and heavy metals that can contaminate ground and surface water. A study conducted at water sources near mining activities across the Navajo Nation found that US EPA guidelines were exceeded in 20% of the water sources for arsenic, 13% for uranium, and 59% for lithium (Credo et al. 2019). While the natural geology may be responsible for some of this contamination it is exacerbated by mineral and heavy metal exposure from mining activities and caused considerable public health effects. While some of the contaminants in mine operations are different than those used in herbicide treatments, additional contaminants could cumulatively increase health risks for outlaying communities and residents. Mechanical treatments in combination with mining activities could cumulatively impact soil stability, native vegetation, sedimentation into drainages especially for Alternative 1. Cumulative impacts of mining activities when combined with Alternative 2 would be reduced because best management practices would implement soil stabilization techniques and encourage the growth of native vegetation through active and passive restoration of treatment sites. OSMRE currently works with mine operators to provide recommendations for addressing noxious weed populations. The IWMP can provide guidance on how best to address such populations in a way that is consistent with neighboring areas and concerns. Additionally, best management practices would establish buffers around water sources to prevent contamination of herbicides, which would prevent cumulative impacts to water sources. Finally, integrated weed control in surrounding areas could limit the spread of noxious weed species to these sites by reducing the cover and density of weed populations.

4.11.4.1 Mine Reclamation

When mines are decommissioned, reclamation activities are conducted for public safety. Reclamation involves filling in and capping mine entrances to prevent accidental or intentional access to these locations. On the Navajo Nation, recent funding from the U.S. EPA has been used to reclaim 219 abandoned uranium mines on the Navajo Nation (USEPA 2008). Additionally, the Office of Surface Mining manages the reclamation of three decommissioned coal mines on the Navajo Nation. Mine reclamation increases ground surface disturbance. Equipment, heavy machinery, and vehicles at reclamation sites are seldom cleaned prior to their arrival, which disturbs soils and could expand noxious weed populations.

U.S. EPA mine reclamation protocols require that when abandoned or decommissioned mines are sealed off, sites should be seeded with an approved native plant mix to improve ground cover and soil stability. To address potential noxious weed infestations, the U.S. EPA stipulates that reclaimed areas be revegetated with certified weed-free native plant seed mixes. Operators must also meet vegetation cover requirements for native plants that are equal or better to plant cover on the site prior to mine operations. However, once areas are returned to the Navajo Nation, there is the potential for previously treated weed populations to return and spread.

Cumulative impacts from mine reclamation and mechanical weed treatments may increase soil erosion and compaction, disturb native vegetation, increase sedimentation to adjacent drainages, and provide wildlife impacts. Under Alternative 2, the proposed action, and Alternative 3 cumulative impacts would be minimized as best management practices and conservation measures would be implemented. Soil erosion and sedimentation in nearby drainages would be minimized with by installing erosion control structures. Native vegetation would be replanted to stabilize soil, enhance wildlife habitat, and provide livestock forage resources. Wildlife cumulative impacts would be short-term during weed treatment activities and as native vegetation establishes. Cumulative impacts would be greater when mine reclamation is combined with weed treatments conducted under Alternative 1 where best management practices and conservation measures are not required. Erosion control structures would not be required which could cumulatively increase soil erosion and sedimentation in adjacent drainages. Since follow-up weed treatments are not required at mine reclamation sites, there is a greater risk for noxious weed expansion if native plants are not restored after weed treatments.

4.11.5 Current Project List

4.11.5.1 Bureau of Indian Affairs – Navajo Regional Office

- BIA Navajo Regional Office Programmatic Pile Burn Prescribed Fire Plan for Hazardous Fuel Reduction
- Farmington Mancos-Gallup Draft Resource Management Plan Amendment and Environmental Impact Statement
- BIA Western Region Integrated Noxious Weed Management Plan and Programmatic Environmental Assessment for Weed Control Projects on Indian Lands
- Blue Gap Pit Enforcement for Recon Oil for illegal sand and gravel mining
- Humate Mineral Lead for Mesa Verde Resources
- McKinley County Mineral Lease for Sand and Gravel
- Souers Construction for Sand and Gravel Reclamation at Hunter’s Point and Nazlini
- Chance Damon Sand and Gravel Leases at Chinle Pit and Whippoorwill Pit
- Mining and Reclamation of Recon Oil Leases at Blue Canyon, Newcomb, and Kaibeto
- Tsaile Dam Lease
- Draft Range Management Plan for Land Management District 3
- Draft Integrated Resource Management Plan for the Former Bennett Freeze Area
- Amcoal Coal Mine Lease at Church Rock

- Four Corners Power Plant and Navajo Mine Energy Project
- Tsegi and Nitsin Canyon Grazing Management Plan and Environmental Assessment
- Oljeto Wash Noxious Weed Control and EA
- Puerco River Noxious Weed Control and EA
- Navajo Partitioned Land Resource Management Plan and EA
- Draft Standard Operating Procedures for Grazing and Agricultural permits, Range and Cropland Improvement

4.11.5.2 Navajo Nation Plans

Navajo THAW Implementation Plan

- Bodaway Gap Chapter Recovery Plan
- Cameron Chapter Recovery Plan
- Coalmine Canyon Recovery Plan
- Coppermine Chapter Recovery Plan
- Kaibeto Chapter Recovery Plan
- Leupp Chapter Recovery Plan
- Tolani Lake Chapter Recovery Plan
- Tonalea Chapter Recovery Plan
- Tuba City Chapter Recovery Plan
- Nahata Dziil Chapter Recovery Plan

Navajo Nation Community Housing and Infrastructure Department Projects

- Landfill and Illegal Dump Sites
    - Cameron Clean Closure Project
    - Rock Point Landfill and Clean Closure Project
    - Klagetoh Landfill and Clean Closure Project
    - Convenience and Recycling Facilities
        - Terreon Regional Convenience Center
        - Whippoorwill Regional Convenience Center
        - Teec Nos Pos Regional Convenience Center
    - Abandoned Vehicle Recycling
        - Chinle, Ft. Defiance, and Western Navajo Agencies

Certified Navajo Nation Chapter Land Use Plans for:

WESTERN
Shonto
Tuba City
Kayenta
Bodaway/Gap
Birdsprings
Chilchinbeto
Leupp
LeChee
Dennehotso
Tonalea
Inscription House

FORT DEFIANCE
Nahata Dziill
Steamboat
Cornfields
Naschitti
Lupton
Dilkon
Greasewood Springs
Kinlichee
Teesto

Ganado
Houck

EASTERN
Littlewater
Bááháálí
Whiterock
Ojo Encino
Baca/Prewitt
Casamero Lake

CENTRAL
Pinon
Whippoorwill Springs
Chinle
Názlíní

NORTHERN
Beclabito
Newcomb
San Juan
Tse Daa K'aan
Sheepsprings
Tolikan
Toadlena/Two Grey Hills
Tiis Tsoh Sikaad
Mexican Water
Upper Fruitland
Aneth
Cove

4.11.5.3 Bureau of Reclamation- Navajo-Gallup Water Supply Project – Upper Colorado Region

- Reach 1 through Reach 12A (Tribal Trust Land) - 1,482 acres.
- Reach 12B (Tribal Trust Land) - 28 acres.
- Tohlakai Hill PP, SJLWTP, PP#2, PP#3, PP#4, and PP#7 (Tribal Trust Land) - 184 acres.
- Reach 12.1 & 12.1 (Tribal Trust Land) - 240 acres.
- Cutter lateral side of the project Reach 22B and Reach 21 (Tribal Trust Land) - estimated 200 acres.

4.11.5.4 Bureau of Land Management – Farmington Field Office

- Department of the Interior Bureau of Land Management Environmental Assessment for the Farmington Field Office Noxious/Invasive Vegetation Management Spot Treatment Program
- Department of the Interior Bureau of Land Management Farmington Proposed Resource Management Plan and Final Environmental Impact Statement
- Department of the Interior Bureau of Land Management Vegetation Treatments using Herbicides for 17 Western States Final Programmatic Environmental Impact Statement
- Department of the Interior Bureau of Land Management Vegetation Treatments for 17 Western States Final Programmatic Environmental Report
- Department of the Interior Bureau of Land Management Final Programmatic Environmental Impact Statement for Vegetation Treatments using Aminopyralid, Fluroxypyr, and Rimsulfuron on Bureau of Land Management Lands in 17 Western States.

4.11.5.5 State Plans for Arizona, New Mexico, and Utah

- Dine Tah "Among the People" Scenic Road Corridor Management Plan - ADOT
- Arizona Department of Transportation Invasive and Noxious Plant Species List
- Arizona Department of Transportation Maintenance Operations Guidelines for Vegetation
- Management Activities Arizona Department of Transportation Herbicide Treatment Program on Bureau of Land Management Lands in Arizona
- Utah Department of Transportation Integrated Roadside Vegetation Management Program

4.11.5.6 National Park Service

- Canyon de Chelly South Rim Road Rehabilitation Draft Environmental Assessment
- Cooperative Watershed Restoration Project: Tamarisk and Russian Olive Management at Canyon de Chelly National Monument Final Environmental Assessment.

- Invasive Plant Management Plan and Final Environmental Assessment for Flagstaff Area National Monuments (Wupatki NM, Walnut Canyon NM, and Sunset Crater Volcano NM)
- Wupatki National Monument Wilderness Eligibility Study
- Bryce Canyon National Park Vegetation Management Plan and Environmental Assessment
- Grand Canyon National Park Exotic Plant Management Plan
- Grand Canyon National Park Fire Management Plan

4.11.5.7 U.S. Department of Agriculture

- Final Environmental Impact Statement for Integrated Treatment of Noxious or Invasive Weeds for the Coconino, Kaibab, and Prescott National Forests within Coconino, Gila, Mojave, and Yavapai Counties, Arizona

4.11.5.8 Native American Tribes

- The Hopi Tribe – Programmatic Environmental Assessment for the Management of Noxious/Invasive Weeds

4.11.5.9 Regional Plans

- San Juan Watershed Woody-Invasives Initiative Implementation Plan
- San Juan Watershed Woody-Invasives Initiative Strategic Plan
- U.S. Environmental Protection Agency Plan for Abandoned Uranium Mine Clean-ups on the Navajo Nation

4.11.5.10 Tribal Transportation Improvement Program Projects (Navajo DOT, BIA DOT, State DOTs)

Navajo Nation Department of Transportation

Farmington Field Office (formerly NIIP Roads):

- N101(1); Ojo Amarillo School Access – This project consists of 0.6 miles of new road construction to provide access to the Ojo Amarillo School. Proposed construction 2018.

New Lands Field Office (Naha Ta Dzill):

- N2007(1-1); Rio Puerco Bridge N666 – This project consists of 1.1 miles of new road construction and bridge replacement. This project is currently under construction.

Shiprock (Northern) Agency:

- N5001(1); Toadlena to Newcomb and Bridges N241 and N214 – This project consists of 6.1 miles of new road construction and two bridge replacements. Proposed construction 2020.
- N5012(1); Sanostee Wash Bridge (N204) – This project consists of 1.2 miles of new road and bridge construction. Proposed construction in 2020.
- N35(8)/ N5045(1); Sweetwater – This project consists of 6.8 miles of new road and bridge construction. Proposed construction in 2018.
- N13(3-3); US491 to Red Valley – This project consists of 10.0 miles of road rehabilitation. Proposed construction in 2021.
- N36(5A-1; US491 to Chaco Wash – This project consists of 7.9 miles of road reconstruction. Proposed construction in 2023.

- N36; US491 to SR371 (San Juan, NM) – This project consists of 0.25 miles of road reconstruction. Proposed construction in 2019.

Western Navajo Agency:

- N6720(1); Bridge N309 – This project consists of bridge replacement. Proposed construction in 2022.
- N71(3); Bird Springs to N15 and Little Singer School Access – This project consists of 7.5 miles of new road construction including an access road to the Little Singer School. Proposed construction in 2018.
- N6486(1); Lower Laguna Creek Bridges N308 and N314 – This project consists of 0.6 miles of new road construction and bridge replacement. Project construction in 2022.
- N6461(1-2)/ N6460(1); Dennehotso Loop Road – This project consists of 5.7 miles of new road construction. Proposed construction in 2018.
- N609(2); Kerly Street – This project consists of 1.2 miles of new road construction. Proposed construction in 2022.
- N71(1-1)(2-1)/ N2(1); Bird Springs (N71/ N2 Junction) – This project consists of 5.2 miles of new road construction. Proposed construction in 2022.
- N6485(1); Kayenta – This project consists of 2.2 miles of new road construction. Proposed construction in 2023.

Eastern Navajo Agency:

- N11(1a); N9 to Mariano Lake South End – This project consists of 6.2 miles of new road construction. Proposed construction in 2019.
- N7054(1); Pinedale east entrance off N11 – This project consists of 3.5 miles of new road construction. Proposed construction in 2018.
- N55(1-1); Alamo to I-40 – This project consists of 6.81 miles of road reconstruction. Proposed construction in 2022.
- N46(4)/ N474(4); Counselor SR-550 – This project consists of 7.6 miles of new road construction. Proposed construction in 2020.

Chinle (Central) Agency:

- N8066(3)/ N8065(1); N41 to Kitsilli (Black Mesa) – This project consists of 7.5 miles of new road construction. Proposed construction in 2021.
- N8084(1); Many Farms to N64 – This project consists of 3.5 miles of new road construction and construction of two new bridges. Proposed construction in 2021.
- N12(19-4); Wheatfields Lake to Tsaile (N12/ N64 Junction) – This project consists of 10 miles of road reconstruction and replacement of two bridges. This project is currently under construction.
- N4(5)/ N8031(2)/ N8031(3)/ N8031(4); Pinon to Hard Rocks – This project consists of 12 miles of new road construction. Proposed construction in 2019.
- N251(5-2); North Loop Tselani off N4 – This project consists of 15.2 mile of road rehabilitation and replacement of a bridge. This project is currently under construction.
- N27(2-3)(2-2); Nazlini to Chinle South Portion – This project consists of 5.6 miles of new road construction. This project is currently under construction.
- N27(4-2)(2-3)/ N7(2-3)/ N105(1); Nazlini to Chinle North Portion – This project consists of 5.4 miles of new road construction. This project is currently under construction.

Ft. Defiance Agency:

- N108(1); Bridge N651 (Tohachi) – This project consists of bridge replacement. Proposed construction in 2022.
- N9073(1)(2); Blue Canyon road and Bridge N606 – This project consists of 6.5 miles of new road construction and bridge replacement. Proposed construction in 2019.
- N203(2); Kinlichee Wash Bridge N629 – This project consists of bridge replacement. Proposed construction in 2022.
- N15(2-3); Burnside to Cornfields – This project consists of 7.1 miles of road reconstruction. Proposed construction in 2018.
- N9402(1); Rio Puerco Bridge N656 – This project consists of bridge replacement. Proposed construction in 2022.
- N12(13-2); Wheatfields Lake to Agency Line (Whiskey Creek) – This project consists of 10.0 miles of road reconstruction. Proposed construction in 2021.
- N15(3-1) (4-1) Cornfields to Sunrise – This project consists of 7.1 miles of road reconstruction. Proposed construction in 2022.
- Navajo Agricultural Products Industry Noxious Weed Program
- Naat'Tsis'Aan Scenic Byway Corridor Management Plan
- 2016 Navajo Nation Long Range Transportation Plan
- Navajo Nation Agriculture Resource Management Plan EIS
- Fort Defiance Agency District 14 EA
- Navajo Nation Department of Agriculture Tribal Ranches Program

5.0 CONSULTATION AND COORDINATION

5.1 Public Scoping and Involvement

As part of the environmental review process, the BIA held public scoping meetings to obtain public, stakeholder, and cooperating agency input required by the NEPA regulations. The NOI was published in the Federal Register on January 14, 2013 with a 45-day comment period, originally ending on February 27, 2013. After receiving several comments to extend the scoping period for additional scoping meetings, a Notice to Extend the Scoping Period was published in the Federal Register on March 8, 2013, extending the scoping period to March 20, 2013. Public Scoping meetings were held during the initial scoping period at five locations on the Navajo Nation. Notification of Public Scoping meetings were advertised in local newspapers, radio announcements, and on fliers at Navajo Nation Chapter Houses. During the scoping period, 45 comments were received. The final plan and PEIS analysis were developed with consideration of the received comments, however the NEPA process was delayed due to funding issues. The environmental review process was resumed in August 2019 to complete public hearings and final PEIS. Additional public comments were requested with the resumption of this project during April – May 2021. A full summary of all scoping activities is described in further detail in Appendix D.

5.2 Cooperating Agencies

Agency/Organization	**Agency Correspondent**	**Title**
NAVAJO NATION		
Division of Community Development	Pearl Yellowman	Director
Division of Natural Resources	Rudy Shebala	Executive Director
Department of Agriculture	Leo Watchman	Director
Department of Fish and Wildlife	Gloria Tom Nora Talkington Brent Powers Leanna Begay	Department Manager Botanist Zoologist Wildlife Biologist
Forestry Department	Alexious Becenti, Sr.	Director
Historic Preservation Department	Richard Begay Tim Begay	Supervisory Archaeologist Supervisory Archaeologist
Parks and Recreation Department	Martin Begaye	Department Manager
Division of Transportation	Darryl Bradley	Department Manager
Environmental Protection Agency	Valinda Shirley	Executive Director
U.S. Department of Agriculture, Natural Resources Conservation Services	Keisha Tatem	State Conservationist
U.S. Department of Agriculture, Animal and Plant Health Inspection Services	Dewey Murray	Arizona Domestic Program Coordinator
Navajo Nation Soil and Water Conservation District	Sadie Lister	Outreach Coordinator, Lower Colorado River SWCD
National Park Service	Michael Reynolds Dan Niosi Karen Skaar (Frankenfeld)	Regional Director IMR Regional Environmental Coordinator IMR NEPA/External Review Coordinator
Arizona Department of Transportation	Paul O’Brien, PE Justin White Kristen Gade	Environmental Planning Administrator Roadside Resources Manager Roadside Resources Specialist
Utah Department of Transportation	Monte Aldridge	UDOT Region 4 Deputy Director
Bureau of Land Management	Tim Spisak	New Mexico State Director
San Juan Soil and Water Conservation District	Melissa May	District Manager

As part of the development of the integrated weed plan and this corresponding PEIS, several agencies and organizations were identified as potential cooperating agencies. A cooperating agency is any federal or tribal agency that has a jurisdiction by law or special expertise with respect to any environmental impact involved in a proposed action. Potential cooperators were notified in writing about the project and invited to a kick-off meeting to provide additional information regarding NNIWMP. The meeting took place on July 19th, 2012, at the Bureau of Indian Affairs Navajo Regional Office in Gallup, NM.

During the preparation of the plan, cooperating agency correspondents were provided regular updates on the progress of the plan and the PEIS. Cooperating Agencies were provided a draft of the integrated weed management plan to review at a planning session on February 24th, 2014. The review session included information on the techniques proposed, the best management practices and mitigation measures incorporated into the planning, and information on planning and coordination to meet additional environmental and cultural resource compliance regulations.

On July 2015, subject matter experts from the cooperating agencies were provided a 30-day review of the draft PEIS. Comments from the agencies were reviewed and incorporated into the public draft of the PEIS by the project team. All correspondents from the cooperating agencies have been provided copies of the public draft at the release of the draft PEIS.

5.3 Additional Agency Consultants

Agency/Organization	Agency Correspondent	Title
Navajo Housing Authority	Aneva Yazzie	CEO
Navajo Tribal Utility Authority	Rex Kontz	Deputy General Manager
U.S. Fish and Wildlife Service	Shaula Hedwall John Nystedt	Fish & Wildlife Biologist AESO Tribal Coordinator
U.S. Forest Service, Southwest Region	Corbin Newman	Regional Forester
Hopi Tribe	Timothy L. Nuvangyaoma	Chairman
New Mexico Department of Transportation	Tom Church	Cabinet Secretary
U.S. Environmental Protection Agency	Arthur Totten	Federal Liaison
BIA National Office	Norman Calero	Pesticide Program
Department of the Interior	Gust Jarvis	Rangeland Management Specialist
Office Navajo-Hopi Indian Relocation	Larry Nez	Legislative Associate
Navajo Agriculture Products Industry/ Navajo Indian Irrigation Project	David Zeller Lionel Haskie	CEO Operations & Maintenance Manager

The additional agencies listed above were either agencies who declined to participate as a cooperating agency or those that were contacted to provide additional expertise or information that has been incorporated into the project.

5.4 BIA Interdisciplinary Team

BIA Branch	BIA Reviewer	Title
Natural Resources	Calvert Curley	Regional Supervisory Natural Resource Specialist
	Renee Benally	Natural Resource Specialist
	Chid Murphy	Regional GIS Coordinator
	Royale Billy	Natural Resource Specialist
	Ashley Curley	Natural Resource Specialist
	Amos Johnson	Supervisory Natural Resource Specialist
	Dean C. Gamble	Natural Resource Manager
	Jerome Willie	Supervisory Natural Supervisory
	Lambert Chee	Natural Resource Specialist
	Tony Robbins	Natural Resource Manager
Environmental Management	George Padilla	Regional Environmental Scientist
	Leonard Notah	NEPA Compliance Coordinator
	Robert Begay	Regional Archeologist
	Myles Lytle	Environmental Protection Specialist
Forestry	Antoine Luxon	Regional Forester
	Jordan Pina	Navajo Regional Forester
Real Estate Services	Calvin Murphy	Realty Specialist
Transportation	Herby J. Larsen	Regional Transportation Engineer
Engineering	Rudy Keedah	Supervisory Civil Engineer

5.5 Non-BIA Subject Matter Expert Reviewers

Resource	Reviewer	Agency, Title
Air Quality	Eugenia Quintana	NNEPA, Air Quality Environmental Department Manager
Water Resources	Jason John	NNEPA, Senior Hydrologist
Wetlands, Water Resources	Melinda O'Daniel	NNEPA, Water Quality
Special Status Plant Species Vegetation	Nora Talkington	NNDFW, Botanist
Wildlife	Brent Powers	NNDFW, Zoologist
Cultural Plant Species	Tony Joe	NNHPD, Supervisory Anthropologist
NAPI	Lionel Haskie	NIIP, Operations & Maintenance Manager
Public Health	Dr. Jill Jim	Navajo Nation Department of Health, Executive Director
Cultural Resources	Richard Begay	NNHPD, Acting Supervisory Archaeologist
Environmental Justice	Leonard Gorman	Navajo Nation Human Rights Commission, Executive Director
	Valinda Shirley	NNEPA, Executive Director
Navajo Tribal Parks	Martin Begaye	NNPRD, Department Manager
Hunting, Fishing	Jeff Cole	NNDFW, Wildlife Manager
Land Use Plans	Pearl Yellowman Mike Halona	Navajo Division of Community Development, Senior Project Specialist
Forestry	Alexious C. Becenti, Sr.	Navajo Forestry Department, Forest Manager
Agriculture	Ferdinand Notah	Navajo Nation Department of Agriculture, Program Projects Specialist

BIA members of the Interdisciplinary Team and Non-BIA Subject Matter Experts were asked to review the PEIS, with special attention paid to the resources and items that were identified as their expertise. Reviewers were provided a copy of the PEIS in July 2021 and given 45 days to review and comment. Comments received from the reviewers were incorporated into the public draft of the PEIS in consultation with the Project Team and document preparers.