



Vegetation Survey and Accuracy Assessment of Vegetation Mapping at Fort Union National Monument, New Mexico

Natural Resource Report NPS/FOUN/NRR—2012/553



ON THE COVER

Entrance to Fort Union National Monument, New Mexico
Photograph by: Joe Stevens

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Executive Summary

The Fort Union National Monument (FOUN) is located on the western high plains of north central New Mexico and was an important military and civilian site in the development of the southwestern United States. The succession of three remote US Army Forts built at the site between 1851 and 1891 significantly impacted the natural vegetation of the site. At times the site was said to have been completely denuded by the intense human and livestock activity.

A classification and map of the vegetation at FOUN were created in 2004 by ecologists with Natural Heritage New Mexico (NHNM) and published as Muldavin et al. (2004). An accuracy assessment (AA) of the FOUN vegetation map was conducted in 2009 by ecologists with the Colorado Natural Heritage Program (CNHP) and published internally as Stevens and Sever (2011). This document was compiled from those efforts by Joe Stevens and Travis Talbot, ecologists with CNHP, and includes both the vegetation inventory and the AA information reformatted to have a consistent flow and eliminate overlaps and duplications.

The vegetation survey and detailed vegetation map for FOUN included the development of a comprehensive plant species list along with a classification of vegetation communities of the park based on the National Vegetation Classification System (Grossman et al. 1998). The legend for the map is based on a vegetation classification with modifications for special features of the monument. The map was developed using available digital ortho-photography and ground checking, and is designed for use at the 1:6,000 scale, with a minimum mapping unit of size 0.10 - 0.25 ha. The species list and map form the foundation of a baseline inventory of plant resources of the monument, and were developed in concert with the guidelines of the National Park Service's Inventory and Monitoring Program to aid in network-wide park natural resource management.

A series of 8 plots and 19 observation points were established in homogeneous stands of vegetation and were used to classify the various plant associations found in the park. Plots were usually 400 m² and square, with other sizes occasionally used to fit the structure of a community, especially along drainages where vegetation stands conform to the channel shape. A list of all vascular plant species and their aerial cover, stratified by life form (tree, shrub, subshrub, grass and forb layers) was compiled for each plot. In addition, several site attributes were recorded including slope percent, aspect, slope shape, surface rock type, and ground cover (percent rock, gravel, bare soil and litter), along with narratives on species composition and site conditions. Observation points were collected where only the dominants and their abundance were recorded. All plot locations were established with handheld Garmin GPS units. Accuracy is estimated to be +/- 10 m or less (see Data Addendum for examples of sampling forms and detailed survey methods). The classification included 18 associations, 6 of which are recognized within the US National Vegetation Classification system (USNVC) (an additional 8 are recognized by NHNM only and 4 are considered Park Specials). This report provides the AA of the vegetation map created in 2004.

The vegetation map was developed through on-screen digitizing of available black and white digital ortho-photographs from 1984 and 1999. The photos were compiled into a GIS with a standard set of ancillary layers provided by the park service (boundaries, roads, facilities, etc.). Using the vegetation classification as the foundation for the map legend, map units were defined

with respect to interpretable patterns in the photography, and with an eye to those patterns that would be most important in natural and cultural resources management within the park. The map included 19 map classes and covered a total of 278.13 ha.

The AA for this project was completed as part of the National Park Service's (NPS) Vegetation Inventory Program and NPS protocols for accuracy assessment were used to develop the sample design (Chris Lea Pers. Comm.) and conduct the analysis. The sample design utilized a minimum mapping unit (MMU) of 0.25 ha and a 15 m internal buffer on all polygon boundaries. In accord with NPS guidelines, between 5 and 30 sample points were assigned to each map class based on area and frequency of the class in the map. The analysis followed the methods proscribed by Lee and Curtis (2010).

Three map classes describing barren and land use areas were excluded from the AA, and an additional 4 map classes were not sampled due to insufficient area and/or frequency given the 0.1- 0.25 ha MMU. The remaining 12 map classes in the map legend were selected for random sampling. Based on the area and frequency of each class within the map, 141 sample points were located across the 12 vegetated map classes.

Field data was collected from the 141 random sample point locations over a five day period from September 21st through September 25th, 2009. Field data was collected using an Archer electronic data logger with a Hemisphere Global Positioning System receiver. The ecologist collecting the data used a field key to the vegetation associations provided by NHNM and had a copy of the map and an aerial photo of the site with the sample points superimposed. The ecologist did not have the list of map classes and was unaware of the map class attribute for all polygons. The resultant vegetation type keyed to by the ecologist was translated to the map class and recorded as the vegetation at that point. The data was collected directly to the electronic field form contained in the handheld data logger unit.

Data analysis followed the methodology provided in *Thematic Accuracy Assessment Procedures* (Lea and Curtis 2010), the NPS's official methodology on completing accuracy assessment of vegetation inventory projects. The methodology analyzes the overall accuracy, the user's and producer's accuracies, and the Kappa statistic as an estimate of chance agreement. The AA calculations were completed in an MS Excel workbook programmed by the NPS with spreadsheets to enter data and complete the various analyses.

The initial accuracy assessment had an overall accuracy of 44.2% with upper and lower 90% confidence intervals of 49.5% and 39.0%, respectively. The analysis produced a kappa index of 37.7%, with upper and lower 90% confidence intervals of 45.7% and 29.7%, respectively.

After the initial accuracy assessment was completed, map classes with higher error proportions were reviewed for possible aggregation. Ecologically similar classes that appeared to be confused with one and another were combined into a new thematically coarser class. The aggregation of low accuracy classes produced revised sample and population contingency tables and improved overall accuracy.

The aggregated classes include 1) those dominated by blue grama grass (*Bouteloua gracilis*), 2) those associated with the disturbance of old trails, and 3) those in disturbed areas dominated by

early successional (ruderal) species. Overall accuracy rose from 44% for the original map legend to 78.7% for the new legend with the aggregated classes.

Introduction

To aid in the management of the natural and cultural resources of Fort Union National Monument, Natural Heritage New Mexico (NHNM) has conducted a vegetation survey and produced a detailed vegetation map for the site. The survey included the development of a comprehensive plant species list along with a classification of vegetation communities of the park based on the National Vegetation Classification System (Grossman et al. 1998). The legend for the map is based on a vegetation classification with modifications for special features of the monument. The map was developed using available digital ortho-photography and ground checking, and is designed for use at the 1:6,000 scale, with a minimum mapping unit of size 0.10 ha. The species list and map form the foundation of a baseline inventory of plant resources of the monument, and were developed in concert with the guidelines of the National Park Service's Inventory and Monitoring Program to aid in network-wide park natural resource management.

Study Area

Fort Union National Monument is located in northeast New Mexico, approximately 10 miles northwest of Watrous and Valmora in Mora County (Figure 1). The monument comprises 721 acres (292 ha), and was established in 1956 to preserve the remains of Fort Union, a complex of three historical forts established beginning in 1851 along the Mountain route of the Santa Fe Trail. The fort was abandoned in 1891, but the previous 40 years brought extensive changes to landscape as the fort became a focal point for not only military activities but also trade and agriculture in the Mora Valley and the region (Harrison and Ivey 1993; Schackel 1983). Following abandonment, the land reverted to general rangeland use up until the site was donated by the Fort Union Ranch to a local preservation society and then to the National Park Service. Since that time, the park has been exclosed from livestock to protect the cultural resources as well as improve range conditions.

The climate of Fort Union National Monument is semi-arid, with an average rainfall of 16.70 in (424 mm) and a mean annual temperature of 49.3°F (9.61°C). The majority of the precipitation (70%) falls during the summer "monsoon" rainy season (May through September), primarily derived from frontal storms off the Gulf of Mexico and to a limited degree the Gulf of California (Table 1; Figure 2). The remainder of precipitation comes in the form of rain and snow from storms out of the west. Seasonal temperature ranges can be extreme (Table 2), with daily fluxes of 30°F (16.8°C) or more. This, in combination with low rainfall, generates a semi-arid, continental climate for the monument. With the exception of June 2000, summer monsoon rainfall during the period of sampling between 2000 and 2002 was significantly below normal, which was in keeping with regional drought conditions (Table 3).

The monument is located in a wide valley of the lower Wolf Creek watershed, a tributary of the Mora River. Elevations range from approximately 6,700 to 6,840 ft. (2,040 to 2,085 m). There are two units to the monument. The largest comprises 637 acres and lies to the east of the creek and upslope along a broad alluvial fan piedmont that extends to the base of the Turkey Mountains. This unit houses the park headquarters and the ruins of the "Star Fort" and "Third Fort," and was the focus of the heaviest usage during the active days of the fort. This gentle terrain is primarily broken by old trails and arroyos that are artifacts of the old Santa Fe Trail

system that converged at the forts. While the creek proper lies outside the boundaries of the units and within the Fort Union Ranch, there are small spring and seepage areas associated with the relatively steep slope that leads down to the creek bottom.

The smaller unit of 83.6 acres lies to the west of the creek up against a bluff that is an extension of Black Mesa. This unit sits on a short piedmont slope that leads down to the creek to the east, but it also contains a small amount of granitic rock outcrop along its western edge against the base of the mesa. This is the site of the "First Fort" established in 1851, which later became an arsenal site after the building of the Third Fort on the opposite slope. Hence, this smaller site also carries the legacy of heavy historical use that is reflected in the vegetation patterns we see today.

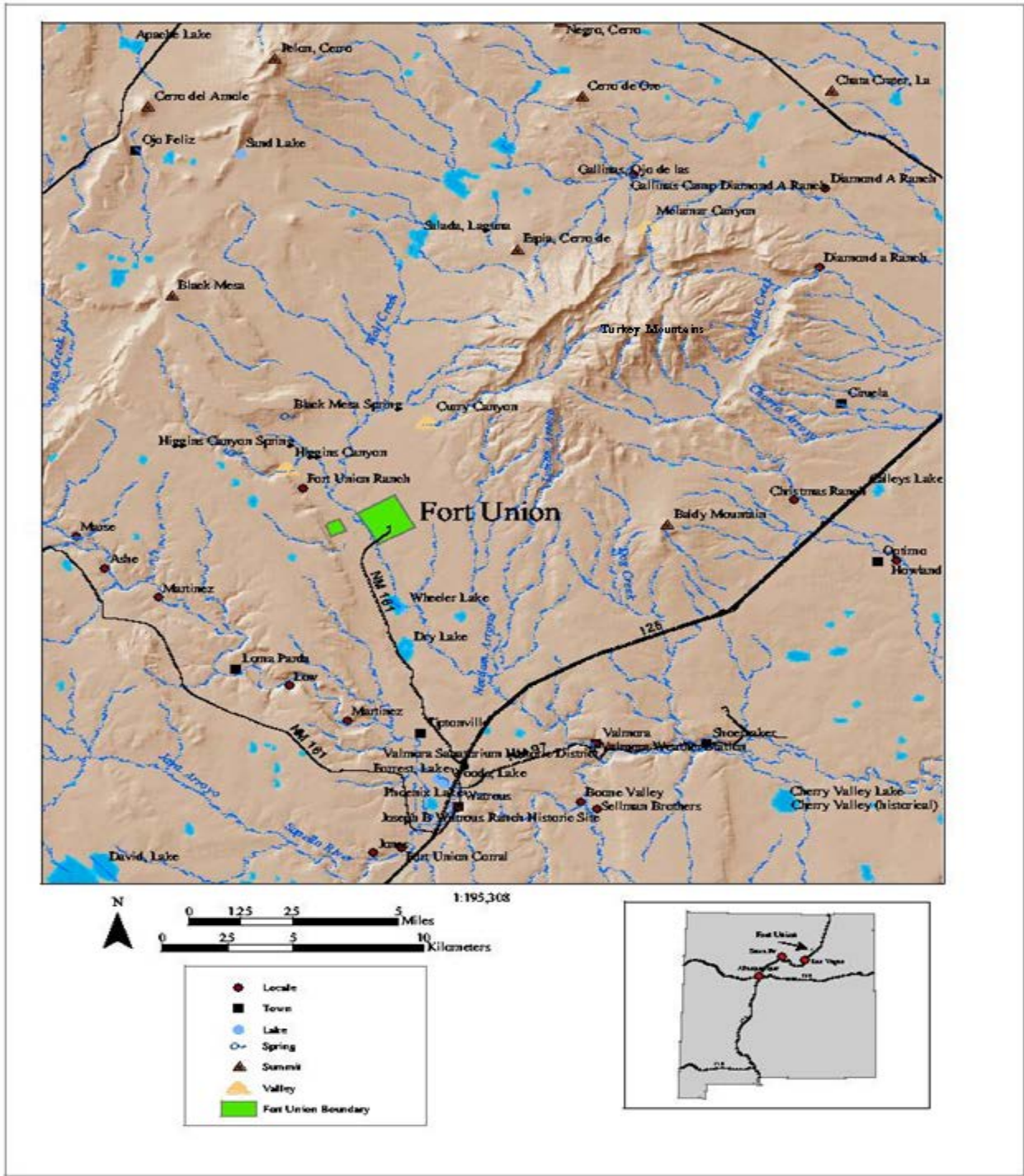


Figure 1. Location of Fort Union National Monument northeast of Las Vegas, NM, near Watrous and Valmora.

Table 1. Seasonal temperature summary for Valmora, NM, approximately 10 miles east of Fort Union National Monument. Period of record is from 1917 through 2003 at 6,310 ft (source: Western Regional Climate Center web page <http://www.wrcc.dri.edu/>).

	Monthly Ave			Daily Extremes				Monthly Extremes				Max Temp		Min Temp	
	Max.	Min.	Mean	High	Date	Low	Date	Highest Mean	Year	Lowest Mean	Year	>= 90 F	<= 32 F	<= 32 F	<= 0 F
	F	F	F	F	yyyy/mm/dd	F	yyyy/mm/dd	F	-	F	-	# Days	# Days	# Days	# Days
Annual	66.3	32.4	49.3	101	1963/07/24	-35	1963/01/13	52.1	34	47.4	61	14.2	8.7	183.6	6.1
Winter	50.0	15.7	32.8	82	1964/12/24	-35	1963/01/13	38.8	20	27.6	44	0.0	6.6	87.6	5.4
Spring	64.0	30.6	47.3	92	1996/05/17	-19	1948/03/05	52.4	89	42.8	98	0.2	1.1	51.1	0.3
Summer	83.0	50.6	66.8	101	1963/07/24	30	1919/06/01	70.5	22	62.8	40	13.3	0.0	0.1	0.0
Fall	67.9	32.8	50.4	94	1922/10/03	-13	1952/11/26	54.2	21	46.1	96	0.7	1.0	44.8	0.3

Table 2. Seasonal precipitation summary for Valmora, NM, approximately 10 miles east of Fort Union National Monument. Period of record is from 1917 through 2003 at 6,310 ft (source: Western Regional Climate Center web page <http://www.wrcc.dri.edu/>).

	Precipitation											Total Snowfall		
	Mean	High	Year	Low	Year	1 Day Max.	Date	>= 0.01 in.	>= 0.10 in.	>= 0.50 in.	>= 1.00 in.	Mean	High	Year
	in.	in.	-	in.	-	in.	yyyy/mm/dd	# Days	# Days	# Days	# Days	in.	in.	--
Annual	16.70	27.22	19	6.56	56	4.73	1965/06/15	58	38	10	3	22.9	75.8	87
Winter	1.30	4.06	87	0.09	37	1.02	1944/12/26	7	4	1	0	12.9	49.7	87
Spring	3.54	11.00	19	0.00	102	3.20	1955/05/19	12	8	2	1	6.9	49.0	58
Summer	8.15	14.80	91	3.50	102	4.73	1965/06/15	26	18	5	2	0.0	0.0	48
Fall	3.70	10.71	42	0.00	92	4.46	1942/09/01	12	8	2	1	3.0	33.0	84

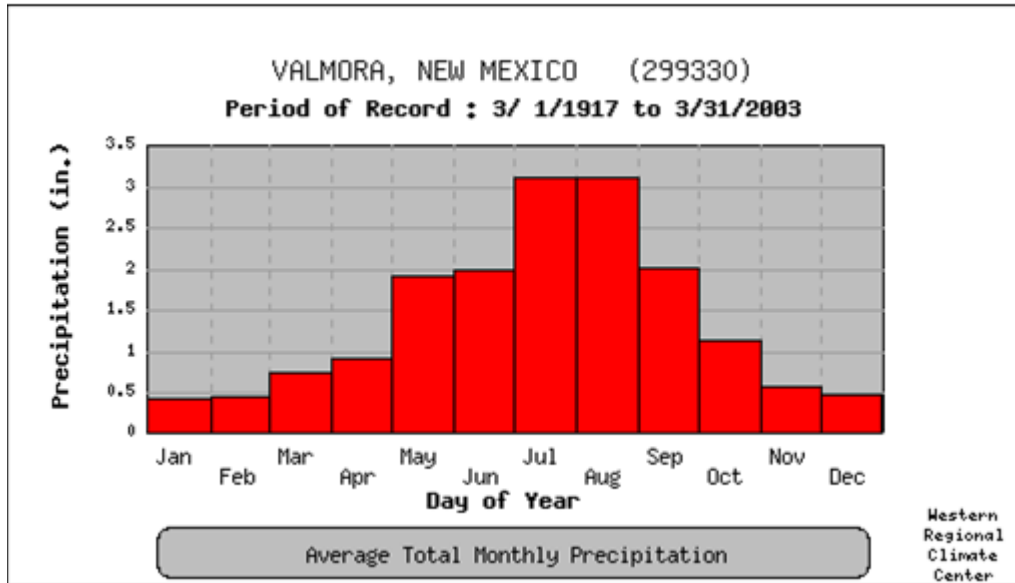


Figure 2. Monthly average precipitation at Valmora, NM, approximately 10 miles east of Fort Union National Monument. Period of record is from 1917 through 2003 (station 299330). Source: Western Regional Climate Center at <http://www.wrcc.dri.edu/>.

Table 3. Monthly precipitation (inches) for Valmora, NM, 10 miles east of Fort Union National Monument, during the vegetation sampling period of 2000-2002, and the long term mean over the period of record from 1917 through 2003 (source :Western Regional Climate Center web page <http://www.wrcc.dri.edu/>).

Year	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Total
2000	0.5	0	1.51	0	0	3.09	0.32	2.05	0.15	4.49	0.57	0.6	10.19
2001	1.75	0.3	2.47	0.08	1.36	1.55	0.88	1.26	0.23	0.3	0.1	0.1	9.02
2002	0.53	0.05	0	0	0	1.6	1.44	0.46	3.44	1.6	0.13	0.5	9.75
MEAN	0.42	0.43	0.75	0.91	1.88	1.94	3.11	3.1	2.01	1.13	0.57	0.46	16.73
YRS	79	82	82	82	82	81	83	81	81	81	80	83	64

Flora and Vegetation

Previous information on the flora and botany of Fort Union is limited. Schackel (1983) presented a review of the historical vegetation of the park as documented in the written and photographic record. She also provided an initial description of the modern dominant vegetation communities in the context of two Soil Conservation Service-defined range sites. The predominant range site was "loamy upland" dominated by blue grama grass (*Bouteloua gracilis*) with varying degrees of codominance with squirreltail (*Elymus elymoides*) and scattered western wheatgrass (*Pascopyrum smithii*), sideoats grama (*Bouteloua curtipendula*), and galleta (*Pleuraphis jamesii*). She also identified a "shallow upland" range site dominated by sideoats grama, blue grama, and little bluestem (*Schizachyrium scoparium*). She concluded that, while past land uses had had a significant impact on vegetation composition, with park protection the vegetation had recovered much of its original composition and abundance.

In addition to the work of Schackel (1983), an informal checklist of the flora of the park was compiled by Mary Whitmore (New Mexico Native Plant Society). She listed 103 vascular plant species, but whether these were vouchered is not known. Additional information on the natural resources is provided by Zhu (1992).

Materials and Methods

Vegetation Survey

Sampling

Over the course of three summer seasons, from 2000 through 2002, a flora survey of the monument was conducted. The floral survey consisted of comprehensive on-foot searches of all habitats found in both park units. Voucher collections of species were taken and identifications later confirmed using the materials at the herbarium of the Museum of Southwestern Biology at the University of New Mexico.

In addition to the floral survey, a series of quantitative plots and mapping points were established in homogeneous stands of vegetation and were used to classify the various plant associations found in the park. Plots were standard NHPM plots that were usually 400 m² and square, with other sizes occasionally used to fit the structure of a community, especially along drainages where vegetation stands conform to the channel shape. A list of all vascular plant species, stratified by life form (tree, shrub, subshrub, grass and forb layers) was compiled for each plot and aerial cover determined for each species using a modified Domin-Krajina Scale (Table 3). In addition, several site attributes were recorded including slope percent, aspect, slope shape, surface rock type, and ground cover (percent rock, gravel, bare soil and litter), along with narratives on species composition and site conditions. Besides the eight vegetation plots, 19 abbreviated mapping points were collected where only the dominants and their abundance were recorded. All plot locations were established with handheld Garmin GPS units and determined from a raw running average of one minute or more. Accuracy is estimated to be +/- 10 m or less (see Data Addendum for examples of sampling forms and detailed survey methods). All vegetation and site data were entered into a Microsoft Access 2000 database and quality controlled through error checking computer routines and manual read-backs. The computerized ASCII dataset and database are provided on a separate data CD.

Table 4. Modified Domin-Krajina Vegetation Cover Scale from Mueller-Dombois and Ellenberg (1974). Cover Class is the scalar value assigned in the field; Percent Canopy Cover is the range of cover the class represents; m²/ 400 m² is the actual area represented by the cover class within the 400 m² plot; and Midpoint % Cover is the midpoint canopy cover value used in data analysis.

Cover Class	Percent Canopy Cover	m ² /400 m ²	Midpoint % Cover
+0	[Undefined]	[Outside plot]	[0.001]
+	< .05	<0.04 m	0.01
1	< 0.1	≥ 0.04 & < 0.5	0.05
2	< 1	≥ 0.5 & < 4	0.5
3	1 – 4	≥ 5 & < 20	2.5
4	5 – 10	≥ 20 & < 40	7.5
5	10 - 25	≥ 40 & <100	17.5
6	25 - 33	≥ 100 & <132	29.0
7	33 - 50	≥ 132 & <200	41.5
8	50 - 75	≥ 200 & <300	62.5
9	> 75	≥ 300 m	87.5

Vegetation Analysis

The vegetation plots were classified into plant associations according to the National Vegetation Classification (Grossman et al. 1998) as modified for use in New Mexico (Table 4). In general, each plot was classified into an Alliance based on dominant or indicator species, and then to a particular Plant Association (PA) based on codominance and/or other groups of differential species. Phases of associations were assigned as necessary to further define the character of the plant community. Since the National Vegetation Classification (NVC) is intended to be part of a universal international system, it, by design, lacks regional categories such as "Great Plains Grassland" or "Rocky Mountain Pinyon-Juniper Woodland," which are part of regional and state classifications such as Brown et al. (1998), Dick-Peddie et al. (1993) or the U.S. Fish and Wildlife Gap Analysis Project classification for New Mexico (Thompson et al. 1996). These regional "biomes" or "zones" are essentially floristically based and can be very useful for general analysis and planning. They conceptually reflect regional knowledge of broad vegetation types and serve as effective categories for communication among scientists, managers and the public in the Southwest. Recently, a new national classification of "ecological systems" has been developed by NatureServe to help addresses these regional entities (NatureServe 2003). Accordingly, NHNM has also attempted to incorporate the regional concepts of vegetation in the development of a comprehensive state classification. The state system keeps the alliance and association levels of the national classification but attempts to integrate regional formation and biome concepts from the above authors plus the NHNM wetland classification of Muldavin et al. (2000).

The plant associations are the fundamental unit of the classification. Ecologists use the concept of plant association to help describe and recognize patterns in the way vegetation occurs in the landscape. By grouping land areas based on the ability to support similar associations, general management observations and recommendations can be made for each grouping. In the past 30 years, resource managers have found that the classification of vegetation into plant associations

has provided insight and the ability to predict vegetation changes in response to various disturbance processes. In addition, plant associations are used to define map unit components in the mapping process, providing the information linkage between vegetation spatial distribution and its ecology.

Table 5. National Vegetation Classification hierarchy for terrestrial vegetation following the FGDC (2008) standard.

Level	Level name	Criteria	Example
Upper levels			
L1	Formation Class	Broad combinations of general dominant growth forms that are adapted to basic temperature (energy budget), moisture, and/or substrate or aquatic conditions.	Mesomorphic Shrub and Herb Vegetation (Shrubland and Grassland)
L2	Formation Subclass	Combinations of general dominant and diagnostic growth forms that reflect global macroclimatic factors driven primarily by latitude and continental position, or that reflect overriding substrate or aquatic conditions.	Temperate and Boreal Shrub and Herb Vegetation (Temperate and Boreal Shrubland & Grassland)
L3	Formation	Combinations of dominant and diagnostic growth forms that reflect global macroclimatic factors as modified by altitude, seasonality of precipitation, substrates, and hydrologic conditions.	Temperate Shrub and Herb Vegetation (Temperate Shrubland & Grassland)
Mid levels			
L4	Division	Combinations of dominant and diagnostic growth forms and a broad set of diagnostic plant taxa that reflect biogeographic differences in composition and continental differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	<i>Andropogon – Stipa – Bouteloua</i> Grassland & Shrubland Division (North American Great Plains Grassland & Shrubland)
L5	Macrogroup	Combinations of moderate sets of diagnostic plant species and diagnostic growth forms that reflect biogeographic differences in composition and subcontinental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes.	<i>Andropogon gerardii – Schizachyrium scoparium – Sorghastrum nutans</i> Grassland & Shrubland Macrogroup (Great Plains Tall Grassland & Shrubland)
L6	Group	Combinations of relatively narrow sets of diagnostic plant species (including dominants and co-dominants), broadly similar composition, and diagnostic growth forms that reflect biogeographic differences in composition and sub-continental to regional differences in mesoclimate, geology, substrates, hydrology, and disturbance regimes	<i>Andropogon gerardii – Sporobolus heterolepis</i> Grassland Group (Great Plains Mesic Tallgrass Prairie)
Lower levels			
L7	Alliance	Diagnostic species, including some from the dominant growth form or layer, and moderately similar composition that reflect regional to subregional climate substrates, hydrology, moisture/nutrient factors, and disturbance regimes.	<i>Andropogon gerardii – (Calamagrostis canadensis – Panicum virgatum)</i> Herbaceous Alliance (Wet-mesic Tallgrass Prairie)

L8	Association	Diagnostic species, usually from multiple growth forms or layers, and more narrowly similar composition that reflect topo-edaphic climate, substrates, hydrology, and disturbance regimes.	<i>Andropogon gerardii</i> – <i>Panicum virgatum</i> – <i>Helianthus grosseserratus</i> Herbaceous Vegetation (Central Wet-mesic Tallgrass Prairie)
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Map Development

The vegetation map was developed through aerial photo interpretation of available black and white digital ortho-photographs from 1984 and 1999. The photos were compiled into a GIS with a standard set of ancillary layers provided by the park service (boundaries, roads, facilities, etc.). Using the vegetation classification as the foundation for the map legend, map units were defined with respect to interpretable patterns in the photography, and with an eye to those patterns that would be most important in natural and cultural resources management within the park.

The map was produced through direct screen digitizing using ArcGIS software. Most interpretation was done at 1:3,000 scale with the intent of operational use at 1:6,000 scale. As a general guideline, the minimum map unit delineation size was 0.25 ha, but some polygons approached 0.1 ha. Given the small size of the monument, an independent, randomized validation would have been impossible. The map was simply error checked on foot in 2003 and 2004, and revised accordingly.

Accuracy Assessment

Sample Design

NPS protocols for AA provide guidance for including and excluding various map classes, defining the observation area (minimum mapping unit), edge buffering of polygon boundaries, and defining the number and placement of sample points required. Sample design for this project was provided by Chris Lea, Program Ecologist with the NPS Vegetation Inventory Program. In accordance with NPS program methodology, the project utilized a MMU of 0.25 ha and a 15 m internal buffer on the edge of all polygon boundaries. In accord with NPS methodology, between 5 and 30 sample points were assigned to each map class based on area and frequency of the class in the map.

The final map legend provided by NMNHP included 19 map classes numbered 1 to 21 (numbers 14 and 16 were not used) and covered a total of 278.13 ha. Three map classes describing barren and land use areas were excluded from the accuracy assessment; these are map classes 17 (modern road, facilities, planted), 18 (water), and 19 (bare ground). An additional 4 map classes were not sampled due to insufficient area and/or frequency given the 0.25 ha MMU; these included 5 (little bluestem-blue grama grassland), 8 (wavyleaf oak montane scrub-pinyon juniper woodland), 9 (willow riparian shrubland), and 13 (narrowleaf cottonwood riparian woodland). The remaining 12 map classes in the map legend were selected for random sampling (Table 10).

The methodology recommends the number of plots needed per map class based on the area of each class within the map. For the FOUN project, 141 sample points were allocated across the 12 vegetated map classes selected for random sampling (Figure 6). The total number of sample points was based on the area and frequency of each map class; some classes received fewer than the maximum number of 30 plots due to their small size. The area and number of map units in each map class is listed in Table 3.

An ArcGIS map project was created to include the imagery, sample points and map class polygons. A stratified random distribution of sample points was placed on the map using the ArcMap extension Hawth's Tools. Point placement within the map classes was based on a minimum map unit of 0.25 ha and all polygon edges were treated with a 15 m internal buffer.

Table 10. List of FOUN Map Classes Selected for Random Sampling

MC#	Map Class Name	Acres	Ha	Map Units
1	Blue Grama/Fringed Sage Grassland	127.7	51.7	53
2	Blue Grama-Mixed Grassland	105.0	42.5	56
3	Western Wheatgrass-Hairy Grama Old Trail Grassland	91.6	37.1	34
4	Blue Grama-Mixed Grassland/Ruderal Vegetation	157.8	63.8	74
6	Arroyo Old Trail Grassland/Ruderal Vegetation	13.4	5.4	2
7	Herbaceous Wetland	9.7	3.9	7
10	Disturbed Grassland/Ruderal Vegetation - Adobe Field	37.5	15.2	5
11	Disturbed Grassland/Ruderal Vegetation- Old Fort Undeveloped	57.3	23.2	24
12	Disturbed Grassland /Ruderal Vegetation - Old Fort Restored	38.3	15.5	4
15	Disturbed Grassland	26.0	10.5	8
20	Sleepygrass/Blue Grama Grassland	4.2	1.7	1
21	Ruderal Vegetation/Bare Ground	18.9	7.6	44
Total		687.4	278.1	353

Field Data Collection

Field data from the 141 randomly located sample point locations was collected over a five day period from September 21st through September 25th, 2009. Field data was collected using an Archer electronic data logger with a Hemisphere Global Positioning System receiver. The data logger uses the Windows Mobile operating system software with Spatial Data Technologies Carto-Pac database and mapping software. All data files are in projected coordinates in NAD83 UTM Zone 13N datum.

A field key to the vegetation associations was provided by NHHM and was used to key vegetation at each of the field sample point locations. The ecologist collecting the data had a copy of the map and sample points superimposed on the aerial photo of the site. The ecologist did not have the list of map classes and was unaware of the map class attribute for all polygons. The resultant vegetation type keyed to by the ecologist was translated to the map class and recorded as the vegetation at that point. The data was collected directly to the electronic field form contained in the handheld data logger unit.

Data Analysis

The FOUN data analysis was completed following the methodology provided in Thematic Accuracy Assessment Procedures (Lea and Curtis 2010), which provides the NPS official methodology on completing accuracy assessment of vegetation inventory projects. The methodology utilizes an analysis of the overall accuracy, the user's and producer's accuracies, and estimates of the chance agreement and Kappa statistic. The AA calculations can be completed in an MS Excel workbook with preprogrammed spreadsheets for the various analyses.

The Excel workbook provided by the NPS as a companion to Lea and Curtis (2010) includes formulas to create a sample contingency table and a population contingency table, estimate overall error, the Kappa coefficient, and estimate producer's and user's error for each map class.

Prior to analysis, the collected data were output from the Archer data collection unit and saved as an MS Access database file. This file was reviewed for accuracy and completeness and exported to an ESRI shapefile format for use in the ArcMap GIS, and to a MS Excel workbook for use in the NPS AA spreadsheet. Within ArcMap, the total area of the map and the proportion of the map area in each map class were calculated. A spatial join was completed between the vegetation polygon layer (sample data) and the field sample point data (reference data) to create a sample contingency table.

The map class descriptors, map class areas, and sample data from the ArcMap sample contingency table were then entered onto the appropriate spreadsheet within the preprogrammed NPS AA workbook. The different spreadsheets automatically calculate the accuracy measures for the user, and provide the ability to build report output from the results.

The sample contingency table provides counts of the agreement and disagreement between the reference data collected in the field and the mapped values (referred to as the true values) of the individual map units sampled within each map class. The population contingency table provides the estimated proportion of the total sampled area represented by each of the map class combinations (true vs. reference). The sum in each column of the population contingency table is an estimate of the proportion of the total sampled area that is truly that map class. The following equations are taken from Lea and Curtis (2010) and were used to calculate the measures of accuracy for FOUN. For detailed discussion of the equations used to calculate measures of accuracy for NPS vegetation inventory projects see Lea and Curtis (2010).

The overall accuracy of the map is defined as the proportion of the total map area that is correctly mapped, or the sum of the area of the map units correctly classified divided by the total map area:

$$\text{Overall Accuracy} = \left(\sum_{i=1}^n P_{ij} \right) / P_{++}$$

where n is the number of map classes in the AA, i are the rows representing mapped classes (sample data), J are columns representing observed classes on the ground (reference data). P is the proportion of map unit area, and P₊₊ is the total map inference area. This formula is simply the sum of the area of map units in agreement divided by the total area of all map units.

User's accuracy is the probability that an area classified as map class i, is truly map class i on the ground. The user's accuracy is calculated as:

$$\text{User's Accuracy} = P_{ii} / P_{i+}$$

where i is the sample map class, P_{ii} is the proportion of map class area in agreement in row I, and P_{i+} is the total area of all samples of i in the map. This formula is the area of correct observations of class i divided by the sum of the area for the row.

Producer's accuracy is the probability that an area of map class j on the ground is actually classified as class J on the map. The producer's accuracy is calculated as:

$$\text{Producer's Accuracy} = P_{jj} / P_{+j}$$

where j is the reference data map class, P_{jJ} is the proportion of map class area in agreement in column J , and P_{+J} is the total of area in column J . This formula is the area of correct observations of class j divided by the sum of the area for the column.

The kappa statistic is used to provide a measure of agreement between two observations (model prediction and reality) or in this case between the map prediction and the field assessment (Congalton 1991). The kappa statistic is scaled from 0 to 1, and allows the user to determine if the values contained in an error matrix represent a result better than random (Lea and Curtis 2010). The proportion of chance agreement if mapping is completely random is defined as the sum of the product of the corresponding row and column sums (P_{i+} and P_{+J} , respectively). The kappa statistic is computed as:

$$kappa = \frac{Overall\ Accuracy - \sum_{i=J}^n P_{i+}P_{+J}}{1 - \sum_{i=J}^n P_{i+}P_{+J}}$$

where n is the total number of classes in the matrix, $i+$ is the total for row i , and $+J$ is the total for column J .

Classification Aggregation

Within the companion workbook provided by NPS are worksheets for calculating sample and population contingency tables for aggregated map classes. The values entered into those sheets are the sums of the estimates of the population proportion and variances from the original population contingency and variance tables.

After the initial accuracy assessment was completed, map classes with higher error proportions were reviewed for possible aggregation. Ecologically similar classes that appeared to be confused with one and another were combined into a new thematically coarser class. The aggregation of low accuracy classes produced revised sample and population contingency tables and an improved overall accuracy

Results

Vegetation Survey

Floral Survey

A total of 142 taxa were identified over the three year period of sampling (Appendix A). For 123 of the taxa, 184 plant voucher specimens were collected to confirm field identifications. The voucher collection was then deposited and databased under the Fort Union National Monument designation at the University of New Mexico Herbarium. Specimens were identified to the lowest level possible given the material at hand (120 to species or lower) and with nomenclature following the PLANTS database (USDA-NRCS 2002). An additional 18 common species were not vouchered, but were observed as part of the vegetation plot record. Those species that were both vouchered and that occurred on the Native Plant Society list of Mary Whitman are indicated. In addition, there are 50 species on her list that have not been confirmed (Appendix Table A3).

Vegetation Classification

Sixteen plant associations (PA) among 11 alliances were identified for Fort Union National Monument (Table 5). Of these, eight were grassland associations belonging to the Western Great Plains Shortgrass Prairie Alliance Group (Figure 5). The most abundant grass was blue grama (*Bouteloua gracilis*), the characteristic species of the short grass prairie from Canada to Mexico. The most common associations on the monument were the Fringed Sage / Blue Grama (*Artemisia frigida* / *Bouteloua gracilis*) and the Blue Grama - Purple Threeawn (*Bouteloua gracilis*-*Aristida purpurea*). The former was previously reported for New Mexico by Dick-Peddie et al. (1993), and provisionally in Colorado (NatureServe 2002), but the record from Fort Union represents the first one in the NHNM database (how common the association is in New Mexico needs further study). With its preponderance of purple threeawn, the Blue Grama - Purple Threeawn PA is indicative of the long disturbance history of the monument. The Soapweed Yucca / Blue Grama grassland (*Yucca glauca* / *Bouteloua gracilis* PA), a common association elsewhere on the prairie in New Mexico, was found only in scattered patches (it too is sometimes indicative of past disturbance, particularly when soapweed yucca abundance is exceptionally high).



Figure 3. Whole leaf Indian paintbrush (*Castilleja integra*) is typical of the wide variety of grassland, woodland, and riparian associates found at FOUN. (Photo: Geoff Carpenter).

The disturbance history of the fort is also reflected in the lasting imprint of the numerous main and side trails associated with the Santa Fe Trail. The trails have a distinctive set of associations from those of the surrounding grasslands. These include the Western Wheatgrass - Blue Grama (*Pascopyrum smithii* - *Bouteloua gracilis*), Hairy Grama / Fringed Sage (*Artemisia frigida* / *Bouteloua hirsuta*), and Fringed Sage / Sleepygrass (*Artemisia frigida* / *Achnatherum robustum*) PA's. Hairy grama is often associated with more compacted soils, while western wheatgrass and sleepygrass are associated with more mesic conditions reflecting a concentration of water in the trails during rainfall events. This has in turn led to some trails degrading through water erosion into arroyos that are dominated by combinations of western wheatgrass grasslands and ruderal (disturbed or weedy) herbaceous vegetation dominated by the Weakleaf Bur Ragweed - Lacy Tansyaster (*Ambrosia confertiflora* - *Machaeranthera pinnatifida*) PA along with areas of bare ground. The Weakleaf Bur Ragweed - Lacy Tansyaster PA is also commonly intermixed in the grasslands, particularly in areas recently dug up by Botta's pocket gophers (*Thomomys bottae*), or in sites heavily disturbed by past uses such as buildings, corrals, and adobe-making ditches.

There is a small occurrence of Little Bluestem - Sideoats Grama (*Schizachyrium scoparium*-*Bouteloua curtipendula*) grassland in the disjunct Old Fort unit to the west. This common prairie element is restricted here to a lower toeslope of the Black Mesa escarpment that just enters the park on its western edge. It is intermixed with the only representatives of Rocky Mountain woodland and shrublands found on the monument, i.e., Pinyon Pine / Blue Grama (*Pinus edulis*/*Bouteloua gracilis*) PA and the Wavyleaf Oak/Western Sedge Shrubland (*Quercus x pauciloba* / *Carex occidentalis*) PA. The pinyon woodland association was only a fragment representative of types that are more common upslope and outside of the monument, and in the region. The Wavyleaf Oak / Western Sedge Shrubland occupies a granitic outcrop that forms the backdrop for the Old Fort just inside the fence line. Both associations are common in northern New Mexico.

Riparian woodlands and shrublands, and herbaceous wetlands make up the remaining natural vegetation communities on the monument. Coyote Willow / Baltic Rush (*Salix exigua* / *Juncus arcticus* var. *balticus*) shrubland has become established along with a small patch of Narrowleaf Cottonwood / Coyote Willow (*Populus angustifolia* / *Salix exigua*) woodland in arroyo bottoms along the western edge of the main park unit. These riparian communities possibly become established naturally following the building of erosion control structures (check dams) in the arroyos meant to slow degradation. There is also a small patch of broadleaf cattail (*Typha latifolia*) wetland in the main arroyo. All of these arroyos appear to be traces of historic trails associated with the Santa Fe Trail. Narrowleaf cottonwood stands have also become established relatively recently around the wastewater ponds and near the freshwater storage tank in the southwestern and northeastern corners of the park, respectively.

Outside of the arroyos are wetlands associated with seeps and springs along the lower western slope of the monument. These are characterized by the Wood's Rose / Baltic Rush (*Rosa woodsii* / *Juncus arcticus* var. *balticus*) PA. Besides Baltic rush and wood's rose, these scattered wetland sites can have a wide variety of species (e.g., switchgrass (*Panicum virgatum*), Carruth's sagewort (*Artemisia carruthii*), whorled milkweed (*Asclepias subverticillata*), carelessweed (*Amaranthus palmeri*), many-flowered mentzelia (*Mentzelia multiflora*) among others) and are perhaps the most biologically diverse vegetation communities on the monument.



Figure 4. Western Great Plains Shortgrass Prairie grassland associations that are dominated by blue grama characterize the landscape of Fort Union National Monument. The grasslands extend westward from the Turkey Mountains (background) along a long piedmont slope leading to Wolf Creek (mid-ground), and eastward along a shorter slope (foreground) leading away from the Black Mesa to the west.

Table 6. A hierarchical plant association classification for the Fort Union National Monument (see Table 4 for hierarchical level definitions) . S = classification status where: 1 = provisional association (1 or 2 plots); 2 = provisional (2-4 plots), or 3 = established plant association (5 or more plots or well-documented elsewhere). N= number of project sample plots. Code=NatureServe database code (ELCODE). Map units refers to the vegetation map units or classes that the plant association is either a primary or a secondary component.

Classification level and name	S	N	Code	Map Units
1. Forest & Woodland				
1.C Temperate Forest				
1.C.2 Cool Temperate Forest				
1.C.2.c Western North America Scrub Woodland & Shrubland				
MG027. Rocky Mountain Pinyon - Juniper Woodland				
GP070. Southern Rocky Mountain Pinyon - Juniper Woodland				
<i>Pinus edulis</i> Woodland Alliance (in part)				
<i>Pinus edulis</i> – <i>Juniperus monosperma</i> / <i>Bouteloua gracilis</i> Woodland	1	1	CEGL002151	8
1.C.3 Temperate Flooded & Swamp Forest				
1.C.3.b Western North America Flooded & Swamp Forest				
MG034. Rocky Mountain and Great Basin Flooded & Swamp Forest				
G[tbd]. Rocky Mountain Subalpine - Montane Riparian Forest and Woodland				
<i>Populus angustifolia</i> Forest Alliance				
<i>Populus angustifolia</i> / <i>Salix exigua</i> Forest	1	1	CEGL000654.	13
1.C.3.c Western North America Warm Temperate Flooded & Swamp Forest				
MG036. Warm Desert Riparian, Flooded & Swamp Forest				
G[tbd]. Southwest Lowland Riparian Woodland and Shrubland				
<i>Salix exigua</i> Shrubland Alliance				
<i>Salix exigua</i> / <i>Juncus arcticus</i> Shrubland	3	1	CEGL001203	9, 13
<i>Rosa woodsii</i> Shrubland Alliance [provisional]				
<i>Rosa woodsii</i> / <i>Juncus arcticus</i> ssp. <i>balticus</i> Shrubland	3	1	Park Special	7
2 Shrubland & Grassland				
2.C Temperate & Boreal Shrubland & Grassland				
2.C.1 Temperate Grassland, Meadow & Shrubland				
2.C.1.a. Vancouverian & Rocky Mountain Grassland & Shrubland				
GP094. Rocky Mountain Lower Montane - Foothill Shrubland				

Classification level and name	S	N	Code	Map Units
<i>Quercus xpauciloba</i> Shrubland Alliance				
<i>Quercus x pauciloba</i> / <i>Carex occidentalis</i> Shrubland	3	1	Park Special	8
2.C.1.b.Great Plains Grassland & Shrubland				
MG Great Plains Shortgrass Prairie and Shrubland				
G [tbd][Southwest Plains / Mesa Grassland]				
<i>Bouteloua gracilis</i> Shrub and Herbaceous Alliances (in part)				
<i>Artemisia frigida</i> / <i>Bouteloua gracilis</i> Dwarf-shrub Herbaceous Vegetation	2	4	CEGL002782	1, 2, 3, 4, 5, 10, 15, 20
<i>Bouteloua gracilis-Aristida purpurea</i> Herbaceous Vegetation	3	2	Park Special	4, 6, 10, 11, 12, 15, 21
<i>Yucca glauca</i> / <i>Bouteloua gracilis</i> Dwarf-shrub Herbaceous Vegetation			Park Special	(2)
<i>Bouteloua gracilis</i> [Monotypic] Herbaceous Vegetation	2	1	CEGL001760	Incidental
<i>Krascheninnikovia lanata</i> / <i>Bouteloua gracilis</i> Shrub Herbaceous Vegetation	1	1	CEGL001321	Incidental
<i>Bouteloua hirsuta</i> Herbaceous Alliance				
<i>Artemisia frigida</i> / <i>Bouteloua hirsuta</i> Dwarf-shrub Herbaceous Vegetation	2	1	Park Special	3
<i>Pascopyrum smithii</i> Herbaceous Alliance				
<i>Pascopyrum smithii</i> - <i>Bouteloua gracilis</i> Herbaceous Vegetation	1	2	CEGL001579	3, 6, 10, 11, 12, 21
<i>Schizachyrium scoparium</i> Herbaceous Alliance				
<i>Schizachyrium scoparium</i> - <i>Bouteloua curtipendula</i> Western Great Plains Herbaceous Vegetation	1	2	CEGL001594	5
<i>Achnatherum robustum</i> Herbaceous Alliance				
<i>Artemisia frigida</i> / <i>Achnatherum robustum</i> Dwarf-shrub Herbaceous Vegetation	3	1	Park Special	20
Gtbd [Southwest Plains - Mesa Ruderal Disturbance Vegetation]				
Ruderal Herbaceous Vegetation Alliance				
<i>Ambrosia confertiflora-Machaeranthera pinnatifida</i> Ruderal Herbaceous Vegetation	3	1	Park Special	6, 7, 10, 11, 12, 12
2.C.5 Temperate & Boreal Freshwater Marsh				
2.C.5.b Western North America Freshwater Marsh				
MG073. Western North America Freshwater Marsh				
G325. Great Plains Freshwater Marsh Group				
<i>Juncus arcticus</i> Herbaceous Alliance				
<i>Juncus arcticus</i> ssp. <i>balticus</i> / Monotypic Herbaceous Vegetation	1	1	CEGL001838	7
<i>Typha latifolia</i> Herbaceous Alliance				
<i>Typha latifolia</i> – [Monotype] Herbaceous	2	1	CEGL002389	7, 9

Classification level and name	S	N	Code	Map Units
6 Miscellaneous				
Sparsely Vegetated – Bare Ground	-	-	Park Special	6, 10, 12, 21

Vegetation Map

Using the vegetation classification as a foundation, we have developed a vegetation map containing 19 mapping units (Table 3). The map has been produced on a single sheet at the original target scale of 1:6,000. While the map can be projected at finer scales in a GIS, we would caution against application at finer scales because of the limits posed by spatial error (geometric correction error of the imagery). More importantly, even though the minimum map delineation is small at 0.1 ha, the focus should remain on the large patch pattern in any interpretation.

Table 7. Vegetation map units for the Fort Union National Monument Vegetation Map.

MU#	Map Unit	Acres	Ha
1	Blue Grama/Fringed Sage Grassland	127.7	51.7
2	Blue Grama-Mixed Grassland	105.0	42.5
3	Western Wheatgrass-Hairy Grama Old Trail Grassland	91.6	37.1
4	Blue Grama-Mixed Grassland/Ruderal Vegetation	157.8	63.8
5	Little Bluestem-Blue Grama Grassland	0.5	0.2
20	Sleepygrass/Blue Grama Grassland	4.2	1.7
7	Herbaceous Wetland	9.7	3.9
9	Willow Riparian Shrubland	1.7	0.7
13	Narrowleaf Cottonwood Riparian Woodland	0.7	0.3
8	Wavyleaf Oak Montane Scrub/Pinyon-Juniper Woodland	26.0	10.5
6	Arroyo Old Trail Grassland/Ruderal Vegetation	13.4	5.4
10	Disturbed Grassland/Ruderal Vegetation - Adobe Field	37.5	15.2
11	Disturbed Grassland/Ruderal Vegetation- Old Fort Undeveloped	57.3	23.2
12	Disturbed Grassland /Ruderal Vegetation - Old Fort Restored	38.3	15.5
15	Disturbed Grassland	26.0	10.5
21	Ruderal Vegetation/Bare Ground	18.9	7.6
19	Bare Ground	4.0	1.6
17	Modern Road, Facilities, and Planted Vegetation	24.0	9.7
18	Water	0.8	0.3
	Total	720.2	291.5

Accuracy Assessment

Field Data Collection

Vegetation at each of the 141 random sample point locations was keyed to the association and assigned to its appropriate map class. For associations without a one-to-one relationship to the map classes, information regarding the geographic location of the point or the cultural history of the point was considered to place the point within the most appropriate map class.

Data Analysis

The initial accuracy assessment had an overall accuracy of 44.2% with upper and lower 90% confidence intervals of 49.5% and 39.0%, respectively. The analysis produced a kappa index of 37.7%, with upper and lower 90% confidence intervals of 45.7% and 29.7%, respectively.

The user's and producer's accuracies by each map class with upper and lower 90% confidence intervals are presented in Table 11. The sample contingency table and associated statistics for the initial accuracy assessment are presented in Table 12. The population contingency table and its associated statistics for the initial accuracy assessment are presented in Table 13. In both the sample and population contingency tables the classes are ordered to locate mutually confused classes near to one another.

Table 11. User's and producer's accuracies by map class from the initial assessment (map class number code in parentheses)

Map Class	User's Accuracy	Lower 90% CI	Upper 90% CI
Arroyo Old Trail Grassland/Ruderal Vegetation (6)	0.0%	0.0%	0.0%
Blue Grama - Mixed Grassland/Ruderal Vegetation (4)	53.3%	36.7%	70.0%
Blue Grama-Mixed Grassland (2)	76.9%	61.4%	92.4%
Blue Grama/Fringed Sage Grassland (1)	20.0%	6.3%	33.7%
Disturbed Grassland/Ruderal Vegetation- Old Fort Undeveloped (11)	72.7%	46.1%	99.4%
Disturbed Grassland / Ruderal Vegetation - Old Fort Restored (12)	87.5%	62.0%	100.0%
Disturbed Grassland/Ruderal Vegetation - Adobe Field (10)	45.5%	16.2%	74.7%
Disturbed Grassland (15)	0.0%	0.0%	7.1%
Ruderal Vegetation/Bare Ground (21)	100.0%	83.3%	100.0%
Sleepygrass/Blue Grama Grassland (20)	0.0%	0.0%	25.0%
Herbaceous Wetland (7)	25.0%	0.0%	73.1%
Western Wheatgrass - Hairy Grama Old Trail Grassland (3)	0.0%	0.0%	5.6%

Map Class	Producer's Accuracy	Lower 90% CI	Upper 90% CI
Arroyo Old Trail Grassland/Ruderal Vegetation (6)	0.0%	0.0%	0.0%
Blue Grama - Mixed Grassland/Ruderal Vegetation (4)	47.9%	42.0%	53.8%
Blue Grama-Mixed Grassland (2)	44.6%	40.6%	48.6%
Blue Grama/Fringed Sage Grassland (1)	62.2%	58.8%	65.6%
Disturbed Grassland/Ruderal Vegetation- Old Fort Undeveloped (11)	34.9%	30.1%	39.6%
Disturbed Grassland / Ruderal Vegetation - Old Fort Restored (12)	100.0%	99.0%	100.0%
Disturbed Grassland/Ruderal Vegetation - Adobe Field (10)	76.4%	74.7%	78.1%
Disturbed Grassland (15)	0.0%	0.0%	0.0%
Ruderal Vegetation/Bare Ground (21)	50.2%	50.0%	50.4%
Sleepygrass/Blue Grama Grassland (20)	0.0%	0.0%	0.0%
Herbaceous Wetland (7)	100.0%	99.5%	100.0%
Western Wheatgrass - Hairy Grama Old Trail Grassland (3)	0.0%	0.0%	0.0%

Table 12. Sample Contingency Table for Initial Classification

Sample Data Map Class #	Reference Data Map Class #												ROW TOTAL (n _{i+})
	6	4	2	1	11	12	10	15	21	20	7	3	
6													0
4		16	2		9		1		2				30
2		4	20	2									26
1		4	18	6	2								30
11		2	1		8								11
12						7			1				8
10					5		5		1				11
15		4	1	2									7
21									3				3
20			2										2
7		1			2						1		4
3	6	3											9
COLUMN TOTAL (n_{+j})	6	34	44	10	26	7	6	0	7	0	1	0	141

Map Class	Map Class Name	
6	Arroyo Old Trail Grassland/Ruderal Vegetation	
4	Blue Grama - Mixed Grassland/Ruderal Vegetation	OVERALL ACCURACY (Pc): 44.2%
2	Blue Grama-Mixed Grassland	LOWER LIMIT, 90% CONFIDENCE INTERVAL: 39.0%
1	Blue Grama/Fringed Sage Grassland	UPPER LIMIT, 90% CONFIDENCE INTERVAL: 49.5%
11	Disturbed Grassland/Ruderal Vegetation- Old Fort Undeveloped	
12	Disturbed Grassland / Ruderal Vegetation - Old Fort Restored	KAPPA (K): 37.7%
10	Disturbed Grassland/Ruderal Vegetation - Adobe Field	LOWER LIMIT, 90% CONFIDENCE INTERVAL: 29.7%
15	Disturbed Grassland	UPPER LIMIT, 90% CONFIDENCE INTERVAL: 45.7%
21	Ruderal Vegetation/Bare Ground	
20	Sleepygrass/Blue Grama Grassland	
7	Herbaceous Wetland	
3	Western Wheatgrass - Hairy Grama Old Trail Grassland	

Table 13. Population Contingency Table for Initial Classification

Sample Data Map Class #	Reference Data Map Class #												USERS' ACCURACY (P _{J=X} i=X)	LOWER LIMIT, 90% CONF. INT	UPPER LIMIT, 90% CONF. INT	ROW TOTAL (p _{i+})	
	6	4	2	1	11	12	10	15	21	20	7	3					
6	0	0	0	0	0	0	0	0	0	0	0	0	0%	0%	0%	0	
4	0	0.122	0.015	0	0.069	0	0.008	0	0.015	0	0	0	53%	37%	70%	0.2296	
2	0	0.024	0.118	0.012	0	0	0	0	0	0	0	0	77%	61%	92%	0.1528	
1	0	0.025	0.111	0.037	0.012	0	0	0	0	0	0	0	20%	6%	34%	0.1858	
11	0	0.015	0.008	0	0.061	0	0	0	0	0	0	0	73%	46%	99%	0.0833	
12	0	0	0	0	0	0.049	0	0	0.007	0	0	0	88%	62%	100%	0.0557	
10	0	0	0	0	0.025	0	0.025	0	0.005	0	0	0	45%	16%	75%	0.0545	
15	0	0.022	0.005	0.011	0	0	0	0	0	0	0	0	0%	0%	0%	0.0379	
21	0	0	0	0	0	0	0	0	0.027	0	0	0	100%	83%	100%	0.0274	
20	0	0	0.006	0	0	0	0	0	0	0	0	0	0%	0%	0%	0.0061	
7	0	0.004	0	0	0.007	0	0	0	0	0	0.004	0	25%	0%	73%	0.0141	
3	0.089	0.044	0	0	0	0	0	0	0	0	0	0	0%	0%	0%	0.1333	
PRODUCERS' ACCURACY (P _{i=Y} J=Y)	0%	48%	45%	62%	35%	100%	76%	0%	50%	0%	100%	0%	OVERALL ACCURACY (P _c): 44.2% KAPPA (K): 37.7%				
LOWER LIMIT, 90% CONF. INT.	0%	42%	41%	59%	30%	99%	75%	0%	50%	0%	99%	0%					
UPPER LIMIT, 90% CONF. INT.	0%	54%	49%	66%	40%	100%	78%	0%	50%	0%	100%	0%					
ESTIMATED TRUE AREA (A+J) (ha)	24.72	71.05	73.25	16.61	48.31	13.57	9.02	0	15.21	0	0.98	0	272.73 ha				

Classification Aggregation

The aggregated classes include 1) those dominated by blue grama grass (*Bouteloua gracilis*), 2) those associated with the disturbance of old trails, and 3) those in disturbed areas dominated by early successional (ruderal) species. Specifically, the aggregated classes and their component classes are listed in Table 14. Due to their confusion with one and another, these associated map classes were appropriate to be merged into three new classes. Other classes with lower proportions of misclassifications were retained. The revised map legend with the new aggregated classes is shown in Table 15.

Table 14. Aggregated Map Classes and the Initial Classes Merged to form them

22	Blue Grama Grassland
	4 Blue Grama - Mixed Grassland/Ruderal Vegetation
	1 Blue Grama/Fringed Sage Grassland
	2 Blue Grama-Mixed Grassland
	15 Disturbed Grassland
	20 Sleepygrass/Blue Grama Grassland
23	Old Trail Grassland/Ruderal Vegetation
	6 Arroyo Old Trail Grassland/Ruderal Vegetation
	3 Western Wheatgrass - Hairy Grama Old Trail Grassland
24	Disturbed-Ruderal Grassland
	12 Disturbed Grassland / Ruderal Vegetation - Old Fort Restored
	10 Disturbed Grassland/Ruderal Vegetation - Adobe Field
	11 Disturbed Grassland/Ruderal Vegetation- Old Fort Undeveloped

Table 15. Revised Map Legend

Aggregated Map Class	Aggregated Map Class Names
5	Little Bluestem - Blue Grama Grassland
7	Herbaceous Wetland
8	Wavyleaf Oak Montane Scrub/Pinyon-Juniper Woodland
9	Willow Riparian Shrubland
13	Narrowleaf Cottonwood Riparian Woodland
17	Modern Road, Facilities, and Planted Vegetation
18	Water
19	Bare Ground/Sparsely Vegetated
21	Ruderal Vegetation/Bare Ground
22	Blue Grama Grassland
23	Old Trail Grassland/Ruderal Vegetation
24	Disturbed-Ruderal Grassland

Overall accuracy increased from 44% for the original map legend to 78.7% for the new legend with the aggregated classes. The sample contingency table for the revised map legend is presented in Table 16. The population contingency table and user's and producer's accuracies for the revised map legend are presented in Table 17.

Table 16. Sample Contingency Table for Revised Map Legend with Aggregated Map Classes

Reference Data						
Sample Data	23	22	24	7	21	• ROW TOTAL (n_{i+})
23	6	3.000	0.000	0.000	0.000	9
22	0.000	81	12.000	0.000	2.000	95
24	0.000	3.000	25	0.000	2.000	30
7	0.000	1.000	2.000	1	0.000	4
21	0.000	0.000	0.000	0.000	3	3
• COLUMN TOTAL (n_{+j})	6	88	39	1	7	141

The aggregation of map classes to increase the accuracy of the map changes the appearance of the map. The original map and revised map with original polygon boundaries are shown in Figure 7 and Figure 8, respectively. The revised legend has fewer map classes and fewer map units within each of the map classes than the original map. The revised map without the original polygon boundaries of the aggregated classes is presented in Figure 9. The revised map legend with the area and count of map units in each map class is presented in Table 18.

Table 17. Population Contingency Table for Revised Map Legend with Aggregated Map Classes

Reference Data									
Sample Data	23	22	24	7	21	USERS' ACC. (P _J =X i=X)	LOWER LIMIT, 90% CONF. INT.	UPPER LIMIT, 90% CONF. INT.	p _{i+}
23	0.089	0.044	0.000	0.000	0.000	67%	0%	0%	0.1333
22	0.000	0.508	0.089	0.000	0.015	83%	68%	98%	0.6121
24	0.000	0.023	0.159	0.000	0.012	82%	70%	94%	0.1936
7	0.000	0.004	0.007	0.004	0.000	25%	23%	27%	0.0141
21	0.000	0.000	0.000	0.000	0.027	100%	92%	100%	0.0274
PROD. ACC. (P _i =Y J=Y)	100%	88%	62%	100%	50%	OVERALL ACCURACY (P _c): 78.7% VARIANCE (P _c): 0.00362			
LOWER LIMIT, 90% CONF. INT.	97%	84%	59%	99%	50%				
UPPER LIMIT, 90% CONF. INT.	100%	92%	66%	100%	50%				
EST. TRUE AREA (ha)	24.24	157.8	69.53	0.963	14.91				

Table 18. Revised Map Classes Showing Area and Count of Map Units

Revised Map Class	Hectares	Map Units
Bare Ground/Sparsely Vegetated	1.6	10
Blue Grama Grassland	170.2	142
Disturbed - Ruderal Vegetation	53.8	26
Herbaceous Wetland	3.9	7
Little Bluestem - Blue Grama Grassland	0.2	1
Modern Road, Facilities, and Planted Vegetation	9.7	3
Narrowleaf Cottonwood Riparian Woodland	0.3	3
Old Trail Grassland	42.5	26
Ruderal Vegetation/Bare Ground	7.6	44
Water	0.3	1
Wavyleaf Oak Montane Scrub/Pinyon-Juniper Woodland	0.5	2
Willow Riparian Shrubland	0.7	3
Grand Total	291.5	268

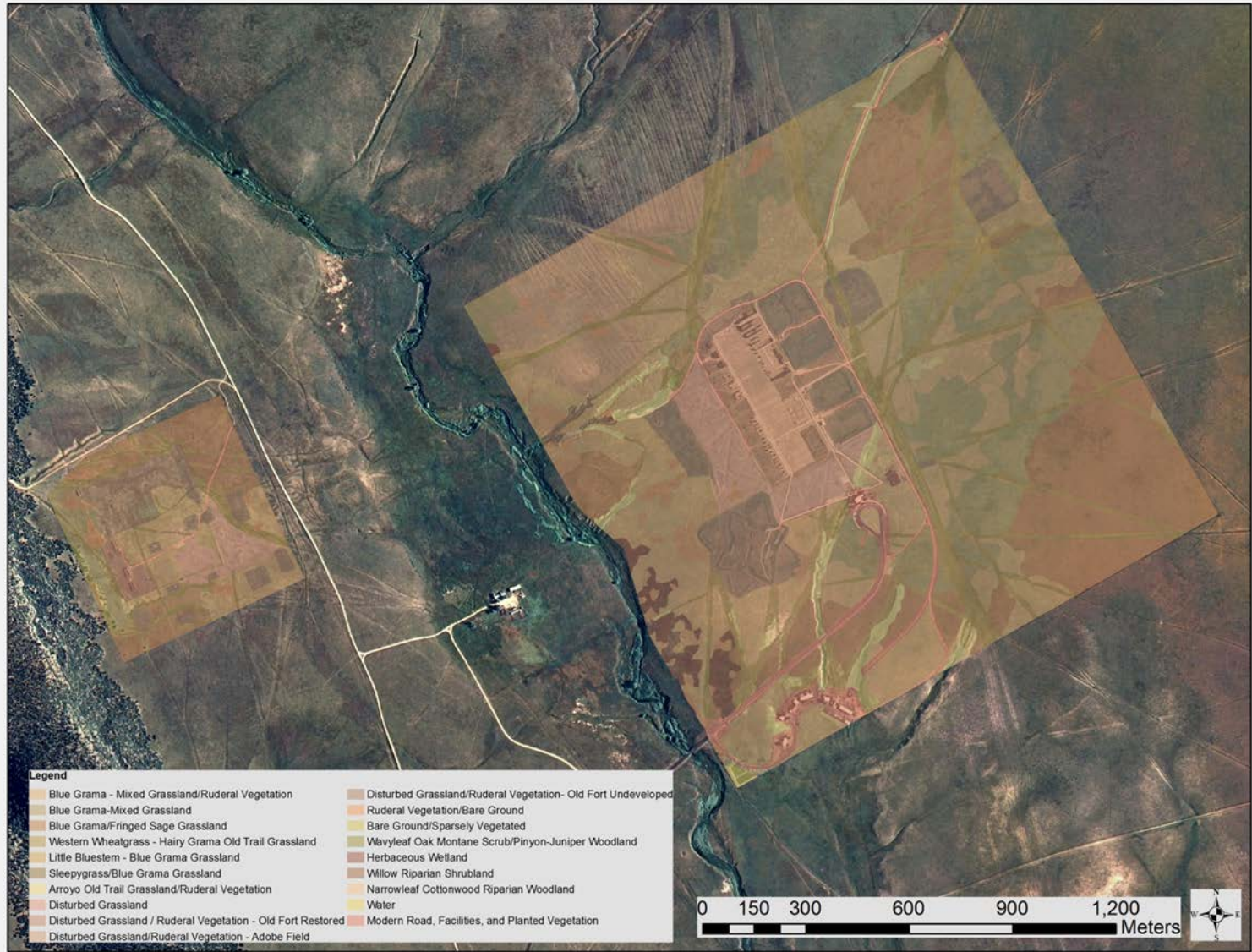


Figure 7. Original Map of FOUN

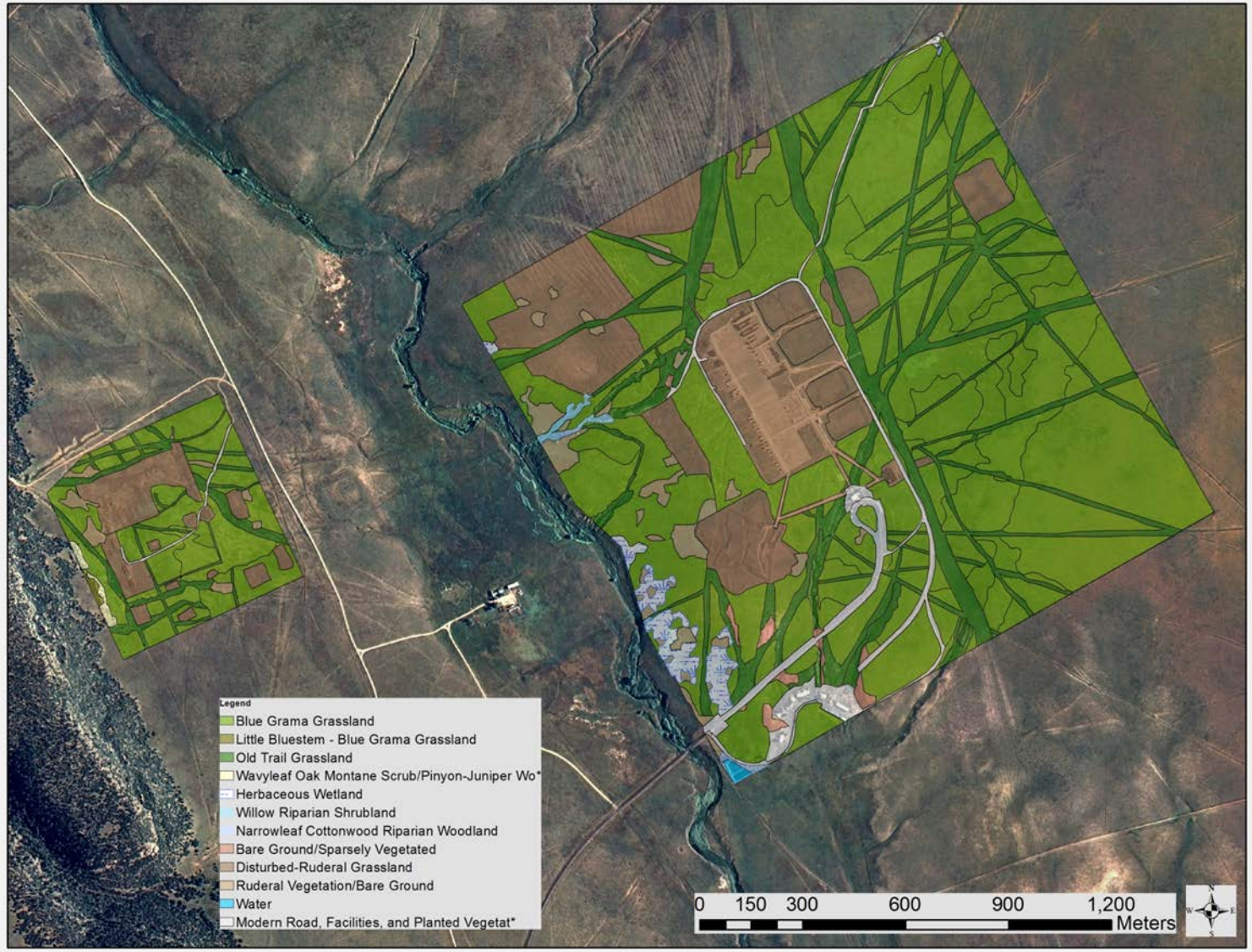


Figure 8. Revised map based on aggregated map classes showing original polygon boundaries

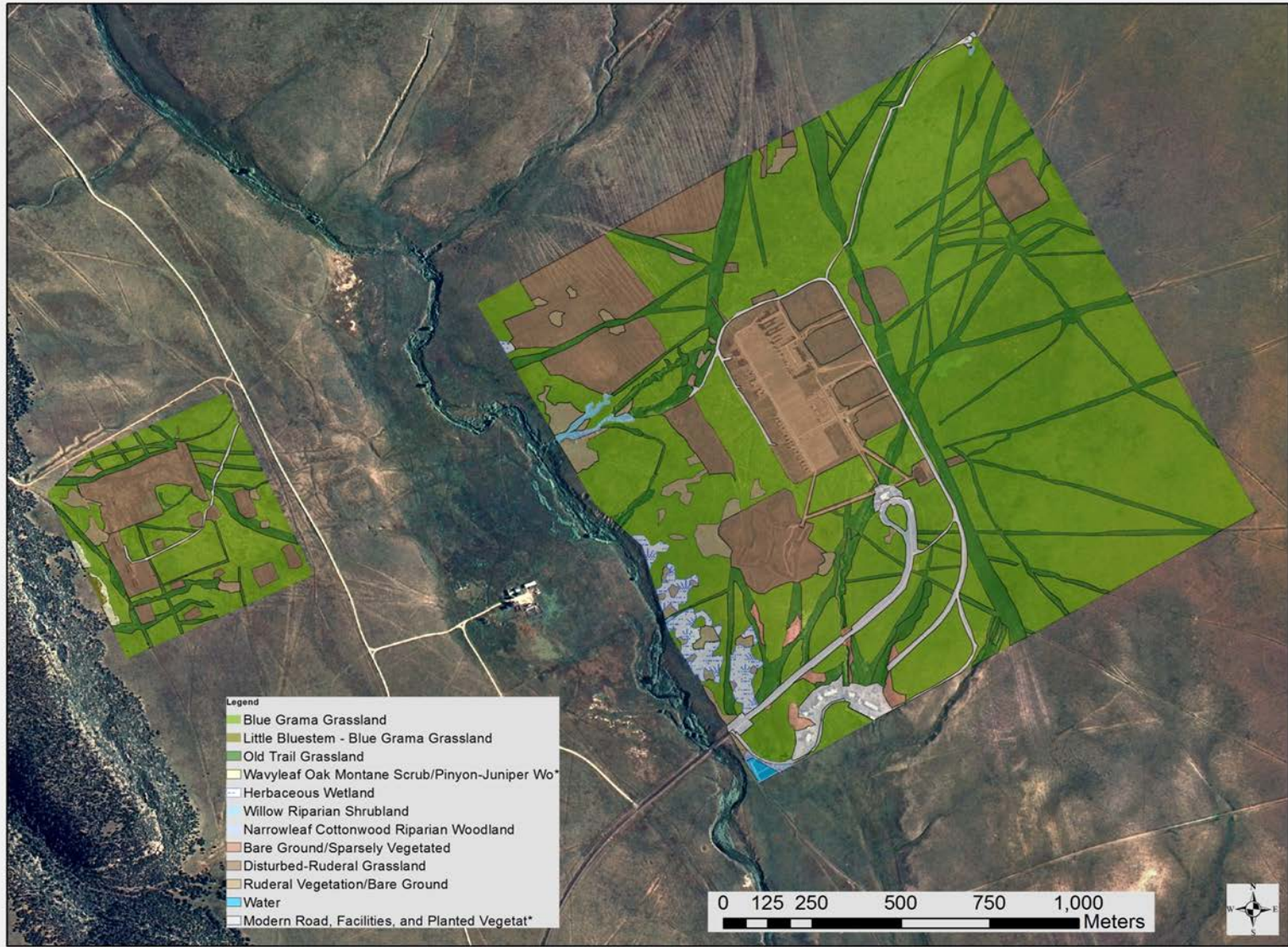





Figure 9. Revised map showing aggregated classes with polygon boundaries removed


Map Unit Descriptions


Map unit descriptions for each map unit listed in Table 6 follow. For each unit, the primary and secondary components are listed along with inclusions. Primary components are those plant associations listed in Table 5 that together comprise the majority of the unit. Secondary components are minor associations that can occupy at least 10% of the unit, but are not the dominants. Inclusions are associations that occupy less than 10% of the area. Plant associations are also ordered by their importance within component groups.


<i>Blue Grama/Fringed Sage Grassland</i>	1	
Acres: 127.7	Ha: 51.7	
Primary Components: Fringed Sage / Blue Grama PA, Typic Phase		
Secondary Components: Blue Grama / Fringed Sage PA, Spike Muhly Phase		
Inclusions: Weakleaf Bur Ragweed - Lacy Tansyaster PA		
Distribution: A major grassland unit within the monument, particularly in the southeastern corner. It is typically bisected by Western Wheatgrass - Hairy Grama Grassland of the old Santa Fe Trail system (3).		


<i>Blue Grama - Mixed Grassland</i>	2	
Acres: 105.0	Ha: 42.5	
Primary Components: Fringed Sage / Blue Grama PA, Spike Muhly Phase		
Secondary Components: Blue Grama / Fringed Sage PA, Typic Phase		
Inclusions: Blue Grama - Purple Threeawn PA Soapweed Yucca / Blue Grama grassland Weakleaf Bur Ragweed - Lacy Tansyaster PA		
Distribution: A major grassland unit within the monument that is often found in transitional areas between Blue Grama / Fringed Sage Grassland (1) and Blue Grama - Mixed Grassland / Ruderal Vegetation (4).		


<i>Western Wheatgrass - Hairy Grama Old Trail Grassland</i>		3	
Acres: 91.6	Ha: 37.1		
Primary Components: Western Wheatgrass - Blue Grama PA Hairy Grama / Fringed Sage PA			
Secondary Components: Fringed Sage / Blue Grama PA, Spike Muhly Phase			
Inclusions: Blue Grama - Purple Threeawn PA			
Distribution: A major grassland unit typically confined to old trails that are part of the Santa Fe Trail system.			


<i>Blue Grama - Mixed Grassland/ Ruderal Vegetation</i>		4	
Acres: 157.8	Ha: 63.8		
Primary Components: Blue Grama - Purple Threeawn PA Weakleaf Bur Ragweed - Lacy Tansyaster PA Blue Grama / Fringed Sage PA, Typic Phase			
Secondary Components: Fringed Sage / Blue Grama PA, Spike Muhly Phase Blue Grama - Western Wheatgrass PA Bare Ground			
Inclusions: Blue Grama / Soaptree Yucca			
Distribution: A major grassland unit associated with both past disturbance from historical fort activities and current disturbance due to pocket gopher. It is found primarily adjacent to fort structures and where the trail system converged into general use areas.			


<i>Little Bluestem - Blue Grama Grassland</i>		5	
Acres: 0.5	Ha: 0.2		
Primary Components: Little Bluestem - Sideoats Grama PA			
Secondary Components:			
Inclusions: Fringed Sage / Blue Grama PA, Typic Phase			
Distribution: A minor unit known only from the western edge of the Old Fort unit along the footslope of Black Mesa.			


<i>Sleepygrass Grassland</i>		20	
Acres: 4.2	Ha: 1.7		
Primary Components: Fringed Sage / Sleepygrass PA			
Secondary Components: Fringed Sage / Blue Grama Sage PA, Typic Phase			
Inclusions: Blue Grama / Fringed Sage PA, Spike Muhly Phase Blue Grama - Western Wheatgrass PA			
Distribution: A minor unit that occurs in a small swale-outwash area at the distal end of a trail arroyo that enters the monument near the northeast corner.			


<i>Herbaceous Wetland</i>		7	
Acres: 9.7	Ha: 3.9		
Primary Components: Wood's Rose / Baltic Rush PA Broadleaf Cattail Monotypic PA			
Secondary Components: Baltic Rush Monotypic PA Weakleaf Bur Ragweed - Lacy Tansyaster PA			
Inclusions: Blue Grama - Purple Threeawn PA Blue Grama - Western Wheatgrass PA Coyote Willow / Baltic Rush PA			
Distribution: A major unit along the western boundary of the main park unit. It is associated with freshwater seepage and spring areas along the lower end of the piedmont slope that overlooks Wolf Creek. It is often found in a complex mosaic with Ruderal Vegetation / Bare Ground (21) and Blue Grama - Mixed Grassland / Ruderal Vegetation (4).			


<i>Willow Riparian Shrubland</i>		9	
Acres: 1.7	Ha: 0.7		
Primary Components: Coyote Willow / Baltic Rush PA			
Secondary Components: Broadleaf Cattail Monotypic Stand PA			
Inclusions: Distribution: A minor unit associated with incised arroyo channels along the western edge of the monument. Coyote willow likely became naturally established following erosion control work on the arroyos.			


<i>Narrowleaf Cottonwood Riparian Woodland</i>		13
<p>Acres: 0.7 Ha: 0.3</p> <p>Primary Components: Narrowleaf Cottonwood / Coyote Willow</p> <p>Secondary Components: Coyote Willow / Baltic Rush</p> <p>Inclusions: Weakleaf Bur Ragweed - Lacy Tansyaster PA Broadleaf Cattail Monotypic Stand PA</p> <p>Distribution: A minor unit found in an incised arroyo channel along the western edge of the monument; around the waste water treatment ponds in the southwest corner, and as a small patch in a drainage outwash area in the northeast corner.</p>		
		


<i>Wavyleaf Oak Montane Scrub/Pinyon-Juniper Woodland</i>		8
<p>Acres: 26.0 Ha: 10.5</p> <p>Primary Components: Wavyleaf Oak / Western Sedge PA</p> <p>Secondary Components:</p> <p>Inclusions: Pinyon Pine (Oneseed Juniper) / Blue Grama Woodland PA</p> <p>Distribution: A minor unit known only from the western edge of the Old Fort unit of the monument along the footslope of Black Mesa, where it is found on granitic boulder outcrops.</p>		
		


<i>Arroyo Old Trail Grassland/ Ruderal Vegetation</i>		6
<p>Acres: 13.4 Ha: 5.4</p> <p>Primary Components: Western Wheatgrass - Blue Grama PA Weakleaf Bur Ragweed - Lacy Tansyaster PA Bare Ground</p> <p>Secondary Components: Blue Grama - Purple Threeawn PA</p> <p>Inclusions: Fringed Sage / Blue Grama PA, Typic Phase Blue Grama / Fringed Sage PA, Spike Muhly Phase Hairy Grama / Fringed Sage PA</p> <p>Distribution: A unit restricted to eroded trail arroyos where some grasses have become established in a matrix of ruderal (weedy) forb vegetation and bare ground.</p>		
		

<i>Disturbed Grassland/Ruderal Vegetation - Adobe Field</i>		10	
Acres: 37.5	Ha: 15.2		
Primary Components: Blue Grama - Purple Threeawn PA Western Wheatgrass - Blue Grama PA Weakleaf Bur Ragweed - Lacy Tansyaster PA			
Secondary Components: Fringed Sage / Blue Grama PA, Typic Phase Fringed Sage / Blue Grama PA, Spike Muhly Phase Bare Ground			
Inclusions: Blue Grama / Soaptree Yucca PA			
Distribution: Located primarily in the northwestern corner of the monument, this vegetation resides in the long dugout troughs used for making adobes for the forts and in the intervening strips of prairie grassland.			

<i>Disturbed Grassland/Ruderal Vegetation - Old Fort Undeveloped</i>		11	
Acres: 57.3	Ha: 23.2		
Primary Components: Western Wheatgrass - Blue Grama PA Weakleaf Bur Ragweed - Lacy Tansyaster PA			
Secondary Components: Blue Grama - Purple Threeawn PA			
Inclusions: Fringed Sage / Blue Grama PA, Typic Phase Fringed Sage / Blue Grama PA, Spike Muhly Phase			
Distribution: A major unit associated with those fort ruins that have not been extensively developed archeologically, particularly old corrals and shed sites. These sites typically have a mix of disturbance-related vegetation that can reflect both historical impacts and recent activity by pocket gophers.			

<i>Disturbed Grassland /Ruderal Vegetation - Old Fort Restored</i>		12	
Acres: 38.3	Ha: 15.5		
Primary Components: Blue Grama - Purple Threeawn PA			
Secondary Components: Western Wheatgrass - Blue Grama PA Weakleaf Bur Ragweed - Lacy Tansyaster PA Bare Ground			
Inclusions: Fringed Sage / Blue Grama PA, Typic Phase Fringed Sage / Blue Grama PA, Spike Muhly Phase			
Distribution: A unit restricted to fort ruins that have been developed archeologically and that receive high visitorship. Typically, vegetation has been modified by and in response to visitor use.			

<i>Disturbed Grassland</i>		15	
Acres: 26.0	Ha: 10.5		
Primary Components: Blue Grama - Purple Threeawn PA			
Secondary Components: Blue Grama / Fringed Sage PA, Typic Phase Blue Grama / Fringed Sage PA, Spike Muhly Phase			
Inclusions: Blue Grama / Soaptree Yucca Weakleaf Bur Ragweed - Lacy Tansyaster PA			
Distribution: A localized unit adjacent to the fort ruins where ground disturbance is less than surrounding areas.			

<i>Ruderal Vegetation/Bare Ground</i>		21	
Acres: 18.9	Ha: 7.6		
Primary Components: Weakleaf Bur Ragweed - Lacy Tansyaster PA Bare Ground			
Secondary Components: Blue Grama - Purple Threeawn PA Western Wheatgrass - Blue Grama PA			
Inclusions: Baltic Rush / Wood's Rose Blue Grama / Fringed Sage PA, Typic Phase Blue Grama / Fringed Sage PA, Spike Muhly Phase			
Distribution: A widely distributed unit where ground disturbance was historically very high or where current pocket gopher activity is high. The sites support mostly ruderal forbs (weeds) and few grasses, but they can be found in a complex matrix with grasslands and wetlands.			

Discussion

Vegetation Survey

The vegetation of Fort Union National Monument is relatively diverse, given its limited size and location on the western edge of the shortgrass prairie. While shortgrass prairie grasslands are still the dominant feature, they exhibit a variety of compositions that bear the imprint of past and current land use, and much of the grassland pattern reflects recovery from the time when the fort was active (prior to 1891). This includes old trail swaths from the Santa Fe Trail system that have either grown in with grasslands or, conversely, eroded into active arroyos. Because the trails themselves are of archeological value and high interest to visitors, this presents a challenge for long-term vegetation management. While further erosion will ultimately destroy the trails, slowing erosion through vegetation controls can make the trails difficult to see and may eventually lead to filling of the trails with sediments, obliterating the trail system, at least on the surface. Nevertheless, this will be a slow process, and through careful surface water management, it may be possible to find an optimal balance between erosion acceleration and excess deposition to preserve what is one of the hallmarks of the monument.

The exclusion of grazing with the establishment of the monument has allowed the vegetation to respond differently from that in the surrounding ranch lands. Qualitatively, there is a higher cover of vegetation within the park boundary than outside, and a suggestion that the grasslands may be more diverse within the fence. Quantitative comparative studies would be useful for determining both the positive and negative impacts of grazing exclusion. What is likely is that without grazing, fuel loads can build and possibly allow for the reintroduction of fire into the grassland ecosystem. The effects of fire can be variable, depending on the species, and there is a large pool of literature on the effects of fire on individual species that can be mined in the process of developing a fire management plan for vegetation. In general, fire in prairies is thought to increase biodiversity and reinvigorate ecosystem processes, but intensity and frequency remain open questions, particularly in the more arid shortgrass prairie of the monument. The use of fire will obviously be limited by the size of the monument and the need to protect the cultural resources, but most of the eastern portion of the monument presents an open grassland where fire could be introduced safely under correct conditions. Furthermore, through cooperation with adjacent landowners, landscape-scale fire becomes possible, but this needs to be considered carefully in the light of altering hydrological processes and the ensuing impacts that might have on the trail system and other cultural resources.

While fire might be considered a threat under certain circumstances, so might the current high density of Botta's pocket gophers (*Thomomys bottae*). This mostly ground-dwelling animal is excavating large patches of monument primarily in areas of past disturbance, both human and otherwise. They tend to be limited by soil depth and friability i.e., the softer and deeper the soil the better the habitat. Hence, many soils in and around the ruins that have been recently deposited or dug up for other purposes have become ideal habitats for these animals. However, they also seem to be expanding to some degree into the open grasslands, yet outside the park their numbers appear to drop off, perhaps due to cattle impacts and associated compaction. Their presence in large numbers leads to the development of large patches dominated by ruderal (disturbance-related) plant species and bare ground, and these areas along with developed monument areas may become sinks for exotic species invasions (as well as directly impacting

cultural resources). On the other hand, these are native species, and their presence in small numbers adds to the natural landscape variability and increases local native plant biodiversity in a similar way to fire. Hence, neither total eradication (not likely possible) nor sidestepping the issue are desirable management strategies. Rather, population level studies should be conducted to determine the dynamics of these animals in relation to soil habitat, available resources, and climatic factors. Based on these studies the optimal control program can be designed that protects both biological and cultural resources while ensuring maximal biodiversity.

The wetlands of Fort Union National Monument are naturally established vegetation that would likely be categorized as jurisdictional wetlands under US Army Corps of Engineers rules (Environmental Laboratory 1987), both as function of species composition and soils conditions. In addition, they are perhaps the most biologically diverse sites on the monument in terms of plant species, and they are also a magnet for animals. Hence, we would suggest that management be oriented towards maintenance and enhancement of these sites primarily by avoiding adverse impacts to the hydrological regime for both surface and subsurface components.

While no rare species were detected at the monument, the complexity of the disturbance history plus the variety of habitats in a limited area without grazing impacts has contributed to a relatively high plant species diversity for the monument. With respect to exotics plant species, only 12 of the 141 taxa described for the monument would be considered non-native alien introductions. Of these, none poses a significant threat to native species at this time, although species such as horehound (*Marrubium vulgare*) or kochia (*Kochia scoparia*) once established on disturbed ground can be a significant impediment to colonization of native species. Furthermore, park personnel should remain vigilant for the possibility of significant cheat grass (*Bromus tectorum*, *B. japonicus*) establishment in the developed areas of the fort. Lastly, it must be remembered that the botanical survey was conducted under drought conditions in 2000 through 2002, and that additional surveys during good years are recommended to capture additional species for the record and track non-native species abundance. Ideally, comparative monitoring sites should be established inside the monument and on the adjacent grazed Fort Union Ranch to track biodiversity status through time with respect to grazing, fire, and alien species encroachment.

Accuracy Assessment

The overall accuracy of the mapped vegetation model in predicting field classifications was low and likely indicative of too finely defined and overlapping vegetation classifications. Calculating the proportions of errors for each map and field class identified classes that were too closely related for accurate mapping. Blue grama-associated classes, trail-associated classes, and classes defined by disturbed grassland and ruderal vegetation were deemed too finely spilt to be useful for management purposes. These classes also demonstrated comparable vegetative characteristics within their associations and likely entail similar management actions.

There are several potential reasons why the original map had low accuracy of 44.2%. First, the original map legend had too many finely defined classes to achieve the accuracy standard. In the original legend there were 17 vegetated map classes representing 17 plant associations. Only eight of those 17 associations occurred in a single map class, while the remaining nine

associations were included in multiple different map classes. Two associations were listed as occurring in as many as eight of the original map classes.

Second, the map legend included multiple classes with ambiguous and seemingly overlapping class names. For example, there were 8 of 17 original classes that represented disturbed / ruderal vegetation. At least five of those classes described essentially the same vegetation association, but included a modifier to designate a fine distinction based on cultural or geographic differences.

Lastly, and possibly most importantly, there was an approximately 4-5 year lag between when the map was created and when the accuracy assessment was completed. Short- and long-term changes in the vegetation composition over that time frame could affect map accuracy. Given that the site was once disturbed and has been undergoing a gradual process of passive, and in some cases active, restoration, it is possible that distinctions between finely split map classes are less discernible in the present than when the map was completed.

Due to its long history of use by people and livestock, the FOUN site includes large areas dominated by ruderal and/or non-native weedy species. In the most severely degraded areas, invasive species form pure monocultures with little to no native species present. The suite of ruderal/disturbance species present occur with high constancy across the entire site and complicate selecting the correct map class using ocular estimates alone. Given that field researchers typically use ocular estimates to differentiate map classes, basing map class distinctions on ubiquitous species or on compositional characteristics below the detection level for ocular estimates is unworkable. In practice, FOUN management will benefit from a map legend with fewer more broadly defined classes that separate weedy disturbed classes as a whole, from the classes representing native vegetation.

The original map classes have been retained in the map, but have been joined to allow FOUN managers the opportunity to use the original legend or the revised aggregated legend depending on their objectives and the tradeoffs between map accuracy and specificity of the classification.

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Appendix A: FOUN Plant Species List



Figure A1. Dotted gayfeather (*Liatris punctata*) was a forb common associate in blue grama grasslands of the monument. Photo by Geoff Carpenter.

Plants identified by Natural Heritage New Mexico as part of the vegetation survey of Fort Union National Monument from 2000 through 2002 are listed in the following tables. Species are listed alphabetically within lifeform (LF) where 1 = trees, 2 = shrubs, 2.5 = subshrubs, 3 = graminoid grass-like species, and 4 = forbs. NHNM code refers to code in the NHNM database, and PLANTS Symbol refers to the code in the national PLANTS database (<http://plants.usda.gov/>). "O" refers to origin as either native (N), introduced (I), or not determined for the taxa (-). "V" refers to whether a voucher specimen was collected (X), or not collected, but part of plot record (P). "Native Plant Society" refers to whether the plant was found on the species list of Mary Whitmore on file at the monument. In Table A1, species are listed alphabetically by scientific name within lifeform, in Table A2, alphabetically by common name within lifeform. Table A3 contains those species on the Native Plant Society list that were not found during the survey.

Table A1. Plant species surveyed at Fort Union National Monument by Natural Heritage New Mexico between 2000 and 2002. Alphabetical by scientific name within lifeform.

LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
1	JUNMON	JUMO	<i>Juniperus monosperma</i>	oneseed juniper	Cupressaceae	N	X	
1	JUNSCO	JUSC2	<i>Juniperus scopulorum</i>	Rocky Mountain juniper	Cupressaceae	N	X	
1	PINEDU	PIED	<i>Pinus edulis</i>	pinyon pine	Pinaceae	N	X	
1	PINPONS	PIPOS	<i>Pinus ponderosa</i> var. <i>scopulorum</i>	ponderosa pine	Pinaceae	N	X	
1	POPANG	POAN3	<i>Populus angustifolia</i>	narrowleaf cottonwood	Salicaceae	N	X	
1	QUEGRI	QUGR3	<i>Quercus grisea</i>	gray oak	Fagaceae	N	X	
1	SALAMY	SAAM2	<i>Salix amygdaloides</i>	peachleaf willow	Salicaceae	N	X	
1	ULMPUM	ULPU	<i>Ulmus pumila</i>	Siberian elm	Ulmaceae	I	X	
2	AMOFRU	AMFR	<i>Amorpha fruticosa</i>	desert indigobush	Fabaceae	N	X	
2	ATRCAN	ATCA2	<i>Atriplex canescens</i>	fourwing saltbush	Chenopodiaceae	N	X	x
2	BRICAL	BRCA3	<i>Brickellia californica</i>	California brickellbush	Asteraceae	N	X	
2	BRIEUPC	BREUC2	<i>Brickellia eupatorioides</i> var. <i>chlorolepis</i>	false boneset	Asteraceae	N	X	
2	BRIMICS	BRMIS	<i>Brickellia microphylla</i> var. <i>scabra</i>	rough brickellbush	Asteraceae	N	X	
2	CHRNAUL	CHNAL2	<i>Chrysothamnus nauseosus</i> ssp. <i>latisquamous</i>	rubber rabbitbrush	Asteraceae	N	X	x (C. nauseosus)
2	CLELIG	CLLI2	<i>Clematis ligusticifolia</i>	western white clematis	Ranunculaceae	N	X	
2	FALPAR	FAPA	<i>Fallugia paradoxa</i>	Apacheplume	Rosaceae	N	X	x
2	KRALAN2	KRLA2	<i>Krascheninnikovia lanata</i>	winterfat	Chenopodiaceae	N	X	
2	NOLMIC	NOMI	<i>Nolina microcarpa</i>	sacahuista	Agavaceae	N	P	
2	PHYMON	PHMO4	<i>Physocarpus monogynus</i>	mountain ninebark	Rosaceae	N	X	
2	QUEUND	QUUN	<i>Quercus undulata</i>	wavyleaf oak	Fagaceae	N	X	
2	RHUTRI	RHTR	<i>Rhus trilobata</i>	skunkbush sumac	Anacardiaceae	N	P	x
2	RIBCER	RICE	<i>Ribes cereum</i>	wax currant	Grossulariaceae	N	X	
2	ROSWOO	ROWO	<i>Rosa woodsii</i>	Woods' rose	Rosaceae	N	X	
2	SALEXI	SAEX	<i>Salix exigua</i>	coyote willow	Salicaceae	N	X	
2	TOXRAD	TORA2	<i>Toxicodendron radicans</i>	poison ivy	Anacardiaceae	N	X	
2	YUCGLA	YUGL	<i>Yucca glauca</i>	soapweed yucca	Agavaceae	N	P	x
2.5	ARTFRI	ARFR4	<i>Artemisia frigida</i>	fringed sagewort	Asteraceae	N	P	x
2.5	BRIBRA	BRBR2	<i>Brickellia brachyphylla</i>	plumed brickellbush	Asteraceae	N	X	
2.5	EHCOC	ECCO5	<i>Echinocereus coccineus</i>	scarlet hedgehog cactus	Cactaceae	N	P	

Table A1. Plant species surveyed at Fort Union National Monument by Natural Heritage New Mexico between 2000 and 2002. Alphabetical by scientific name within lifeform.

LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
2.5	ECHVIR	ECVI2	<i>Echinocereus viridiflorus</i>	nylon hedgehog cactus	Cactaceae	N	P	x
2.5	GUTSAR	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed	Asteraceae	N	P	x
2.5	OPUPHA	OPPH	<i>Opuntia phaeacantha</i>	tulip pricklypear	Cactaceae	N	P	
2.5	OPUPOL	OPPO	<i>Opuntia polyacantha</i>	plains pricklypear	Cactaceae	N	P	x
2.5	ZINGRA	ZIGR	<i>Zinnia grandiflora</i>	Rocky Mountain zinnia	Asteraceae	N	X	x
3	AGRGIG	AGGI2	<i>Agrostis gigantea</i>	redtop	Poaceae	I	X	
3	ARIDIV	ARDI5	<i>Aristida divaricata</i>	poverty threeawn	Poaceae	N	X	
3	ARIPUR	ARPU9	<i>Aristida purpurea</i>	purple threeawn	Poaceae	N	P	x
3	BOUCUR	BOCU	<i>Bouteloua curtipendula</i>	sideoats grama	Poaceae	N	P	
3	BOUGRA	BOGR2	<i>Bouteloua gracilis</i>	blue grama	Poaceae	N	P	x
3	BOUHIR	BOHI2	<i>Bouteloua hirsuta</i>	hairy grama	Poaceae	N	X	
3	BROANO	BRAN	<i>Bromus anomalus</i>	nodding brome	Poaceae	N	X	
3	BROCAT	BRCA6	<i>Bromus catharticus</i>	rescuegrass	Poaceae	I	X	x
3	CAREX	CAREX	<i>Carex</i> spp.	sedge	Cyperaceae	-	X	
3	CAROCC	CAOC2	<i>Carex occidentalis</i>	western sedge	Cyperaceae	N	X	
3	CARROS	CARO5	<i>Carex rossii</i>	Ross' sedge	Cyperaceae	N	X	
3	CYPFEN	CYFE2	<i>Cyperus fendlerianus</i>	Fendler's flatsedge	Cyperaceae	N	X	
3	DISSPI	DISP	<i>Distichlis spicata</i>	inland saltgrass	Poaceae	N	X	
3	ELYCAN	ELCA4	<i>Elymus canadensis</i>	Canada wildrye	Poaceae	N	X	
3	ELYELY	ELEL5	<i>Elymus elymoides</i>	bottlebrush squirreltail	Poaceae	N	X	x (<i>X. longifolius</i>)
3	ELYTRA	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	Poaceae	N	X	
3	JUNARCB	JUBA	<i>Juncus arcticus</i> var. <i>balticus</i>	Baltic rush	Juncaceae	N	X	
3	LYCSET	LYSE3	<i>Lycurus setosus</i>	Bristly Wolfstail	Poaceae	N	X	x
3	MUHMOM	MUMO	<i>Muhlenbergia montana</i>	mountain muhly	Poaceae	N	X	
3	MUHTOR	MUTO2	<i>Muhlenbergia torreyi</i>	ring muhly	Poaceae	N	P	
3	MUHWRI	MUWR	<i>Muhlenbergia wrightii</i>	spike muhly	Poaceae	N	X	
3	ORYMIC	ORMI2	<i>Oryzopsis micrantha</i>	littleseed ricegrass	Poaceae	N	X	
3	PANCAP	PACA6	<i>Panicum capillare</i>	witchgrass	Poaceae	N	X	
3	PANOBT	PAOB	<i>Panicum obtusum</i>	vine mesquite	Poaceae	N	X	x
3	PANVIR	PAVI	<i>Panicum virgatum</i>	switchgrass	Poaceae	N	X	
3	PASSMI	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	Poaceae	N	X	x (<i>Elymus smithii</i>)
3	SCHSCO	SCSC	<i>Schizachyrium scoparium</i>	little bluestem	Poaceae	N	X	

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LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
3	SPOAIR	SPAI	<i>Sporobolus airoides</i>	alkali sacaton	Poaceae	N	X	
3	SPOCRY	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	Poaceae	N	X	
3	STIROB	STRO3	<i>Stipa robusta</i>	sleepygrass	Poaceae	N	X	
4	ALLCER	ALCE2	<i>Allium cernuum</i>	nodding onion	Liliaceae	N	X	
4	AMAHYB	AMHY	<i>Amaranthus hybridus</i>	slim amaranth	Amaranthaceae	N	X	x
4	AMAPAL	AMPA	<i>Amaranthus palmeri</i>	carelessweed	Amaranthaceae	N	P	
4	AMBCON	AMCO3	<i>Ambrosia confertiflora</i>	weakeaf bur ragweed	Asteraceae	N	X	no, but <i>Ambrosia psilostachya</i>
4	ARELANS	ARLAS	<i>Arenaria lanuginosa</i> ssp. <i>saxosa</i>	spreading sandwort	Caryophyllaceae	N	X	
4	ARTCAR	ARCA14	<i>Artemisia carruthii</i>	Carruth's sagewort	Asteraceae	N	X	
4	ARTLUD	ARLU	<i>Artemisia ludoviciana</i>	Louisiana sagewort	Asteraceae	N	X	x
4	ASCSUB	ASSU2	<i>Asclepias subverticillata</i>	whorled milkweed	Asclepiadaceae	N	X	no, but <i>A. involucrata</i>
4	BERLYR	BELY	<i>Berlandiera lyrata</i>	lyreleaf greeneyes	Asteraceae	N	X	x
4	CASINT	CAIN14	<i>Castilleja integra</i>	wholeleaf Indian paintbrush	Scrophulariaceae	N	X	x
4	CHAERI	CHER2	<i>Chaetopappa ericoides</i>	rose heath	Asteraceae	N	X	x
4	CHAFEN	CHFE3	<i>Chamaesyce fendleri</i>	Fendler's sandmat	Euphorbiaceae	N	X	
4	CHASER2	CHSE6	<i>Chamaesyce serpyllifolia</i>	thymeleaf sandmat	Euphorbiaceae	N	X	
4	CHEHIA	CHHI	<i>Chenopodium hians</i>	hians goosefoot	Chenopodiaceae	N	X	no, but <i>C. watsonii</i>
4	CHEINC	CHIN2	<i>Chenopodium incanum</i>	mealy goosefoot	Chenopodiaceae	N	X	
4	CHELEP	CHLE4	<i>Chenopodium leptophyllum</i>	narrowleaf goosefoot	Chenopodiaceae	N	X	
4	CIRUND	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle	Asteraceae	N	X	
4	CIRWHE	CIWH	<i>Cirsium wheeleri</i>	Wheeler's thistle	Asteraceae	N	X	
4	COMDIA	CODI4	<i>Commelina dianthifolia</i>	birdbill dayflower	Commelinaceae	N	X	
4	COMUMP	COUMP	<i>Comandra umbellata</i> ssp. <i>pallida</i>	pale bastard toadflax	Santalaceae	N	X	
4	CONARV	COAR4	<i>Convolvulus arvensis</i>	field bindweed	Convolvulaceae	I	X	x
4	CONCAN	COCA5	<i>Conyza canadensis</i>	Canadian horseweed	Asteraceae	N	X	
4	CRYTHY	CRTH	<i>Cryptantha thyrsoiflora</i>	calcareous cryptantha	Boraginaceae	N	X	no, but <i>C. crassisepala</i>
4	CUCFOE	CUFO	<i>Cucurbita foetidissima</i>	Missouri gourd	Cucurbitaceae	N	X	x
4	DALCANO	DACAO	<i>Dalea candida</i> var. <i>oligophylla</i>	white prairieclover	Fabaceae	N	P	
4	DALPUR	DAPU5	<i>Dalea purpurea</i>	purple prairieclover	Fabaceae	N	X	
4	DYSPAP	DYPA	<i>Dyssodia papposa</i>	fetid marigold	Asteraceae	N	X	x
4	ENGPER	ENPE4	<i>Engelmannia peristenia</i>	Engelmann's daisy	Asteraceae	N	X	= <i>Engelmannia pinnatifida</i>
4	ERIALA	ERAL4	<i>Eriogonum alatum</i>	winged buckwheat	Polygonaceae	N	P	x

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4	ERICAN	ERCA4	<i>Erigeron canus</i>	hoary fleabane	Asteraceae	N	X	
4	ERIHIE	ERHI3	<i>Eriogonum hieraciifolium</i>	hawkweed buckwheat	Polygonaceae	N	X	
4	ERIJAM	ERJA	<i>Eriogonum jamesii</i>	James' buckwheat	Polygonaceae	N	X	
4	EUPDAV	EUDA5	<i>Euphorbia davidii</i>	David'sspurge	Euphorbiaceae	I	X	
4	GAUCOC	GACO5	<i>Gaura coccinea</i>	scarlet beeblossom	Onagraceae	N	X	x
4	GLYLEP	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	Fabaceae	N	X	x
4	GRINUDA	GRNUA	<i>Grindelia nuda</i> var. <i>aphanactis</i>	curlytop gumweed	Asteraceae	N	X	no, but <i>G. squarosa</i>
4	HELANN	HEAN3	<i>Helianthus annuus</i>	common sunflower	Asteraceae	N	X	x
4	HETVILM	HEVIM3	<i>Heterotheca villosa</i> var. <i>minor</i>	hairy false goldenaster	Asteraceae	N	X	x (<i>Chrysopsis villosa</i>)
4	HYMFIL	HYFI	<i>Hymenopappus filifolius</i>	fineleaf hymenopappus	Asteraceae	N	X	x
4	IPOPUR	IPPU2	<i>Ipomoea purpurea</i>	tall morningglory	Convolvulaceae	I	X	
4	KOCSCO	KOSC	<i>Kochia scoparia</i>	common kochia	Chenopodiaceae	I	X	no, but <i>K. americana</i>
4	LATEUC	LAEU	<i>Lathyrus eucosmus</i>	bush peavine	Fabaceae	N	X	x
4	LATHYR	LATHY	<i>Lathyrus</i> spp.	peavine	Fabaceae	-	X	
4	LIAPUN	LIPU	<i>Liatris punctata</i>	dotted gayfeather	Asteraceae	N	X	x
4	LYGJUN	LYJU	<i>Lygodesmia juncea</i>	rush skeletonplant	Asteraceae	N	X	
4	MACCANA	MACAA	<i>Machaeranthera canescens</i> var. <i>ambigua</i>	hoary tansyaster	Asteraceae	N	X	x (<i>Machaeranthera canescens</i>)
4	MACPIN	MAPIP	<i>Machaeranthera pinnatifida</i>	lacy tansyaster	Asteraceae	N	X	x (<i>Haplopappus spinulosus</i>)
4	MARVUL	MAVU	<i>Marrubium vulgare</i>	horehound	Lamiaceae	I	X	x
4	MELOFF	MEOF	<i>Melilotus officinalis</i>	yellow sweetclover	Fabaceae	I	X	x
4	MENMUL	MEMU3	<i>Mentzelia multiflora</i>	manyflowered mentzelia	Loasaceae	N	X	x
4	MIRLIN	MILI3	<i>Mirabilis linearis</i>	narrowleaf four o'clock	Nyctaginaceae	N	X	x
4	OENCOR	OECO2	<i>Oenothera coronopifolia</i>	crownleaf evening-primrose	Onagraceae	N	X	no, but <i>O. albicaulis</i>
4	OXYTRO	OXYT	<i>Oxytropis</i> spp	Crazyweed	Fabaceae	N	X	
4	PHYHEDC	PHHEC	<i>Physalis hederifolia</i> var. <i>comata</i>	ivyleaf groundcherry	Solanaceae	N	X	x (var. <i>fendleri</i>)
4	PINEDU1	PIED	<i>Pinus edulis</i>	pinyon pine	Pinaceae	N	X	
4	POROLE	POOL	<i>Portulaca oleracea</i>	common purslane	Portulacaceae	N	X	
4	PSOTEN	PSTE5	<i>Psoraleidium tenuiflorum</i>	slimflower scurfpea	Fabaceae	N	X	x (<i>Psorelea tenuiflora</i>)
4	RATTAG	RATA	<i>Ratibida tagetes</i>	green prairie coneflower	Asteraceae	N	X	x
4	SALREF	SARE3	<i>Salvia reflexa</i>	lanceleaf sage	Lamiaceae	N	X	x
4	SALTRA	SATR12	<i>Salsola tragus</i>	prickly Russian thistle	Chenopodiaceae	I	X	x (<i>S. kali</i>)
4	SENSPAM	SENMUL	<i>Senecio spartioides</i> var. <i>multicapitatus</i>	broomlike ragwort	Asteraceae	N	X	

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LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
4	SOLELA	SOEL	<i>Solanum elaeagnifolium</i>	silverleaf nightshade	Solanaceae	N	X	x
4	SOLMOL	SOMO	<i>Solidago mollis</i>	velvety goldenrod	Asteraceae	N	X	
4	SPHCOC	SPCO	<i>Sphaeralcea coccinea</i>	scarlet globemallow	Malvaceae	N	X	x
4	SPHHAS	SPHA	<i>Sphaeralcea hastulata</i>	spear globemallow	Malvaceae	N	X	
4	SPHINC	SPIN2	<i>Sphaeralcea incana</i>	gray globemallow	Malvaceae	N	X	
4	SYMERI	SYERE	<i>Symphyotrichum ericoides</i>	heath aster	Asteraceae	N	X	
4	SYMFAL2	SYFAC2	<i>Symphyotrichum falcatum</i> var. <i>crassulum</i>	white prairie aster	Asteraceae	N	X	
4	SYMLANH	SYLAH6	<i>Symphyotrichum lanceolatum</i> ssp. <i>hesperium</i>	white panicle aster	Asteraceae	N	X	
4	TALPAR	TAPA3	<i>Talinum parviflorum</i>	showy flameflower	Portulacaceae	N	X	
4	TETACA	TEAC	<i>Tetranneuris acaulis</i>	stemless hymenoxys	Asteraceae	N	X	no, but <i>T. grandiflora</i>
4	TEULAC	TELA	<i>Teucrium laciniatum</i>	lacy germander	Lamiaceae	N	X	x
4	THEMEG	THME	<i>Thelesperma megapotamicum</i>	Hopi tea greenthread	Asteraceae	N	X	x
4	TRAPRA	TRPR	<i>Tragopogon pratensis</i>	meadow salsify	Asteraceae	I	X	no, but <i>T. dubius</i>
4	VERENC	VEEN	<i>Verbesina encelioides</i>	golden crownbeard	Asteraceae	N	X	x
4	VERMAC	VEMA	<i>Verbena macdougalii</i>	MacDougal verbena	Verbenaceae	N	P	no, but <i>V. bipinnatifida</i>
4	VERTHA	VETH	<i>Verbascum thapsus</i>	common mullein	Scrophulariaceae	I	P	x
4	ZIGELE	ZIEL2	<i>Zigadenus elegans</i>	mountain deathcamas	Liliaceae	N	X	

Table A2. Plant species surveyed at Fort Union National Monument by Natural Heritage New Mexico between 2000 and 2002.
 Alphabetical by common name within lifeform

LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
1	QUEGRI	QUGR3	<i>Quercus grisea</i>	gray oak	Fagaceae	N	X	
1	POPANG	POAN3	<i>Populus angustifolia</i>	narrowleaf cottonwood	Salicaceae	N	X	
1	JUNMON	JUMO	<i>Juniperus monosperma</i>	oneseed juniper	Cupressaceae	N	X	
1	SALAMY	SAAM2	<i>Salix amygdaloides</i>	peachleaf willow	Salicaceae	N	X	
1	PINEDU	PIED	<i>Pinus edulis</i>	pinyon pine	Pinaceae	N	X	
1	PINPONS	PIPOS	<i>Pinus ponderosa</i> var. <i>scopulorum</i>	ponderosa pine	Pinaceae	N	X	
1	JUNSCO	JUSC2	<i>Juniperus scopulorum</i>	Rocky Mountain juniper	Cupressaceae	N	X	
1	ULMPUM	ULPU	<i>Ulmus pumila</i>	Siberian elm	Ulmaceae	I	X	
2	FALPAR	FAPA	<i>Fallugia paradoxa</i>	Apacheplume	Rosaceae	N	X	x
2	BRICAL	BRCA3	<i>Brickellia californica</i>	California brickellbush	Asteraceae	N	X	
2	SALEXI	SAEX	<i>Salix exigua</i>	coyote willow	Salicaceae	N	X	
2	AMOFRU	AMFR	<i>Amorpha fruticosa</i>	desert indigobush	Fabaceae	N	X	
2	BRIEUPC	BREUC2	<i>Brickellia eupatorioides</i> var. <i>chlorolepis</i>	false boneset	Asteraceae	N	X	
2	ATRCAN	ATCA2	<i>Atriplex canescens</i>	fourwing saltbush	Chenopodiaceae	N	X	x
2	PHYMON	PHMO4	<i>Physocarpus monogynus</i>	mountain ninebark	Rosaceae	N	X	
2	TOXRAD	TORA2	<i>Toxicodendron radicans</i>	poison ivy	Anacardiaceae	N	X	
2	BRIMICS	BRMIS	<i>Brickellia microphylla</i> var. <i>scabra</i>	rough brickellbush	Asteraceae	N	X	
2	CHRNAUL	CHNAL2	<i>Chrysothamnus nauseosus</i> ssp. <i>latisquamous</i>	rubber rabbitbrush	Asteraceae	N	X	x (C. nauseosus)
2	NOLMIC	NOMI	<i>Nolina microcarpa</i>	sacahuista	Agavaceae	N	P	
2	RHUTRI	RHTR	<i>Rhus trilobata</i>	skunkbush sumac	Anacardiaceae	N	P	x
2	YUCGLA	YUGL	<i>Yucca glauca</i>	soapweed yucca	Agavaceae	N	P	x
2	QUEUND	QUUN	<i>Quercus undulata</i>	wavyleaf oak	Fagaceae	N	X	
2	RIBCER	RICE	<i>Ribes cereum</i>	wax currant	Grossulariaceae	N	X	
2	CLELIG	CLLI2	<i>Clematis ligusticifolia</i>	western white clematis	Ranunculaceae	N	X	
2	KRALAN2	KRLA2	<i>Krascheninnikovia lanata</i>	winterfat	Chenopodiaceae	N	X	
2	ROSWOO	ROWO	<i>Rosa woodsii</i>	Woods' rose	Rosaceae	N	X	
2.5	GUTSAR	GUSA2	<i>Gutierrezia sarothrae</i>	broom snakeweed	Asteraceae	N	P	x
2.5	ARTFRI	ARFR4	<i>Artemisia frigida</i>	fringed sagewort	Asteraceae	N	P	x
2.5	ECHVIR	ECVI2	<i>Echinocereus viridiflorus</i>	nylon hedgehog cactus	Cactaceae	N	P	x
2.5	OPUPOL	OPPO	<i>Opuntia polyacantha</i>	plains pricklypear	Cactaceae	N	P	x
2.5	BRIBRA	BRBR2	<i>Brickellia brachyphylla</i>	plumed brickellbush	Asteraceae	N	X	
2.5	ZINGRA	ZIGR	<i>Zinnia grandiflora</i>	Rocky Mountain zinnia	Asteraceae	N	X	x

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LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
2.5	ECHCOC	ECCO5	<i>Echinocereus coccineus</i>	scarlet hedgehog cactus	Cactaceae	N	P	
2.5	OPUPHA	OPPH	<i>Opuntia phaeacantha</i>	tulip pricklypear	Cactaceae	N	P	
3	SPOAIR	SPAI	<i>Sporobolus airoides</i>	alkali sacaton	Poaceae	N	X	
3	JUNARCB	JUBA	<i>Juncus arcticus</i> var. <i>balticus</i>	Baltic rush	Juncaceae	N	X	
3	BOUGRA	BOGR2	<i>Bouteloua gracilis</i>	blue grama	Poaceae	N	P	x
3	ELYELY	ELEL5	<i>Elymus elymoides</i>	bottlebrush squirreltail	Poaceae	N	X	x (<i>E. longifolius</i>)
3	LYCSET	LYSE3	<i>Lycurus setosus</i>	Bristly Wolfstail	Poaceae	N	X	x
3	ELYCAN	ELCA4	<i>Elymus canadensis</i>	Canada wildrye	Poaceae	N	X	
3	CYPFEN	CYFE2	<i>Cyperus fendlerianus</i>	Fendler's flatsedge	Cyperaceae	N	X	
3	BOUHIR	BOHI2	<i>Bouteloua hirsuta</i>	hairy grama	Poaceae	N	X	
3	DISSPI	DISP	<i>Distichlis spicata</i>	inland saltgrass	Poaceae	N	X	
3	SCHSCO	SCSC	<i>Schizachyrium scoparium</i>	little bluestem	Poaceae	N	X	
3	ORYMIC	ORMI2	<i>Oryzopsis micrantha</i>	littleseed ricegrass	Poaceae	N	X	
3	MUHMON	MUMO	<i>Muhlenbergia montana</i>	mountain muhly	Poaceae	N	X	
3	BROANO	BRAN	<i>Bromus anomalus</i>	nodding brome	Poaceae	N	X	
3	ARIDIV	ARDI5	<i>Aristida divaricata</i>	poverty threeawn	Poaceae	N	X	
3	ARIPUR	ARPU9	<i>Aristida purpurea</i>	purple threeawn	Poaceae	N	P	x
3	AGRGIG	AGGI2	<i>Agrostis gigantea</i>	redtop	Poaceae	I	X	
3	BROCAT	BRCA6	<i>Bromus catharticus</i>	rescuegrass	Poaceae	I	X	x
3	MUHTOR	MUTO2	<i>Muhlenbergia torreyi</i>	ring muhly	Poaceae	N	P	
3	CARROS	CARO5	<i>Carex rossii</i>	Ross' sedge	Cyperaceae	N	X	
3	SPOCRY	SPCR	<i>Sporobolus cryptandrus</i>	sand dropseed	Poaceae	N	X	
3	CAREX	CAREX	<i>Carex</i> spp.	sedge	Cyperaceae	-	X	
3	BOUCUR	BOCU	<i>Bouteloua curtipendula</i>	sideoats grama	Poaceae	N	P	
3	STIROB	STRO3	<i>Stipa robusta</i>	sleepygrass	Poaceae	N	X	
3	ELYTRA	ELTR7	<i>Elymus trachycaulus</i>	slender wheatgrass	Poaceae	N	X	
3	MUHWRI	MUWR	<i>Muhlenbergia wrightii</i>	spike muhly	Poaceae	N	X	
3	PANVIR	PAVI	<i>Panicum virgatum</i>	switchgrass	Poaceae	N	X	
3	PANOBT	PAOB	<i>Panicum obtusum</i>	vine mesquite	Poaceae	N	X	x
3	CAROCC	CAOC2	<i>Carex occidentalis</i>	western sedge	Cyperaceae	N	X	
3	PASSMI	PASM	<i>Pascopyrum smithii</i>	western wheatgrass	Poaceae	N	X	x (<i>Elymus smithii</i>)
3	PANCAP	PACA6	<i>Panicum capillare</i>	witchgrass	Poaceae	N	X	

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Alphabetical by common name within lifeform

LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
4	GLYLEP	GLLE3	<i>Glycyrrhiza lepidota</i>	American licorice	Fabaceae	N	X	x
4	COMDIA	CODI4	<i>Commelina dianthifolia</i>	birdbill dayflower	Commelinaceae	N	#	
4	SENSPAM	SENMUL	<i>Senecio spartioides</i> var. <i>multicapitatus</i>	broomlike ragwort	Asteraceae	N	X	
4	LATEUC	LAEU	<i>Lathyrus eucosmus</i>	bush peavine	Fabaceae	N	X	x
4	CRYTHY	CRTYH	<i>Cryptantha thyrsoiflora</i>	calcareous cryptantha	Boraginaceae	N	X	no, but <i>C. crassisepala</i>
4	CONCAN	COCA5	<i>Conyza canadensis</i>	Canadian horseweed	Asteraceae	N	X	
4	AMAPAL	AMPA	<i>Amaranthus palmeri</i>	carelessweed	Amaranthaceae	N	P	
4	ARTCAR	ARCA14	<i>Artemisia carruthii</i>	Carruth's sagewort	Asteraceae	N	X	
4	KOCSCO	KOSC	<i>Kochia scoparia</i>	common kochia	Chenopodiaceae	I	X	no, but <i>K. americana</i>
4	VERTHA	VETH	<i>Verbascum thapsus</i>	common mullein	Scrophulariaceae	I	P	x
4	POROLE	POOL	<i>Portulaca oleracea</i>	common purslane	Portulacaceae	N	X	
4	HELANN	HEAN3	<i>Helianthus annuus</i>	common sunflower	Asteraceae	N	X	x
4	OXYTRO	OXYT	<i>Oxytropis</i> spp.	Crazyweed	Fabaceae	N	X	
4	OENCOR	OECO2	<i>Oenothera coronopifolia</i>	crownleaf evening-primrose	Onagraceae	N	X	no, but <i>O. albicaulis</i>
4	GRINUDA	GRNUA	<i>Grindelia nuda</i> var. <i>aphanactis</i>	curlytop gumweed	Asteraceae	N	X	no, but <i>G. squarosa</i>
4	EUPDAV	EUDA5	<i>Euphorbia davidii</i>	David's spurge	Euphorbiaceae	I	X	
4	LIAPUN	LIPU	<i>Liatris punctata</i>	dotted gayfeather	Asteraceae	N	X	x
4	ENGPER	ENPE4	<i>Engelmannia peristenia</i>	Engelmann's daisy	Asteraceae	N	X	= <i>Engelmannia pinnatifida</i>
4	CHAFEN	CHFE3	<i>Chamaesyce fendleri</i>	Fendler's sandmat	Euphorbiaceae	N	X	
4	DYSPAP	DYPA	<i>Dyssodia papposa</i>	fetid marigold	Asteraceae	N	X	x
4	CONARV	COAR4	<i>Convolvulus arvensis</i>	field bindweed	Convolvulaceae	I	X	x
4	HYMFIL	HYFI	<i>Hymenopappus filifolius</i>	fineleaf hymenopappus	Asteraceae	N	X	x
4	VERENC	VEEN	<i>Verbesina encelioides</i>	golden crownbeard	Asteraceae	N	X	x
4	SPHINC	SPIN2	<i>Sphaeralcea incana</i>	gray globemallow	Malvaceae	N	X	
4	RATTAG	RATA	<i>Ratibida tagetes</i>	green prairie coneflower	Asteraceae	N	X	x
4	HETVILM	HEVIM3	<i>Heterotheca villosa</i> var. <i>minor</i>	hairy false goldenaster	Asteraceae	N	X	x (<i>Chrysopsis villosa</i>)
4	ERIHIE	ERHI3	<i>Eriogonum hieraciifolium</i>	hawkweed buckwheat	Polygonaceae	N	X	
4	SYMERI	SYERE	<i>Symphyotrichum ericoides</i>	heath aster	Asteraceae	N	X	
4	CHEHIA	CHHI	<i>Chenopodium hians</i>	hians goosefoot	Chenopodiaceae	N	X	no, but <i>C. watsonii</i>
4	ERICAN	ERCA4	<i>Erigeron canus</i>	hoary fleabane	Asteraceae	N	X	
4	MACCANA	MACAA	<i>Machaeranthera canescens</i> var. <i>ambigua</i>	hoary tansyaster	Asteraceae	N	X	x (<i>Machaeranthera canescens</i>)
4	THEMEG	THME	<i>Thelesperma megapotamicum</i>	Hopi tea greenthread	Asteraceae	N	X	x

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LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
4	MARVUL	MAVU	Marrubium vulgare	horehound	Lamiaceae	I	X	x
4	PHYHEDC	PHHEC	Physalis hederifolia var. comata	ivyleaf groundcherry	Solanaceae	N	X	x (var. fendleri)
4	ERIJAM	ERJA	Eriogonum jamesii	James' buckwheat	Polygonaceae	N	X	
4	TEULAC	TELA	Teucrium laciniatum	lacy germander	Lamiaceae	N	X	x
4	MACPIN	MAPIP	Machaeranthera pinnatifida	lacy tansyaster	Asteraceae	N	X	x (Haplopappus spinulosus)
4	SALREF	SARE3	Salvia reflexa	lanceleaf sage	Lamiaceae	N	X	x
4	ARTLUD	ARLU	Artemisia ludoviciana	Louisiana sagewort	Asteraceae	N	X	x
4	BERLYR	BELY	Berlandiera lyrata	lyreleaf greeneyes	Asteraceae	N	X	x
4	VERMAC	VEMA	Verbena macdougalii	MacDougal verbena	Verbenaceae	N	P	no, but V. bipinnatifida
4	MENMUL	MEMU3	Mentzelia multiflora	manyflowered mentzelia	Loasaceae	N	X	x
4	TRAPRA	TRPR	Tragopogon pratensis	meadow salsify	Asteraceae	I	X	no, but T. dubius
4	CHEINC	CHIN2	Chenopodium incanum	mealy goosefoot	Chenopodiaceae	N	X	
4	CUCFOE	CUFO	Cucurbita foetidissima	Missouri gourd	Cucurbitaceae	N	X	x
4	ZIGELE	ZIEL2	Zigadenus elegans	mountain deathcamas	Liliaceae	N	X	
4	MIRLIN	MILI3	Mirabilis linearis	narrowleaf four o'clock	Nyctaginaceae	N	X	x
4	CHELEP	CHLE4	Chenopodium leptophyllum	narrowleaf goosefoot	Chenopodiaceae	N	X	
4	ALLCER	ALCE2	Allium cernuum	nodding onion	Liliaceae	N	X	
4	COMUMBP	COUMP	Comandra umbellata ssp. pallida	pale bastard toadflax	Santalaceae	N	X	
4	LATHYR	LATHY	Lathyrus spp.	peavine	Fabaceae	-	X	
4	PINEDU1	PIED	Pinus edulis - yng regen	pinyon pine	Pinaceae	N	X	
4	SALTRA	SATR12	Salsola tragus	prickly Russian thistle	Chenopodiaceae	I	X	x (S. kali)
4	DALPUR	DAPU5	Dalea purpurea	purple prairieclover	Fabaceae	N	X	
4	CHAERI	CHER2	Chaetopappa ericoides	rose heath	Asteraceae	N	X	x
4	LYGJUN	LYJU	Lygodesmia juncea	rush skeletonplant	Asteraceae	N	X	
4	GAUCOC	GACO5	Gaura coccinea	scarlet beeblossom	Onagraceae	N	X	x
4	SPHCOC	SPCO	Sphaeralcea coccinea	scarlet globemallow	Malvaceae	N	X	x
4	TALPAR	TAPA3	Talinum parviflorum	showy flameflower	Portulacaceae	N	X	
4	SOLELA	SOEL	Solanum elaeagnifolium	silverleaf nightshade	Solanaceae	N	X	x
4	AMAHYB	AMHY	Amaranthus hybridus	slim amaranth	Amaranthaceae	N	X	x
4	PSOTEN	PSTE5	Psoraleidium tenuiflorum	slimflower scurfpea	Fabaceae	N	X	x (Psorelea tenuiflora)
4	SPHHAS	SPHA	Sphaeralcea hastulata	spear globemallow	Malvaceae	N	X	
4	ARELANS	ARLAS	Arenaria lanuginosa ssp. saxosa	spreading sandwort	Caryophyllaceae	N	X	

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 Alphabetical by common name within lifeform

LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	V	Native Plant Society List
4	TETACA	TEAC	<i>Tetaneuris acaulis</i>	stemless hymenoxys	Asteraceae	N	X	no, but <i>T. grandiflora</i>
4	IPOPUR	IPPU2	<i>Ipomoea purpurea</i>	tall morningglory	Convolvulaceae	I	X	
4	CHASER2	CHSE6	<i>Chamaesyce serpyllifolia</i>	thymeleaf sandmat	Euphorbiaceae	N	X	
4	SOLMOL	SOMO	<i>Solidago mollis</i>	velvety goldenrod	Asteraceae	N	X	
4	CIRUND	CIUN	<i>Cirsium undulatum</i>	wavyleaf thistle	Asteraceae	N	X	
4	AMBCON	AMCO3	<i>Ambrosia confertiflora</i>	weakeaf bur ragweed	Asteraceae	N	X	no, but <i>Ambrosia psilostachya</i>
4	CIRWHE	CIWH	<i>Cirsium wheeleri</i>	Wheeler's thistle	Asteraceae	N	X	
4	SYMLANH	SYLAH6	<i>Symphyotrichum lanceolatum</i> ssp. <i>hesperium</i>	white panicle aster	Asteraceae	N	X	
4	SYMFAL2	SYFAC2	<i>Symphyotrichum falcatum</i> var. <i>crassulum</i>	white prairie aster	Asteraceae	N	X	
4	DALCANO	DACAO	<i>Dalea candida</i> var. <i>oligophylla</i>	white prairieclover	Fabaceae	N	P	
4	CASINT	CAIN14	<i>Castilleja integra</i>	wholeleaf Indian paintbrush	Scrophulariaceae	N	X	x
4	ASCSub	ASSU2	<i>Asclepias subverticillata</i>	whorled milkweed	Asclepiadaceae	N	X	no, but <i>A. involucrata</i>
4	ERIALA	ERAL4	<i>Eriogonum alatum</i>	winged buckwheat	Polygonaceae	N	P	x
4	MELOFF	MEOF	<i>Meililotus officinalis</i>	yellow sweetclover	Fabaceae	I	X	x

Table A3. Plant species on the Native Plant Society list of Mary Whitmore that were *not* collected (nc) by Natural Heritage New Mexico as part of the vegetation survey between 2000 and 2002. Alphabetical by scientific name within lifeform.

LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	Comment
2.5	DALALB	DAAL	<i>Dalea albiflora</i>	whiteflower prairie clover	Fabaceae	N	nc
2.5	ERISIM	ERSI3	<i>Erigeron simplex</i>	onestem fleabane	Asteraceae	N	nc but add to list
2.5	HETVIL	HEVI4	<i>Heterotheca villosa</i>	hairy goldenaster	Asteraceae	N	NHNM:Heterotheca villosa var. minor
3	BROJAP	BRJA	<i>Bromus japonicus</i>	Japanese brome	Poaceae	I	nc
3	BROTEC	BRTE	<i>Bromus tectorum</i>	cheatgrass	Poaceae	I	nc
3	BUCDAC	BUDA	<i>Buchloe dactyloides</i>	buffalograss	Poaceae	N	nc
3	ELYLON	ELLO3	<i>Elymus longifolius</i>	longleaf squirreltail	Poaceae	N	syn = <i>Elymus elymoides</i>
3	MUHREP	MURE	<i>Muhlenbergia repens</i>	creeping muhly	Poaceae	N	nc
3	NASVIR	NAVI4	<i>Nassella viridula</i>	green needlegrass	Poaceae	N	nc
3	SCHPAN	SCPA	<i>Schedonnardus paniculatus</i>	tumblegrass	Poaceae	N	nc
4	AMBPSI	AMPS	<i>Ambrosia psilostachya</i>	Cuman ragweed	Asteraceae	N	nc, but <i>Ambrosia confertiflora</i>
4	ASCINV	ASIN14	<i>Asclepias involucrata</i>	dwarf milkweed	Asclepiadaceae	N	nc
4	ASTAGR	ASAG2	<i>Astragalus agrestis</i>	purple milkvetch	Fabaceae	N	nc
4	ASTCRA	ASCR2	<i>Astragalus crassicaucus</i>	groundplum milkvetch	Fabaceae	N	nc
4	ASTMOL	ASMO7	<i>Astragalus mollissimus</i>	woolly milkvetch	Fabaceae	N	nc
4	CASAPPM	CAAPM	<i>Castilleja chromosa</i>	wavyleaf Indian paintbrush	Scrophulariaceae		nc = <i>Castilleja applegatei</i> ssp. <i>martinii</i>
4	CHACOR	CHCO2	<i>Chamaesaracha coronopus</i>	greenleaf five eyes	Solanaceae	N	nc
4	CHEWAT	CHWA	<i>Chenopodium watsonii</i>	Watson's goosefoot	Chenopodiaceae	N	nc
4	CIRNEO	CINE	<i>Cirsium neomexicana</i>	New Mexico thistle	Asteraceae	N	nc
4	CRYCRA	CRCR3	<i>Cryptantha crassisepala</i>	hiddenflower	Boraginaceae	N	nc
4	DESPIN	DEPI	<i>Descurainia pinnata</i>	western tanseymustard	Brassicaceae	N	nc
4	ERIDIV	ERDI4	<i>Erigeron divergens</i>	spreading fleabane	Asteraceae	N	nc
4	EROCIC	ERCI6	<i>Erodium cicutarium</i>	redstem stork's bill	Geraniaceae	I	nc
4	ERYCAP	ERCA14	<i>Erysimum capitatum</i>	sanddune wallflower	Brassicaceae	N	nc
4	GAIPIN	GAPI	<i>Gaillardia pinnatifida</i>	red dome blanketflower	Asteraceae	N	nc
4	GLABIP	GLBI2	<i>Glandularia bipinnatifida</i>	Dakota mock vervain	Verbenaceae	N	nc
4	GRISQU	GRSQ	<i>Grindelia squarrosa</i>	curlycup gumweed	Asteraceae	N	nc, but <i>Grindelia nuda</i> var. <i>aphanactis</i>
4	KOCAME	KOAM	<i>Kochia americana</i>	greenmolly	Chenopodiaceae	N	syn= <i>Kochia scoparia</i>
4	LAPOCC	LAOC3	<i>Lappula occidentalis</i>	flatspine stickseed	Boraginaceae	N	nc
4	LEPDEN	LEDE	<i>Lepidium densiflorum</i>	common pepperweed	Brassicaceae	N	nc
4	LINARI2	LIAR3	<i>Linum aristatum</i>	bristle flax	Linaceae	N	nc
4	LINLEW	LILE3	<i>Linum lewisii</i>	prairie flax	Linaceae	N	nc

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LF	NHNM Code	PLANTS Symbol	Scientific Name	Common Name	Family	O	Comment
4	LITINC	LIIN2	Lithospermum incisum	narrowleaf gromwell	Boraginaceae	N	nc
4	MACBIG	MABI	Machaeranthera biglovii	Bigelow's tansyaster	Asteraceae	N	nc
4	MACCAN	MACA2	Machaeranthera canescens	hoary aster	Asteraceae	N	NHNM: Machaeranthera canescens var. ambigua
4	MEDLUP	MELU	Medicago lupulina	black medick	Fabaceae	I	nc
4	OENALB	OEAL	Oenothera albicaulis	whitest eveningprimrose	Onagraceae	N	nc, but Oenothera coronopifolia
4	OROFAS	ORFA	Orobanche fasciculata	clustered broomrape	Orobanchaceae	N	nc
4	PENWHI	PEWH	Penstemon whippleanus	Whipple's penstemon	Scrophulariaceae	N	nc
4	PHLNAN	PHNA2	Phlox nana	Santa Fe phlox	Polemoniaceae	N	nc
4	PHYHEDF	PHHEF	Physalis hederifolia var. fendleri	Fendler's groundcherry	Solanaceae	N	nc, but Physalis hederifolia var. comata
4	PLAPAT	PLPA2	Plantago patagonica	woolly plantain	Plantaginaceae	N	nc
4	PRUVUL	PRVU	Prunella vulgaris	common selfheal	Lamiaceae	N	nc
4	PSEMON	PSMO	Pseudocymopterus montanus	alpine false springparsley	Apiaceae	N	nc
4	SENMUL	SESPM	Senecio multicapitatus	broomlike ragwort	Asteraceae	N	syn=Senecio spartioides var. multicapitatus
4	SONASP	SOAS	Sonchus asper	spiny sowthistle	Asteraceae	I	nc
4	TAROFF	TAOF	Taraxacum officinale	common dandelion	Asteraceae	I	nc
4	TETSCAS	TESCS	Tetraneuris scaposa var. scaposa	stemmy four-nerve daisy	Asteraceae	N	nc, but Tetraneuris acaulis
4	TEUCAN	TECA3	Teucrium canadense	Canada germander	Lamiaceae	N	nc, but Teucrium laciniatum
4	TRADUB	TRDU	Tragopogon dubius	yellow salsify	Asteraceae	I	nc, but Tragopogon pratensis

Appendix B: Vegetation Association Key

Introduction

The following vegetation key and local vegetation descriptions for plant associations of Fort Union National Monument (FOUN) have been developed as an addendum to “A Vegetation Survey and Map of Fort Union National Monument, New Mexico” produced by Natural Heritage New Mexico for the monument in 2004 (Muldavin et al. 2004) and its update in 2009 (Version 2.0). The key and local descriptions are based on the original 14 releve plots collected for the survey plus an additional 20 plots gathered specifically for the classification in the summer of 2005. Methods for field data collection and analysis are provided in Muldavin et al. (2004). A diagnostic dichotomous key is presented developed along with detailed descriptions of floristics and environmental setting of each association. The classification hierarchy used here follows the original National Vegetation Classification System (Federal Geographic Data Committee 1997; Grossman et al. 1998). The national classification is in transition to a new hierarchy that better reflects regional biogeographical elements of vegetation (Federal Geographic Data Committee 2008). While the description in this addendum are in the old hierarchy, the new classification system is reported in Version 2.0 of the main map report of Muldavin et al (2004) to provide a linkage to subsequent maps in neighboring parks of the Southern Plains Network.

Key to the Vegetation Associations

The dichotomous key to plant associations of Fort Union National Monument that follows either explicitly specifies cover values as part of the decision rule in each step or uses specific adjectives in Table 1. Descriptions for each association follow the key.

1. Total tree cover greater than 25%, or if < 25% then shrubs clearly the dominant life form over others: **Key I. Forests and Woodlands**
1. Trees absent: **(2)**
2. Total woody shrub cover >25%, or if < 25% then shrubs clearly the dominant life form over others: **Key II: Shrubland**
2. Total woody shrub cover less than 25%, often absent, or clearly subordinate to grasses and forbs: **Key III: Herbaceous Vegetation**

Key I: Forests and Woodlands

1. Wetland broadleaf species dominate, i.e., *Populus angustifolia* (narrowleaf cottonwood) dominates the overstory canopy with *Salix exigua* (coyote willow) co-dominating in the understory: ***Populus angustifolia* / *Salix exigua* Forest**
1. Upland conifer species dominate, i.e., *Pinus edulis* (pinyon pine) and *Juniperus monosperma* (oneseed juniper) dominate the overstory canopy with *Bouteloua gracilis* (blue grama) dominant in the herbaceous layer:
***Pinus edulis* (*Juniperus monosperma*) / *Bouteloua gracilis* Woodland**

Key II. Shrublands

1. *Salix exigua* (coyote willow) dominates the shrub layer with *Juncus arcticus* var. *balticus* (Baltic rush) greater than 1% in herbaceous layer: ***Salix exigua* / *Juncus arcticus* var. *balticus* Shrubland**
1. *Salix exigua* (coyote willow) not dominant or absent: **(2)**
2. *Quercus* ×*pauciloba* (wavyleaf oak) dominates the shrub layer with *Carex occidentalis* or (western sedge) other deer sedges present in herbaceous layer: ***Quercus* ×*pauciloba* / *Carex occidentalis* Shrubland**
2. *Quercus* ×*pauciloba* (wavyleaf oak) not dominant or absent, *Rosa woodsii* (Woods' rose) dominates with *Juncus arcticus* dominant in the herbaceous layer: ***Rosa woodsii* / *Juncus arcticus* var. *balticus* Shrubland**

Key III. Herbaceous Vegetation

1. Vegetation dominated by ruderal forbs such as *Ambrosia confertiflora* and *Machaeranthera pinnatifida* or sparsely vegetated (1<% vegetation cover): **(12)**
1. Vegetation dominated by graminoids and greater than 1% cover; ruderal forbs subordinate or absent: **(2)**.
2. Vegetation of wetland and riparian areas dominated by obligate or facultative wetland species: **(3)**
2. Vegetation of upland areas and dominated by upland graminoids: **(4)**
3. *Typha latifolia* (broadleaf cattail) dominant: ***Typha latifolia* Monotype Herbaceous Vegetation**
3. *Typha latifolia* (broadleaf cattail) not dominant; poorly represented or absent; *Juncus arcticus* var. *balticus* (Baltic rush) dominant: ***Juncus arcticus* var. *balticus* / Monotypic Herbaceous Vegetation**
4. *Achnatherum robustum* abundant and dominant or co-dominant and *Artemisia frigida* common: ***Artemisia frigida* / *Achnatherum robustum* Dwarf shrub Herbaceous Vegetation**
4. *Achnatherum robustum* not dominant; poorly represented or absent: **(5)**
5. *Schizachyrium scoparium* dominant and well represented to luxuriant: ***Schizachyrium scoparium* - *Bouteloua curtipendula* Herbaceous Vegetation**
5. *Schizachyrium scoparium* (little bluestem) not dominant; poorly represented absent: **(6)**
6. *Bouteloua hirsuta* well-represented and dominant and *Artemisia frigida* common: ***Bouteloua hirsuta* / *Artemisia frigida* Herbaceous Vegetation**
6. *Bouteloua gracilis* dominant; *hirsuta* poorly represented or absent; not dominant: **(7)**

7. *Pascopyrum smithii* well represented: ***Bouteloua gracilis* - *Pascopyrum smithii*
Herbaceous Vegetation**
7. *Pascopyrum smithii* poorly represented or absent: **(8)**
8. *Krascheninnikovia lanata* common: ***Bouteloua gracilis* / *Krascheninnikovia lanata*
Shrub Herbaceous Vegetation**
8. *Krascheninnikovia lanata* uncommon or absent: **(9)**
9. *Yucca glauca* common: ***Bouteloua gracilis* / *Yucca glauca* Dwarf shrub Herbaceous
Vegetation**
9. *Yucca glauca* uncommon or absent: **(10)**
10. *Artemisia frigida* common present: ***Bouteloua gracilis* / *Artemisia frigida* Herbaceous
Vegetation**
10. *Artemisia frigida* uncommon or absent: **(11)**
11. *Aristida purpurea* (purple threeawn) well-represented:
***Bouteloua gracilis* - *Aristida purpurea* Herbaceous Vegetation**
11. *Aristida purpurea* (purple threeawn) poorly represented: ***Bouteloua gracilis* /
Monotypic Herbaceous Vegetation**
12. *Ambrosia confertiflora* and *Machaeranthera pinnatifida* or other ruderal forbs well-
represented to abundant and dominant; ground usually disturbed by animals or past
human use:
***Ambrosia confertiflora* - *Machaeranthera pinnatifida* Ruderal Herbaceous Vegetation**
12. Ruderal forbs uncommon, sites mostly bare ground, often disturbed: **Sparsely vegetated-
Bare Soil**

Descriptor	Definition
Absent	Individuals are not found in stand.
Present	Individuals found in stand.
Accidental	Individuals very infrequent, occasional, or limited to special microsites.
Scarce / Scattered	Canopy coverage < 1%.
Common	Canopy coverage > 1%.
Poorly Represented	Canopy coverage < 5%.
Well Represented	Canopy coverage >5%, but less than 25%.
Abundant	Canopy coverage > 25%, but less than 50%.
Luxuriant	Canopy coverage > 50%.
Dominant	Cover is greater than any other species of the same life form.
Co-dominant	Cover is as great as any other species of the same life form.
Regeneration	Understory trees represented by established seedlings, saplings.

Appendix C: Vegetation Association Descriptions

Introduction

The following plant association descriptions for Fort Union National Monument are presented according to the national vegetation classification hierarchy down to the Formation level. Below the Formation, they are organized the dominant species and then alphabetically by the names used in dichotomous key.

The description fields are defined as follows:

ALLIANCE: The alliance the association belongs to in the National Classification System (

ECOLOGICAL SYSTEM(S): the ecological system the association belongs in per NatureServe's Ecological Systems Classification (Comer et al. 2004).

USFWS Wetland System: U.S. Fish and Wildlife Service classification of wetlands and deepwater habitats following Cowardin et al. (1979).

Range: The range describes where this association was mapped in the project area and information on where particular plots were sampled.

ENVIRONMENTAL DESCRIPTION: Environmental description describes the abiotic conditions measured related to the association / alliance. In the local descriptions, all slopes are described as a range of elevation (lowest to highest elevation) as well as an average elevation across all plots measured in feet (ft) and meters (m). Soil profile information is derived from NTCS soil survey covering the park.

VEGETATION DESCRIPTION: This section identifies the vegetation characteristics specific to the association / alliance. Locally, total vegetation cover is described as absolute percent cover and is given as a range (lowest to highest percent cover) and / or average across all plots. In addition, Table 1 provides specific adjectives that were used when referring to abundance.

MOST ABUNDANT SPECIES: The local dominant and / or indicator species.

ASSOCIATED SPECIES: Species describes other constant species associated with all of the plots locally.

OTHER NOTEWORTHY SPECIES: Rare or other species of interest.

MAP UNITS: Vegetation map units where the plant association is either a primary or secondary component.

CONSERVATION STATUS RANK: The state-level conservation rank used to identify and prioritize conservation areas applied to NVC associations by Natural Heritage New Mexico (Table 2).

COMMENTS: Additional information on the local classification and description of the association.

CLASSIFICATION CONFIDENCE: The NHNM state classification confidence level where: 1 = strong, established type, typically five or more supporting plots; 2 = moderate, provisional type, three to four supporting plots; 3 = weak, new type; one or two plots.

ELEMENT SOURCES

Local Field Data: Plots and notes used for the description.

Database codes: Unique Natural Heritage New Mexico database code for vegetation associations; NatureServe global code if available.

Local Description Authors: Names and affiliation of the individuals who authored the local descriptions.

References: references that relate to the description. These are provided in a References list at the end of the document.

Table C1. Conservation Status Global and State Element Ranks (G-rank / S-rank)*	
Rank	Definition
G1 (S1)	Critically Imperiled. Generally 5 or fewer occurrences, and / or very few remaining acres, or very vulnerable to extinction throughout its range.
G2 (S2)	Imperiled. Generally 6-20 occurrences and / or few remaining acres, or very vulnerable to elimination throughout its range.
G3 (S3)	Vulnerable. Generally 21-100 occurrences. Either very rare and local throughout its range, or found locally, even abundantly, within a restricted range, or vulnerable to elimination throughout its range due to specific factors.
G4 (S4)	Apparently Secure. Uncommon, but not rare (although possibly quite rare in parts of its range, especially at the periphery). Apparently not vulnerable in most of its range.
G5 (S5)	Secure. Common, widespread and abundant. Not vulnerable in most of its range.
GH (SH)	Presumed Eliminated (Historic) throughout its range, with virtually no likelihood of rediscovery, but with potential for restoration.
GX (SX)	Eliminated throughout its range, with no restoration potential due to extinction of dominant or characteristic species.
GNR (SNR)	Not Yet Ranked
GNA (SNA)	Rank not applicable. <i>Ruderal</i> communities resulting from succession following significant human disturbance. <i>Invasive</i> , dominated by invasive alien species; <i>Cultural</i> is agricultural and highly modified.
GM (SM)	Modified / Managed communities resulting from management or modification of natural / near-natural vegetation.
GU	Unrankable. Status cannot be determined at this time.
G?	Unranked. Status not yet determined.
Modifiers and Rank Ranges	
?	When added to rank expresses an uncertainty about the rank in the range of 1 either way on the 1-5 scale.
G#G#	Greater uncertainty about rank is expressed by indicating the full range of ranks that may be appropriate (e.g., G1G4).
Q	Denotes questionable taxonomy for the community.
* The ranking criteria for evaluating conservation status based on Grossman et al. (1998). The global G-ranks are based on the range-wide status of a community; state ranks (S-ranks) follow the same criteria, but apply only to the within-state distribution.	

Association Descriptions

II. WOODLAND

II. A Evergreen woodland

II.A Evergreen woodland

II.A.4. Temperate or subpolar needle-leaved evergreen woodland

II.A.4.N.a. Rounded-crowned temperate or subpolar needle-leaved evergreen woodland

Pinus edulis (Juniperus monosperma) / Bouteloua gracilis Woodland

Oneseed Juniper / Blue Grama Woodland

ALLIANCE: *Pinus edulis (Juniperus sp) / Bouteloua gracilis* Woodland Alliance

ECOLOGICAL SYSTEM(S): Rocky Mountain / Great Basin Open Conifer Woodland

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This minor association of FOUN was sampled and mapped along the western boundary of the Old Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association is found on boulder-strewn escarpment slopes. Soils are rocky, shallow, and derived from limestone. The slope is steep (45%) and the aspect north-easterly (72°).

VEGETATION DESCRIPTION

Fort Union National Monument

This short-statured woodland-savanna type is dominated by *Pinus edulis* and *Juniperus monosperma* with canopies that range from 10% to 60% cover. Shrubs are generally poorly represented although *Quercus x pauciloba* can be common. Instead, the understory is characteristically grassy and dominated by well represented to abundant *Bouteloua gracilis*, along with a variety of other graminoid associates growing in the inter-tree spaces.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Tall Shrub	<i>Pinus edulis, Juniperus monosperma</i>
Graminoids	<i>Bouteloua gracilis</i>

ASSOCIATED SPECIES

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-8

CONSERVATION STATUS RANK: SNR

COMMENTS

Fort Union National Monument

This is a minor element on the far western edge of the monument, but well-documented elsewhere in New Mexico.

CLASSIFICATION CONFIDENCE: 3

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM 2005 field plot 01FU0010.

Database code: Local Description Authors: A. Browder; E. Muldavin.
Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

II.B Deciduous woodland

II.B.2 Cold-deciduous woodland

II.B.2.N.b. Temporarily flooded cold-deciduous woodland

Populus angustifolia / *Salix exigua* Forest check national classification on woodland

Narrowleaf Cottonwood / Coyote Willow Forest

ALLIANCE: *Populus angustifolia* Temporarily Flooded Woodland Alliance (A.641)

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Forested wetland

RANGE

Fort Union National Monument

This minor association can be found within the main drainage that flows into Wolf Creek in the northwest corner of the New Fort main unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association occurs at 6,745 ft (2056 m) along a low-gradient (3%), west-facing drainage channel that supports perennial water generated from nearby seeps and springs. The drainage channel may have been initiated in an old trail or roadway. Litter dominates the ground cover with some exposed soil and gravel.

VEGETATION DESCRIPTION

Fort Union National Monument

This riparian association is characterized by an open (40%) tree canopy dominated by *Populus angustifolia*. The canopy reaches a height of about 33 ft (10 m) and contains younger poles and saplings in the understory. *Juniperus scopulorum* is also common in the subcanopy. An abundant shrub layer is diagnostic and dominated by *Salix exigua* (30% cover), with *Rosa woodsii* and *Rhus trilobata* also commonly occurring. The herbaceous layer is dominated by graminoids where *Juncus arcticus* var. *balticus* and *Poa pratensis* is well represented, and *Schoenoplectus pungens* and *Agrostis stolonifera* are common (2.5%). Perennial forbs are scattered with *Psoraleidum tenuiflorum* and the exotic *Melilotus officinalis* the most abundant (0.5%).

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Tree canopy	<i>Populus angustifolia</i>
Tall Shrub	<i>Salix exigua</i>
Graminoids	<i>Juncus arcticus</i> var. <i>balticus</i> , <i>Poa pratensis</i>

ASSOCIATED SPECIES

Juniperus scopulorum, *Rosa woodsii*, *Rhus trilobata*, *Schoenoplectus pungens*, *Pascopyrum smithii*, *Elymus trachycaulus*, *Agrostis stolonifera*

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

Juncus arcticus var. *balticus*, *Schoenoplectus pungens*, and *Agrostis stolonifera* are obligate or facultative wetland indicator species.

MAP UNITS: FOUN-13

CONSERVATION STATUS RANK: G3 / S3

COMMENTS

Fort Union National Monument

A Baltic rush phase occurs where *Juncus arcticus* var. *balticus* is well represented, reaching as much as 18% cover. This association is a well-established type that has been reported elsewhere in northern New Mexico.

CLASSIFICATION CONFIDENCE: 1

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM 2005 field plot 05YC063.

Database code: NHNM plot database: NML6RecId-383; NatureServe: CEG000654.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

III. SHRUBLAND

III.B Deciduous shrubland

III.B.2 Cold-deciduous shrubland

III.B.2.N.a Temperate cold-deciduous shrubland

***Quercus x pauciloba* / *Carex occidentalis* Shrubland
Wavyleaf Oak / Western Sedge Shrubland**

ALLIANCE: *Quercus X pauciloba* Shrubland Alliance (A.941)

ECOLOGICAL SYSTEM(S): Rocky Mountain Gambel Oak-Mixed Montane Shrubland [provisional]

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This minor association of FOUN was sampled and mapped along the western boundary of the Old Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association is found on boulder-strewn escarpment slopes. Soils are rocky, shallow, and derived from lime stone. The slope is steep (45%) and the aspect north-easterly (72°).

VEGETATION DESCRIPTION

Fort Union National Monument

In this montane scrub association *Quercus x pauciloba* forms a dense shrub canopy of over 60% cover. *Rhus trilobata* is also common and there are occasional *Nolina greenei* present. Graminoids are well represented in the herbaceous layer with *Carex occidentalis* dominating at 7.5% cover. There are other scattered grasses such as *Muhlenbergia montana* and *Bouteloua gracilis*. Forbs are scarce and may include *Heterotheca fulcrata* and *Solidago mollis*.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Tall Shrub	<i>Quercus undulata</i>
Graminoids	<i>Carex occidentalis</i>

ASSOCIATED SPECIES

Rhus trilobata

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

Quercus x pauciloba is also known as *Quercus x undulata*

MAP UNITS: FOUN-8

CONSERVATION STATUS RANK: SNR

COMMENTS

Fort Union National Monument

This is a small occurrence on the far western edge of the monument. A previously undescribed type but similar to *Quercus x pauciloba* / *Bouteloua curtipendula* Shrubland known from rocky breaks in northern New Mexico.

Synonym: *Quercus undulata* / *Carex occidentalis* Shrubland

CLASSIFICATION CONFIDENCE: 3

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM 2005 field plot 01FU003.

Database code: Local Description Authors: A. Browder; E. Muldavin.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

III.B.2.N.e Seasonally flooded cold-deciduous shrubland

Salix exigua / *Juncus arcticus* var. *balticus* Shrubland Coyote Willow / Baltic Rush Shrubland

ALLIANCE: *Salix* (*exigua*, *interior*) Temporarily Flooded Shrubland Alliance (A.947)

ECOLOGICAL SYSTEM(S): Rocky Mountain Lower Montane Riparian Woodland and Shrubland (CES306.821)

USFWS WETLAND SYSTEM: Scrub-shrub wetland

RANGE

Fort Union National Monument

This association can be found within the main drainage that flows into Wolf Creek in the northwest corner of the main New Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association occurs at 6,760 ft (2,060 m) in and along a low-gradient (3 - 5%), west-facing drainage channel that supports perennial water generated from nearby seeps and springs. The drainage channel may have been initiated in an old trail or roadway. Litter dominates the ground cover with some exposed soil and gravel.

VEGETATION DESCRIPTION

Fort Union National Monument

This riparian association is characterized by a luxuriant shrub cover dominated by *Salix exigua* (98%). Other shrubs and dwarf shrubs are poorly represented. Graminoid cover is also limited, reaching 2% total cover and dominated by *Juncus arcticus* var. *balticus*. *Pascopyrum smithii* and *Elymus elymoides* are present but scattered. Forbs are poorly represented, barely exceeding 1% in total cover and including *Artemisia carruthii* and *Psoralidium tenuiflorum*.

MOST ABUNDANT SPECIES

Fort Union National Monument

Stratum

Tall Shrub
Graminoids

Species

Salix exigua
Juncus arcticus var. *balticus*, *Poa pratensis*

ASSOCIATED SPECIES

Pascopyrum smithii, *Elymus elymoides*, *Artemisia carruthii*, and *Psoraleidium tenuiflorum*

OTHER NOTEWORTHY SPECIES

Salix exigua and *Juncus arcticus* var. *balticus* are obligate wetland indicator species.

MAP UNITS: FOUN-9

CONSERVATION STATUS RANK: S3S4

COMMENTS

Fort Union National Monument

This association is a well established type that has been reported elsewhere in northern New Mexico. This association is potentially within a jurisdictional wetland.

CLASSIFICATION CONFIDENCE: 1

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM field plot 05YC061.
Database code: NHNM database NML6RecId-2387; NatureServe: to be assigned.
Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

III.B.2.N.g Saturated cold-deciduous shrubland

***Rosa woodsii* / *Juncus arcticus* ssp. *balticus* Shrubland
Woods' Rose / Baltic Rush Shrubland**

ALLIANCE: *Rosa woodsii* Saturated Flooded Shrubland Alliance (proposed)

ECOLOGICAL SYSTEM(S): Western Great Plains Open Freshwater Depression Wetland (CES303.675)
[provisional assignment]

USFWS WETLAND SYSTEM: Palustrine shrub-scrub wetland

RANGE

This major association of FOUN was sampled and mapped along the western portion of the New Fort main unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This wetland is associated with seeps and springs that occur along the north-to-south trending hillslope that bounds the Wolf Creek drainage. The slopes are about 4% on southwestern aspects (240°). There is little exposed soil or gravel.

VEGETATION DESCRIPTION

Fort Union National Monument

This Great Plains emergent wetland is dominated by graminoids approaching 45% total cover. *Juncus arcticus* var. *balticus* is the clear dominant at about 42% cover. Other graminoids are scattered and include *Muhlenbergia repens*, *Pascopyrum smithii*, and *Achnatherum robustum*. Abundant *Rosa woodsii* (40%) in the shrub layer is diagnostic.

Forbs are well represented with *Ambrosia confertiflora*, *Gaura parviflora*, and *Artemisia ludoviciana* the most abundant.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Tall Shrub	<i>Rosa woodsii</i>
Graminoids	<i>Juncus arcticus</i> ssp. <i>balticus</i>

ASSOCIATED SPECIES

Muhlenbergia repens, *Lactuca serriola*, *Gaura parviflora*, *Artemisia ludoviciana*, and *Ambrosia confertiflora*

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

Juncus arcticus var. *balticus* is an obligate wetland indicator species.

MAP UNITS FOUN-7

CONSERVATION STATUS RANK: GNR / SNR

COMMENTS

Fort Union National Monument

Adjacent sites are often patches of ruderal forbs resulting from gopher disturbance.

CLASSIFICATION CONFIDENCE: 3

ELEMENT SOURCES

Fort Union National Monument The description is based on NHNM field plot 05YC070.

Database code: NHNM database NML6RecId-2388; NatureServe: to be assigned.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

V. HERBACEOUS VEGETATION

V.A. Perennial graminoid vegetation

V.A.5 Temperate or subpolar grassland

V.A.5.N.c. Tall sod temperate or subpolar grassland

***Artemisia frigida* / *Achnatherum robustum* Dwarfshrub Herbaceous Vegetation
Fringed Sagewort / *Sleepygrass* Dwarfshrub Herbaceous Vegetation**

ALLIANCE: *Achnatherum robustum* Dwarfshrub Herbaceous Vegetation Alliance [Provisional]

ECOLOGICAL SYSTEM(S): Western Great Plains Foothill and Piedmont Grassland (CES303.817) [provisional]

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This association was sampled and mapped in the northeast corner of the main New Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association can be found elevations of around 6,835 ft (2083 m) in swales or depressions in the gently sloping (2%) plains that extend into the monument from the northeast. The swales may be associated with abandoned roads and trails (Santa Fe Trail). Litter and exposed soil are well represented, but gravel, rock, and microphytic species

are scarce or absent. Soils are variants of the Partri series (fine, mixed, mesic Aridic Argiustolls) with slow permeability and medium runoff.

VEGETATION DESCRIPTION

Fort Union National Monument

This plains grassland association is characterized by the dominance of *Achnatherum robustum* with cover reaching 22%. While *Bouteloua gracilis* is common within the association, other grass species are scattered. The dwarf shrub *Artemisia frigida* is also an indicator of the association, with up to 4% cover. Tall shrub species are poorly represented or absent. Forbs are scattered and may include *Brickellia eupatorioides* var. *chlorolepis* and *Ratibida tagetes*.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Short shrub	<i>Artemisia frigida</i>
Graminoids	<i>Achnatherum robustum</i>

ASSOCIATED SPECIES

Brickellia eupatorioides var. *chlorolepis* and *Ratibida tagetes*.

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-20

CONSERVATION STATUS RANK: SNR

COMMENTS

Fort Union National Monument

A previously undescribed association and alliance.

CLASSIFICATION CONFIDENCE: 3

ELEMENT SOURCES

Fort Union National Monument: NHNM field plot 00FU002.

Database code: NHNM database NML6RecId- 2172; NatureServe: to be assigned.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

V.A.5.N.d. Medium-tall bunch temperate or subpolar grassland

***Schizachyrium scoparium* - *Bouteloua curtipendula* Western Great Plains Herbaceous Vegetation**

Little Bluestem-Sideoats Grama Western Great Plains Herbaceous Vegetation

ALLIANCE: *Schizachyrium scoparium* - *Bouteloua curtipendula* Herbaceous Alliance (A.1225)

ECOLOGICAL SYSTEM(S): Western Great Plains Foothill and Piedmont Grassland (CES303.817)

USFWS WETLAND SYSTEM: Upland

RANGE

This association was sampled and mapped the western boundary of the Old Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association is known to occur on the north to northeast aspects (0 - 70°) of a lower toe-slope of an escarpment (5 - 12%) at 6,800 ft (2,070 m) in elevation. While grass and litter cover are high (75%), exposed soil and gravel can reach 90% and 5%, respectively.

VEGETATION DESCRIPTION

Fort Union National Monument

In this plains grassland association shrubs and subshrubs are poorly represented (3% or less) but may include *Gutierrezia sarothrae* and *Artemisia frigida*. In contrast, graminoids are luxuriant (50 - 60%) and are dominated by *Schizachyrium scoparium*, reaching a cover of 60%. *Bouteloua curtipendula* is a co-dominant at 8% cover. *Bouteloua gracilis* and *Elymus elymoides* are poorly represented. Forbs are also poorly represented with typically 3% cover or less, but species richness is high, with 23 forbs known from this association. The most common are *Eriogonum alatum* and *Thelesperma megapotamicum*.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Graminoids	<i>Schizachyrium scoparium</i> , <i>Bouteloua curtipendula</i>

ASSOCIATED SPECIES *Gutierrezia sarothrae*, *Artemisia frigida*, *Eriogonum alatum*, and *Thelesperma megapotamicum*

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-5

CONSERVATION STATUS RANK: G3 / S3

COMMENTS

Fort Union National Monument

Most *Schizachyrium scoparium* grasslands are considered vulnerable throughout their distribution.

CLASSIFICATION CONFIDENCE: 1

ELEMENT SOURCES

Fort Union National Monument: NHNM plots: 01FU002 and 05YC052.

Database code: NHNM database NML6RecId- 267; NatureServe: C EGL001594.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

V.A..N.e. Short sod temperate or subpolar grassland

***Bouteloua gracilis* Grasslands**

***Artemisia frigida* / *Bouteloua gracilis* Dwarfshrub Herbaceous Vegetation**

Fringed Sage / Blue Grama Dwarfshrub Herbaceous Vegetation

ALLIANCE: *Bouteloua gracilis* Dwarf-shrub Herbaceous Alliance (A.1571)

Ecological System(s): Western Great Plains Shortgrass Prairie (CES303.672) [provisional]; Western Great Plains Foothill and Piedmont Grassland (CES303.817) [provisional]

USFWS Wetland System: Upland

Range

Fort Union National Monument

This major association of FOUN was widely sampled and mapped on the east side of the main New Fort unit and in the Old Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association is known to occur on the south to southwest aspects (200 - 245°) on a gently sloping (2 - 3%) alluvial piedmont plain at elevations from 6,760 - 6,840 ft (2,060 - 2,080 m). Exposed soil is common but litter and grass cover predominate. The soils are deep loams to clay loams of the Partri series (fine-silty, mixed, superactive, mesic Calcic Argiustoll) with slow permeability and medium runoff.

VEGETATION DESCRIPTION

Fort Union National Monument

This plains grassland is dominated by *Bouteloua gracilis*, which can reach 60% cover. *Elymus elymoides* can also be common, and *Aristida purpurea* and *Sporobolus cryptandrus* are typically present, but scattered. The subshrub *Artemisia frigida* is an indicator species that can be well represented to abundant (5 - 30% cover). *Gutierrezia sarothrae* can also be common. Forbs range from poorly to well represented (2 - 15%) and typically include *Sphaeralcea coccinea*, *Thelesperma megapotamicum* and *Liatris punctata*. Species richness is high, with 33 forb species recorded for this association.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Short shrub	<i>Artemisia frigida</i>
Graminoids	<i>Bouteloua gracilis</i> , <i>Muhlenbergia wrightii</i> , <i>Elymus elymoides</i> , <i>Aristida purpurea</i>
Forbs	<i>Sphaeralcea coccinea</i> , <i>Liatris punctata</i>

ASSOCIATED SPECIES

Gutierrezia sarothrae, *Echinocereus viridiflorus*, *Thelesperma megapotamicum*

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-1, FOUN-2, FOUN-4

CONSERVATION STATUS RANK: G4 / S4.

COMMENTS

Fort Union National Monument

A spike mughly phase occurs where *Muhlenbergia wrightii* is well represented, reaching as much as 8% cover. Previously sampled in central New Mexico.

CLASSIFICATION CONFIDENCE: 2

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM field plots: 00FU004, 01FU001, 05YC056, and 05YC067.

Database code: NHNM database NML6RecId-2391; NatureServe: to be assigned.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

***Bouteloua gracilis* - *Aristida purpurea* Herbaceous Vegetation**
Blue Grama-Purple Threawn Herbaceous Vegetation

ALLIANCE: *Bouteloua gracilis* Herbaceous Alliance

ECOLOGICAL SYSTEM(S): Western Great Plains Shortgrass Prairie (CES303.672) [provisional]; Western Great Plains Foothill and Piedmont Grassland (CES303.817) [provisional]

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This association was sampled and mapped in both the New Fort and Old Fort units, typically adjacent to old trail cuts; scattered elsewhere.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association is found on gentle slopes (7 - 10%) at elevations of 6,780 to 6,820 ft (2,060 - 2,080m), typically adjacent to the *Bouteloua gracilis* - *Pascopyrum smithii* swales and Santa Fe Trail cuts. Litter and exposed soil are well represented, but gravel, rock, and microphytic species are scarce or absent. The soils are deep loams to clay loams of the Partri series (fine-silty, mixed, superactive, mesic Calcic Argiustoll) with slow permeability and medium runoff.

VEGETATION DESCRIPTION

Fort Union National Monument

Shrubs are scarce to poorly represented (0.5 - 3%) and can include *Gutierrezia sarothrae* and *Opuntia phaeacantha*. Graminoids are abundant to luxuriant (40 - 50%), and are co-dominated by *Bouteloua gracilis* and *Aristida purpurea*, which can reach 40% and 8% cover, respectively. Typically, *Elymus elymoides* and *Pascopyrum smithii* are present, but scarce. The forb layer is well represented, and species richness is high, with 31 species known from this association. *Artemisia carruthii*, *Teucrium laciniatum*, *Ratibida tagetes* and *Grindelia nuda* var. *aphanactis* are common.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Graminoids	<i>Bouteloua gracilis</i> , <i>Aristida purpurea</i>
Forbs	<i>Artemisia carruthii</i> , <i>Teucrium laciniatum</i> , <i>Ratibida tagetes</i> , <i>Plantago patagonica</i>

ASSOCIATED SPECIES

Gutierrezia sarothrae, *Pascopyrum smithii*, *Elymus elymoides*, *Grindelia nuda* var. *aphanactis*

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-4, FOUN-10, FOUN-12

CONSERVATION STATUS RANK: SNR-Ruderal

COMMENTS

Fort Union National Monument

A community typically associated with both past disturbance from historical fort activities and current disturbance due to pocket gophers. It is found primarily adjacent to fort structures and where the trail system converged into general use areas.

The association has been previously described in south-central and southwestern New Mexico.

CLASSIFICATION CONFIDENCE: 2

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM field plots 05YC054 and 05YC060.

Database code: NHNM database: NML6RecId-1769; NatureServe: to be assigned.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004; Sellnow 1981

***Bouteloua gracilis* / Monotypic Herbaceous Vegetation**
***Blue Grama* / Monotypic Herbaceous Vegetation**

ALLIANCE: *Bouteloua gracilis* Herbaceous Alliance (A.1282)

ECOLOGICAL SYSTEM(S): Western Great Plains Shortgrass Prairie (CES303.672); Western Great Plains Foothill and Piedmont Grassland (CES303.817).

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This minor association of FOUN was sampled to the east of the third fort in the main New Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This minor association of FOUN occurs on a southwest aspect (222°), gently sloping (4%) alluvial piedmont plain at 6,798 ft (2,072 m). The soils are deep loams to clay loams of the Partri series (fine-silty, mixed, superactive, mesic Calcic Argiustoll) with slow permeability and medium runoff. Exposed soil is common but litter and grass cover predominate.

VEGETATION DESCRIPTION

Fort Union National Monument

This plains grassland is almost exclusively dominated by *Bouteloua gracilis* (60%); other scattered grasses include *Elymus elymoides* and *Sporobolus cryptandrus*. Tall shrubs are absent and there are scattered subshrubs (0.1% in total cover, the most common being *Yucca glauca*, *Opuntia phaeacantha* and *Echinocereus viridiflorus*. Forbs are also scattered, and commonly include *Sphaeralcea coccinea*, *Ambrosia confertiflora*, and *Cirsium undulatum*.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Graminoids	<i>Bouteloua gracilis</i>

ASSOCIATED SPECIES

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS FOUN-1

CONSERVATION STATUS RANK: GNR / S5

COMMENTS

Fort Union National Monument

This association, while related to the *Bouteloua gracilis* Herbaceous Vegetation (CEGL001760) of the NVC, has a monoculture aspect of *B. gracilis*, explicitly identified here.

CLASSIFICATION CONFIDENCE: 1

ELEMENT SOURCES

Fort Union National Monument The description is based on NHNM field plot 05YC068.

Database code: NHNM database NML6RecId-1469; NatureServe: to be assigned.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

***Krascheninnikovia lanata* / *Bouteloua gracilis* Shrub Herbaceous Vegetation**

Winterfat / Blue Grama / *Shrub Herbaceous Vegetation*

ALLIANCE: *Bouteloua gracilis* Shrub Herbaceous Alliance [provisional new]

ECOLOGICAL SYSTEM(S): Western Great Plains Shortgrass Prairie (CES303.672) [provisional assignment]; Western Great Plains Foothill and Piedmont Grassland (CES303.817) [provisional assignment]

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This minor association of FOUN was sampled near the west boundary of New Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association occurs on a southwest aspect (236°), gently sloping (5%) alluvial piedmont plain at 6,732 ft (2,052 m). Locally, the occurrence is on a small rise in the plain just south of the main drainage that feeds into Wolf Creek. The soils are deep loams to clay loams of the Partri series (fine-silty, mixed, superactive, mesic Calcic Argiustoll) with slow permeability and medium runoff. Exposed soil is common but litter and grass cover predominate.

VEGETATION DESCRIPTION

Fort Union National Monument

In this plains grassland, grass cover exceeds 50% and is dominated by *Bouteloua gracilis* (30%) in association with *Elymus elymoides* (17.5%) and *Muhlenbergia torreyi* (3%). In the Shrub layer, *Krascheninnikovia lanata* is diagnostic and well represented. The subshrubs *Zinnia grandiflora* and *Artemisia frigida* are also common. Forbs are well represented as a whole and include *Engelmannia peristenia*, *Ratibida tagetes*, *Sphaeralcea coccinea* and *Teucrium laciniatum*.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Tall Shrub	<i>Krascheninnikovia lanata</i>
Graminoids	<i>Bouteloua gracilis</i>
Forbs	<i>Teucrium laciniatum</i>

ASSOCIATED SPECIES

Zinnia grandiflora, *Artemisia frigida*, *Muhlenbergia torreyi*, *Engelmannia peristenia*, *Sphaeralcea coccinea*, and *Ratibida tagetes*

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-1 [provisional]

CONSERVATION STATUS RANK: G4 / S4

COMMENTS

Fort Union National Monument

This association is also known from central New Mexico.

CLASSIFICATION CONFIDENCE: 1

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM field plot 05YC065.

Database code: NHNM database NML6RecId-587; NatureServe: CEGL001321.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

Yucca glauca / *Bouteloua gracilis* Dwarf-shrub Herbaceous Vegetation

Soapweed Yucca / Blue Grama / Dwarf-shrub Herbaceous Vegetation

ALLIANCE: *Bouteloua gracilis* Dwarf-shrub Herbaceous Alliance (A.1571)

ECOLOGICAL SYSTEM(S): Western Great Plains Shortgrass Prairie (CES303.672) [provisional].

USFWS WETLAND SYSTEM:

RANGE

Fort Union National Monument

This minor association of FOUN was sampled and mapped north of the star fort and just west of the third fort in the New Fort main unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association occurs on a southwest-facing (231°), gently sloping (4%) alluvial piedmont plain at 6,771 ft (2,052 m). It is associated with abandoned trails and roads and there is extensive exposed soil (50% of the ground surface cover) relative to grass and litter cover (45%).

VEGETATION DESCRIPTION

Fort Union National Monument

In this plains grassland, grass cover exceeds 25% and is diverse, with *Bouteloua gracilis*, *Pascopyrum smithii* and *Buchloe dactyloides* common, and *Elymus elymoides* and *Aristida purpurea* well represented. Subshrubs approach 15% total cover, and while *Gutierrezia sarothrae* is the most abundant (7.5%), *Yucca glauca* is the indicator species with a cover of 2.5%. *Zinnia grandiflora* and *Artemisia frigida* are also common subshrub associates. Total forb cover also approaches 15% cover and is diverse (23 species) with *Dalea candida* var. *oligophylla*, *Heterotheca villosa*, and *Artemisia carruthii* the most common forb associates.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Short shrub	<i>Gutierrezia sarothrae</i> , <i>Yucca glauca</i>
Graminoids	<i>Elymus elymoides</i> , <i>Aristida purpurea</i> , <i>Bouteloua gracilis</i>

ASSOCIATED SPECIES

Zinnia grandiflora, *Yucca glauca*, *Artemisia frigida*, *Pascopyrum smithii*, *Buchloe dactyloides*, *Dalea candida* var. *oligophylla*, *Heterotheca villosa*, and *Artemisia carruthii*

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-1

CONSERVATION STATUS RANK: GNR / S5

COMMENTS

Fort Union National Monument

This association, while minor here, is common elsewhere in eastern New Mexico.

This association was originally reported in Muldavin et al. (2004) per the NHPM state classification as *Bouteloua gracilis* / *Yucca glauca* Grassland (Blue Grama / Soapweed Yucca Grassland) of the *Bouteloua gracilis* Alliance.

CLASSIFICATION CONFIDENCE: 2

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHPM field plot 05YC069.

Database code: NHPM database NML6RecId-937; NatureServe: to be assigned.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

Bouteloua Hirsuta (hairy grama) Grasslands

***Artemisia frigida* / *Bouteloua hirsuta* Dwarf-shrub Herbaceous Vegetation Fringed Sagewort / Hairy Grama Dwarf-shrub Herbaceous Vegetation**

ALLIANCE: *Bouteloua hirsuta* Herbaceous Alliance (A.1285)

ECOLOGICAL SYSTEM(S): Western Great Plains Shortgrass Prairie (CES303.672) [provisional]; Western Great Plains Foothill and Piedmont Grassland (CES303.817) [provisional].

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This minor association of FOUN was sampled and mapped in the eastern portion of the New Fort main unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association can be found within abandoned old trails and roads cuts at an elevation of 6,810 ft (2,075 m). The slope is gentle (2%) and the aspect southwestern at 220°. The soils are deep loams to clay loams of the Partri series (fine-silty, mixed, superactive, mesic Calcic Argiustoll) with slow permeability and medium runoff. Exposed soil is common but litter and grass ground cover predominate.

VEGETATION DESCRIPTION

Fort Union National Monument

This Great Plains grassland is dominated by *Bouteloua hirsuta* with a cover of 20%, with *Muhlenbergia wrightii* a well represented associate. Other graminoid species and forbs are poorly represented. *Artemisia frigida* is the subshrub indicator species that is present at about 3% cover. Other subshrub species are scattered and include *Opuntia polyacantha* and *Gutierrezia sarothrae*.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Short shrubs	<i>Artemisia frigida</i>
Graminoids	<i>Bouteloua hirsuta</i> ,

ASSOCIATED SPECIES

Muhlenbergia wrightii

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS FOUN-3

CONSERVATION STATUS RANK: GNR / SNR

COMMENTS

Fort Union National Monument

This association was originally reported in Muldavin et al. (2004) per the NHNM state classification as *Bouteloua hirsuta* / *Artemisia frigida* PA (Hairy Grama / Fringed Sage Grassland).

CLASSIFICATION CONFIDENCE: 2

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM field plot 00FU005.

Database code: NHNM database NML6RecId-2392; NatureServe: to be assigned.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

Pascopyrum smithii (western wheatgrass) Grasslands

***Pascopyrum smithii* - *Bouteloua gracilis* Herbaceous Vegetation
Western Wheatgrass - Blue Grama Herbaceous Vegetation**

ALLIANCE: *Pascopyrum smithii* Herbaceous Alliance (A.1232)

ECOLOGICAL SYSTEM(S): Western Great Plains Shortgrass Prairie (CES303.672) [provisional]; Western Great Plains Foothill and Piedmont Grassland (CES303.817) [provisional]

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This association was primarily sampled and mapped west and north of the Old Fort, but small patches may occur in the New Fort unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This association is known to occur on gentle slopes (2 - 5%) within swales and old Santa Fe Trail cuts at elevations between 6,700 and 6,800 ft (2,040 - 2,070m). Exposed soil is common but litter and grass cover predominate.

VEGETATION DESCRIPTION

Fort Union National Monument

This Great Plains grassland is dominated by a mix of *Bouteloua gracilis* and *Pascopyrum smithii*, which can reach 30% and 40% cover, respectively. *Elymus elymoides* and *Aristida purpurea* can be present, but scattered. The subshrub *Artemisia frigida* is poorly represented or absent, and other low shrubs and succulents such as *Gutierrezia sarothrae*, *Opuntia phaeacantha* and *O. polyacantha* are also uncommon. In contrast, forbs are well represented, averaging 10% total cover, and include *Engelmannia peristenia*, *Ratibida tagetes* and *Sphaeralcea coccinea*.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Graminoids	<i>Bouteloua gracilis</i> , <i>Pascopyrum smithii</i>
Forbs	<i>Engelmannia peristenia</i> , <i>Plantago patagonica</i>

ASSOCIATED SPECIES

Opuntia polyacantha, *Opuntia phaeacantha*, *Gutierrezia sarothrae*, *Echinocereus viridiflorus*, *Ratibida tagetes*, *Sphaeralcea coccinea*, and *Conyza canadensis*

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-3

CONSERVATION STATUS RANK: G5 / S5

COMMENTS

Fort Union National Monument

This association was originally reported in Muldavin et al. (2004) per the NHPM state classification as the *Bouteloua gracilis* - *Pascopyrum smithii* Grassland Herbaceous Vegetation of the *Bouteloua gracilis* Alliance.

CLASSIFICATION CONFIDENCE: 1

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHPM field plots 05YC053, 05YC055.

Database code: NHPM database NML6RecId-1775; NatureServe: CEG001578.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

V.A.5.N.k Seasonally flooded temperate or subpolar grassland

Juncus arcticus ssp. *balticus* / Monotypic Herbaceous Vegetation Baltic Rush / Monotypic Grassland

ALLIANCE: *Juncus balticus* Seasonally Flooded Herbaceous Alliance (A.1374)

ECOLOGICAL SYSTEM(S): Western Great Plains Open Freshwater Depression Wetland (CES303.675)

USFWS WETLAND SYSTEM: Palustrine emergent wetland

RANGE

Fort Union National Monument

This minor association of FOUN was sampled and mapped along the western portion the New Fort main monument

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This emergent wetland is associated with seeps and springs that occur along the north-to-south trending hillslope that bounds the Wolf Creek drainage. Slopes range from 3 - 7% of southwestern aspects (220°).

VEGETATION DESCRIPTION

Fort Union National Monument

Juncus arcticus var. *balticus* dominates this Great Plains emergent wetland with cover reaching 95%. Other graminoids are scattered and can include *Achnatherum robustum* and *Sporobolus airoides*. Forbs species are few and low in cover with *Ambrosia confertiflora* the most abundant at 3% cover.

MOST ABUNDANT SPECIES

Fort Union National Monument

Stratum

Species

Graminoids

Juncus arcticus var. *balticus*

ASSOCIATED SPECIES

Ambrosia confertiflora

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

Juncus arcticus var. *balticus* is an obligate wetland indicator species.

MAP UNITS: FOUN-7

CONSERVATION STATUS RANK: G5 / S5

COMMENTS

Fort Union National Monument

CLASSIFICATION CONFIDENCE: 1

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM field plots 00FU006.

Database code: NHNM database NML6RecId-2386; NatureServe: CEGL001838.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

V.A.5.N.1 Semi permanently flooded temperate or subpolar grassland

***Typha latifolia* Herbaceous Vegetation** **Broadleaf Cattail Stand Herbaceous Vegetation**

ALLIANCE: *Typha (angustifolia, latifolia) - (Schoenoplectus spp.)* Semipermanently Flooded Herbaceous Alliance (A.1436)

ECOLOGICAL SYSTEM(S): Western Great Plains Open Freshwater Depression Wetland (CES303.675)

USFWS WETLAND SYSTEM: Palustrine emergent wetland

RANGE

This minor association of FOUN was sampled and mapped within a drainage that flows into Wolf Creek in the northwest corner of the New Fort main unit.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This wetland occurs at 6,725 ft (2,050 m) along a low-gradient (3 - 5%), west-facing (278°) drainage channel that supports perennial water generated from nearby seeps and springs. The drainage channel may have been initiated in an old trail or roadway. Litter is well represented in the ground cover of this association, while soil is scarce.

VEGETATION DESCRIPTION

Fort Union National Monument

This emergent wetland is clearly dominated by *Typha latifolia*, which reaches 80% cover. *Berula erecta* is common in the forb layer along with scattered *Epilobium ciliatum* and *Urtica dioica*. The shrub layer is represented solely by *Salix exigua*, which is common at 2% cover.

MOST ABUNDANT SPECIES

Fort Union National Monument

<u>Stratum</u>	<u>Species</u>
Forbs	<i>Typha latifolia</i>

ASSOCIATED SPECIES

Salix exigua, Berula erecta

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

Typha latifolia and *Salix exigua* are obligate wetland indicator species.

MAP UNITS: FOUN-7

CONSERVATION STATUS RANK:G5 / S5

COMMENTS

Fort Union National Monument

This is referred to in the FOUN map by Muldavin et al. 2004 as *Typha latifolia* / Monotype Herbaceous Vegetation.

CLASSIFICATION CONFIDENCE: 2

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM field plot 05YC062.

Database code: NHNM database NML6RecId-280; NatureServe: CEGLO02010.

Local Description Authors: A. Browder; E. Muldavin

REFERENCES: Muldavin et al. 2004

Park Specials

Ruderal Herbaceous Vegetation

***Ambrosia confertiflora* - *Machaeranthera pinnatifida* Ruderal Herbaceous Vegetation
Weakleaf Bur Ragweed-Lacy Tansyaster Ruderal Herbaceous Vegetation**

ALLIANCE:

ECOLOGICAL SYSTEM(S):

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This park special association that occurs mostly in the New Fort unit. was primarily sampled in areas adjacent to historical fort use or and mapped in areas of extensive animal soil perturbation or past human settlement disturbance.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This park special association occurs primarily in disturbance areas of intensive historical human use or extensive animal soil perturbation (gophers).

VEGETATION DESCRIPTION

Fort Union National Monument

The composition of this association is variable, but at the time of sampling was dominated by ruderal forb species such as *Ambrosia confertiflora* and *Machaeranthera pinnatifida* along with assorted annuals.

MOST ABUNDANT SPECIES

Fort Union National Monument

Stratum Species

Forbs *Ambrosia confertiflora* and *Machaeranthera pinnatifida*

ASSOCIATED SPECIES

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN-1, 2, 3, 6, 7, 10, 11, 15

CONSERVATION STATUS RANK: G5 / S5

COMMENTS

Fort Union National Monument

This association is likely highly variable form year to year depending on sed sources and available moisture.

CLASSIFICATION CONFIDENCE: 3

ELEMENT SOURCES

Fort Union National Monumen:t The description is based on NHNM obs. points:

Database code: NHNM database; NatureServe: .

Local Description Authors: E. Muldavin

REFERENCES: Muldavin et al. 2004

Sparsely Vegetated

ALLIANCE:

ECOLOGICAL SYSTEM(S):

USFWS WETLAND SYSTEM: Upland

RANGE

Fort Union National Monument

This park special element is distributed in decreasing intensity as distances from the forts increase.

ENVIRONMENTAL DESCRIPTION

Fort Union National Monument

This park special association occurs primarily in disturbance areas of intensive historical human use or extensive animal soil perturbation (gophers).

VEGETATION DESCRIPTION

Fort Union National Monument

Vegetation is less than 15% cover.

MOST ABUNDANT SPECIES

Fort Union National Monument

Stratum

Species

ASSOCIATED SPECIES

OTHER NOTEWORTHY SPECIES

Fort Union National Monument

MAP UNITS: FOUN

CONSERVATION STATUS RANK: G5 / S5

COMMENTS

Fort Union National Monument

CLASSIFICATION CONFIDENCE: 3

ELEMENT SOURCES

Fort Union National Monument: The description is based on NHNM obs. points:

Database code: NHNM database; NatureServe: .

Local Description Authors: E. Muldavin

REFERENCES: Muldavin et al. 2004

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