Appendix C: Monitoring Protocols

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Standard Operating Procedure:

Obtaining Approval Of GIS Data For Placement Into Utah National Guard GIS Geodatabases

References:
DIAM-MD (Ar210-20) 2001
National Spatial Data Infrastructure (NSDI)
EO 12906 (1994)
Defense Directive 3200.15
Department of Defense Instruction 4715.3.
Appendix 1 (at the end of the document)

Purpose:
This SOP ensures the maintenance and continued assurance that all spatial data incorporated into Utah National Guard GIS databases is of the highest quality and accurate to the best available knowledge.

Definition of Terms
GeoDataBase: relational database specific to ESRI ArcGIS.
UTNG Master GIS Geodatabase: Geodatabase consisting of all available GIS data from all directorates.
UTNG Environment Resource Management (ERM) GIS Geodatabase: Geodatabase consisting of Environmental GIS data. Managed and updated by ERM GIS personnel.
UTNG Construction, Facilities Management Office (CFMO) GIS Geodatabase: Geodatabase consisting of Construction and Facilities Management Office data. Managed and updated by CFMO GIS personnel.
Spatial Data: information about the location, shape, attributes, and relationships among features on the landscape. This includes, but is not limited to, remotely sensed data, map data, interior building data, and feature data.
Attribute: Information specific to an individual feature, such as the name, size, dimensions, type, use, etc.

Policies:
The management and updating of the UTNG Master GIS Geodatabase is the responsibility of the UTNG ERM GIS Manager.
The management and updating of the UTNG ERM GIS Geodatabase is the responsibility of the UTNG ERM GIS personnel.
The management and updating of the UTNG CFMO GIS Geodatabase is the responsibility of the UTNG CFMO GIS personnel.

Procedures:
QAQC: Spatial data will be visually inspected by personnel who have knowledge of the data, a “subject matter expert”. The data will be presented to the subject matter expert in paper map format to allow for corrections and comments on the map. Attribute data will be presented at the same time with a corresponding table format (i.e. Excel) to facilitate editing

by the subject matter expert. Edits will take place by the appropriate GIS personnel and follow the outlined procedure above.
Geodatabase Format: All spatial data will be compliant with Spatial Data Standards for Facilities, Infrastructure and Environment (SDSFIE) format and attribute information.
Metadata: Metadata accompanying the GIS data will meet Federal Geographic Data Content (FGDC) compliant standards. See Appendix 1 below for specifics. Metadata will be reviewed by the GIS Manager.
Items for Metadata Reference > General> Contact>Details should be filled in as follows (note this is the contact information and not the person who created the data):
Person: GIS Manager, Pat Terletzky
Organization: Utah Army National Guard
Contact Voice Telephone: (435) 797-0741
Address Type > Mailing Address
Address> 5230 Old Main Hill
Line 2: Utah State University
City> Logan
State> UT
Postal Code> 84322-5230

Responsibilities:
GIS Manager:
Ensure that a subject matter expert has evaluated the GIS data.
Ensure that GIS data is SDSFIE compliant.
Ensure that associated metadata accompanies the submitted data and that it is FGDC compliant.
ERM and CFMO GIS personnel:
Ensure that a subject matter expert has evaluated the GIS data.
Ensure that GIS data is SDSFIE complaint.
Ensure that associated metadata accompanies the submitted data and that it is FGDC compliant.
Person submitting data:
Provide spatial data in shapefile, coverage, or Geodatabase format.
Associated metadata file submitted at the same time as the spatial data.
Evidence of paper map and attribute table having been presented to a subject matter expert.

Miscellaneous:
All personnel attempting to place digital data into the UTNG GIS database must comply with this directive.
Data should be in following coordinate/projection system:UTM, Zone 12, meters, and NAD1983.

Rescission:
This SOP takes precedence over all previously written SOPs on GIS data incorporation.

Effectivity:
This directive shall take effect on 01 Nov 2004

Appendix 1

REQUIRED METADATA
BASED ON FGDC COMPLAINT STANDARDS

*Based on identification in ArcCatalog field. From the on-line help “Elements that are mandatory in the FGDC standard appear with red text in the editor. If you complete this suggested documentation, your metadata will satisfy the FGDC standard's minimum requirements.”

Outline based on the FGDC ESRI format in ArcCatalog 8.3

Parameters are not required but should be added:
Identification> Security>Security Classification
Data Quality> Horizontal Accuracy>Value
Data Quality> Source Information> General
Data Quality> Source Information> Source Citation

Identification
General
Abstract
Purpose
Access Constraints
Use Constraints
Citation
General
Originator
Publication Date
Title
Time Period
Currentness Reference
Calendar Date (Time Period Information)
Status
Progress
Update Frequency
Keywords
Keyword
Thesaurus
Data Quality (not FGDC but required if available for Utah NGB)
Positional Accuracy
Horizontal Accuracy
Value
Explanation
Process Step
Process Description

Spatial Reference
General
Geographic coordinate system name
Project coordinate system name
Horizontal datum name
Ellipsoid name
Semi-major Axis (if applicable)
West Bounding Coordinate
East Bounding Coordinate
North Bounding Coordinate
South Bounding Coordinate
Keywords
Theme
Access Constraints
Use Constraints
Metadata Reference
General
Contact> Details
Person
Organization
General> Contact Voice Telephone
Address> Address Type
Address> City
Address> State or Providence
Address> Postal Code

Fire Fuel Load Monitoring Protocol

Camp W.G. Williams
2004

Oak Procedure
Background Information
Use 17.9 foot hoops (default to 18 feet hoops) (Ottmar, 2000) for late seral, low density.
If the tree diameter is less than 5" then use the 6.8 foot hoop (default to 7 foot hoops)
Move the center of the hoop to the 10', 20', 30', and 40' points on the transects for the 7 foot diameter hoops (area = 410 sq. ft.).
Move the center of the hoop to the 20', 40', 60', and 80' points on the transects for the 18 foot hoops (area = 3431 sq. ft.).

Procedures
Go to stake and place one transect 30 degrees to the right and place a second transect 30 degrees to the left from original transect placement to use the tape as a guide for hoop placement. (Ottmar, 2000)
Look over the plot and decide the stem density class of oak. If the stem density is less than 5" then use the 7 foot hoops. Otherwise use 18 foot hoops.
Place 4 hoops down on both the first and second transects with the corresponding spacing; therefore, a total of 8 hoops will be used on each plot.
Count the trees that fall within each hoop according to size classification (0-0.49, 0.5-0.99, 1-1.49, 1.5-1.99, 2-2.99, 3-4.99, 5-10 cm) that are rooted within the hoop using the other go-no-go tool and measure the diameter 4 cm above the ground (Clary and Tiedemann 1986). If the tree diameter is over 10 cm then give the exact diameter of the tree (usually in the late seral only).
If more than half of the base of the tree is in the hoop then count the tree is counted. If not than do not count the tree in the hoop.

Calculations
Total biomass for the each stem:
$\text{Log10 } Y = 0.195 + 1.92 \text{ Log10 } X$

Where Y = ovendry biomass in kg/ha
X = basal diameter in mm

Each hoop will be broken up into size classifications (i.e. #10 0-0.5 cm, #3 0.5-1 cm, #6 1-1.5 cm, #4 1.5-2 cm, etc.). Use the equation above for each size and multiply the biomass by how many were within that size class. Once all the biomass has been calculated for each size classification add them all together to get the total biomass within the hoop for a total biomass present in kg/ha.

Juniper Procedure
Background Information
Use 17.9 foot hoops (default to 18 foot hoops) (Ottmar, 2000)
Move the center of the hoop to the 20', 40', 60', and 80' points on the transects for the 18 foot hoops (area = 3431 sq. ft.).
Each hoop is 0.005 of an acre.

Procedures
Go to stake and place one transect 30 degrees to the right and place a second transect 30 degrees to the left from original transect placement to use the tape as a guide for hoop placement. (Ottmar, 2000)
Place 4 hoops down on both the first and second transects with the corresponding spacing; therefore, a total of 8 hoops will be used on each plot.
Record the crown diameter and the Diameter of outside Bark (DOB) taken at 30 cm, or 11.8 inches, from the ground. If there is one or more than one stem at stump height record all of the diameters and you will later calculate the equivalent diameter (Meeuwig, 1979).
Record the height along with the percent cover of the trees (Grier, 1992).

Calculations
If multiple stems originate from below the soil (DOB) or more than one stem at stump height (30 cm from the ground). Calculate the equivalent diameter: (Grier, 1992)
Equivalent diameter = Square root (summation (DOB)2)
For the biomass, use the following calculation: (Meeuwig, 1979)
Ln (total aboveground biomass (kg)) = 0.85*[Ln (diameter of the outside bark at stump height or DOB(cm))] + 0.642*[Ln (total height (dm))] + 1.392*[Ln (average crown diameter (dm))] -5.805

Stump height = 30 cm = 11.8 in.
1 dm = 0.1 m
To calculate the loading per area (tons/acre):
Convert the hoop size to acres (18' hoops = 0.005 acres, therefore, multiply by 200 to get in acres). Convert the biomass to tons (2000 lbs = 1 ton). Calculate the tons per acre per hoop and take the average of the 8 hoops.

Sagebrush Live Woody Stem Count Procedure

Background Information
Use for cover types:
Sage/grass, grass/sage, sage/oak, and sage/juniper
Classify sagebrush according to the percent cover (Firemon How To)
Use 17.9 foot hoops (default to 18 feet hoops) (Ottmar, 2000) for 75% density or lower (low density plots).
If the density is over 75% then use the 6.8 foot hoop (default to 7 foot hoops)
Move the center of the hoop to the 10' and 20'points on the transects for the 7 foot diameter hoops (area = 205 sq. ft.).
Move the center of the hoop to the 20' and 40'points on the transects for the 18 foot hoops (area = 1716 sq. ft.).

Procedures
Go to stake and place one transect 30 degrees to the right and place a second transect 30 degrees to the left from original transect placement to use the tape as a guide for hoop placement. (Ottmar, 2000)
Place 2 hoops down on both the first and second transects with the corresponding spacing; therefore, a total of 4 hoops will be used on each plot (We found it to be too cumbersome to do 8 hoops; therefore, we used 4 hoops total).
Count standing woody that is at least 50% rooted within each hoop according to size classification (0-0.49, 0.5-0.99, 1-1.49, 1.5-1.99, 2-2.99, 3-4.99, 5-10 cm) for both the dead and live (more than 10% of leaves are living) woody vegetation (Brown, 1982).
Also, find the height, length (parallel to transect tape), and width (perpendicular to the transect tape) of all the live sagebrush throughout the hoops to calculate the average volume of the total sagebrush (Ottmar, 2000 and Uresk, 1977).

Calculations
To calculate the mean biomass per shrub based on the clipped shrubs use the following equation:

$$Yds = Yn + b(Xn' - Xn)$$

Where:
Yds = mean phytomass of double sampling (biomass of the plot) for each category
Yn = mean biomass/shrub based on the n =10 clipped shrubs
b = slope of regression of biomass per shrub on volume per shrub
Xn' = mean volume per shrub of the n' = number of live shrubs in the 8 plots
Xn = mean volume of the 10 clipped shrubs

(Uresk, 1977)
To calculate the variance of the biomass per shrub use the following equation:

$$\mathrm{Var}\,(\bar{Y}_{ds}) = S^2{}_{y.x}\left[\frac{1}{n} + \frac{(\bar{X}_{n'} - \bar{X}_n)^2}{\sum_{i=1}^{20}(X_i - \bar{X}_n)^2}\right] + \frac{S^2{}_y - S^2{}_{y.x}}{n'}$$

Where Var (Yds) = variance of the biomass
S2y.x = residual variance about the regression line (1-R2 and you want a low value). Find when you calculate b from first equation.
S2y = variance of the biomass data points used to find b from first equation.
Variance = (summation (Xi - μ)2)/n
Instead of the number 20 on the summation, use 10.

(Uresk, 1977)
To calculate the average biomass of sagebrush/area:
Y = Yds * Z

Where Y = the average biomass of sagebrush/ft^2
Yds = average biomass/shrub
Z = number of shrubs per square foot
(Uresk, 1977)

Destructive Sample Protocol

When collecting the sample gather the height, length, width, diameter classification, and weight.
Once the data has been gathered cut down the sample and place in a labeled bag.
Take the sample back to the oven.
If the sample is not already in a paper bag place it in one and label it.
The oven needs to be at 100 degrees Celsius.
Record the time and date the sample was placed in the oven since the sample needs to be kept in the oven for 24 hours, but if the samples were wet when they were taken they may need to be in the oven for 48 hours.
Do not place additional (new) samples in with samples that have been in the oven since the moisture can be transferred back into the samples that were already drying.
After the samples are oven dried the percent moisture content can be calculated by using the following equation:

Wet weight of sample –dry weight of sample * (100) = percent moisture content
Dry weight of sample – container tare weight

Or use the excel spreadsheet already created.

Citations:

Brown, James K.; Oberheu, Rick D.; Johnston, Cameron M. 1982. Handbook for Inventorying Surface Fuels and Biomass in the Interior West. Gen. Tech. Rep. INT-129. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 23 p.

Clary, Warren P.; Teidemann, Arthur R. 1986. Distribution of biomass within small tree and shrub form Quercus gambelii. Forest Science. 32(1): 234-242.

Grier, Charles C.; Elliott, Katherine J.; McCulloguh, Deborah G. 1992. Biomass distribution and productivity of Pinus edulis-Juniperus monosperma woodlands of north central Arizona. Forest Ecology and Management. 50: 331-350.

Meeuwig, R.O. 1979. Growth characteristics of pinyon-juniper stands in the western Great Basin. Res. Pap. INT-238. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 22 p.

Ottmar, Roger D.; Vihnanek, Robert E.; Regelbrugge, Jon C. 2000. Stereo Photo Series for Quantifying Natural Fuels. Vol. IV: Pinyon-Juniper, Chaparral, Sagebrush Types in the Southwestern United States.

Ottmar, Roger D.; Vihnanek, Robert E.; Regelbrugge, Jon C. 2000. Stereo Photo Series for Quantifying Natural Fuels. Vol. III: Lodgepole Pine, Qaking Aspen, and Gamble Oak Types in the Rocky Mountains.

Pollet, Jolie (2003). Fuel Moisture Sampling Guide. Bureau of Land Management, Utah State Office.

Uresk, D.W.; Gilbert, R.O.; Rickard, W.H. 1977. Sampling big sagebrush for phytomass. Journal of Range Management. 30(4): 311-314.

Range and Training Land Assessment Protocols

(extracted from Johnson 2000)

1.3 Plot Methodology

Figure 2. The LCTA crew in oakbrush.

Initial plot methodology is described in Tazik *et al.* (1992). Monitoring at Camp Williams was started in summer, 1993, and has occurred annually thereafter. The plot methodology was modified and additional plots added in 1995 and 1996 . Modifications to methods were constrained by the need for data to be comparable between years (Bonham 1989). Two other tasks, an assessment of concealment and surveys for noxious weeds, have been added to the LCTA crews duties. Only changes to the original methodology are described here.

Camp Williams was initially assigned 49 plots. It was felt that certain reflectance classes, which represented high-use vegetation cover types (e.g., juniper), used to assign the plots were under-represented. Therefore an additional 34 plots were added. While these plots change the original proportion of plots to reflectance classes, they were placed randomly between and within reflectance polygons. These were therefore felt to be representative of the installation and were considered "core" plots for analysis (criteria in Price *et al.* 1995). An additional 16 plots have been purposely added in under-represented, high-use training areas and other special situations over the years (special use plots).

By 1995, many plots, especially in oakbrush and other dense vegetation types, were showing signs of high use felt to be caused not by training or other land use but by the field crew during LCTA data collection (Figure 2). Little military use occurs in many of these types, especially oakbrush, but many plots were located in these types since they occupy about 30% of the camp's area. Therefore, groups of similar plots located near to each other were put on two- and three-year sampling rotations such that one is monitored every year. This does complicate analysis and will be discussed in the following Analysis Approach Section.

In 1995, the field crew started conducting walking surveys within 20 meters of each plot for a plant diversity collection. Specimens of all plants at each plot, not just those captured in monitoring data, were collected, mounted and entered into a database. This survey is updated annually. The diversity of the area can then be compared to diversity represented in plot data. This plot plant collection also ensures consistency between and within field crews and helps the crew identify plants they may not know.

The most substantial change is in collection of cover data. Previously all vertical contacts for all species at each point on a 100-meter point intercept transect were recorded. The methodology was modified so only the topmost intercept for each plant at a point is now recorded. This saves considerable time (one to three hours per plot) and appears to yield the same species composition and useful structure information, though at a modest sacrifice of some concealment information.

Cover measurement has certain drawbacks, primarily that it emphasizes dominant plants, may not reflect changes in structure and is affected by annual climatic condition (Bonham 1989).

Also, vegetation cover may stay consistent, but not reflect changes in age and structure over time. Because there are no experimental controls, interpretation of the data will include analysis of annual climatic fluctuations. The structure, as reflected in height data, will also be taken into account during interpretation.

The density methodology was modified so that species, height and count are recorded, but the X-Y coordinate is not. The main impetus was saving time (again, from one to three hours per plot) by deleting the collection of less than useful data not related to density. Density tends to over-emphasize small, numerous species (Bonham 1989), which needs to be kept in mind during interpretation.

Figure 3. Concealment board. Squares 1 through 3 are "concealed" 50% or greater by vegetation.

A more direct measure of concealment for soldiers replaced the former cover measurements. It is based on a measurement of hiding cover for mammals (Bookhout 1994). It consists of a board, six-by-one foot, divided into one-foot squares. squares are blocked more than 50% by vegetation (Figure 3). In this evaluation phase of its use, two transects are run. In the first, the board is held upright at the 25, 50, 75 and 100 meter points on the line transect, while the reader (at the headstake) records which squares are blocked more than 50% by vegetation. In the second transect, the board and the reader are 15 meters apart at six locations along the 100-meter transect.

During the field season, the crew traverses and becomes familiar with Camp Williams. To take advantage of this, they are tasked with surveying for noxious weeds as they travel to and from LCTA plots (UTNG 2000). This has proved invaluable for control efforts and takes relatively little additional effort. They have located several new introductions before the weeds became well established, which is important for control.

Despite all quality control efforts in the collection of data, small variations between field crews over the years have probably occurred. Poor field techniques can induce artificial trends in vegetation status (Anderson 1988).

1.4 Approach to Analysis

The objectives for monitoring and analysis come from and support the INRMP and the ITAM mission, including:

- Maintain community types across the landscape.
- Maintain the land to support training.
- Minimize exotic and noxious species.
- Monitor rehabilitation efforts.

The U.S. Forest Service's "Properly Functioning Condition" (PFC) is a process to identify natural systems at risk in a condition where they may not maintain themselves (USDA Forest Service 1998). Each community type in a landscape is assessed by indicators. The LCTA plots

will be assigned to the three PFC community types applicable to Camp Williams and assessed by the indicators (Table 1) for an overview of camp-wide condition.

Measurement of vegetation canopy and ground cover and of woody plant density is the heart of LCTA. The focus of analysis is on detection of change in these measurements for key indicators (Table inside rear cover). Determination of appropriate indicators requires an understanding of the vegetation types and of the nature and consequences of land use. Literature on military and non-military land use and from that related to vegetation communities will be reviewed for possible indicators of change in the next section. Scientific literature related to military land use is relatively small though expanding; that related to other factors (e.g., grazing, climate, etc.) and concerning the different vegetation types are fairly broad.

Table 1. PFC Indicators of Landscape Condition (U.S. Forest Service, Manti-Lasal National Forest).

Pinyon-juniper*		Gambel Oak*		Big Sagebrush/Grassland	
grass/forb	~10%	grass/forb	~10%	sagebrush crown cover	
seedling	~10%	early seral	~20-40%	0-5%	~10%
young forest	~20%	mid seral	~20-40%	6-15%	~50%
mid-aged forest	~20%	late seral	~20-40%	>15%	~40%
mature forest	~20%	Herbaceous layers well		Bare ground <20%;	
old forest	~20%	developed and distributed;		sagebrush is dominant.	
Shrub, forb and grass composition >20% of total; bare ground <20%.		bare ground <20%.			

*Community development stage

The UTNG was the forerunner of efforts to store and analyze LCTA data through GIS (ArcView) now called the National Environmental Database (NED). GIS enables both spatial and tabular data to be combined and compared[1]. Thus, plots can be grouped and analyzed by management (training) area, by cover type or any other subset. Paired comparisons can then be made of trends in selected indicators between plots grouped by different characteristics (e.g., cheatgrass cover between plots of varying training intensity within a particular cover type).

Data on scheduled use by training area are recorded by Range Facilities Management Scheduling System (RFMSS). Fires are typically mapped (e.g., Godfrey 1995). While grazing use is being mapped through a USU project, that information is not yet available and only estimated here. Climate data were obtained from the Draper Point of the Mountain Weather Station, about three miles away.

Table 2. Example of remedying introduced species cover for a group of eight plots.

	1993	1994	1995	1996	1997	1998
Number of plots sampled	8	8	3	5	6	6
Average by eight plots*	21%	23%	6%	26%	12%	26%
Average by number of plots	21	23	16	42	24	52
Average with data rectified	21	23	19	31	31	33

*as NED currently does it.

Many thanks to Tom Van Neil for reprogramming Camp Williams' NED.

[1] LCTA Analysis using ArcView and the NED GIS Decision Support CD's. WWW.NR.USU.EDU/NED/LCTAANAL.HTML

Interpretation of trends in indicators can be made by comparing high versus low groupings. Natural trends and processes, such as those caused by climate, will be apparent in both groupings. Plots affected by fires or other large-scale, natural disturbance will be grouped and analyzed separately. The goal is to identify indicators that are land use and community specific.

A challenge in analysis is that some plots are not sampled every year. If these data holes are ignored and plot groups are averaged, it produces an artificial trend because samples vary in composition (for instance, exclusion of a plot with high introduced cover lowers the group average for that year) (Table 2). Data holes were rectified by averaging between years for each plot (Table 3). The effect on the analysis is to smooth the trend for groups of plots. Since we are interested in long-term (several year) trends and not annual fluctuations, this seems to work well. Holes in the last year's data (1998) were filled by copying the previous year's measurement. The effect on analysis is to somewhat conceal true trends in the final year.

Table 3. A hypothetical example of rectifying missing data.

	1996	1997	1998
original data, 1997 not sampled	30%	-	40%
rectified data	30%	***35%***	40%
original data, 1998 not sampled	30%	35%	-
rectified data	30%	35%	***35%***

1.5 Indicators of Military Training

Military training can have a drastic effect on the environment, especially in arid regions. For instance, the effects of tank training under General Patton during WWII in the Mojave Desert are still visible (Prose 1985). Impacts are inherent to training and unavoidable. The severity of effect varies with the season, frequency, intensity and type of land use (Kuss 1986).

Shaw *et al.* (1990), from analysis of LCTA monitoring at the Pohakuloa Training Area (PTA), Hawaii, found that the most obvious damage was on fixed artillery firing points and favorite bivouac sites, which are repeatedly and heavily used. Both types of sites showed a decline in native species and an increase in exotic species, which were not found in other areas[2]. Similar shifts in composition have been reported by others for vehicle traffic (Goran *et al.* 1983 in Price *et al.* 1995; and Wilson 1988) and is indicative of disturbance.

In addition, cover of perennial warm-season grasses was less on areas used for tracked vehicle maneuvering compared to unused areas, which had greater cover of undesirable cool-season grasses and annual forbs (Shaw and Diersing 1990). A number of other studies have reported a shift from perennials to annuals associated with vehicle traffic (Shaw and Diersing 1990; Thurow *et al.* 1993; and Goran *et al.* 1983 in Price *et al.* 1995). Trampling by foot also influences invasion by exotic species (Crowder 1983 in Price ***et al.*** 1995).

Environmental disturbance caused by training at the PTA was associated with increased bare ground and gravel (Shaw *et al.* 1990). Similar results were noted for high traffic areas in

[2]Extracted indicators are compiled in Table 4.

Minnesota at Camp Ripley (Greene and Nichols 1996). Although soils were generally dry, the effect on wet or sloping soils was thought much greater because they are more easily compacted and eroded. Such was the finding of Wilson (1988); spring driving of tanks on Canadian prairies significantly increased bare ground over summer driving, probably due to wet soils. Denser, clayey soils inhibit infiltration, increasing soil erosion and delaying revegetation (Thurow *et al.* 1982). The intensity of effects on dry soils was mild and of shorter duration compared to those on wet soils. Increased bare ground probably indicates disturbance and can lead to erosion and weedy species establishment (Price *et al.* 1995). Although other categories of ground cover generally help protect against erosion, an increase in rock may indicate severe existing erosion. Disturbance and subsequent bare ground facilitate the invasion of exotics and noxious weeds, such as thistles.

Table 4. Key indicators of change for use in analysis

Military-specific	Juniper woodlands
decline in native species,	cover and density of juniper
increase in exotic species	proportion of trees, shrubs, forbs and grasses
decline in perennial species,	
increase in annual species	Oakbrush communities
decline in grasses,	height, cover and density of oak
increase in forbs	increasers and decreasers (Nixon 1967)
decline in total plant cover,	
decline in litter cover,	Grass and mixed forb
increase in bare ground	total vegetation cover
decline in density of woody plants	cover of perennial grasses
	...bluebunch wheatgrass
Grazing	...Sandberg bluegrass
decline in native grasses,	...woody plants
increase in cheatgrass and shrubs	...sagebrush
	...juniper
Fire	...snakeweed
decline in native grasses or shrubs,	
increase in cheatgrass	Sagebrush communities
decline in shrubs,	cover of sagebrush
increase in grasses	...rabbitbrush
	...perennial grasses
Plant communities	...cheatgrass
structural diversity	...juniper
cover of perennial grasses	
...cheatgrass	
...sagebrush	
...Gambel oak	
...juniper	

Paralleling an increase in bare ground is a decrease in plant cover. Tracked vehicle traffic at Fort Hood, Texas, was found to increase surface bulk density, erosion on wet soils, and bare ground (with high use levels) and to decrease vegetation biomass (Thurow *et al.* 1982). The effect varied by soil and vegetation type. The long-term effect of military traffic in a northern forest in Minnesota reduced total basal plant cover significantly, with an ecologically significant but sensitive species (aspen) accounting for most of the reduction (Greene and Nichols 1996). Mid-story plant cover was also significantly reduced. Moderate levels of traffic resulted in a seral stage with changed species composition, diversity and density that was moderately stable. Similarly, heavy impacts from tracked vehicles drastically reduced total vegetation cover (especially trees) and a shift from grasses to forbs was observed (Goran *et al.* 1983 in Price *et al.* 1995). Tracked-vehicle (tank) training at the Pinyon Canyon Maneuver Site (PCMS) was also found to decrease vegetation basal and litter cover and to increase bare ground (Shaw and Diersing 1990). Decreased tree cover and density was especially important in juniper stands, which tend to be highly erodible.

Impacts from military activities, especially tracked vehicles, severely reduced the density of woody species without shifting their composition at Fort Hood (Goran *et al.* 1983 in Price *et al.* 1995). Tracked vehicles compact soil, increase soil erosion and crush vegetation, particularly woody species (Diersing *et al.* 1988). Tracking was found to significantly reduce the density of all shrubs and trees, except those able to resprout, and of succulents. Density of juniper decreased 7% over two years. The understory was more seriously impacted than were the trees. Woody plants are damaged easily by trampling, by either foot or vehicle (Sun and Liddle 1993; Price *et al.* 1995). Grasses are generally resistant to trampling damage. The largest drop in species was found with only a moderate level of trampling (Kuss and Hall 1991 in Price *et al.* 1995). Trampling can also decrease the amount of litter (Thurow *et al.* 1993).

3.5 Impact from Training

The main concern of LCTA monitoring is determining what, if anything, training is doing to the environment. Other monitoring and scientific literature state that the main impacts will likely occur in high use areas, such as bivouacs and firing points, and from bivouacking and tracked vehicles more than wheeled vehicles or foot traffic. The primary effect will be to reduce tree and shrub cover and cause a shift from desirable to undesirable plants, especially cheatgrass (see Section 1.5, Indicators of Military Training).

The four LCTA plot groups discussed in this section include those thought to be in higher use areas of the training site (Figure 17). Although the data on training use captured by RFMSS was sparse, they were used to provide collaboration of these judgements. The military use and impact specific to juniper was discussed in the previous section, and little training takes place in the oak; therefore, only the sagebrush/grass plots will be discussed here.

The first area discussed is in the greater Region V area, which also includes the Land Navigation Course and the 100 Series Firing Points. Outside of individual small arms ranges, Region V is the most heavily used area on the camp[3]. Also heavily used are the 200 Series Firing Point, Area 51, and the bench area above the garrison (called East Bench here). Several other solitary plots that show impacts are also discussed. These will be compared to plots in less-used

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[3] CPT Simondi, Camp Williams Operations and Range Control, 23 February 1999.

areas on Sheps Ridge and elsewhere. The Range Areas and the Impact Area are discussed in a following section because they are not directly impacted by on-ground training but by small arms and artillery fire.

The Region V area is a relatively flat area of grasses and sagebrush with hills dominated by juniper. In 1995, a wildfire came down from the north into the sagebrush flats and burnt approximately 500 acres in this area[4]. Area 51 is the designation of a bowl-shaped area frequently used as a bivouac. Cedar Point is the southeast corner of the camp. It has primarily south aspects and contains the heavily used 200 Series Firing Points (Figure 18). The bench area includes sagebrush/grasslands and oak stands.

Results

In general, the groups with the least on-the-ground military use were in the best shape; that is, the indicators were generally more positive than those in used areas (Table 11). The groupings with the most on-ground use (e.g., bivouacs, firing points, etc.), primarily in the Region V area and the southeast corner of the facility (including the 200 Series FP), were the worst, the indicators were negative. Also, indicators of good condition were generally changing slower than poor indicators were changing for the worse. Even so, the difference between areas considered lightly or unused and heavily used was important but smaller than expected.

At first glance, the average cover of indicators in the Region V area all appear somewhat average compared to other groupings (Table 11). However, introduced and annual cover has more than doubled while native and perennial cover has only slightly increased. Shrub cover (sagebrush and bitterbrush) has declined, although snakeweed has remained constant. Cheatgrass is approximately half of the total grass cover. All grasses have fluctuated up and down but appear to remain the same proportion. This area probably has the greatest diversity of perennial grasses.

In Area 51, introduced and annual cover has increased slightly (~5% each), and native and perennial cover has decreased (~7% each). Most indicators fluctuated but appear to be in approximately the same proportions. The most significant change was in the disappearance of Sandberg bluegrass.

On Cedar Point, introduced, native, annual and perennial cover values are among the worst compared to other groupings but are all improving the most. Gambel oak cover increased slightly (~5%). While sagebrush remained unchanged, snakeweed increased from 2% to 9%. Cover of two weedy forbs, alyssum and curlcup gumweed, both increased. Cheatgrass remained relatively unchanged, as did most other grasses.

Introduced, native, annual and perennial cover on the 200 Series FP (a heavily used subset of the Cedar Point Group) were also among the worst but seemed to be improving since major artillery exercises have moved to Dugway Proving Grounds. Sagebrush cover increased, although a number of forbs that indicate disturbance were present, including alyssum, curlcup gumweed, and annual sunflower (Figure 19). Cheatgrass dramatically dropped and bulbous bluegrass increased. Two important grasses, western wheatgrass and bluebunch wheatgrass, were conspicuously absent.

On the East Bench, introduced, annual and perennial cover were also in the bottom compared to all other groups, but introduced and annual cover increased the least compared to

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[4] This area was reseeded and the affected LCTA plots are analyzed for restoration success in Section 4.8, Restoration.

other groups. Sagebrush cover decreased, largely on the undisturbed sagebrush plot discussed in Section 3.3, Sagebrush/Grass. Most other shrubs, including snakeweed, were either absent or less than 2% cover. Cheatgrass cover was the highest for any group but decreased slightly. Bluebunch wheatgrass cover was low and decreasing, while western wheatgrass and Sandberg bluegrass cover were high and increasing (again largely due to the undisturbed sagebrush plot).

Five plots, new in 1996, were not included in this analysis. These plots were deliberately placed at under-represented areas, primarily on the East Bench. Introduced, native, annual and perennial cover were all quite high. Cheatgrass was initially high but decreased by about half over the three years of monitoring (1996-1998). Most other grasses increased so that total grass cover remained relatively constant. Few forbs or shrubs indicative of disturbance were found.

Discussion

When compared to plots grouped on Sheps Ridge, the condition of these plots stand out. Introduced and annual cover ranges from slightly to much higher, although only on one plot is it increasing greater than on the ridge. Native and perennial cover is much lower and either decreasing or increasing slower than elsewhere on all but Cedar Point. Cheatgrass cover is higher and increasing faster. The trend of other species vary, probably due to differences in the sites and vegetation.

If the juniper plots are included, the Region V area is in the worst condition of anywhere and, with two exceptions, the trends are among the worst. While natural processes within juniper and from wildfire have had an effect, it is clear that military training is having an undesirable impact as well. Much of what was discussed for the juniper plots in the previous section applies for the larger area as well. Military training appears to be having a similar, undesirable impact on Area 51 as well.

Cedar Point is probably used less than the other areas, and the cover values show it. The originally low values are probably due to its being a southern slope, making it a less hospitable site to begin with. The two plots on the 200 Series FP, however, were in a worse condition than the surrounding area, and the trends were not improving. They had a number of forbs present and important grasses absent that both indicate disturbance.

The East Bench area has probably been historically heavily used, since it is so close to the garrison area and therefore convenient for day training use. The cover indicated poor condition, but the trends were somewhat positive.

3.6 Impact from Weapon and Artillery Fire

The main effect on the environment from weapon and artillery firing appears to be an increase in fires and fire-associated effects. Fires are a natural part of semi-arid ecosystems, changing the structure and composition of vegetation. The main harmful effect is on non-sprouting species and cover types, where fires change juniper and sagebrush cover types into grasslands[5]. Desirable species are often replaced after fire by cheatgrass, an introduced, fire-prone species, and other weedy species. Despite this, fires are not necessarily bad and can drive beneficial natural processes, including nutrient cycling. However, Camp Williams experiences

[5] Discussed in Section 1.7, Description and Indicators in Vegetation Communities, Sagebrush Communities.

fires more frequently than would occur naturally. These fires are the result of small arms and artillery firing (Godfrey 1995).

However, neither area receives vehicle or foot traffic or other military training use due to hazard restrictions associated with the live ordinance, which somewhat offsets damage compared to other areas. This protection of sorts has been since the small arms ranges were moved from another area in the mid-1980's. However, the impact of livestock grazing complicates analysis and assignation of cause. Cattle and sheep have grazed these areas for many years and probably heavily in the early part of the century. Sheep are typically trailed along the Range areas annually, and both areas have traditionally been heavily grazed by cattle summer-long.

Figure 20. A new artillery impact crater.

The LCTA plots in the Range grouping are on the hills above the small arms ranges along the south border of the Impact Area and in the lower half of Oak Springs. They tend to be on dry, somewhat rocky, south or west slopes, which make it a poorer site than elsewhere. The primary discussion involves six sagebrush/grass plots established in 1993. Another four plots were established in 1996, two in grass, one in oakbrush and the last in juniper.

The Impact Area is so called because it receives the impact from artillery fire. The main visible impact are craters approximately five feet across and several deep (Figure 20) and past fires. Craters are frequent close to targets with few found further away, and they fill in quickly. The 11 original plots in the Impact Area are sagebrush/grass vegetation types. Two additional plots, in tree-size oak and in juniper, were established in 1996.

Table 14. Cover values of important indicators in the Range and Impact Area.

	Ranges		Impact Area	
	1993	1998	1993	1998
Bare Ground	%	%	%	%
Introduced	26	40	29	36
Native	33	43	49	54
Annual	30	36	23	34
Perennial	29	41	54	55
Grass	37	39	29	39
Bluebunch	14	7	6	6
Cheatgrass	22	20	17	23
Bitterbrush	1	1	7	9
Snakeweed	1	7	3	5

Results

In the Range area, introduced, annual, native and perennial cover average about 30% each in 1993 and about 40% in 1998 (Table 14). Total grass cover remained fairly constant; although bluebunch wheatgrass cover decreased from14 to 7% other grasses increased slightly to make up the difference. Cheatgrass cover fluctuated between 20% and 28% during the six years but seemed stable. Forb cover increased from 15 to 30%, primarily in alyssum (3 to 17%) and wooly mullein (1 to 5%). Both are considered weedy species that invade disturbed, gravelly areas (Whitson 1996). Shrub cover doubled from 9 to 18%. While an increase in snakeweed was expected (1 to 7%), an increase in sagebrush in an area where the primary disturbance is fire was

not (6 to 10%). Only one of the plots could be called a sagebrush cover type, the majority are grass/weed types with some sagebrush. The highest sagebrush cover was in a plot that is not "downrange" of small arms fire; the plots downrange had low cover relative to elsewhere. Slight amounts (3-4%) of juniper were found on two of these plots. The cover and apparent trends on the two sagebrush plots established later in 1996 were comparable.

The oak plot in the Range area had modest levels of Gambel oak and had a stable understory mix of sagebrush, bitterbrush, snakeweed and other shrubs. While native and perennial species covers were higher, there were a fair number of introduced and annual species unlike most oak plots. The reason is that the oak here is in small stands (or mottes) interspersed with open grassy areas like a savanna.

In the Impact Area, average introduced, native, annual and perennial cover increased gradually (Table 14). Grass cover increased, some of which was due to cheatgrass, but western wheatgrass and crested wheatgrass also increased to 2% each. Forbs fluctuated but ended with the same cover. One plot had a significant cover (30%) of annual sunflower (indicating fire disturbance) in 1993, which disappeared over time. Shrubs essentially remained the same. Bitterbrush was much more abundant in the Impact Area than any other area on the camp and remained essentially unchanged. Snakeweed cover was moderate and essentially unchanged. Rabbitbrush was found in a trace amount on one plot (1%). Juniper and oak were found in minor amounts (3-4%) on two of the original plots.

Only three years of data exists for the juniper plot established later in the Impact Area. All indicators dip significantly in 1997 then rebound to as high or higher in 1998. Introduced (60%) and annual (64%) cover is extremely high in 1998; predominantly of cheatgrass and alyssum, both undesirable weeds. Native/perennial cover is more stable (49%, 44%, 50%) and primarily consists of juniper and tall wheatgrass. The biodiversity of this stand is low. The oak plot was the tree-stage plot discussed previously in the Landscape Analysis section on Gambel Oak. It is significant because it is one of the two oak tree stands (which provide different habitat than does the shrub or young pole stages), both of which are in the Impact Area.

Discussion

The plots above the Range area indicate a poorer condition than are those in the Impact Area or on the adjacent Sheps Ridge. The ratio of introduced and annual to native and perennial cover are the worst for anywhere. Cheatgrass is about 2/3 of the total grass cover. Forbs that indicate disturbance are increasing. Snakeweed increased over seven times its original low value.

Any impact is probably not due to fires, since shrub cover has doubled, albeit partly due to the undesirable snakeweed, and juniper is present -- both of which are fire-intolerant. Although the increase in shrub cover and decrease in the cover of desirable forage grasses parallels changes on Sheps Ridge, the accelerated degree of change indicates that grazing might have a role. However, poorer site quality (soils in the Range Areas appear to be more gravelly, less fertile and on steeper slopes with southern aspects) is probably a more significant factor than grazing in evaluating the change.

The plots in the Impact Area show relatively little disturbance and appear to be in a more favorable condition than either those on Sheps Ridge or along the Ranges. Total vegetation cover is increasing, which is probably a function of a wetter climatic cycle (see Section 4.1, Interpretation of Trends). The increase in grass cover may indicate that grazing is not impacting the area as severely as above the ranges. Although one of the plots was burnt within two years

before monitoring started, the evidence suggests that fires do not play a widespread role in the area's condition. That shrub cover, in particular bitterbrush, is high and junipers are invading several plots indicates that while fire may affect limited areas, they do not greatly influence the condition of the Impact Area as a whole.

Pygmy Rabbits and Sage Grouse

Submitted by Dr. Michael Wolfe
Dept. Forest, Range & Wildlife Sciences
Utah State University

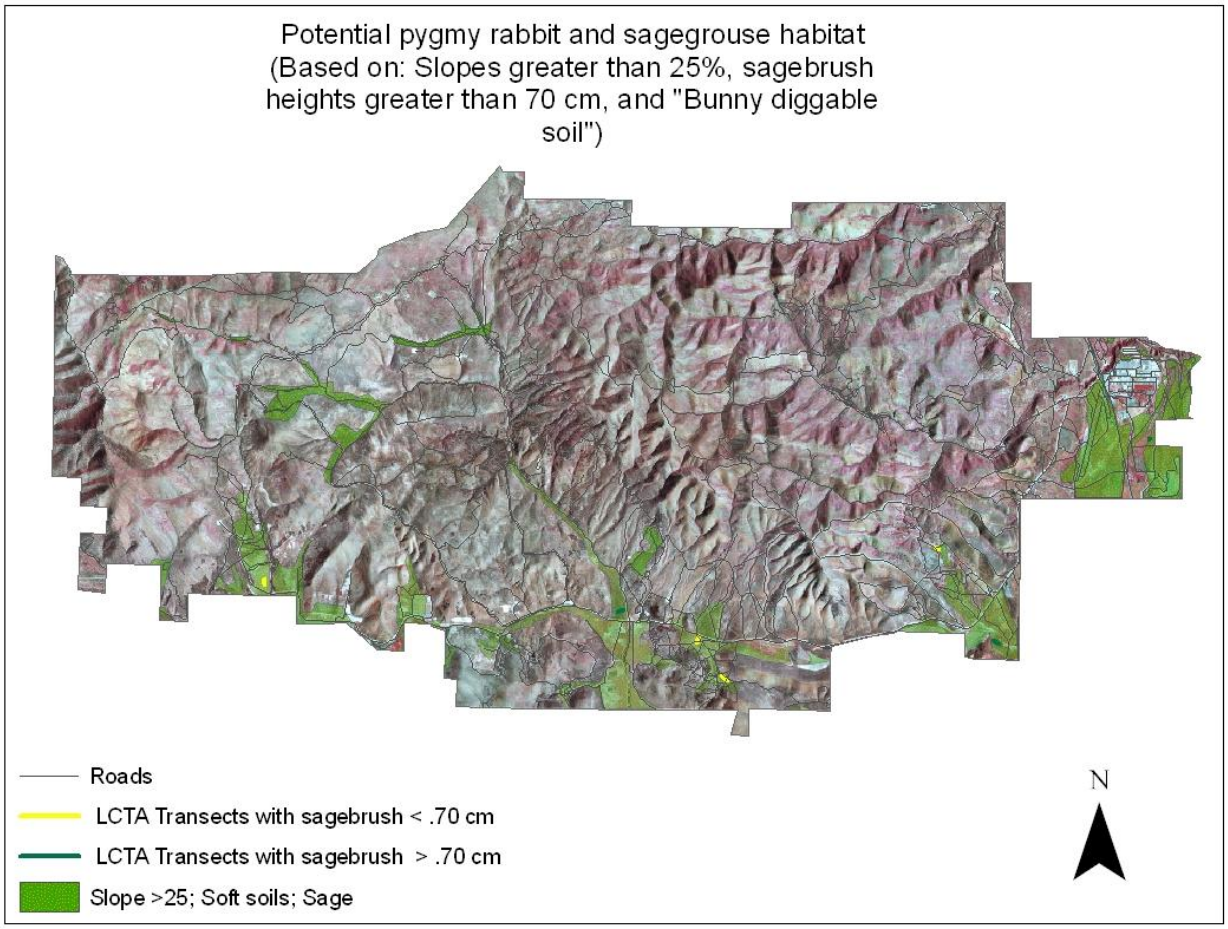
The Camp Williams (CW) property falls within the historic range of two sagebrush-obligate species, namely pygmy rabbit (Brachylagus idahoensis) and greater sage-grouse (Centrocercus urophasianus), that are listed on the Utah Sensitive Species List. Both species are listed as "Wildlife Species of Concern," and the pygmy rabbit has been proposed as a candidate for listing pursuant to the provisions of the Endangered Species Act (ESA)1. Neither species has been documented on the installation since the inception of faunal surveys in 1992, but sage grouse were observed on the Kennecott Utah Copper property in 2003 (Hendrix, personal communication).

In 2004 nominal surveys were initiated to document the possible occurrence of these species at AGCW. For pygmy rabbits, a GIS algorithm was developed based on information contained in the literature, which would generate a priori locations of the highest probability of occurrence. These factors included: (1) slopes of <25%; (2) sagebrush vegetation with a height of 70 cm; and (3) soft soils. These were used to produce a map (Figure 1), which provided locations for on-the-ground searches for possible indications of the species presence.

Ground-based searches were conducted at two locations, which according to the map suggested the highest probability of occurrence of pygmy rabbits. These searches were conducted on 14 April and 04 May at two locations in the Tickville Gulch area. The latter search involved the RTLA crew for the summer of 2004. They had received instruction on recognition of signs of the presence of pygmy rabbits and sage grouse. The instruction was a modified version of a PowerPoint presentation developed by the Utah Division of Wildlife Resources to train personnel from various agencies and NGO's, which included photographs of pygmy rabbit sign (i.e., burrows and fecal pellets) as well as droppings of sage grouse.

Neither of these searches revealed evidence of the presence of either species. Similar surveys need to be conducted at other locations of possible occurrence on the facility.

[1] It has since been rejected for listing.



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Riparian Monitoring

Standard Operating Procedure

Materials Needed:

Tape marked in feet
GPS Unit
Datasheets, clipboard, writing utensil
Stakes and Hammer
Camera
Compass

Riparian Monitoring

The base methods for riparian monitoring at Camp W.G. Williams are taken from Winward (2000) for the Vegetation Cross-Section Composition and Platts et al (1987) for the Streambank Stability.

Transects are established perpendicular to the grade in the riparian area in such a way as to cross the entire riparian area. These transects should be randomly placed in such a way as to best represent the entire complex. One foot increments will be used to calculate community type composition in the areas categorized as stream rather than the steps used by Winward because of the small nature of the streams. Steps will be used in the areas categorized as marsh. The data gathered is designed to quantify the percent of each community type in a particular complex.

Streambank stability will measure the ability of vegetation and other materials on the streambank to resist soil and vegetative erosion from flowing water and ice.

Transect data needs to be entered at the end of each day and the photos downloaded to the computer and labeled according to transect.

Methodology

For riparian complexes categorized as stream at least 3 transects will be placed. For riparian complexes categorized as marsh at least 2 transects will be placed. The beginning and ending points for each transect will be permanently marked with stakes. These stakes should be placed far enough back in the non-riparian area to allow for subsequent quantification in case the riparian area expands in size. The stakes should then be marked with a GPS unit.
Vegetation Cross-Section Composition

Community type composition is obtained by taking the total number of feet encountered for each type in all the transects divided by the total number of feet measured in all the transects.

Composition should be recorded from bank-full to bank-full and not from stake to stake. Bank-full is defined as the height of the stream at peak flow.

$$\frac{\text{Number of feet/steps of each community type}}{\text{Total number of feet/steps}} = \text{Community type Composition}$$

Dominant species will be listed first on the data sheet using the plant codes, and any co-dominant species will be listed second. No more than two species should be listed for community types. Community types should be lumped rather than split to simplify the process and reduce subjectivity.

Streambank Stability

A streambank stability rating will be made at each transect following the guidelines on the data sheet. The ratings will then be averaged to obtain an overall streambank stability rating. The rating should be based on the lesser of the two sides for each transect.

Photopoints

A photo will be taken at each transect. The photo should be taken from the side of the transect providing the best view and that information recorded for future reference (when both sides have a similar view the photo should be taken from the right hand side when facing downstream). Photos will also be taken at other points of interest. These points should be marked with the GPS unit and a stake and the azimuth recorded for future reference.

The SOP for the Riparian Transects looks good. We could not find anything that needed to be changed. We do have a few things that we thought need to be mentioned for future users though.
The Riparian folder containing the pressed plants is out of date and needs to be updated. It would be good for next years crew to take the presses with them and collect each species while they are out there.
When doing the Hidden Valley transects they should start from the top. We started from the bottom last year and it is a pain. We suggest that they park by the large pipe just below the memorial area and work their way down. The first transect that they would do is right above the large pipe.
We replaced Tickville transect number 6 because we could not find it. Some of the precious years GPS points for riparian were either not downloaded or just not taken. Therefore, some of the transects were very hard to find. Transect number 6 was never able to be found so we created a new one and gave it a waypoint. We also gave all transects not downloaded waypoints.