APPENDIX G

CUMULATIVE IMPACTS ANALYSIS BACKGROUND

This Page Intentionally Left Blank

G.0 CUMULATIVE IMPACTS ANALYSIS BACKGROUND

The CEQ regulations require the scope of an EIS to consider cumulative actions which, when viewed with the proposed action, may have cumulatively significant impacts. Cumulative impacts are defined as impacts on the environment which result from the incremental impact of the proposed action when added to other past, present, and reasonably foreseeable future actions.

The ROI defined for the McGregor Range Land Withdrawal Renewal in this LEIS varies by resource area and represents the geographic area established for the cumulative effect analysis.

For the purposes of this LEIS, three types of activities have been identified that, in combination with the proposed action, have the potential for contributing to cumulative impacts. They are:

- On-going or projected military activities in the ROI including activities at WSMR, HAFB, Doña Ana Range–North Training Areas, South Training Areas, and the Fort Bliss main cantonment area.

- Nonmilitary activities and plans that affect areas or resources affected by proposed actions.

Section G.1 through G.3 describe activities in each of these areas that are included in the cumulative impact analysis from a regional viewpoint. Section G.4 describes changes in vegetation cover on Fort Bliss using June 1986 and June 1996 remote sensing reconnaissance scans. This is an installation program in its infancy but is included here to address past and present condition trends, using the only data available for this LEIS.

G.1 MILITARY ACTIVITIES ON THE FORT BLISS TRAINING COMPLEX (OTHER THAN McGREGOR RANGE)

Fort Bliss is a multi-mission, U.S. Army TRADOC installation located on approximately 1.12 million acres in Texas and New Mexico. The installation's principal mission is the U.S. Army ADA USAADACENFB. However, ongoing peacetime force structure realignments and weapons system development continue to affect the composition of the Fort Bliss mission and, consequently, management actions necessary to meet mission requirements. The *Fort Bliss Mission and Master Plan* PEIS describes potential environmental impacts associated with land use and management proposed decisions regarding installation assets, capabilities, and infrastructure to support current and future missions. These proposed decisions are reflected in the RPMP, the INRMP, and the ICRMP, and activities envisioned in the TADC and other installation initiatives. Mission activities conducted on the South Training Areas and Doña Ana Range–North Training Areas that may contribute to cumulative impacts include:

- Weapons firing,
- SDZs,
- Off-road vehicle maneuvers,
- Dismounted training,
- Aircraft operations.

G.2 MILITARY ACTIVITIES AT WSMR

The WSMR is part of the DoD's Major Range and Test Facility Base and has, as its primary mission, the support of research, development, test and evaluation (RDT&E) of Army missile and rocket systems. The WSMR also supports RDT&E programs by the USAF, Navy, and NASA. The WSMR has a land area approximately 100 miles long and 40 miles wide that includes numerous laboratories, facilities, test areas, and missile launch sites (Figure G-1).

The *White Sands Missile Range Range-Wide Environmental Impact Statement* (U.S. Army, 1996p) identified ongoing and projected test programs and other missions anticipated at WSMR and within WSMR airspace. During the 5-year period from 1989 to 1993, WSMR completed an average of 4,366 scheduled missions per year. These include the following:

- Air-to-air and air-to-surface missile programs. These include projects that test missiles, such as the AMRAAM, launched from aircraft against targets in the air or on the ground. On average, about 200 missions are conducted annually. Typical tests include captive carry, during which the missile remains attached to a carrier aircraft, and hot firings.

- Surface-to-air missile programs. On average, about 700 surface-to-air missile missions are conducted at WSMR annually. These include development and flight testing of the Extended Range Intercept Technology (ERINT) interceptor missile, testing of Forward Area Air Defense System (FAADS) such as Stinger missiles, and test firing and tracking of Patriot missiles. THAAD missile program test activities are also conducted.

- Surface-to-surface missile programs. On average, 250 surface-to-surface missions are conducted at WSMR annually. These include test launches of the ATACMS solid-propellant missiles from MLRS launchers (including high explosives tests in approved areas), flight tests and fire control tests of the solid-propellant Line-of-Sight Anti-Tank (LOSAT) missile, and testing of new propulsion systems for 13 cm and 20 cm guns.

- Testing of drone target systems. On average, 400 missions are conducted annually of target systems for Stinger, Chaparral, and Hawk missile programs.

- Meteorological and Upper Atmosphere Probes. On average, 15 meteorological and upper atmosphere probes missions have been conducted each year.

- NASA and space program support. On average, 400 NASA and space program missions are conducted annually at WSMR, including the Space Shuttle program, shuttle training aircraft, and Single Stage Rocket Test program. The WSMR is an alternate landing site for the space shuttle. Laboratories at NASA's White Sands Test Facility (WSTF) test the compatibility of materials being considered for use in aerospace applications. The WSTF's tracking and data relay system station provides satellite data relay services to spacecraft such as the shuttle. NASA operates and maintains a shuttle training aircraft that provides a realistic simulation of the shuttle landing from 35,000 feet to touchdown. The Single Stage Rocket Test Program is a U.S. Army Ballistic Missile Defense Organization program to develop a vertically launched and recoverable suborbital rocket capable of lifting up to 3,000 pound payload and returning to the launch site for a precise soft vertical landing. The WSMR is providing preflight static testing, hover flight, and rotation flight tests for this program.

- Equipment components and subsystem tests. On average, 300 such tests are performed at WSMR annually and typically include flight testing on helicopter or fixed-wing aircraft.

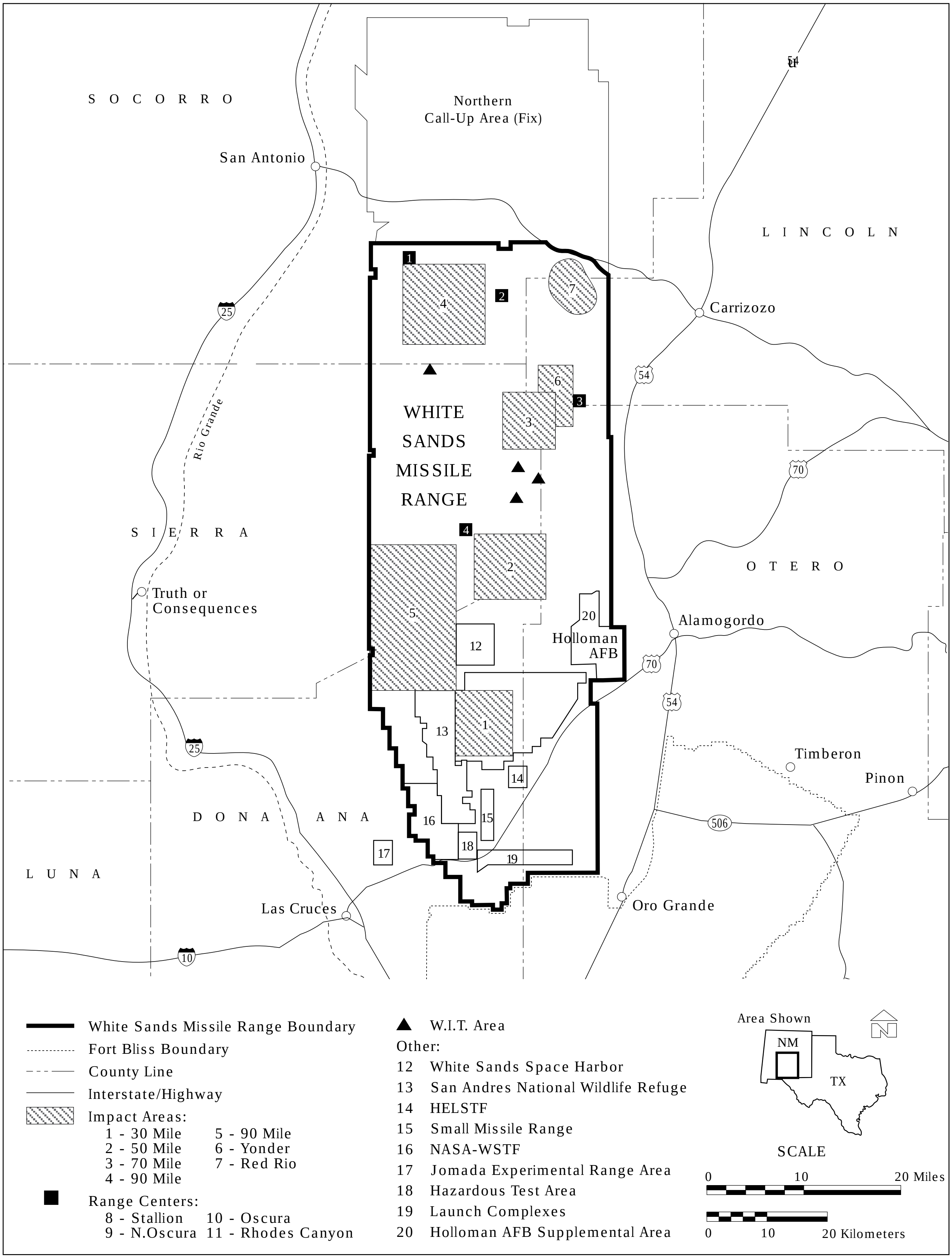


Figure G-1. White Sands Missile Range (WSMR) Operations and Land Use Area.

- High-energy laser missions. On average, 100 high-energy laser missions are conducted annually at various approved locations on WSMR.

- Research and development programs, primarily in nuclear effects (conducted in simulated environments) and research rockets (e.g., sounding rockets).

- Special tasks, normally consisting of small-scale training exercises, indoor testing, field tests, and explosives ordnance disposal.

In addition, WSMR supports air-to-ground training at Red Rio and Oscura Target Complexes and air-to-air training in its Restricted Areas.

G.3 MILITARY ACTIVITIES AT HAFB

HAFB is located approximately 7 miles west of Alamogordo in Otero County, New Mexico, and 85 miles northeast of El Paso, Texas. Ongoing and projected mission changes at HAFB that will affect airspace over, and land use on, the Fort Bliss Training Complex include completion of the Taiwanese Air Force Training program at HAFB. Deactivation of the 435th Fighter Squadron was analyzed in the *Final Environmental Assessment for The Drawdown of AT-38 Aircraft and Deactivation of the 435 Fighter Squadron at Holloman Air Force Base, New Mexico* (USAF, 1997j). Scheduled to occur in the second quarter of FY 97, it reduces T-38 operations at HAFB, McGregor Range (use of the existing Class C air-to-ground, unscored, inert bombing circle), WSMR, Beak and Talon MOAs, and several MTRs, including IR-133, IR-134, IR-195, and VR-125.

This reduction is partially offset by the establishment of an air-to-ground tactical target complex for use by USAF and GAF units. On May 29, 1998, the USAF selected Otero Mesa as the location for the tactical target complex which is incorporated into Alternative 1 of this LEIS.

G.4 ACTIVITIES AND PLANS IN AREAS AFFECTED BY THE PROPOSED ACTION

This section discusses the activities and plans in the vicinity of McGregor Range. BLM, USFS, state and county activities, and plans are discussed.

G.4.1 BLM

The McGregor Range ROI is within the New Mexico State Office of BLM (that includes New Mexico, Texas, Oklahoma, and Arizona). Within the New Mexico State Office are two relevant BLM district offices: the Las Cruces District in New Mexico and the Tulsa District that includes Texas. Although, the Main Cantonment Area and the South Training Areas are within the Tulsa District boundaries, there are no BLM lands in Texas adjacent to McGregor Range boundaries.

The DOI's overall philosophy is to manage public lands under a multiple-use and sustained yield concept. The Classification and Multiple Use Act of September 19, 1964 (43 USC 1411-1418) is referenced in 43 CFR Part 2300. No overall priority is assigned by the Classification and Multiple Use Act or by the Secretary of the Interior to any specific use. Section 1 of the Classification and Multiple Use Act lists ten objectives of public land and specifies the methods of management of the public lands will be governed by the provision of existing laws (43 USC 1725.3-3). The listed objectives as interpreted by the Secretary of Interior are as follows:

- Domestic livestock grazing
- Fish and wildlife development and utilization
- Industrial development
- Mineral production
- Occupancy
- Outdoor recreation
- Timber production
- Watershed protection
- Wilderness preservation
- Preservation of public values.

Out of 1,500 access permits issued for recreational use on Fort Bliss, 1 percent were for Otero Mesa over a 1-year period (1996), except during big game hunts. The Secretary of the Interior or his delegate such as the BLM will authorize, under applicable authority, that use or combination of uses will best achieve the objectives of multiple use, taking into consideration all pertinent factors. These factors include, but are not limited to, ecology, existing uses, and the relative values of the various resources in particular areas (43 CFR Sec. 1725.3-1). The BLM may place special emphasis on specific requirements for Special Management Areas and ACEC. Land use and range-land improvements are thoroughly analyzed to restrict new surface disturbance, reduce resource conflicts, and aid in the management of all resources. All proposals are subject to the NEPA process and especially to the mitigation of impacts.

The Las Cruces Field Office encompasses portions of the Fort Bliss Training Complex: the Doña Ana Range–North Training Areas and McGregor Range. The BLM has published *Resource Area Management Plans* that describes the agency's activities that could contribute to cumulative effects in the region.

G.4.2 USFS

The USFS manages lands of the Lincoln National Forest that are adjacent to the northeastern boundary of McGregor Range encompassing TA 33. There are no currently known actions on these lands that would contribute to cumulative effects of the proposed action. Activities currently occurring in this area include grazing, fuel-wood gathering, hunting, and recreation.

G.4.3 State of New Mexico

The New Mexico State Highway Department is evaluating plans to widen U.S. Highway 54 through portions of Otero County that pass through the Fort Bliss Training Complex. The demand for aggregate to support this activity could increase cumulative impact, if any, on this resource in the vicinity of the Fort Bliss Training Complex.

G.4.4 State of Texas

The Texas State Land Office and other State agencies administer nonprivate lands adjacent to Fort Bliss in Texas. There are no currently known actions on these lands that would contribute to cumulative effects of the proposed action.

G.4.5 Doña Ana County, New Mexico

The *Doña Ana County Comprehensive Plan* (Doña Ana County, 1994) provides a combination of goals, policies, and actions the county will use to make responsible decisions through the year 2015. Planning areas adjacent to the Fort Bliss Training Complex boundaries include the eastern portions of the Border

Planning Area, the South Planning Area, and the southeastern portion of the Central Planning Area. There are no currently known actions on these lands that would contribute to cumulative effects of the proposed action.

G.4.6 Otero County, New Mexico

Otero County adopted an *Interim Land Use Policy Plan* in 1993, and is now developing a *Comprehensive Land Use Plan*. The primary goal of the plan is to guide the use of public lands and resources in the county and to protect the rights of private land owners. The draft plan identifies areas of historic and customary use that are of value to county residents, including the use of water, agriculture, livestock grazing, timber and wood production, mineral production, cultural resources, recreation, hunting, federal and military activities, transportation and access, wilderness, wildlife, and threatened and endangered species. No specific management actions or priorities for land resource allocation have been identified at this time. Therefore, there are no currently known actions on these lands that would contribute to cumulative effects of the proposed action.

G.4.7 El Paso, County, Texas

General growth projected for the El Paso metropolitan area has raised groundwater availability issues. Regional water supply issues focus on two general topics: (1) the availability of long-term water supply from the Hueco Bolson aquifer, and (2) supplementing or reducing dependence on locally derived groundwater. The Fort Bliss Training Complex and its facilities are a subset of a greater issue of cumulative urban water availability and demand.

G.5 COMPREHENSIVE LANDSCAPE MONITORING

The Fort Bliss Training Complex landscape was assessed for cumulative effects from training, grazing, and natural impacts on natural and cultural resources. Monitoring will be a four-part process consisting of remote sensing reconnaissance, site inspections, plot sampling, and GIS analysis. Remote sensing reconnaissance will scan entire land base to monitor seasonal trends, detect impacts, and focus field investigations on high priority areas. Field investigation will validate remote sensing images/data and quantify intensity of impacts on natural and cultural resources. Distribution, frequency, and intensity of impacts will be stored in a GIS database. This process will support enforcement of environmental laws and NEPA provisions, provide data for the ITAM program, record cumulative impacts, and provide information to adjust training operations as needed (Adaptive Management Strategy).

G.5.1 Components Of Monitoring System

The monitoring systems used in the vicinity of the Fort Bliss Training Complex are described in this section. The monitoring systems discussed include Advance Very High Resolution Radiometer (AVHRR) Time Series Imagery, mission specific monitoring, LANDSAT Thematic Mapper Satellite Imagery, and plot data collection.

G.5.1.1 AVHRR Time Series Imagery

The NASA AVHRR is a satellite-mounted sensing the system has been used to monitor environmental conditions on a global scale. AVHRR normalized vegetation index has proved to be a very robust measure of vegetation health, phenology, and production. AVHRR thermal and visible bands have been used to monitor temperature, cloud cover, soil moisture, transpiration, forest fires, and fuel build up. AVHRR provides regional context to environmental conditions on the Fort Bliss Training Complex.

Therefore, plot data can be related to regional environmental conditions such as soil moisture, phenological status, and temperature. This capability will provide the ability to compare plots from different time periods. Fort Bliss is obtaining AVHRR satellite data on a daily basis from the Army Research Laboratory at WSMR.

G.5.1.2 Mission-specific Monitoring

Major training actions such as Roving Sands require on-the-ground monitoring to ensure compliance with NEPA provisions for monitoring and mitigation activities. Fort Bliss ITAM program (DPT-IT), in conjunction with the 1st CAS BN, has a system of on-site monitoring that uses GPS and field data collection to develop a GIS data base for each training exercise. This consists of on-site visits to training units to ensure compliance with NEPA guidelines, recording the units position and "footprint" with GPS, and recording environmental damage in the Site Rep database. The end result is a site-specific database for each proponent's training exercise.

G.5.1.3 LANDSAT Thematic Mapper Imagery

NASA LANDSAT Thematic Imagery will be used to monitor the entire landscape of the Fort Bliss Training Complex at high spatial resolution to capture variability in land cover on training areas. This capability will allow positioning of monitoring plots to provide an accurate sample of impacts on the training landscape. Additional post sampling analysis using plot data, monitoring data, and GIS themes will allow analysts to map the extent and impact of training activities on a landscape scale.

G.5.1.4 Plot Data Collection

The objective of plot data collection is to record changes in species composition and ground cover at the observer level. The distribution of plots is designed to provide the highest level of confidence in data at the lowest cost. LANDSAT imagery and on-site monitoring are critical elements in the sampling procedure. On-site monitoring ensures that monitoring plots are located in areas that have received training impacts and LANDSAT image analysis ensures that control plots are positioned in areas that represent undisturbed conditions typical of the training area.

G.5.2 Methods of Analysis

The monitoring systems previously discussed will provide the following types of information.

G.5.2.1 Training Impacts

Coordinated analysis of on-site monitoring data, field plots, and satellite imagery will provide a synopsis of training impact intensity and extent.

G.5.2.2 Environmental Trends

Time series analysis of satellite imagery and control plot data will provide baseline data on the response of plant communities to climatic variation and natural disturbance. This will be a valuable source of baseline data for future NEPA analysis.

G.5.2.3 Cumulative Impacts

Environmental health of training lands is a product of training impacts and environmental trends. Time series analysis of training impacts and environmental trends provides data on ecosystem response. The GIS system provides a method to record impacts and analyze their effects over time.

G.5.3 Monitoring Cover Change Using Thematic Mapper Satellite Imagery

G.5.3.1 General Approach

The general approach is to estimate actual cover values for the total vegetative cover area, using the Gram-Schmidt process to produce optimal perspective for separation of land cover classes from multi-spectral satellite imagery (Crist and Kauth, 1986; Jackson, 1983). The fundamental basis of the Gram-Schmidt process involves finding data structures inherent to a particular sensor and land cover classes, and adjusting the axes of observation in multispectral viewing space such that the land cover classes can be most easily and completely observed. After the Gram-Schmit procedure, correlation analysis with ground truth data is implemented to produce a cover estimate based on a linear regression model. The cover estimate then becomes a thematic layer in the GIS system. This method allows comparison of land cover change over time by subtracting cover estimates made from imagery acquired from different dates. The use of correlation analysis and regression models provides statistical confidence estimates and error estimates for each thematic layer. This method makes it possible to assess the condition of the landscape synoptically and track changes in landscape condition over time.

G.5.3.2 Methods

Overview. There are four major steps involved in converting digital values obtained from satellite imagery to vegetation cover maps: geographic coding, image calibration, feature extraction, and cover modeling. Geographic coding ties the pixels in the satellite image to geographic coordinates. The satellite image becomes a map with scale, projection, and a coordinate grid. This allows direct comparisons between conventional maps and other geographically coded images. Image calibration converts the digital numbers recorded by satellite sensors into numbers with physical meaning, such as radiance and reflectance. Feature extraction uses spectral profiles of elements in a pixel to identify the composition of a pixel through statistical analysis. Cover modeling uses linear regression to establish relationship between ground plot data and spectral features.

Imagery. Two images were selected for use in this comparison: *LT503303703886163*, a LANDSAT Thematic Mapper 5 image, acquired June 12, 1986; and *LT50330370389696175*, a LANDSAT Thematic Mapper 5 image, acquired June 23, 1996.

Geographic Coding. Image to image registration was accomplished by selecting corresponding points on each image and performing a first order polynomial transformation to UTM zone 13 row S NAD27 coordinates. The accuracy obtained through this process is within one half of one pixel.

G.5.4 Image Calibration

LANDSAT digital images are commonly analyzed by using the digital numbers for each pixel. Although this procedure may be satisfactory for a single image used, it may produce incorrect results when more than one image is used in time sequence overlays. The digital numbers for each pixel should be converted to their dimensional equivalents; numbers with physical meaning. Radiance and reflectance are two values commonly used for time sequence analysis of imagery. These values vary depending on sensor calibration, sun angle, earth-sun distance, the state of the atmosphere, slope and angle of terrain, and surface cover. Radiance is measured at the satellite in milliwatts per square centimeter per steradian. Reflectance is the ratio of radiant energy reflected by a surface to incident energy and is calculated as a percentage of radiance at the sensor (Robinove, 1982). This conversion corrects for sun angle differences, sensor variability, and earth-sun distance. Calibration allows images from different dates to be compared directly. Reflectance values were used for this study because reflectance for various surfaces has been measured and catalogued by the USGS Spectral Laboratory, and is the standard parameter for use in image spectrometry and other methods used for identifying the composition of surfaces from remotely sensed imagery.

G.5.5 Feature Extraction

Vegetation indices, such as normalized vegetation index (NDVI), which are commonly used to measure vegetation biomass, leaf area index, or fractional cover in agricultural fields, grasslands, and forests, do not perform well in measuring cover in semi-arid range land. Brightness indices, or linear combinations of spectral bands, are more closely related to vegetative cover in semi-arid range land (Yang and Prince, 1997). The two-dimensional perpendicular vegetation index (PVI) and six dimensional greenness index for Thematic Mapper satellite imagery are examples. The method used here relies on the Gram-Schmidt (Jackson, 1983) procedure to produce brightness indices based on image measured soil reflectance, albedo, and the spectral profiles of dry grass and calcite acquired from the USGS Spectral Laboratory. This process mathematically reduces variation in a cover feature, from multiple spectral variables (bands) to one band. These bands represent variation in cover, but at this point, they are not expressed in meaningful units. Linear equations based on least squares regression are used to convert raw cover values to percent cover. These methods have been used extensively to measure cover in dry land situations (Duncan et al., 1993; Griffiths and Collins, 1983; Larson, 1993; Olson, 1984).

G.5.6 Cover Modeling

Thirty step-toe transects were established in grassland and shrub sites at sites selected for use in the aplomado falcon habitat evaluation. Percent cover for grasses, shrubs, litter, and soil were calculated using methods described by the U.S. Army (1997k). The transects were converted to raster thematic maps using field collected geographic positioning system (GPS) data to accurately position the plots in UTM zone 13 row S NAD27 coordinates. Cover values obtained from these transects were compared with spectral feature layers from satellite imagery using Pearson Product Moment correlation. This analysis indicated a strong linear relationship between plot data and spectral feature layers (Table G-1 and Figure G-2).

Albedo and Dry Grass Index had the best correlation with cover area measurements on the aplomado falcon transects. Results indicate that acceptable cover maps of shrub cover area, soil cover area, and total vegetation cover area can be created by developing least squares models using these indices. Total vegetation cover area was selected as an indicator of ecological condition, and maps of vegetation cover were created using formulas derived from least square regression analysis. The coefficient of correlation for this model is 0.79.

This model allows prediction of vegetation cover area (in percent) with a confidence interval of error of 3.27 percent at the .01 level.

G.5.7 Description of Changes 1986 through 1996

Maps and data produced by linear multiple regression models provide a valuable tool for extrapolation of plot data to the landscape scale. However, the results must be interpreted with some qualifications. The

Table G-1. Correlation of Plot Data and Spectral Indices

Cover Area Measure	*Grass*	*Litter*	*Forb*	*Shrub*	*Soil*	*Total Vegetation*
Spectral Index						
Albedo	0.31	-0.62	-0.45	-0.69	0.71	*-0.73*
Greeness	-0.19	-0.03	0.01	-0.05	0.16	*-0.16*
NDVI	0.05	-0.08	-0.25	-0.12	0.12	*-0.14*
Dry Grass	-0.47	0.48	0.39	0.77	-0.58	*0.74*
Soil	*-0.04*	-0.22	-0.42	-0.23	0.32	*-0.34*
Calcite	*-0.19*	-0.03	0.01	-0.05	0.19	*-0.16*

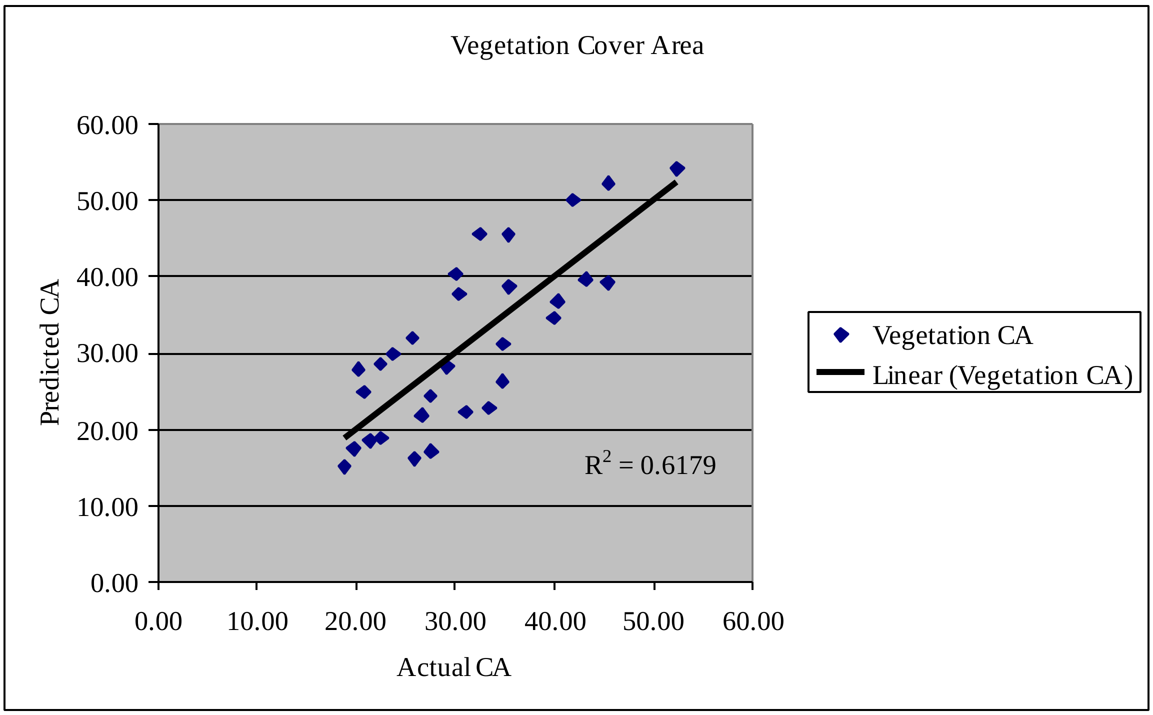


Figure G-2. Vegetation Cover Area and Linear Multiple Regression Model Prediction.

model was generated from plot data in grassland and desert shrub communities where vegetation cover area ranged from 15 to 53 percent of the total cover area. Extrapolation of the model to other vegetation types, or to cover area, outside of the range of the model cannot be evaluated for accuracy. Therefore, comparisons made in other vegetation types or outside of the model's range should be viewed as preliminary comparisons. The images used in the analysis represent a snapshot view of conditions for 2 days 10 years apart, and do not represent trends in vegetation cover area. Observational variations represent changes that occur in both short- and long-term timeframes. Trend analysis is used to separate long-term change from short-term variation. The number of observations over time correlates to the reliability of the trend analysis. This analysis is an example of the process being implemented at Fort Bliss to evaluate cumulative impacts of military training, grazing, and natural events on training lands. To this end, Fort Bliss has acquired satellite imagery from 1972 to 1997. These images will be used to establish long-term trends in landscape change on Fort Bliss with the goal of publishing the results in a peer reviewed scientific journal.

G.5.7.1 Environmental Setting

Precipitation and fires are significant factors affecting vegetation cover area. These factors can produce change in short- and long-term timeframes, depending on their duration and intensity. Knowledge of environmental conditions that affect vegetative condition is necessary for interpretation of satellite derived vegetation cover maps. A summary of conditions from January 1984 to January 1986 and January 1994 to June 1996 is provided to aid in interpretation of the results (Tables G-2 and G-3).

In the 30 months preceding the 1986 image there was a total of 37.6 inches of precipitation at Oro Grande, 33.15 inches at WSMR, and 29.0 inches at EPIA, while there were 27.55 inches at Oro Grande and 16.69 inches at WSMR and EPIA, respectively, in the 30 months preceding the 1996 image.

These data indicate low fire frequency prior to the 1986 image and relatively high fire frequency prior to the 1996 image. There were significant fires in the Organ Mountains in 1994 and 1993, and on Otero Mesa in 1993 and 1994. Natural causes were responsible for 31 fires, and 7 fires were attributed to man-made causes. These data suggest that vegetation cover area would generally decline from 1994 to 1996 as a result of below normal precipitation, and that cover would be drastically reduced in areas that were affected by fires. Results from change analysis of cover maps suggest that there was generally less vegetative cover in 1996 than there was 1986, and that areas impacted by fire suffered greater losses in cover than relatively undisturbed areas.

G.5.7.2 Interpretation

The data should be interpreted with some qualifications because two data points are not sufficient to establish a trend and environmental conditions prior to the image dates were significantly different. There were over 33 inches of precipitation in the 20 months preceding the 1986 image, while there were only 16.79 inches in the 20 months before the 1996 image. Desert areas are known for having highly variable precipitation and frequent droughts. Cover response to drought depends on plant physiognomic characteristics. Annual plants avoid drought by seed dormancy; germination will not occur until there is adequate moisture. Perennial plants respond by reducing their leaf area. These effects would result in lower annual plant cover and reduced leaf areas in perennial vegetation.

Fires are another contributing factor. Twenty-five of 28 fires recorded on Fort Bliss from 1982 to 1996 occurred between 1986 and 1996. Vegetation cover area cover would be severely reduced in these areas. Despite these qualifications, some observations can be made:

- Woody vegetation at high elevations was not affected as severely by drought, most cover loss was associated with fires in these vegetation types;

- The most severe drought effects were at lower elevations in mesquite coppice dune and sand scrub vegetation;

- Vegetation cover in grazed grasslands is significantly lower than in ungrazed grasslands for both dates; and

- Vegetation cover in Roving Sands controlled access FTX sites is not significantly different from vegetation cover in grazed areas.

Table G-2. Precipitation in Inches During 30 Months Preceding Image Dates

Station	*Year*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	
296435 Oro Grande, New Mexico	1984	0.75	0.0	0.0	0.0	1.31	4.72	1.08	6.38	0.48	3.1	0.87	2.16	30-month Total prior to Jul 86 37.6
	1985	1.13	0.34	0.29	0.42	0.8	0.83	0.82	2.75	3.45	3.45	0.05	0.07	
	1986	0.05	0.35	0.33	0.0	0.26	2.08							
	1994	0.61	0.38	0.27	0.32	0.92	0.09	2.67	2.58	1.01	0.77	0.79	1.1	30-month Total prior to Jul 96 27.55
	1995	0.76	0.69	0.26	0.0	0.0	5.57	1.46	0.87	2.8	0	0	0.29	
	1996	0.49	0.13	0.0	0.15	0.0	2.57							
299686 White Sands National Monument, New Mexico	1984	0.31	0.0	0.32	0.0	0.86	3.82	1.58	2.94	0.24	2.03	11.3	2.77	30-month Total prior to Jul 86 33.15
	1985	1.26	0.42	0.34	0.82	0.5	0.85	1.82	2.69	1.42	4.13	0.05	0.05	
	1986	0.02	0.57	0.35	0.01	0.37	1.48							
	1994	0.27	0.0	0.17	0.27	0.75	0.02	1.09	0.65	0.2	0.54	0.77	0.99	30-month Total prior to Jul 96 16.69
	1995	0.77	0.56	0.08	0.0	0.0	0.8	1.58	1.52	2.88	0	0.06	0.15	
	1996	0.45	0.06	0.0	0.31	0.0	1.75							
412797 EPIA, Texas	1984	0.31	0.0	0.44	0.01	0.59	3.18	0.69	5.57	0.58	3.12	0.51	1.17	30-month Total prior to Jul 86 29
	1985	0.95	0.19	0.59	0.07	0.01	0.1	1.32	1.46	1.47	1.82	0.13	0.05	
	1986	0.01	0.39	0.39	0.0	0.83	3.05							
	1994	0.03	0.23	0.37	0.65	0.8	0.67	0.18	0.02	0.03	0.35	0.54	1.61	30-month Total prior to Jul 96 16.69
	1995	0.26	0.88	0.42	0.04	0.01	1.74	0.28	0.76	3.18	0.0	0.26	0.23	
	1996	0.11	0.19	0.0	0.49	0.0	2.36							

Note: Missing data estimated by interpolation among months surrounding the data point over the 3-year period.
Source: NOAA, National Climatic Data Center.

Table G-3. Fires on Fort Bliss 1982 to 1996

Fire Name	*Discovery Date*	*Stated Cause*	*Total Acreage*
Aguirre Sprigs	8/8/82	Natural	*1.0*
Ladrone	6/17/85	Natural	*10.0*
South	1/14/86	Man-made	*0.1*
Oingo	6/21/89	Natural	*50.0*
Cli	6/21/89	Natural	*7.5*
Dry Peak	6/21/89	Natural	*250.0*
Cooper	6/22/89	Natural	*40.0*
Triangle	6/22/89	Natural	*340.0*
Hoot	7/9/89	Natural	*650.0*

Source: Las Cruces Field Office, BLM.

Table G-3. Fires on Fort Bliss 1982 to 1996 (Continued)

Fire Name	*Discovery Date*	*Stated Cause*	*Total Acreage*
Horse Camp	7/18/89	Natural	*25.0*
Mary Toy	6/21/90	Natural	*750.0*
Charlie R	5/14/92	Natural	*0.5*
Haymeadow	10/1/92	Man-made	*1.2*
Mackdraw	10/7/92	Man-made	*100.0*
Oterrell	5/24/93	Natural	*40.0*
Chatfield	5/31/93	Natural	*350.0*
Wind Mountain	5/31/93	Natural	*2.0*
Escondido	6/1/93	Natural	*8.9*
Mashed O	6/1/93	Natural	*1.4*
Martin	6/1/93	Natural	*4.1*
Cockleburr	6/1/93	Natural	*1.0*
West Mesa	6/1/93	Natural	*66.0*
Wildcat	6/1/93	Natural	*75.0*
Cristo Rey	6/14/93	Natural	*0.3*
Charlie	4/4/94	Man-made	*5.0*
Impact	4/20/94	Natural	*80.0*
Martin	4/22/94	Natural	*3.0*
Savage	4/22/94	Natural	*3.0*
Hat	6/29/94	Natural	*9.0*
Corner	6/29/94	Natural	*20.0*
Prather	6/30/94	Natural	*3.0*
Mw	7/13/94	Natural	*0.5*
Littledraw	8/21/94	Natural	*2.0*
Blacktank	9/27/94	Natural	*5.0*
Horsecamp	10/3/94	Natural	*350.0*
Unit 9	11/7/94	Man-made	*6.0*
West Tank	11/9/94	Man-made	*6.0*
Horse Mesa	5/10/95	Man-made	*5.5*

Source: BLM, Las Cruces Field Office.

More data is needed to assess plant cover response to drought years and moist years in desert environments. This would require analysis of long-term data sets that represent a series of wet and dry years. The cumulative changes in vegetation cover from June 12, 1986, to June 23, 1996, are depicted on Figure G-3. Changes in the two LANDSAT images of the McGregor Range are portrayed in terms of percentage loss and percentage gain, as shown by the legend of Figure G-3.

Tables G-4 through G-7 present the percent of total vegetation cover area or cover and dynamics between the 2 years for McGregor Range. Vegetation cover is described for various vegetation communities and developed or barren areas. Histograms portraying the data in each table are shown along with the tabular data.

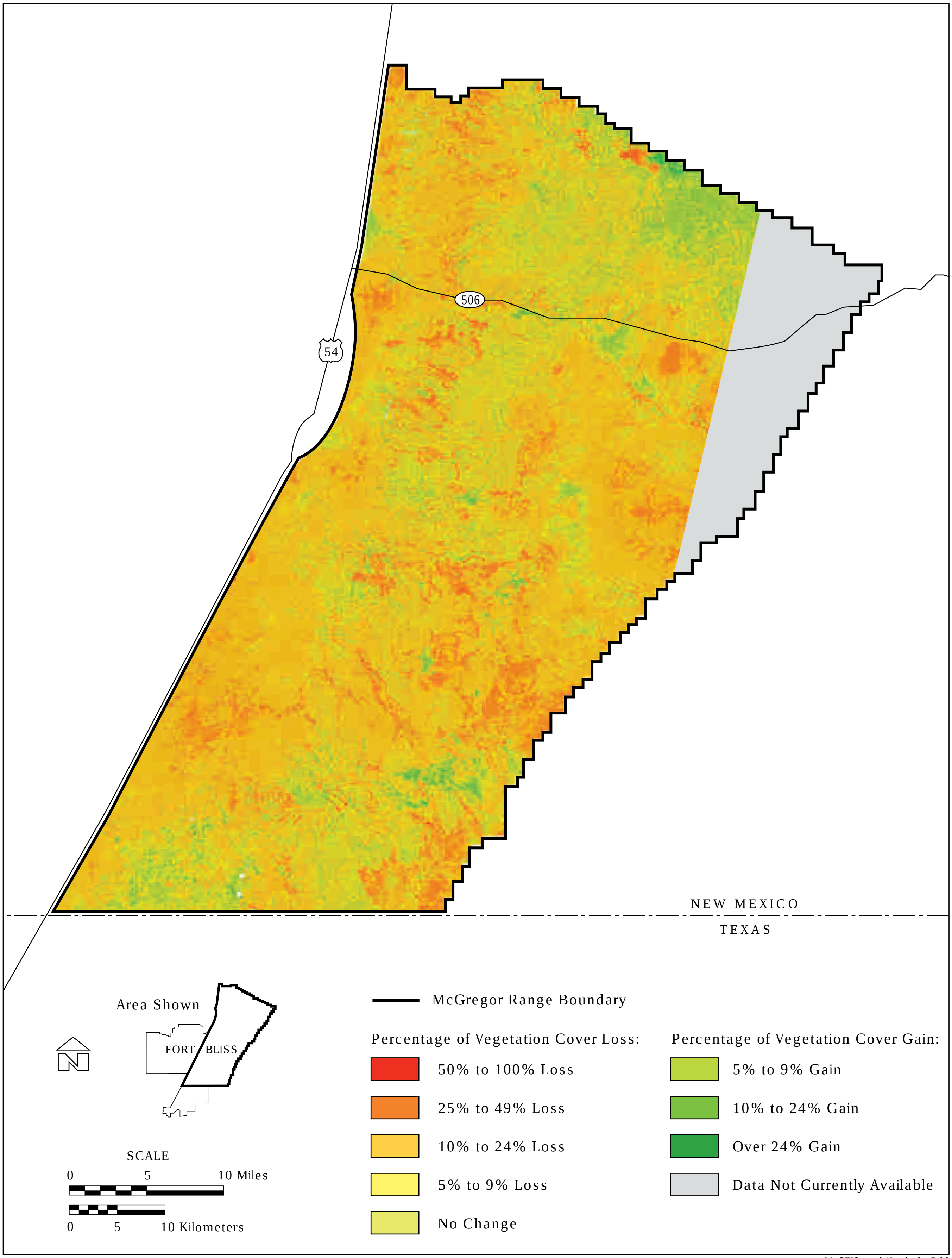
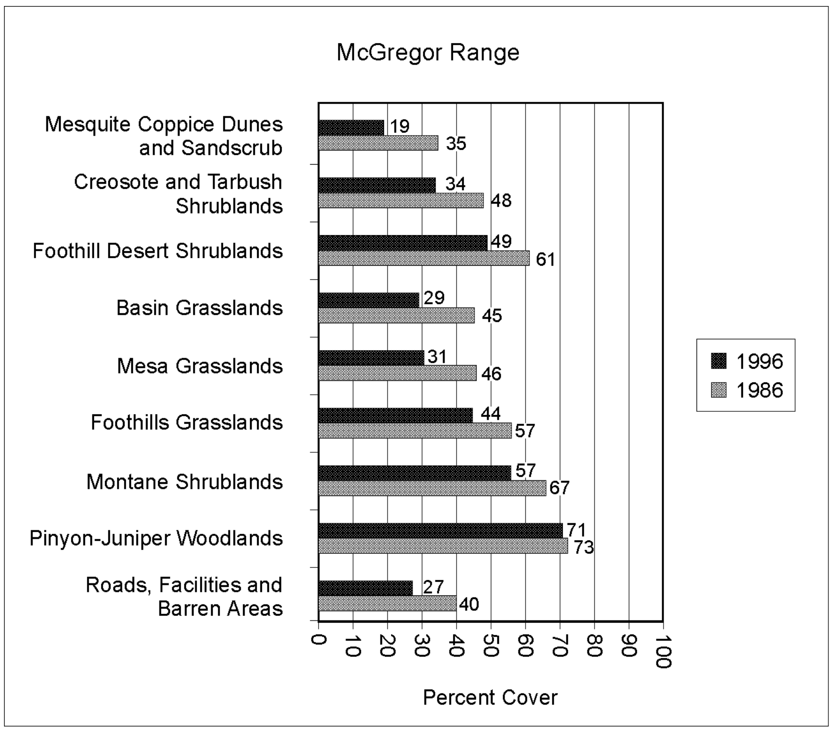


Figure G-3. LANDSAT Derived Vegetation Change on McGregor Range, 1986 to 1996.

Table G-4. Vegetation Cover and Dynamics on McGregor Range 1986 to 1996 (with Histograms)

Vegetation Cover				*Vegetation Dynamics*			
McGregor Range	*Percent of Total Cover Area*			*McGregor Range*	*Area Percent*		
	1986	*1996*	*Avg. Change %*		*Cover Loss*	*No Change*	*Cover Gain*
Mesquite Coppice Dunes and Sand Scrub	35	19	-16.14	Mesquite Coppice Dunes and Sand Scrub	94	6	0
Creosote and Tarbush Shrublands	48	34	-14.00	Creosote and Tarbush Shrublands	91	8	1
Foothill Desert Shrublands	61	49	-12.00	Foothill Desert Shrublands	90	10	0
Basin Grasslands	45	29	-15.82	Basin Grasslands	94	6	0
Mesa Grasslands	46	31	-15.00	Mesa Grasslands	94	6	0
Foothills Grasslands	57	44	-12.57	Foothills Grasslands	84	14	2
Montane Shrublands	67	57	-10.20	Montane Shrublands	55	37	8
Pinyon-juniper Woodlands	73	71	-2.00	Pinyon-juniper Woodlands	38	41	17
Roads, Facilities and Barren Areas	40	27	-13.00	Roads, Facilities and Barren Areas	85	13	2

Note: Total cover area is the indicator of ecological condition used in the vegetation cover modeling.



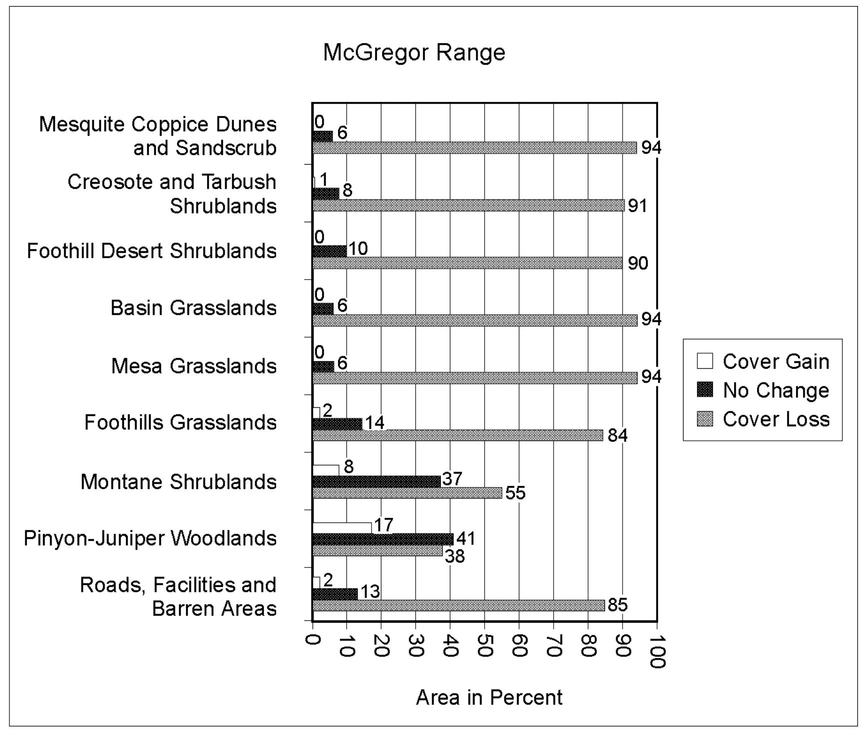
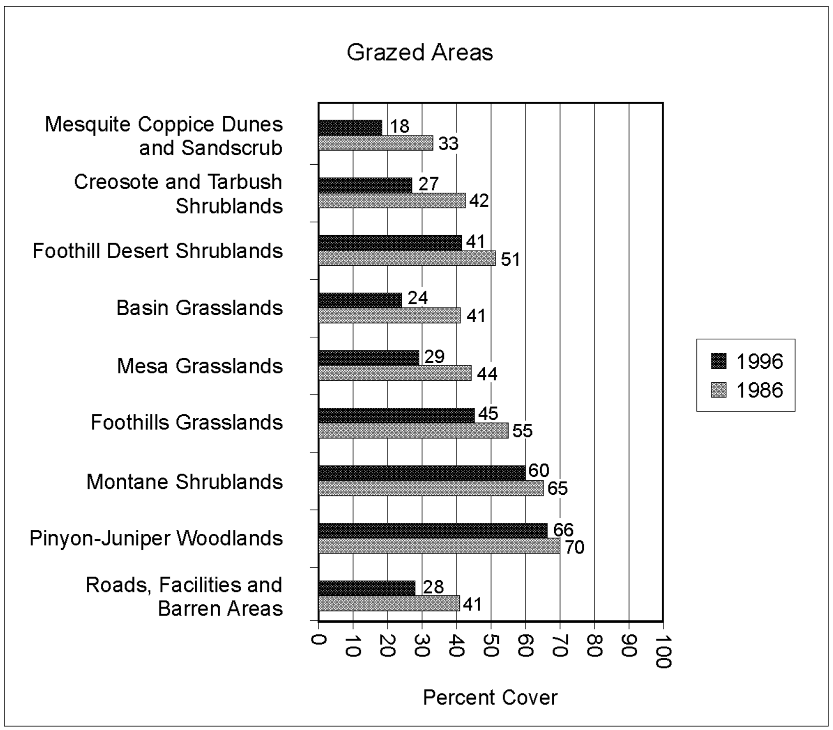


Table G-5. Vegetation Cover and Dynamics of Grazed Areas on McGregor Range 1986 to 1996 (with Histograms)

Vegetation Cover				*Vegetation Dynamics*			
Grazed Areas	*Percent of Total Cover Area*			*Grazed Areas*	*Area Percent*		
	1986	*1996*	*Avg. Change %*		*Cover Loss*	*No Change*	*Cover Gain*
Mesquite Coppice Dunes and Sand Scrub	33	18	-15.00%	Mesquite Coppice Dunes and Sand Scrub	94	6	0
Creosote and Tarbush Shrublands	42	27	-15.00%	Creosote and Tarbush Shrublands	93	7	0
Foothill Desert Shrublands	51	41	-10.00%	Foothill Desert Shrublands	81	17	2
Basin Grasslands	41	24	-17.00%	Basin Grasslands	96	4	0
Mesa Grasslands	44	29	-15.00%	Mesa Grasslands	95	5	0
Foothills Grasslands	55	45	-10.00%	Foothills Grasslands	77	20	3
Montane Shrublands	65	60	-5.00%	Montane Shrublands	50	42	8
Pinyon-juniper Woodlands	70	66	-4.00%	Pinyon-juniper Woodlands	42	48	10
Roads, Facilities and Barren Areas	41	28	-13.00%	Roads, Facilities and Barren Areas	86	12	2

Note: Total cover area is the indicator of ecological condition used in the vegetation cover modeling.



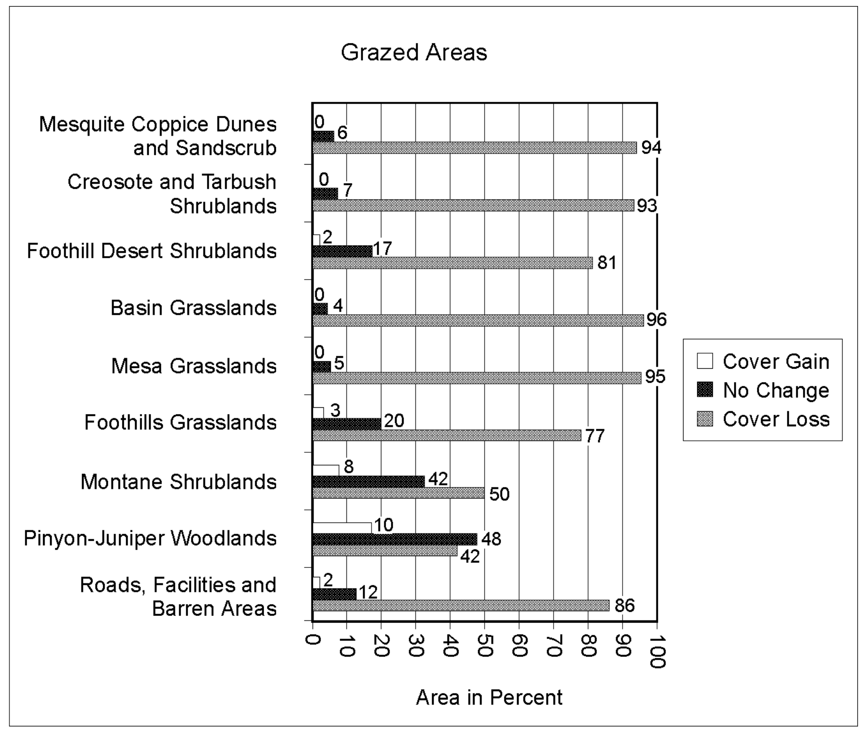
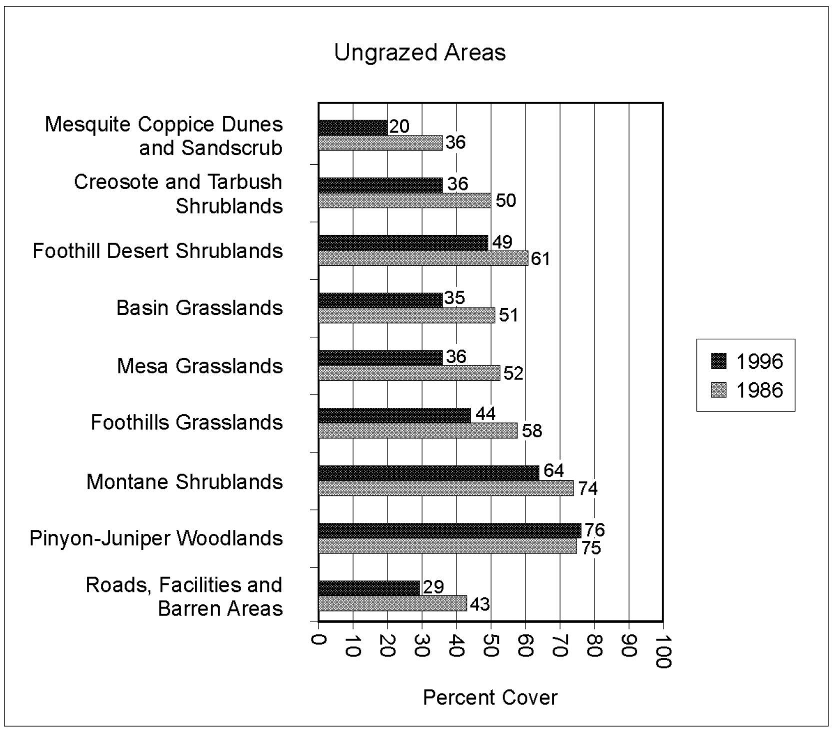


Table G-6. Vegetation Cover and Dynamics of Ungrazed Areas on McGregor Range 1986 to 1996 (with Histograms)

Vegetation Cover				*Vegetation Dynamics*			
Ungrazed Areas	*Percent of Total Cover Area*			*Ungrazed Areas*	*Area Percent*		
	1986	*1996*	*Avg. Change %*		*Cover Loss*	*No Change*	*Cover Gain*
Mesquite Coppice Dunes and Sand Scrub	36	20	-16.00%	Mesquite Coppice Dunes and Sand Scrub	98	2	0
Creosote and Tarbush Shrublands	50	36	-14.00%	Creosote and Tarbush Shrublands	90	9	1
Foothill Desert Shrublands	61	49	-12.00%	Foothill Desert Shrublands	90	9	1
Basin Grasslands	51	35	-16.00%	Basin Grasslands	92	7	1
Mesa Grasslands	52	36	-16.00%	Mesa Grasslands	91	7	2
Foothills Grasslands	58	44	-14.00%	Foothills Grasslands	88	10	2
Montane Shrublands	74	64	-10.00%	Montane Shrublands	67	25	8
Pinyon-juniper Woodlands	75	76	1.00%	Pinyon-juniper Woodlands	33	34	32
Roads, Facilities and Barren Areas	43	29	-14.00%	Roads, Facilities and Barren Areas	89	9	2

Note: Total cover area is the indicator of ecological condition used in the vegetation cover modeling.



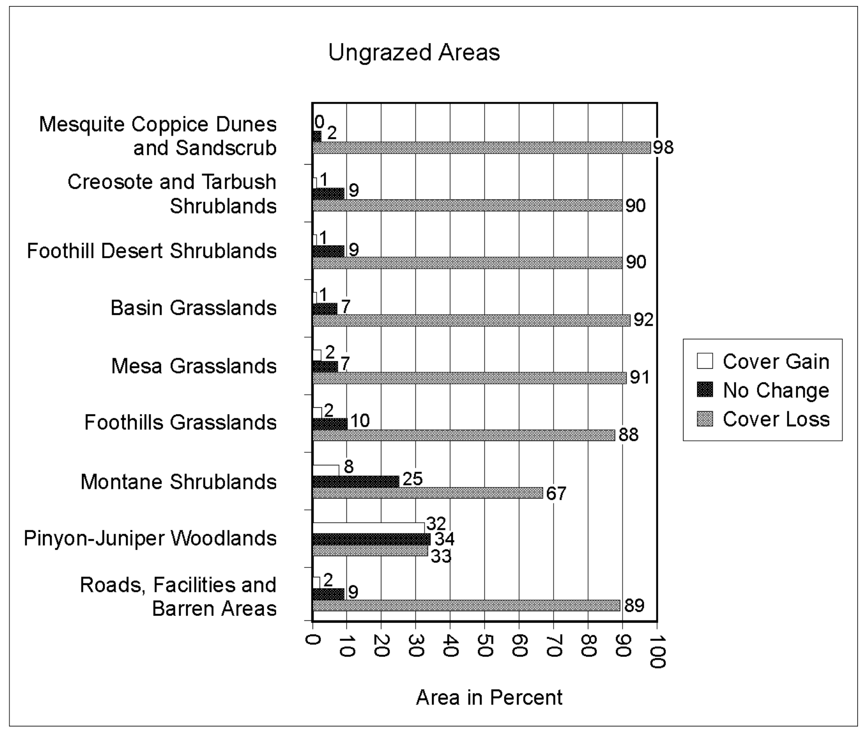
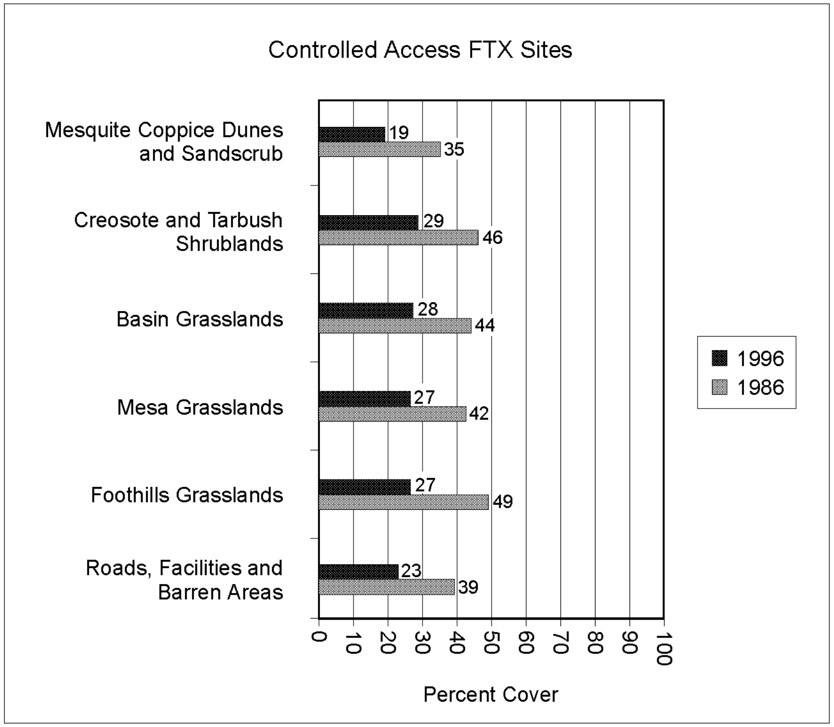
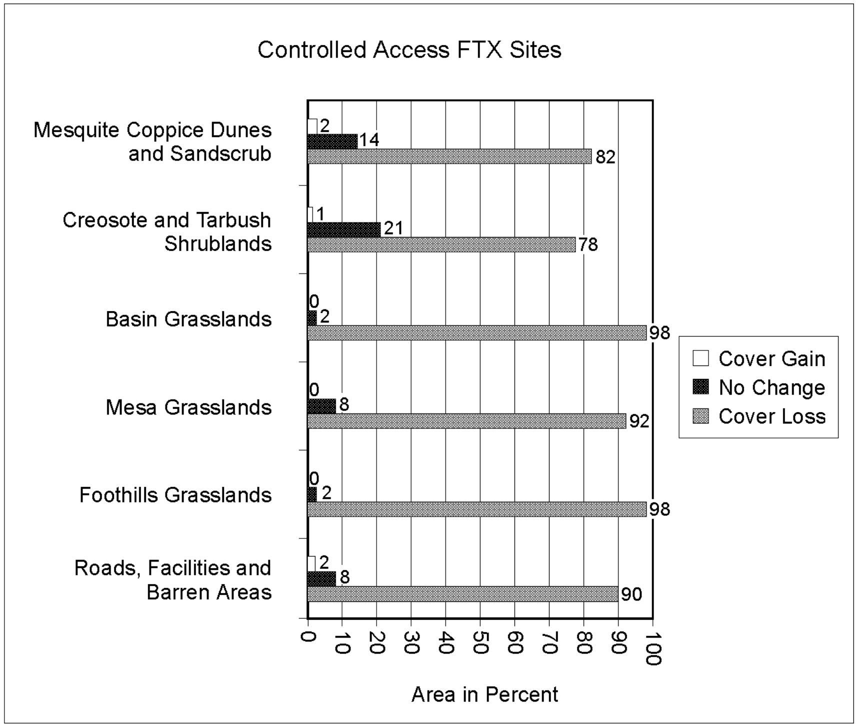


Table G-7. Vegetation Cover and Dynamics of Controlled Access FTX Sites on McGregor Range 1986 to 1996 (with Histograms)

Vegetation Cover				*Vegetation Dynamics*			
Controlled Access FTX Sites	*Percent of Total Cover Area*			*Controlled Access FTX Sites*	*Area Percent*		
	1986	*1996*	*Avg. Change %*		*Cover Loss*	*No Change*	*Cover Gain*
Mesquite Coppice Dunes and Sand Scrub	35	19	-16.00%	Mesquite Coppice Dunes and Sand Scrub	82	14	2
Creosote and Tarbush Shrublands	46	29	-17.00%	Creosote and Tarbush Shrublands	78	21	1
Basin Grasslands	44	28	-16.00%	Basin Grasslands	98	2	0
Mesa Grasslands	42	27	-15.00%	Mesa Grasslands	92	8	0
Foothills Grasslands	49	27	-22.00%	Foothills Grasslands	98	2	0
Roads, Facilities and Barren Areas	39	23	-16.00%	Roads, Facilities and Barren Areas	90	8	2

Note: Total cover area is the indicator of ecological condition used in the vegetation cover modeling.





G.5.7.3 Future Evaluations

The methods for estimating vegetation cover area from Thematic Mapper Imagery provide a robust means for estimating land condition and trend. The method could be improved by establishing plots in a wider variety of vegetation types and a greater range of cover. Current results indicate the method will be valuable in identifying impacted and undisturbed areas. Field plot sampling is crucial for providing the information needed to drive the cover models. The maps produced by the models will provide a sound basis for sample design in biological studies. Vegetation cover area maps are a valuable tool for land managers and scientists because they provide dynamic information at the landscape scale. A *Landscape Monitoring Plan* is being prepared that will provide a synoptic, repeatable method for identifying and recording impacts to training lands. The GIS system provides a platform for landscape scale analysis of impacts. Impact data will provide the basis for assessing training land readiness, scheduling training, and identifying rehabilitation needs. Portions of the plan are in place at the present time. Fort Bliss is archiving AVHRR satellite imagery for time series analysis of vegetation phenology and soil moisture. The installation has coordinated on-site monitoring, field plots and satellite imagery to measure training impact and extent for Roving Sands since 1996. Fort Bliss has developed methods and acquired imagery for cumulative impact assessment that can track changes in vegetation cover over time. A database is being developed for training and natural impacts that can be used to evaluate the effects of these factors on the natural environment.