Characterization of Mexican Spotted Owl (*Strix occidentalis lucida*) Habitat in Madrean Sky Island Ecosystems

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Abstract—*This project characterized Mexican spotted owl (MSO) home territories on the Fort Huachuca Military Reservation (FHMR) in the Huachuca Mountains using existing data on owl occupancy, fire history, and site characteristics. Although many nest sites were found in canyon environments with riparian, mixed conifer, and oak tree components, MSO territory composition was variable depending on topographic position. Data analysis suggests MSOs are not mixed conifer dependent and that oak and riparian tree species were important components in each territory. There is potential for adverse wildfire effects in MSO territories due to high fuel loads, stand density, and human ignitions.*

Introduction

Mexican spotted owls (*Strix occidentalis lucida*) (MSO) are widely distributed throughout the Southwest and are found typically in isolated mountain systems with sufficient habitat. Although several studies have characterized MSO habitat, few have focused on Madrean sky islands in southeastern Arizona and southwestern New Mexico (Ganey, 1988; Ganey and Balda 1989, 1994). MSO habitat in the southern part of Arizona and New Mexico varies from the northern part of the States because vegetation structure and composition is controlled largely by topographic gradients (Barton 1994; Whittaker and Niering 1965). Although nest/roost areas are identified in the field, owl territories are generally delineated without detailed knowledge of owl movements (Ganey et al. 1992).

This project characterized MSO habitat on the Fort Huachuca Military Reservation (FHMR) in the Huachuca Mountains of southeastern Arizona using data collected from annual MSO surveys, a wildland fuel inventory, and fire history studies. This paper will focus on vegetation composition in owl territories.

Methods

A vegetation map was developed for the Huachuca Mountains using remote sensing imagery by combining a land cover/vegetation type classification with field data collected from a fuel inventory conducted on the FHMR (Miller et al. 2003). A geographic information system (GIS) was used to clip the MSO critical habitat, territories, and a 200 m buffer centered on each nest/roost site from this map to compare vegetation composition using pixel counts (figure 1). Vegetation communities follow the taxonomy in Brown (1994). Surface and aerial fuels (i.e., tree and shrub density, downed woody material (DWM), herbaceous material) were sampled from 47 randomly distributed fuel inventory plots that fell within MSO territories. Fuel loads were calculated using equations from Brown (1974); shrub biomass was calculated using dimension analysis developed by Ludwig et al. (1975); and herbaceous biomass was estimated using a relative-weight estimate method following Hutchings and Schmautz (1969).

Fire occurrence patterns were determined by collecting full and partial cross section samples from living and dead trees that contained fire scars (Arno and Sneck 1977). Danzer (1998) collected fire-scarred samples along an elevational gradient in the Garden Canyon watershed on the FHMR. Kaib (1998) collected samples in canyons, based on presence of fire-scarred pines and proximity and connectivity to lower desert grasslands. Dendrochronology provided a method to assign a calendar year to each annual ring and to each fire scar (Dieterich and Swetnam 1984; Stokes and Smiley 1968). The reconstructed fire history ranged from 1532 A.D. through 1996.

The FHMR has conducted annual MSO surveys since the early 1990s following established USDA Forest Service protocols (1990). Eight protected activity centers (PAC) and two inventory areas (IA) (from this point called MSO territories) were established as a result of the monitoring efforts.

The Chi square statistic ($\alpha = 0.05$) was used to test all relationships. MSO territories are displayed from lowest to highest in elevation based on mean elevation.

Results and Discussion

Data available for the FHMR provided several scales to assess MSO habitat. The vegetation map provided 30 m pixel resolution over the entire study area. The fire history was conducted in the mixed conifer community in the Huachuca Mountains and the fuel and MSO inventories were site specific.

Averaged percent vegetation by type for critical habitat versus all MSO territories, MSO territories alone, and nest/roost sites within a 200 m buffer is shown in figure 2. Scrub grassland and savanna were significant components of the critical habitat

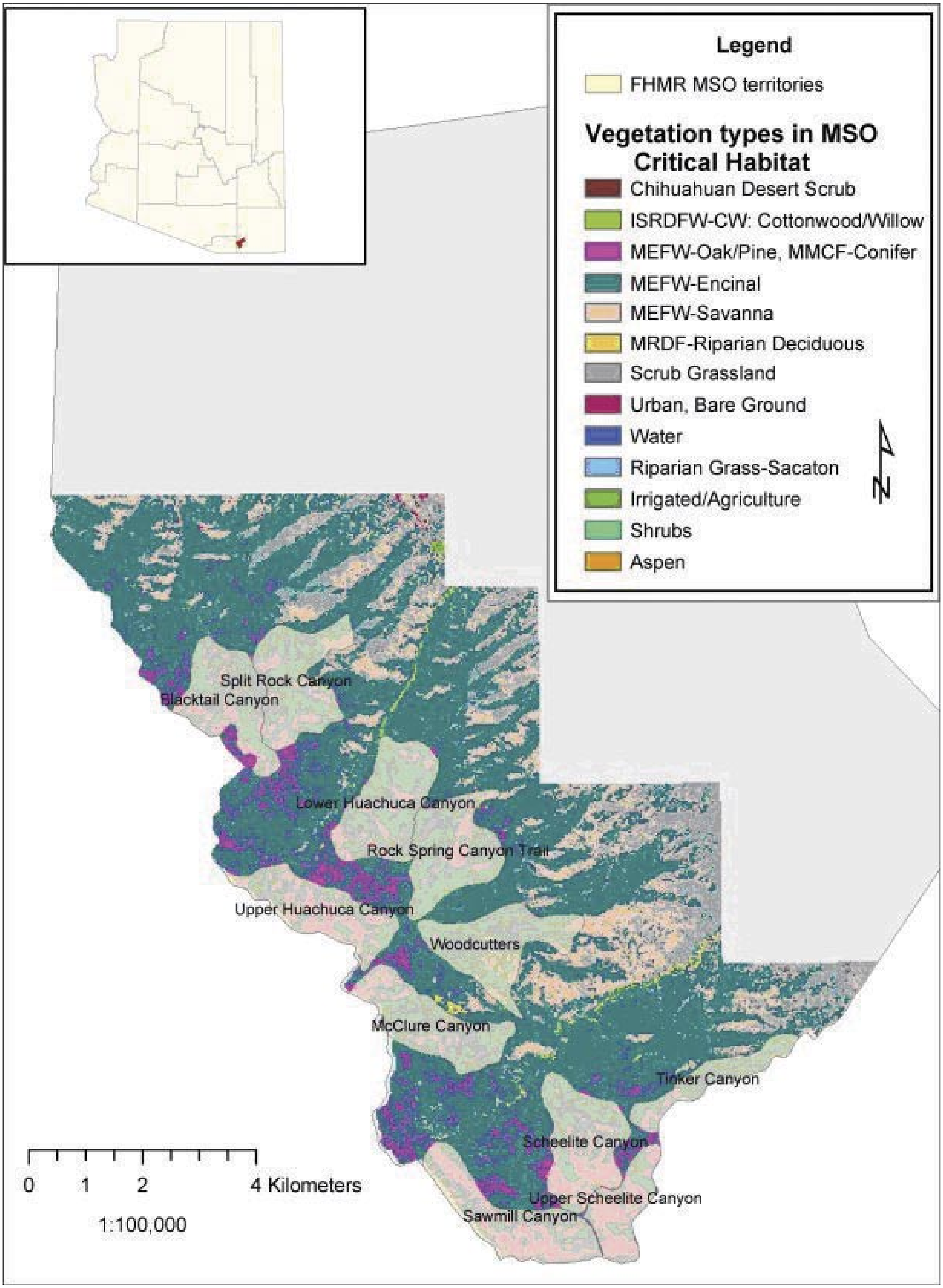


Figure 1—Critical habitat vegetation with Protected Activity Areas and Inventoried Areas (PAC/IA) on the Fort Huachuca Military Reservation (Miller et al. 2003).

and all owl territories. Scrub grassland and encinal are present in lower elevation sites and absent in higher elevation sites. The savanna component (<30% cover) is ubiquitous on lower slopes and present on south-facing slopes at all elevations, although tree/shrub composition may vary. Aspen (*Populus tremuloides*) is significant in Upper Scheelite Canyon.

Many of the owl territories were in steep, rocky canyons, with mature trees, a complex understory, and high canopy cover typical of MSO habitat identified in other areas. However, these canyons, and other small community types, are not well represented on the vegetation map because they are less than the minimum mapping size identifiable using remote sensing techniques. The oak/pine and conifer (O/P/C) categories were combined because the resolution was too coarse to separate them, and because there were not enough fuel samples to train the unsupervised classification used to create the vegetation polygons (Miller et al. 2003).

Between owl territories, scrub grassland was significant in Tinker, and O/P/C and encinal in Woodcutters and Upper Huachuca Canyons. The riparian component was significant in McClure Canyon. Within the buffered nest/roost sites, the oak component was significant in the lower elevation sites and conifer in the upper elevation sites. Tinker, Woodcutters, and Upper Scheelite were not represented in the nest analysis because there was no record of recent nest/roost sites.

Historically wide-spread, low intensity surface fires were most common in these ponderosa pine dominated forests, with a mean fire interval (MFI) of 4 to 10 years (Danzer 1998; Kaib 1998; Swetnam and Baisan 1996). The last mountain-wide fire in the Huachuca Mountains was in 1899. FHMR has mapped most wildland fires since the 1970s. These combined records indicated that there have been no fires in any of the owl territories for >100 years.

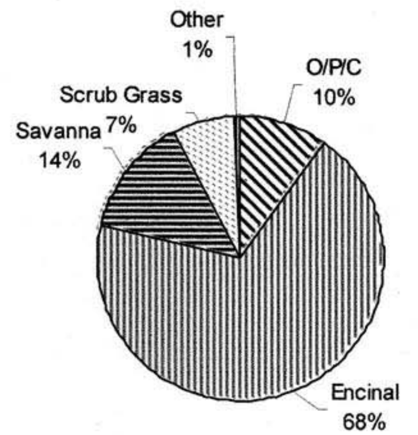
In contrast to the low-intensity, pre-settlement fires, several large crown fires have occurred in the Huachuca Mountains within the last 100 years. Areas susceptible to crown fires in the Huachuca Mountains could be characterized as mature forests (oldest trees >80 years old) with a complex structure and high canopy cover.

Number of fuel plots within MSO territories by vegetation type ranged from 2 to 11 (table 1). Stand density and composition information was obtained from 40 of the 47 plots. Tinker was eliminated from plot analysis because there were no fuel plots sampled and there have been no MSO sightings in that canyon since the late 1980s. Current tree composition based on field sampling is shown in figure 3. Pinyon (low elevation) and riparian trees (canyon sites) were significant components. Conifer species comprise 29% of the overall vegetation for the territories combined, while the oaks comprise 48%. Deciduous trees, evergreen oaks, and conifers were significant in Scheelite, which is a steep, north-facing canyon. Analysis of fuel plots indicates that oak species decrease with increased elevation while the reverse is true of mixed conifers.

Tree density ranged from 61 to 5,091 trees/ha. Total basal area ranged from 1.9 to 206 m^2/ha. Both tree density and basal area were variable within each owl territory. Shrub biomass ranged from 0 to 70,000 kg/ha, although only 43% of plots had a shrub component. A significant shrub component in these ecosystems can be evidence of both absence of fire (thus, understory is preserved) or presence of fire (resprouting after crown fire).

DWM was tallied in the following size classes: 0–0.6 cm (1 h fuels), 0.6–2.5 cm (10 h fuels), 2.5–7.6 cm (100 h fuels), and >7.6 (1,000 h fuels). DWM in size classes <7.6 cm ranged from 2.9 t/ha to 52 t/ha. Most of the MSO territories on the FHMR are found in riparian corridors; there are no studies of fuel

Figure 2a



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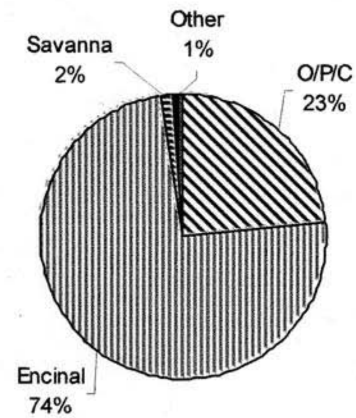

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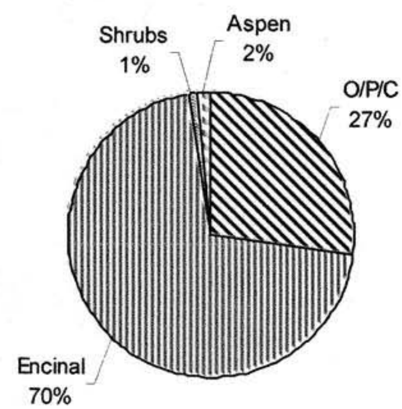

Figure 2—Percent vegetation in critical habitat: (a) MSO territories, (b) and nest/roost sites with 200 m buffer, (c) O/P/C = oak/pine/conifer.

Table 1—Number of fuel plots by vegetation type for each MSO territory. MMCF = Madrean Montane Coniferous Forest; MRDF = Madrean Riparian Deciduous Forest.

Territory	Encinal	Oak/pine	MMCF	MRDF	Total
Woodcutters	5	0	0	1	6
Split Rock	2				2
L.Huachuca	3				3
L.Scheelite				2	2
U.Huachuca	1	2			3
Rock Spring		1	1		2
McClure	5	2	1	3	11
Blacktail		3	3		6
Sawmill IA	4	2	1		7
U. Scheelite			5		5

loads for oak woodlands or riparian communities for comparison purposes. However, these fuel loads are within the range of variability reported for southwestern mixed conifer sites (Sackett and Haase 1996). Herbaceous fuels average >1,500 kg/ha for lower elevation encinal sites and <500 kg/ha sites containing more conifer species. With increase in elevation, depending on topographic position, the herbaceous component decreases as litter (e.g., pine needles) increases. There is an inverse relationship between litter and herbage yields in ponderosa pine communities (Pase 1958; Biswell 1972).

Topographic positions of nests were derived from a digital elevation model (DEM). Mean nest/roost elevation was 2,015 m (ranging from 1,772 m to 2,323 m), mean slope was 34%, and mean aspect was 207º. Of the 10 nest/roost sites analyzed, seven were on northwest facing slopes. Nest/roost sites were found on cliffs, in various oak and pine species, and in white fir (*Abies concolor*).

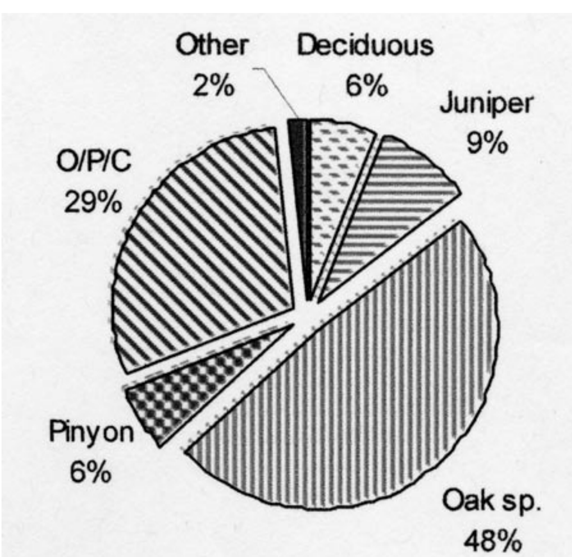

Figure 3—Tree composition based on field sampling. O/P/C = oak/pine/conifer.

Conclusions—Management Implications

The Basin and Range-West recovery unit (RU) ranks third in terms of concentration of MSO sites in the United States (USDI 1995). Most studies of MSO in other RUs suggest that mixed conifer forests dominated by Douglas fir are the most important habitat associations, with pine/oak, evergreen oak, pinyon/juniper, and riparian forests having little to no importance (Ganey and Balda 1994; Jenness 2000). May and Gutierrez (2002) suggested, based on a study in central Arizona, that MSO are not forest dependent. Data from the FHMR suggest that:

- MSO are not dependent on the mixed conifer habitat, and that
- Riparian and oak/pine (O/P/C) stands are important habitat types.

Owls were mainly found in canyon environments with riparian, mixed conifer, and oak tree components, with nests found as low as 1,772 m elevation. Oaks were a major component of all owl territories, with >65% oaks in the most productive sites based on the vegetation map and >45% based on field sampling. Both methods showed decreasing amounts of oaks and increasing mixed conifers with increasing elevation. Abundance of oaks in the Huachuca Mountains could be a result of many factors including historical overharvesting of pines, lack of fire, and oak reproduction following large stand-replacing fires (Felger and Johnson 1994). Southwestern oak species resprout vigorously following disturbance.

Because owl territories on FHMR have not sustained a fire for >100 years, the threat of catastrophic fire is real. In addition, the potential for human-ignited fires is greater here than in other mountain ranges because undocumented illegal (UDI) border traffic is purposely funneled through this area. Many of the fires in 2002 were attributed to UDI traffic. In the Huachuca Mountains, MSO habitat of uneven-aged, multi-storied stands, with high canopy closure may be a result of fire suppression. Forest communities contain high fuel loads, and the multi-storied ladder fuels contribute to catastrophic crown fires. Perhaps, fire suppression created additional habitat allowing the owls to expand into areas previously considered marginal. Because historically surface fires burned with a decadal frequency, stand density was lower; and, if we assume that this was historical MSO territory, then owls may have been adapted to a less dense stand structure.

How do we manage MSO habitat in areas that have suffered a century of fire suppression, with high potential for catastrophic fire? MSO territories should be targeted for treatment, to decrease stand density and minimize surface fuel hazard, using a combination of mechanical thinning and prescribed fire. The steep-walled canyons may be fire refugia, but if the home territories and surrounding areas are not treated the potential for catastrophic crown fires is high and probably certain.

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