White Sands Missile Range Environmental Document
Report # WSMR97FO13-2003

Mexican Spotted Owl (*Strix occidentalis lucida*) Habitat Evaluation on White Sands Missile Range

Date: 12 September 2003

White Sands Missile Range
Environment and Safety Directorate
White Sands Missile Range, New Mexico 88002

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MEXICAN SPOTTED OWL (*Strix occidentalis lucida*) HABITAT EVALUATION ON WHITE SANDS MISSILE RANGE

Final Report

Submitted to:

White Sands Missile Range, New Mexico
Directorate of Environment and Safety
Environmental Stewardship Division
White Sands Missile Range, New Mexico 88002

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INTRODUCTION

The Mexican spotted owl (*Strix occidentalis lucida*) is widely but patchily distributed throughout the southwestern United States and northern Mexico, apparently reflecting the disjunct distribution of the forested mountains and canyonlands it occupies (Ganey and Dick 1995). This subspecies is frequently associated with late-successional forests (Gutiérrez et al. 1995) and was listed by the US Fish and Wildlife Service as threatened in 1993, primarily because of past and projected loss of forest habitat (USDI 1993). To effectively manage this subspecies, land managers are seeking cost-effective methods for estimating distribution and abundance of potential habitat for this bird. In response to this need, White Sands Missile Range (WSMR) contracted with Natural Heritage New Mexico to evaluate potential Mexican spotted owl habitat across the two million acres of WSMR. The goals of this study were to assess the usefulness of various remotely-sensed imagery and other data sources in evaluating Mexican spotted owl habitat over a large scale and to identify, delineate, and rank potential breeding and migratory habitat areas.

BREEDING HABITAT

Mexican spotted owls breed in mixed conifer forest dominated by Douglas-fir (*Psuedotsuga menziesii*), pine (*Pinus* spp.), or true fir (*Abies* spp.), and pine-oak forests (Ganey and Balda 1989a, 1994, Seamans and Gutiérrez 1995, USDI 1995). They also select steep, narrow canyons with cliffs and a perennial water source (Rinkevich et al. 1995, Willey 1993). Canyon habitats usually contain conifer or riparian forests or clumps of trees, but they also may be sparsely vegetated (Rinkevich et al. 1991, Willey 1998). In contiguous forest areas, they have been shown to select old-growth forests (Ganey and Balda 1989a) or forests that have more complex structure than surrounding forests

(Seamans and Gutiérrez 1995). Previous studies (reviewed in Ganey and Dick 1995) suggest that Mexican spotted owls are highly selective of roosting and nesting habitat but forage in a wider array of habitats. Table 1 summarizes habitat use studies, most of which concern the breeding season. In general, these studies suggest that breeding habitat typically has a minimum 60% canopy cover, but 70-80% is more typical. Where canopy cover is extremely high, associated slopes can be as low as 20%, but typically range from 35-75% (Table 1).

MIGRATION/DISPERSAL

Adult Mexican spotted owls have high breeding site fidelity, and only a few cases of breeding dispersal have been observed (Gutiérrez et al. 1996). Therefore, the majority of dispersing birds are juveniles (Arsenault et al. 1997). Relatively few studies have been conducted on dispersal behavior of juvenile spotted owls. Seasonal adult migration distances from 8 birds in 6 studies ranged from 20 to 50 km with vertical displacement ≥ 1,000 m (Gutiérrez et al. 1995).

Nine juvenile owls were radio-tracked in 1993 and 1996 in the Black Range and San Mateo Mountains of southwestern New Mexico (Figure 1; Arsenault et al. 1997). Five birds monitored intensively during the first week of dispersal (between late August and early September) moved an average total distance of 24.3 ± 12.3 km (16.3-44.8 km, a maximum distance of 11.3 km per night) and remained in the new area for 3 to 16 days before subsequent long-distance movements. The mean straight-line distance birds moved (n=9) to their last known location (an average of 99.8 days later) was 21.8 km (1.3 - 57.6 km). The two birds with the greatest straight-line distances (44.8 km and 57.6 km) moved from the San Mateo Mountains across 20-40 km of unsuitable breeding habitat (juniper savannah/grasslands) to the Black Range (Figure 1). This type of dispersal may be fairly common but is undocumented elsewhere in New Mexico.

Figure 1. Map of New Mexico showing relevant mountain ranges.

Table 1. Mexican spotted owl habitat studies and general descriptions of site, vegetation, and study results. All habitat data is from breeding-season studies, unless otherwise noted.

ARIZONA

Source	Areas	Elev-ation	Site Descriptions	Vegetation	Vegetation Details	Other
Ganey and Balda 1989a	Southern and Northern Arizona	1,125 to 2,930 m	canyons (particularly in the southern range of the state) and forested slopes (above 2,300)	Vegetation ranged "from coniferous forests to evergreen oak forest and associated deciduous riparian forests. Owls were also associated in canyons containing extensive rocky cliffs with potholes and caves [for roosting and nesting]."	<u>Lower elevations</u>: cliffs, evergreen oaks, Mexican pinyon (*Pinus cembroides*), and broadleaved riparian trees. <u>Middle elevations</u>: variable, Arizona Cypress, and types listed above. <u>Higher elevations</u>: 2 major types: mixed-conifer forest (67%), ponderosa pine forest (5%) – generally between the ponderosa pine and spruce-fir forest belts.	
Ganey and Balda 1989b	San Francisco Peaks, Walnut Canyon, White Mountains	1,830 to 2,930 m	forested slopes, narrow canyons	ranged from mixed coniferous forest with steep slopes (at S.F. Peaks and W. Mountains) to rocky cliff areas with ponderosa pint (W. Canyon)	Homerange results: Unlogged old-growth forest: 43% Selective-logged forests: 55%	homeranges for part of the year: individual owls – 648 ha, pairs – 847 ha
Ganey and Balda 1994	San Francisco Peaks, Walnut Canyon, White Mountains	1,830 to 2,930 m	forested slopes, narrow canyons	ranged from mixed coniferous forest with steep slopes (at S.F. Peaks and W. Mountains) to rocky cliff areas with ponderosa pint (W. Canyon)	Significant differences between roosting, foraging, and random 0.04 ha plots: small logs/ha (148 vs. 117 vs. 96), big logs/ha (123 vs. 84 vs. 48), canopy closure (80 vs. 67 vs. 52%), trees/ha (813 vs. 647 vs. 445), snags/ha (97 vs. 55 vs. 23), tree basal area (52 vs. 48 vs. 30), snag basal area (9 vs. 6 vs. 2).	Overall, roost sites were denser than foraging sites, and foraging sites were denser than random sites. Also, pine forest used more for foraging than roosting.
Ganey et al. 2000	Coconino N. F., 40 km south of Flagstaff	1,850 to 2,440 m	small canyons	ponderosa pine, with scattered meadows or parks. Alligator juniper, quaking aspen, narrowleaf cottonwood, and boxelder occurred locally	<u>Breeding season roots:</u> slope 20%, canopy cover 74%, roost tree dbh 32 cm, roost tree height 15 m, overstory height 22.3 m, perch height 10 m, rel. owl height 64%. <u>Nonbreeding season roosts:</u> slope 16%, canopy cover 59%, roost tree dbh 31 cm, roost tree height 15 m, overstory height 21 m, perch height 10 m, rel. owl height 66%.	This study did not evaluate habitat use vs. availability.

Table 1 (continued)

NEW MEXICO

Source	**Areas**	**Elev-ation**	**Site Descriptions**	**Vegetation**	**Vegetation Details**	**Other**
Zwank et al 1994	Sacramento Mountains (southcentral NM)	2050 to 2750 m	moderately steep forested mountain slopes	Rio Penasco drainage: "predominantly Douglas-fir, white fir and southwestern white pine." Sixteen Springs drainage: less steep slopes with mostly ponderosa pine. Pinyon pine, alligator juniper and small patches of mixed conifer are also present.	Roost elevation: 2156 - 2597 m Winter roosts: males 65%, females 63% in mixed-conifer. Breeding-season roosts: males 77% in mixed conifer. Some roosting in ponderosa pine. Other roosting data (averages across sex, season and location): owl ht: 6.5 to 10.9 m, tree ht: 16.1 to 20.7 m; canopy closure: 75.4 – 83.3%; tree basal area: 98.3 – 147.2 sq cm; slope: 19.5 – 23.1%.	homeranges for 101 – 301 days after marking: individual owls – 742 ha, pairs – 1178 ha
Seamans and Gutiérrez 1995	Tularosa Mountains (westcentral NM)	2,150 to 2,800 m	mixed-conifer/oak forest. Most nest and roost site found on the lower third of north-facing slopes.	- "Most nest and roost sites had an understory of Gamble oak, which added to the forest structure." - all subspecies "selected nest and roost sites primarily in mixed-conifer forest with larger and taller trees, higher canopy closure, and higher variation in tree heights than random sites." - "habitats such as pinon-juniper woodland of even-aged pine and mixed-conifer lacked the vertical structure typical of nest and roost sites.	Significant differences between SPOW sites and random plots, in descending discriminant analysis rank: Roosts: higher canopy closure (85 vs. 51%), tree height (19 vs. 12 m), tree ht variance (2.2 vs. 1.1), live tree basal area (32 vs. 20), mature tree basal area (9 vs. 4), slope (18 vs. 11%), small debris cover (4 vs. 2%), tree dbh var. (6 vs. 5), tree dbh (36 vs. 31 cm) Nests: tree height variance (2.2 vs. 1.1), mature tree basal area (12 vs. 4), tree height (20 vs. 14), canopy closure (76 vs. 56%), tree dbh variance (8 vs. 6).	- owls nested and roosted in mixed conifer /oak forest more, and pine/oak and woodland less than expected - compared to random trees, nest trees were older (164 vs. 120 yrs), taller (27 vs. 18 m), and had larger DBHs (61 vs. 43)
Stacey and Hodgson 1999	San Mateo Mountains (near T or C)	1,800 to 3,200 m	deep forested mountain canyons	Mixed scrub oak, pinyon-juniper, ponderosa pine, mixed conifer, and limited aspen and spruce-fir forests. Some remnant riparian vegetation in canyon bottoms: Gambel oak and narrowleaf cottonwoods – these areas now altered from livestock, now considered "mixed conifer/deciduous"	2/3 of roost sites in mixed-conifer/deciduous, remaining roosts in mixed-conifer, no roosts in pinyon-juniper or ponderosa pine forest – differed significantly from random points. Higher canopy closure (60%), higher live tree density (773/ha),	Lower basal area (b.a.) of pinyon-juniper and ponderosa pine (0.2 and 3.0 sq.m/ha), and higher Douglas-fir, white pine, and Gamble oak/other deciduous b.a.(7/5, 2.9, and 5.5 sq.m/ha)

Table 1 (continued)

NEW MEXICO (continued)

Source	Areas	Elev-ation	Site Descriptions	Vegetation	Vegetation Details	Other
Ganey et al. 2000	Sacramento Mountains (southcentral NM)	2,000 to 2,800 m	moderate to steep montane canyons	- Mesic study area: mixed-conifer forest dominated by Douglas-fir and/or white fir. Southwestern white pine, ponderosa pine, and quaking aspen less abundant. - Xeric study area: mixed-conifer was restricted to cool microsites such as drainage bottoms and north-facing slopes. Most south-facing slopes and ridgetops were dominated by woodlands of pinyon pine and alligator juniper, sometimes mixed with ponderosa pine. Other slopes were dominated by ponderosa pine sometimes with a strong component of Gambel oak	Significant differences between SPOW sites and random plots, in descending discriminant analysis rank (with ranges for 'mesic' and 'xeric' study areas): Breeding season roots: slope 36-37%, canopy cover 76-70%, roost tree dbh 40-29 cm, roost tree height 20-15 m, overstory height 29-22 m, perch height 8-7 m, rel. owl height 46-44%. Nonbreeding season roosts: slope 33-30%, canopy cover 80-70%, roost tree dbh 43-32 cm, roost tree height 21-16 m, overstory height 27-21 m, perch height 9-7 m, rel. owl height 46-44%.	

UTAH

Source	Areas	Elev-ation	Site Descriptions	Vegetation	Vegetation Details	Other
Kertell 1977	Zion National Park	1560 m	steep-walled canyons cut by intermittent streams	canyons are "perhaps 20 degrees F cooler than one would expect at the bottom of Zion Canyon or on the plateau above"	white fir, Douglas-fir, bigtooth maple, and boxelder	prey: woodrats, pocket gopher, beetles
Willey 1998	Southern Utah	1,109 to 3,960 m	arid canyonlands, with varied vegetation	Roost plots vs. random plots: temp (23 vs. 28 C), slope (54 vs. 13°), canopy cover (36 vs. 36%), ledges (5 vs. 1), trees (3 vs. 5), tree dbh (31 vs. 15 cm), tree ht (9 vs. 5 m), caves (2 vs. 0.4)	For dispersing juveniles, use of pinyon-juniper areas stayed relatively constant from May-April (50% over 3 4-month periods (total 1 year)), mixed conifer use decreased (42 to 15%) , desert scrub use increased (8 to 30%).	

Table 1 (continued)

MEXICO

Source	**Areas**	**Elev-ation**	**Site Descriptions**	**Vegetation**	**Vegetation Details**	**Other**
Tarango et al. 1997	Sierra Madre Occidental, southwestern Chihuahua	2,280 to 2,480	steep, north-facing slopes with high canopy closure	Tree roosting plots: oaks (48.5%), Arizona pine (18.4%), Mexican white pine (15.4%), Douglas-fir (11.6%). Cliff-roosting plots: oaks (44.1%), Douglas-fir (17.8%), Mexican white pine (15.5%), ash (9.7%), and Durango pine (8.8%). Also: madrone, black cherry.	tree roosting sites (0.04 ha): slope (67%), canopy closure (ave 68%; 52-74%), mean tree height (13 m; 11-17 m), mean dbh (25 cm), >2 canopy layers, tree density (643; 350-950 per ha), basal area (29; 17-44). Cliff-nesting sites: slope (ave 76%; 67-84%), mean canopy closure (68%; 61-79%), mean tree ht (13 m, 11-15 m), mean dbh (26; 22-30), >3 canopy layers, tree density (610; 500-681 per ha), basal area (31; 25-34).	one nest found, in Mexican white pine site, 2 canopy layers, 81% slope, 71% canopy closure, 30.1 dbh white pine, 16 m tall tree, 12 m tall nest.
Young et al. 1998	Sierra Madre Occidental of southwestern Chihuahua	2,072 to 2,600 m	forests and incised canyon areas	Primarily pine-oak, dominated by Durango pine, Mexican white pine, and Arizona pine. Oak species included netleaf oak and Arizona white oak. Some Douglas-fir, Arizona cypress, Chihuahuan spruce, madrones, and black cherry	Roost vs. random (within-territory) sites: slope (63 vs. 41%), canopy layers (2.6 vs. 1.8), canopy height (19 vs. 15 m), canopy closure (73 vs. 40%), live basal area (21 vs. 7), snag basal area (1.1 vs. <0.1). Also no bare ground in roost plots, and higher % of litter, rock, herbaceous vegetation, grass, and wood debris.	No statistical tests made
Tarango et al. 2001	Sierra Madre Occidental, Aguas-calientes	2,150 to 2,800 m	isolated forest patches in steep canyons	Second-growth oak-pine associations. Pines: ocote, nut, Chihuahua, weeping, and Michoacan. Also co-dominated by junipers, manzanita, and madrone.	Roost tree measurements: tree height 10.4 m, perch height (7.0 m), dbh (34.7 cm), slope (18.9%), canopy closure (61%), 66.6% found on north-facing slopes. 2-4 canopy layers present at roost sites.	diet dominated (89%) by *Neotoma*, *Peromyscus*, and *Sylvilagus floridanus* (Young et al. 1997)

In another New Mexico study, of two juveniles captured in the Tularosa Mountains of west central New Mexico, one dispersed 56 km northwest to Escondido Mountain, while the other was recaptured 22 km south of its natal site (Gutiérrez et al. 1996). These movements are not particularly notable, due to the generally continuous nature of montane forest vegetation in the area. One movement of particular interest was by an adult female found electrocuted near Deming, New Mexico, approximately 187 km southeast of its banding location and approximately 80 km from the nearest suitable nesting habitat (i.e., mixed-conifer or pine-oak forest). The bird was 68 g lighter when recovered than when it was banded, but it appeared to be overall in good condition with no indication of starvation or poor health.

In southern Utah, Willey and van Riper (2000) found an average total dispersal distance of 29.2 ± 22.5 km (1.7 – 92.3 km) from natal areas (n = 26 birds). Several individuals had average daily movement distances greater than 7 km. Most birds dispersed in September and appeared to disperse randomly, switching direction frequently. Birds dispersed across a wide range of habitats but were found most frequently in pinyon-juniper and desert scrub vegetation types (also documented in Willey 1998). Dispersal paths frequently crossed open country, with juveniles found at roosts in solitary trees, in shrubs, and among rocks in open talus.

In a study of 24 owls in Northern Arizona, Ganey et al. (1998) found a median maximum dispersal of 25.2 km (2.1 – 73.5 km). Two-thirds of juvenile birds dispersed in September and moved in no consistent direction during dispersal. Owls roosted at lower elevations (mean = 1,753 ± 44 m) during early (August – October) dispersal than during late (November – April) dispersal periods (mean = 2,177 ± 25.4 m) and roosted in Gambel oak less and in pinyons and junipers more often in the late versus the early dispersal period. In that study, four juveniles monitored beyond mid-November moved down in elevation, with at least two establishing apparent home ranges containing pinyon-juniper forests and habitat very different in composition and structure from known breeding habitat. These observations are similar to those in Ganey et al. (1992) and Rinkevich et al. (1995) of dispersing and adult owls wintering in atypical habitats.

The Recovery Plan for the Mexican spotted owl (USDI 1995) determined that nearly all isolated habitat patches defined as mixed conifer or ponderosa pine (*Pinus ponderosa*) in New Mexico and throughout the Southwest, although not preferred breeding habitat, could be reached if an owl could disperse at least 60 km between isolated habitat patches.

WHITE SANDS MISSILE RANGE

WSMR encompasses approximately 885,910 ha. Forest/woodland communities occupy approximately 22,000 ha in the Oscura, San Andres, and parts of the Organ Mountains (Muldavin et al. 2000). Due to the size and inaccessibility of parts of WSMR, we adopted a remote sensing approach to mapping potential Mexican spotted owl habitat on WSMR. Remote sensing tools, such as satellite imagery and aerial photography, allow visualization of large landscape areas like WSMR. For this project, we assessed the utility of various remote-sensing data for identifying and mapping potential Mexican spotted owl habitat. We combined the most useful available WSMR data, information from field visits, and information gathered from peer-reviewed literature on the Mexican spotted owl to generate a habitat suitability map for WSMR.

Minimal vegetation data from a variety of sources were available for the majority of forest areas identified, but detailed information on vegetation structure was available for only a small subset of areas. The field component of this project consisted of visits to focal areas to evaluate potential canyon- or forest-nesting Mexican spotted owl habitat. This allowed us to correlate particular remotely-sensed variables with vegetation features on the ground and to refine a habitat model and ranking index using the detail of field information and the large-scale remotely-sensed data.

METHODS

We incorporated literature, imagery, existing vegetation maps and databases, other data sources, and field visits by NHNM staff in the development of the final assessment and habitat model. These sources allowed us to locate, delineate, and assess Mexican spotted owl breeding and non-breeding habitat.

LITERATURE SOURCES

Although less-studied than the northern spotted owl (*Strix occidentalis caurina*), the Mexican spotted owl has been the subject of many studies since the 1980s. Researchers have primarily studied birds in Arizona and New Mexico, but populations in southern Utah and northern Mexico have also received attention. The most frequently-studied aspect of Mexican spotted owl biology has been habitat selection and use, typically by breeding adults, but some studies have included winter habitat and habitat use by dispersing juveniles. We assembled data from these studies and summarized them in Table 1. Other study topics have included food habits (Ganey 1992), behavior (Ganey 1990, Delaney et al. 1999), population dynamics (Seamans et al. 1999, 2002), and movement and dispersal patterns (Gutiérrez et al. 1996, Arsenault et al. 1997, Ganey et al. 1998, Willey and van Riper 2000).

Imagery Sources

USGS Digital Raster Graphics

United States Geological Survey (USGS) Digital Raster Graphics (DRG) at a resolution of 1:24,000 provided general information on forest cover, water sources, and topography. Forest cover information was very coarse and was useful only for indicating isolated forest and/or open areas. Elevation contour isolines, though also generalized, provided easy interpretation of topography, including slope and aspect.

Landsat Thematic Mapper

Geometrically-corrected Landsat Thematic Mapper (TM) imagery of WSMR at a resolution of approximately 1:100,000 was available at Natural Heritage. The 1:100,000 resolution means that each pixel in the imagery is approximately 28.5 m long (812.25 m^2). Forest vegetation, although often apparent in contrast with surrounding open vegetation, was not easily interpretable. In addition, the coarse resolution proved inadequate for detecting most riparian forest areas, which tend to be narrow.

WSMR Vegetation Map

The White Sands Missile Range Vegetation Map (Muldavin et al. 2000) defines 33 vegetation mapping units. The map, generated using Landsat TM imagery and field vegetation plots, includes several montane forest map units of pinyon pine (*Pinus edulis*) woodland types and one ponderosa pine forest type. The map allowed general delineations of forest areas, but the coarse resolution did not allow precise patch delineations.

USGS Digital Orthophoto Quadrangles

Digital Orthophoto Quadrangles (DOQs) have recently been made available by the USGS for all of WSMR. These digital photographic images, taken in the mid-1990s, are orthographically rectified for GIS purposes with a resolution of one meter. This resolution provides very fine detail for the discrimination of forest boundaries, narrow riparian forest patches, and general forest structural characteristics. Nearly half of WSMR was available in color infrared images, with the remaining portions in panchromatic black and white. Most of the San Andres Mountains was included in color images, while the Oscura Mountains were included in black and white images. The most useful attribute of the DOQs is that they allow discrimination of vegetated from non-vegetated surfaces, and simple visual inspection is sufficient to verify the presence of vegetation.

Digital Elevation Model

A digital elevation model (DEM) of WSMR was available at a 28.5 m resolution. Although not appropriate for detection of very subtle topographic features, this imagery allowed a variety of analyses of slope, aspect, and coarse elevation. Combining this information with other data sources on vegetation was also helpful.

NON-IMAGERY DATA SOURCES

WSMR Springs Survey

A springs survey conducted in the mid-1990s detailed 276 spring locations within the San Andres and Oscura Mountains (Boykin et al. 1996). The survey included information on characteristics of hydrology, vegetation, and species composition, including evaluations of each location as potential endangered species habitat; e.g., for the southwestern willow flycatcher (*Empidonax traillii* *extimus*). That report and its associated digital data provided invaluable information on spring-based mountain canyon riparian habitat. The report also had a supplementary set of slide photographs that allowed a more accurate assessment of vegetation at and surrounding spring study locations. We thoroughly examined information available for each spring site to generate a priority list of sites having potential for supporting cliff- and canyon-nesting Mexican spotted owls.

<u>WSMR Riparian Areas Map</u>

As part of a delineation of potential habitat for the southwestern willow flycatcher and western yellow-billed cuckoo (*Coccyzus americanus occidentalis*), NHNM created a shapefile map that delineates riparian habitat patches (WSMR 2003). This map and associated database were developed using many of the data sources and imagery described above and below, with the addition of several other hydrology-specific databases. The map and associated data supplemented spring site information from the Boykin et al. (1996) surveys and helped in ranking sites for field visits. Data included vegetation patch and microhabitat measurements taken by NHNM staff and additional hydrology information from the ongoing Waters of the U.S. study (Lichvar and Sprecher 1998).

<u>Oscura Mountains Fire History Map</u>

NHNM recently developed a draft map in ArcView shapefile format that describes WSMR fire history and forest vegetation structure, canopy cover, topography, and other characteristics (Muldavin et al. 2003). The map delineates forest areas into patches (minimum size = 0.6 ha), based on these measures. We used this map for selecting areas of montane forest for field visits (see Breeding Habitat Evaluation: Montane Forest Breeding Habitat, below) and for non-breeding habitat (see Non-Breeding Habitat Evaluation, below).

USGS Geographic Names Information System

The U.S. Geological Survey Geographic Names Information System database (GNIS) provided locations of potential water sources and riparian/wetland vegetation on WSMR. Ten lakes, 130 reservoirs/tanks, 131 springs, and 140 wells currently or historically present on WSMR are included in the GNIS database. We used the GNIS to identify locations of potential riparian forest/woodland areas that could be photo-inspected with DOQ images. Most of these wetland sites were subsequently eliminated as potential spotted owl habitat, based on information from other sources such as DOQs, the willow flycatcher/cuckoo database, etc.

National Hydrography Dataset

The National Hydrography Dataset (NHD), available as an ArcView shapefile, provided additional location information useful for identifying drainages for photo-inspection with DOQ imagery. Because Mexican spotted owl habitat is often associated with drainages containing cooler-climate forest communities, this shapefile, in combination with vegetation information, was helpful in identifying potential cliff- or canyon-nesting habitat within or adjacent to drainages.

NHNM Plot Floristic Database

Throughout their range, Mexican spotted owls typically nest in mixed-conifer forest vegetation. As WSMR does not have significant areas of this forest type, we queried the plot floristic database (in NHNM 2003) for vegetation plots containing pine (*Pinus* spp.) and riparian forest species such as willow (*Salix* spp.), cottonwood (*Populus* spp.), maple (*Acer* spp.), and ash (*Fraxinus* spp.). One hundred seventy plots (8.7% of all 1,955 plots) were of pinyon or ponderosa pine communities, while 88 (4.5% of all 1,955) included one or more of the target riparian species. In addition to general community and species information, the database also provided abundance (cover) information for each species in each plot.

Species Locations

We examined the NHNM Natural Heritage Information System (NHIS) for any reported observations of Mexican spotted owls on or near WSMR. The NHIS contains numerous Element Occurrences (EOs) for Mexican spotted owls in New Mexico, with geographic location and information on longevity of territories, per-season breeding success, and nesting habitat. Daisan Taylor, Wildlife Biologist at WSMR, also recommended sites for evaluation. Though no Mexican spotted owls have yet been observed on WSMR, information on breeding territories in nearby mountain ranges provided guidelines on elevation, some habitat characteristics, and distance to the nearest breeding population.

In addition to owl locations, we also reviewed available location data on potential montane prey species for spotted owls. Potential prey included small-to-medium sized mammal species such mice (*Peromyscus* spp.), woodrats (*Neotoma* spp.), and rabbits (*Sylvilagus* spp.). This information provided some additional perspectives on Mexican spotted owl habitat suitability.

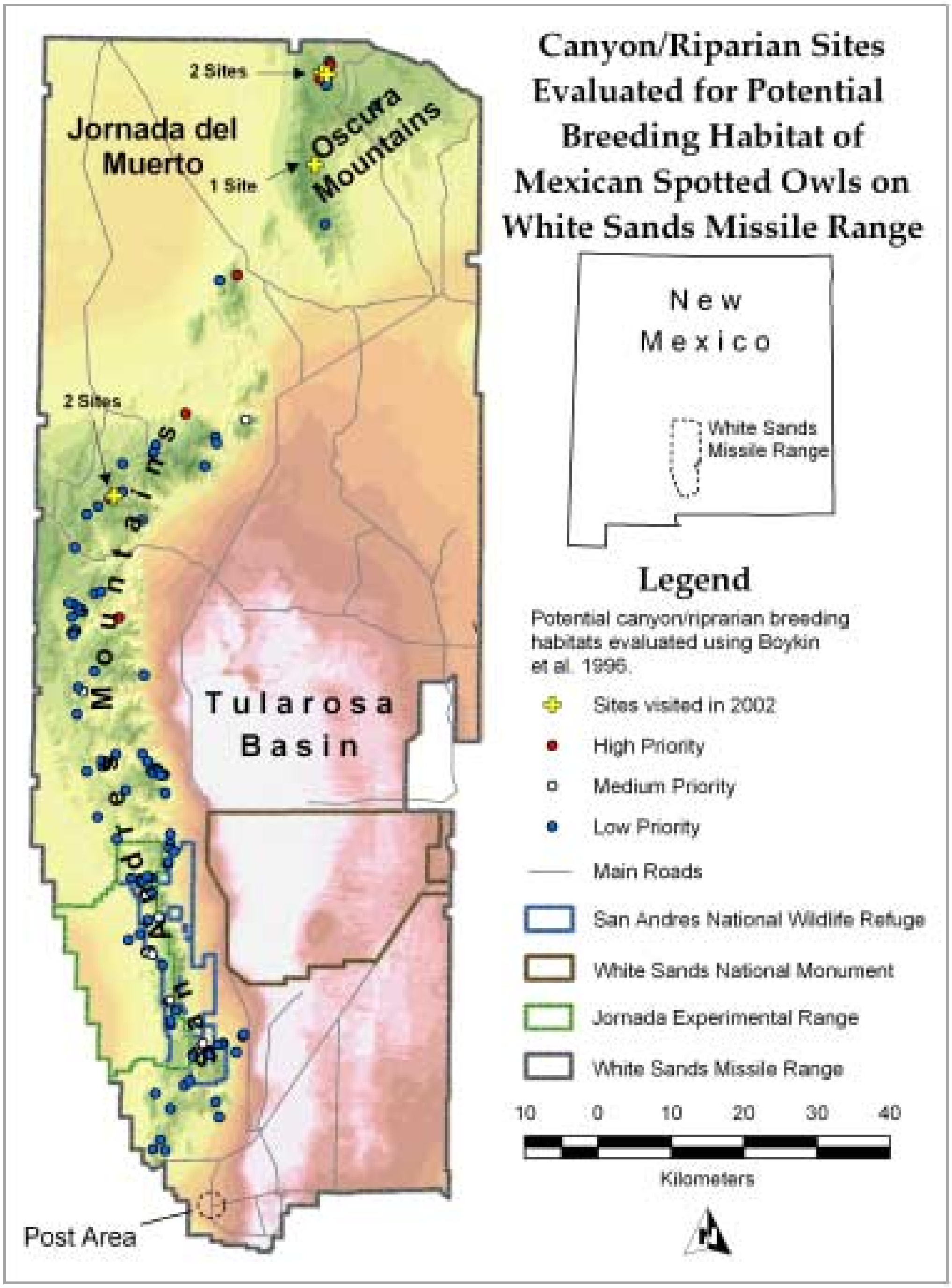
BREEDING HABITAT EVALUATION

Canyon/Riparian Breeding Habitat

To identify potential breeding habitat within canyon areas we relied heavily on available data on springs (GNIS, Boykin et al. 1996), drainages (NHD), riparian areas (Sadoti et al. 2002), and topography (DEMs and DRGs). The most comprehensive study documenting many of these features was the WSMR springs survey (Boykin et al. 1996; see data description above). Because this study included all active or historic mountain springs, we first limited our query of this data source to those springs having associated patches of riparian vegetation. In addition to examining the vegetation information associated with this source, for each spring having riparian patches, we carefully reviewed photographic records provided with the report. Additional field data and photographs from WSMR 2003 (see Non-Imagery Data Sources, above) were available for 16 of these sites in the San Andres Mountains and 28 riparian/wetland sites outside of mountain areas on WSMR. The springs survey and additional photos, linear drainage features of the NHD (see Non-Imagery Data Sources, above), and a map of slopes derived from the DEM provided additional cues for characterizing canyon/drainage areas in DOQ imagery. Springs and canyons were then ranked and priorities were set for field visits based on topographic relief and vegetation density, structure, and area. Low-ranked sites typically had: low slopes (< 50% grade), short-stature (< 5 m tall, typically pinyon-juniper) woodlands with only one canopy layer, and/or small (< 0.5 ha) riparian patch areas. Sites ranked highly had cliffs or steep slopes in proximity to forest areas with multi-layered canopies (usually over 10 m tall). Medium-ranked sites had either taller (> 10 m) forest patches or steeper slopes, but not both.

We visited five of the ten high-ranking canyon/riparian habitat sites from April 30 to May 2, 2002 (Figure 2). These incised canyons occur in the northern San Andres Mountains, the South Oscura Ridge area, and the northern Oscura Mountains. During these visits, we recorded descriptions of topography and general structural and compositional characteristics of five drainages.

Figure 2. Canyon/Riparian sites evaluated for potential breeding habitat for the Mexican spotted owl on White Sands Missile Range.



Montane Forest Breeding Habitat

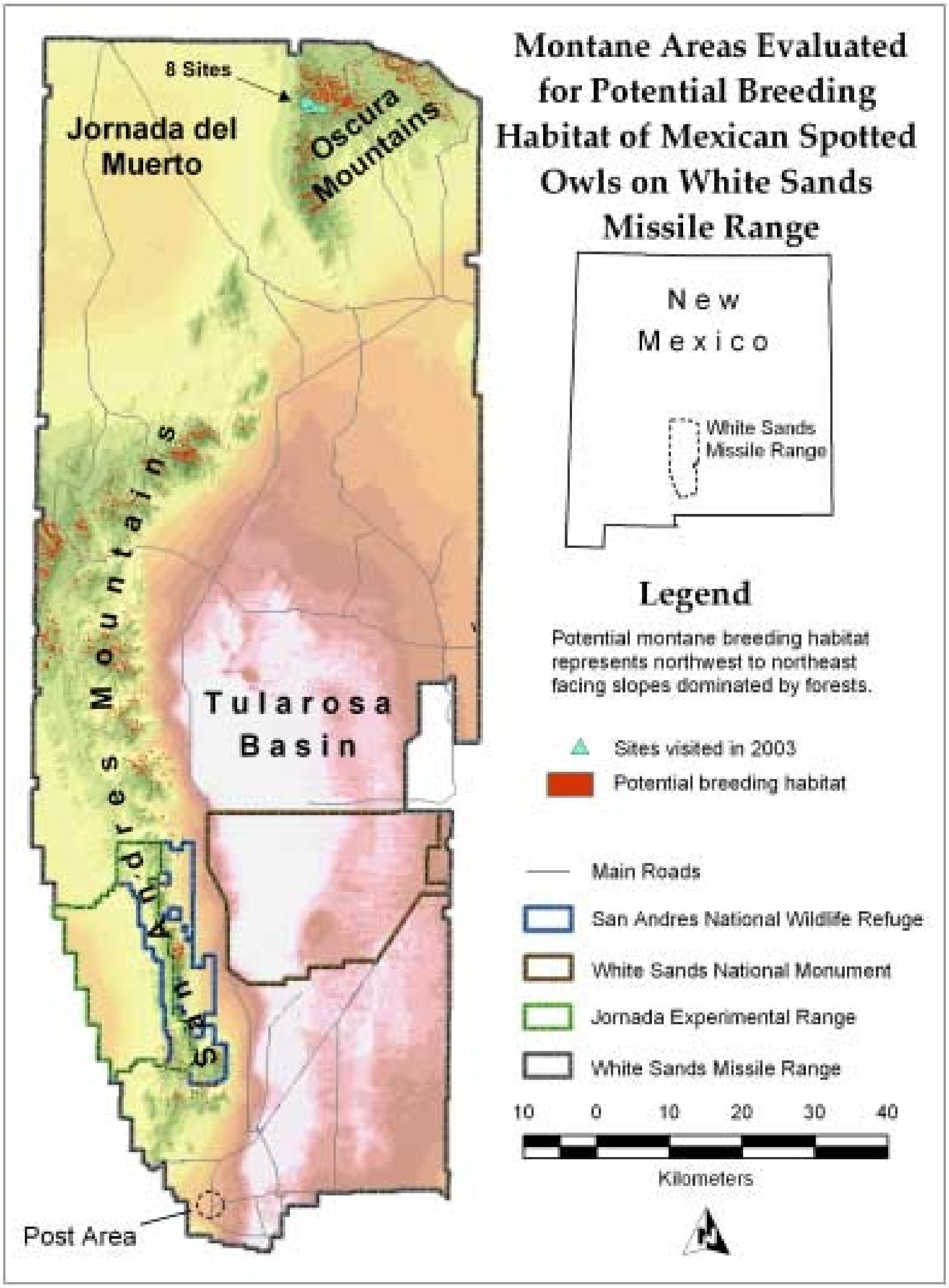
The identification of potential Mexican spotted owl breeding habitat in higher elevation montane areas required a similar approach as in canyon/riparian areas, but it included some new data sources and excluded others. We used the distribution of the five forest types mapped on the WSMR vegetation map (Muldavin et al. 2000, see Imagery Sources above) to identify target areas of montane forest. We then narrowed the forested areas to those on north-facing slopes (Figure 3). Then we visually scanned DOQs of all north-facing forested areas for large, densely-forested patches. We evaluated density and degree of contiguity between forest-class cells (28.5 m resolution) within a 5-cell radius using DOQ imagery and/or vegetation data from the NHNM plot floristic database (in NHNM 2003). These final sources provided finer-scale vegetation structure information. In addition to the sources listed above, we also had detailed information on all forest and topography characteristics listed above, plus additional structural characteristics for the entire north Oscura Mountains (Muldavin et al. 2003).

This examination of the montane forested areas revealed no suitable breeding habitat in either the San Andres or Oscura Mountains. We nevertheless picked eight field sites for field visits, to verify the remote-sensing evaluation. Sites visited included primarily sites with the most potential for breeding habitat, but a few less-promising sites were also included, for purposes of field checking our remote sensing methods. Areas not considered for field visits typically had low canopy cover (if known, < 30%) and/or were generally patchy (< 50% of the cells in each 5-cell radius were forest).

Based on the data sources above, we had eliminated all areas evaluated in the San Andres Mountains as potential breeding habitat, due to tree density or size of patch containing dense trees. A small patch of ponderosa pine does occur in the San Andres, but photographs of those areas (provided by E. Muldavin) showed the forests to be quite open and clearly unsuitable for breeding, thus eliminating the need for further consideration of those areas. We therefore limited our field checking to the north Oscura Mountains.

We visited eight areas of montane forest habitat in the north Oscura Mountains, during March 17-18, 2003 and April 11, 2003. During these field visits, we made general descriptions of forest vegetation and vegetation measurements at eight 0.02-ha circular plots. These descriptions included species, height, and diameter-at-breast-height (DBH) of all overstory trees and number and relative species dominance of understory trees/shrubs.

Figure 3. Montane areas evaluated for potential breeding habitat for the Mexican spotted owl on White Sands Missile Range.



NON-BREEDING HABITAT EVALUATION

Unlike breeding habitat, which is quite specific and well-defined, non-breeding habitat for Mexican spotted owls can include a variety of habitat types. It was necessary to somehow rank the several habitat types on WSMR that might be used by spotted owls outside the breeding season. We therefore evaluated potential non-breeding habitat on WSMR using quantitative modeling techniques.

Using vegetation data from the Oscura fire study map (Muldavin et al. 2003), we developed a Mexican spotted owl dispersal/wintering habitat suitability model for the northern Oscura Mountains. We focused on the vegetation variables that were significant in multivariate tests discussed in Seamans and Gutiérrez (1995) and Ganey et al. (2000) and in univariate tests from other studies (Table 1). These variables, in descending order of importance, included percent total canopy cover, percent slope, and tree height variance. The first two variables were available for each forest area delineated in the fire study map (minimum size = 0.6 ha). We calculated tree height variance from the ratio of total percent canopy cover to percent emergent canopy cover. Areas with 50% emergent cover were considered to have the highest possible height variance, while areas with low or high total cover-to-emergent cover ratios were considered to have lower height variance. This occurs because, for example, 70% total canopy cover and 30% emergent canopy cover provides a less variable canopy height than 50% total canopy and 50% emergent canopy.

We used a similar approach in other forested areas outside the Oscura fire study boundary. Because total canopy and emergent canopy data were not available outside the Oscuras, we used canopy cover data from the NHNM plot floristics database for the 170 points forested by *Pinus* spp. (in NHNM 2003) and slope information calculated from the WSMR DEM. For these areas, we determined canopy cover for each NHNM vegetation plot from abundance measurements for pinyon and ponderosa pines in the mature tree class (class 3, Muldavin et al. 2003). These cover data were then used to generate a 28.5 m-resolution interpolated grid across the extent of WSMR. This method essentially creates a continuous surface of estimated canopy cover based on values at vegetation plots. A similar method is used to generate slopes using a DEM, whereby the differences in elevation between adjacent cells in the model are used to calculate degree or percent slope of the surface of each cell. We combined the canopy cover and DEM grids to generate a new grid containing both slope and interpolated cover data. We then clipped this grid to only those areas classified as pinyon or ponderosa pine-community forests in the WSMR vegetation map (Muldavin et al. 2000).

Once we obtained values for each cell/area on each variable, it was necessary to weight each value according to the importance of the variable to Mexican spotted owls. We developed models to include available variables weighted by approximate importance for roosting Mexican spotted owls (Seamans and Gutiérrez 1995, Ganey et al. 2000). Variable weights (coefficients) in each model totaled 1.0. The model for the north Oscura Mountains forest patches weighted total canopy cover with 0.7, percent slope with 0.2, and height variance with 0.1. The model for forest areas outside the north Oscura fire study map weighted canopy cover with 0.8 and slope with 0.2. Final values for the north Oscura patches and the other forest areas were adjusted to range from 0 to 100, so scores from the two models would be comparable. Some overlap occurred between the North Oscura study area and the other forest areas on WSMR. These areas of overlap allowed us to compare the final ranking values for several areas sampled by both methods: intensively in standardized vegetation plots (in the plot floristic database) and areas delineated in the North Oscura map.

RESULTS

LITERATURE SOURCES

Although the Mexican spotted owl is less studied than the northern spotted owl, information on habitat use and selection was abundant. Studies with at least a minimal habitat component are summarized in Table 1.

IMAGERY SOURCES

The variety of imagery sources available for inspection (see Methods) provided helpful information on vegetation, topography, and general geography. Among the most helpful were the WSMR vegetation map, which offered a broad estimation of the distribution of forest areas on WSMR (see Table 2 for summary data from this map); the WSMR DEM, which provided information on topography and elevation for closer investigation of both potential canyon and mountain habitat; USGS DOQs, which allowed closer inspection of forest areas of interest; and the Oscura Mountains fire study map, which provided delineation and quantification of a variety of forest structure characteristics.

Table 2. Woodland/forest vegetation types of WSMR, and total areas of each (Muludavin et al. 2000).

Pinyon Pine Woodlands	
Pinyon Pine/Scribner's Needlegrass or New Mexico Muhly Montane Woodlands	12130.71 ha
Pinyon Pine/Wavyleaf Oak Montane Woodland	163.75 ha
Pinyon Pine-Gambel's Oak Montane Woodland	428.14 ha
Pinyon Pine/Wavyleaf Oak or Scribner's Needlegrass Montane Woodlands	8742.90 ha

Pondersosa Pine Forest	
Ponderosa Pine/Arizona Fescue Forest and Gambel's Oak-Whortleleaf Snowberry Montane Shrubland	91.05 ha
	Total: 21556.55 ha

NON-IMAGERY DATA SOURCES

Species Locations

A geographic query of the NHIS yielded numerous Mexican spotted owl Element Occurrences (EOs) in the vicinity of WSMR. One of the most-studied breeding populations of Mexican spotted owls in New Mexico occurs in the Sacramento Mountains east of WSMR, Alamogordo, and Tularosa. The three closest breeding territory EOs in this population occurred in canyon areas draining the western slope of the mountain range. The closest EO was approximately 24 km from the eastern WSMR boundary and approximately 60 km from closed-forest areas in the Oscura Mountains. Elevations of activity centers of these three breeding territories varied from 2218 m to 2508 m. The closest EO to WSMR was an isolated observation of one adult and one fledgling Mexican spotted owl from the Organ Mountains in 1979 (NHNM 2003). The owls were in an area of white fir (*Abies concolor*) forest at 2180 m elevation. Surveys in May and July 1991 and June 1992 detected no owls in this area.

BREEDING HABITAT ON WSMR

Canyon/Riparian Breeding Habitat

Of the 276 mountain springs (Boykin et al. 1996), 120 had associated riparian patches. Other data sources (e.g., Sadoti et al. 2002) provided some additional information on these sites, but the additional data sources did not add any new sites for further priority-ranking. Of these 120 springs, we ranked 97 springs as low priority, 13 as medium priority, and only 10 as high priority for field verification (Figure 2). Field visits to five of these high-priority sites in the first field season (2002, Appendix A) revealed no potential breeding habitat for Mexican spotted owls. Some of these areas featured the steep terrain favored by nesting birds, but they had inadequate forest structure, inappropriate forest composition, and/or inadequate habitat patch size for nesting. Additionally, these areas, although sometimes containing cliffs with appropriate ledges for nesting, were far too exposed due to wide canyons. They also had patchy and/or short-stature forests that did not provide the cooler microclimates needed by canyon- or cliff-nesting Mexican spotted owls. Conversely, areas with well-developed riparian patches had little topographic relief and/or very little surrounding forest vegetation. All five sites were inadequate in at least two ways. All five sites had little or no canopy closure. In three, there was no understory, in three the canyon was not deeply incised enough, and in two the habitat was generally too exposed (see Appendix A for details). These field checks verified that there were no canyon-riparian sites suitable for breeding.

<u>Montane Forest Breeding Habitat</u>

Mexican spotted owls do not typically breed outside mixed conifer forests, except in extremely incised canyons with mature forest nearby. Suitable areas of mixed conifer do not occur on WMSR. In addition, no canyons are sufficiently incised to support breeding. Our examination of forest cover and patch size (DOQs) demonstrated that the San Andres Mountains contained no acceptable breeding habitat, and for that reason we confined our field checking to the Oscuras, where habitat, although still not acceptable for breeding, was higher quality than that in the San Andres.

Before the field checks, we considered the montane areas in the northern Oscura Mountains to have the highest potential for breeding Mexican spotted owl habitat. The eight sites visited in the second field season (2003, Appendix A) included sites in the highest-quality habitat areas, based the criteria described previously (Methods: Breeding Habitat Evaluation). However, of several broad montane forest areas in the Oscura Mountains, most sections were far too patchy, had short stature and only one canopy layer, and/or occurred on gentle slopes. Some montane canyon areas had cliff faces with presumably suitable nesting ledges, but, as with non-montane canyon areas visited during this study, these sites were also far too exposed to provide protection from the elements required by spotted owls. Four of the eight sites were inadequate in at least two ways. Five of the eight sites were on slopes that were too gentle to provide the appropriate microclimate for nesting. At three, the canopies were too open or patchy. At two sites the understory was too dense. One site had steeper slopes that were too sparsely vegetated, and at another the surrounding forest was too short (Appendix A).

In summary, WSMR lacks the chief habitat characteristics necessary for breeding Mexican spotted owls: mixed conifer forests; large, dense patches of tall trees; and steeply incised canyons associated with mature forest. Therefore, we did not map breeding habitat.

NON-BREEDING HABITAT ON WSMR

Several studies of Mexican spotted owl habitat use (Table 1) have shown that wintering and dispersal areas typically include habitat generally unsuitable for breeding. Our model of non-breeding Mexican spotted owl habitat allowed a general visual overview of forested habitat characteristics on WSMR (Figure 4). This model was subject to inaccuracies of the WSMR vegetation map, the digital elevation model, and the interpolated canopy cover surface. However, we used consistent methods among areas and variables with clear ecological importance to the Mexican spotted owl. In spite of potential sources of error, the resulting models proved useful for detecting potential areas for occurrence of dispersing or migrating/wintering owls. The spatial approach provided consistent rankings between the fire study area (north Oscura Mountains) and other parts of WSMR. Comparisons of areas in both models showed similarity (within 10-20 index points) between models. These similarities were most consistent in areas with higher concentrations of vegetation plots (in NHNM 2003).

The northern Oscura Mountains had 18.6% of areas included in the model, but they contained 85.7% of areas with habitat suitability indices between 71 and 100. Thus, the habitat models indicated that the Oscuras had a disproportionate amount of higher quality Mexican spotted owl non-breeding habitat. In contrast, areas outside the northern Oscura Mountains contained 81.4% of the total forested area but only 14.3% of the area with habitat suitability indices between 71 and 100 (Table 3).

Figure 4. Habitat suitability for non-breeding Mexican spotted owls on White Sands Missile Range, modeled using available information on canopy cover, forest structure, forest composition, and slope.

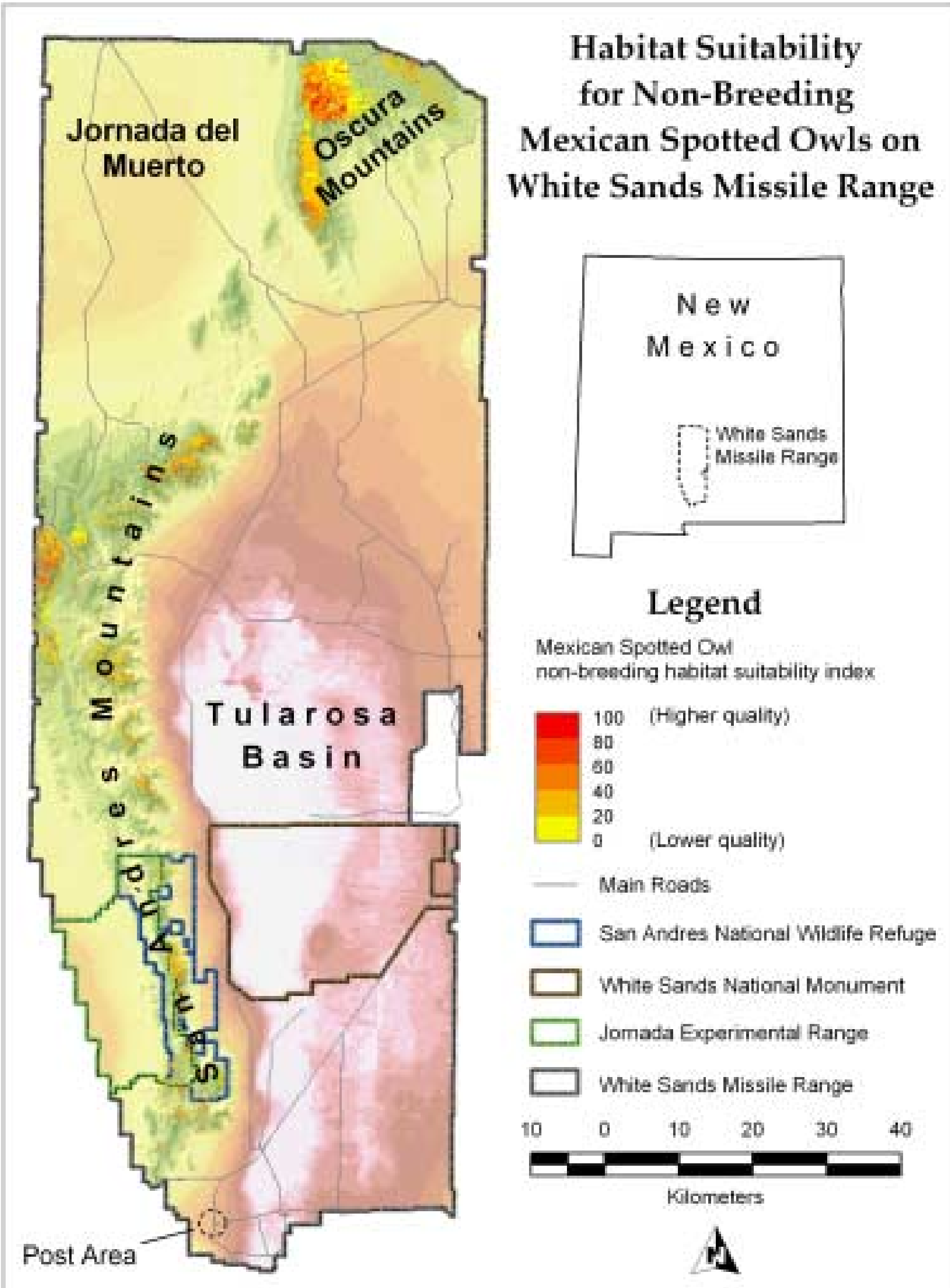


Table 3. Results of spatial models for potential Mexican spotted owl dispersal/stopover habitat on WSMR. This model includes only forested areas either delineated in the north Oscura Mountains, or classified as forest communities in the WSMR vegetation map. Scores for both models have been adjusted to a scale of 100.

Habitat suitability index range	**1–10**	**11–20**	**21–30**	**31–40**	**41–50**	**51–60**	**61–70**	**71–80**	**81–90**	**91–100**	**Total**
North Oscura Mountains (ha)	146.7	169.2	690.7	625.8	491.3	648.7	482.4	346.0	218.2	67.0	3886.0
Other mountain areas (ha)	128.1	1337.0	4162.9	6385.0	3088.0	1345.7	404.9	81.1	19.3	4.6	16956.6
Total (ha)	274.8	1506.1	4853.7	7010.8	3579.3	1994.5	887.3	427.0	237.4	71.6	20842.6

Habitat suitability index range, %	**1–10**	**11–20**	**21–30**	**31–40**	**41–50**	**51–60**	**61–70**	**71–80**	**81–90**	**91–100**
North Oscura Mountains (% total)	53.4%	11.2%	14.2%	8.9%	13.7%	32.5%	54.4%	81.0%	91.9%	93.5%
Other mountain areas (% total)	46.6%	88.8%	85.8%	91.1%	86.3%	67.5%	45.6%	19.0%	8.1%	6.5%

CONCLUSIONS AND RECOMMENDATIONS

We conclude that the vegetation, elevation, and topography of WSMR are not suitable to support breeding Mexican spotted owls. In the mountains, slopes are generally not steep enough to support canyon nesting, and elevations are not high enough to support the large trees used for forest nesting. Where riparian vegetation is apparently adequate, the canyons are either not sufficiently incised or are isolated from appropriate montane forests. Where canyons are more deeply incised, the trees are too short.

Dispersing, wintering, or vagrant owls, however, could occur within forested habitats on WSMR between fall and spring. Pinyon-juniper woodland areas in the Sierra Blanca Mountains (the northern extent of the Sacramento Mountains) are separated from similar woodlands in the Oscura Mountains and nearby Chupadera Mesa by a corridor of desert scrub and grassland vegetation approximately 30 km wide and centered near the town of Carrizoso. It is likely that wintering adults or dispersing juveniles would remain in the Sacramento Mountains through the fall and winter, albeit perhaps at lower elevations or in marginal breeding habitat; however, it is possible that competition for breeding territories and/or prey may stimulate longer-distance movements in search of available resources (Arsenault et al. 1997).

Arsenault et al. (1997) documented the dispersal of two juveniles between the San Mateo Mountains and the Black Range across 20-40 km of unsuitable breeding habitat. The elevation (approximately 2,000 m) in this area may have allowed these birds to avoid heat stress and thus survive dispersal across unsuitable habitat. Areas separating the Oscura and Sierra Blanca Mountains are at lower elevations (approximately 1,500 m) and are less wooded. The distance between the Oscuras and Sierra Blancas is also within the range observed for juvenile dispersal and seasonal adult migration documented in other studies (Table 1). However, distance between breeding habitat in the San Mateos/Black Range and Sierra Blancas is over 125 km. Without suitable breeding habitat in the Oscura Mountains, the likelihood of Mexican spotted owls dispersing or migrating to and/or through the Oscura Mountains is probably low.

Based on the isolation of the San Andres Mountains, it seems less likely that birds will disperse or migrate to/through this range than the Oscura Mountains. It is worth noting, however, that the Mexican spotted owls observed in the Organ Mountains (south of the San Andres Mountains) in 1979 were over 75 km from the closest known breeding population –- a distance almost entirely devoid of forest vegetation.

If Mexican spotted owls did reach forested areas in either the Oscura or San Andres Mountains, it appears the small- to medium-sized mammals in these mountains could support them. Abundance data on potential mammalian prey species are lacking for areas otherwise apparently suitable for foraging; however, these areas support a diversity of rodents and lagomorphs (Table 4, and Sullivan and Smartt 1989, 1990a, 1990b), including *Neotoma* (woodrats), the genus most commonly hunted by Mexican spotted owls.

In conclusion, we do not recommend breeding-season surveys for Mexican spotted owls, because of the absence of suitable nesting habitat on WSMR. It is possible that a bird dispersing from breeding areas in the Sacramentos could stop at WSMR in the non-breeding season. However, Mexican spotted owls do not respond to calling surveys in the non-breeding season, so any dispersing/wintering birds would only be detected opportunistically. Due to the limited likelihood of any such individuals arriving at WSMR and the unpredictability of their arrival locations, we do not recommend surveys for wintering birds at this time. Prior to habitat alteration for mission purposes or prescribed burning for wildfire control, especially in the Oscuras, we recommend that WSMR personnel consult our non-breeding habitat map. Higher-quality wintering/dispersal habitat should be maintained if possible.

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Table 4. Potential prey items of Mexican spotted owls found in higher elevation areas of WSMR (from Burkett and Kamees 1996).

Species	**Status on WSMR**
desert cottontail (*Sylvilagus auduboni*)	Common. Common throughout WSMR.
eastern cottontail (*Sylvilagus floridanus*)	Probable. Probably inhabits higher mountainous regions of WSMR.
whitetail antelope squirrel (*Ammospermophilus luecurus*)	Common. Occurs mainly in grasslands and scattered pinyon/juniper woodlands of WSMR. Appears to prefer level sandy areas, but may also be found in rocky situations.
Colorado chipmunk (*Tamias quadrivittatus*)	Uncommon. Occurs only in the higher elevations of WSMR where pinyon/juniper dominates especially if rock outcrops are present.
white-throated woodrat (*Neotoma albigula*)	Common.
Mexican woodrat (*Neotoma mexicana*)	Common.
brush mouse (*Peromyscus boylii*)	Uncommon. Prefers mesic (moist) areas and dense evergreen shrub habitat above 5,500 feet.
rock mouse (*Peromyscus difficilis*)	Uncommon. Associate with pinyon/juniper and oak woodland areas.
cactus mouse (*Peromyscus eremicus*)	Common. Found along rocky foothills of the mountains of WSMR.
deer mouse (*Peromyscus maniculatus*)	Common. Probably the most widespread and numerous mouse on WSMR.
pinyon mouse (*Peromyscus truei*)	Uncommon. Within WSMR this mouse inhabits juniper savanna and pinyon/juniper woodlands from about 5,000 to 8000 feet.

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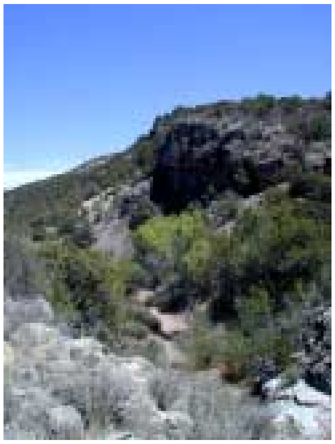
Appendix A. Field visit site and plot site descriptions

no photo available for this site

Site Name	CYN01
Date	4/30/2002
UTM Easting	375001
UTM Northing	3726484
Comments	Montane xeric scrub. No canopy closure in creek bed. Isolated large roost trees (40'), overall habitat too exposed, cliff face in this shallow canyon lacking necessary height. Higher elevations give way to contiguous P-J. Tightly clustered, very dry, with no understory.

Site Name	CYN02
Date	5/1/2002
UTM Easting	375997
UTM Northing	3739109
Comments	No canopy closure. Several large pinyon trees, canyon shallow. P-J slopes, with oak and deciduous shrubs.

Site Name	CYN03
Date	5/1/2002
UTM Easting	376699
UTM Northing	3738871
Comments	Single level P-J, no incisement, no emergent trees or snags.



Site Name	CYN04
Date	5/2/2002
UTM Easting	347316
UTM Northing	3680850
Comments	No understory, several large deciduous trees, thin P-J stand on slopes. Deep canyon, fairly open, little canopy closure. Cliff face is less than vertical, broken rock, and exposed. No possible nesting habitat.

Site Name	CYN04B
Date	5/2/2002
UTM Easting	347541
UTM Northing	3681077
Comments	No understory, several large deciduous trees, thin P-J stand on slopes. Deep canyon, fairly open, little canopy closure. Cliff face is less than vertical, broken rock, and exposed. No possible nesting habitat.

Plot Number	1
Date	3/17/2003
UTM East (NAD83 zone 13)	374271
UTM North (NAD83 zone 13)	3734306
Dominant Tree spp.	*Pinus edulis*
Overstory trees (n)	4
Ave. overstory height (SD) (m)	8 (1.4)
Ave. overstory DBH (SD) (cm)	30 (7)
Understory trees/shrubs (n)	11
Dominant understory spp.	pinyon, juniper
Woody stems/ha	1400
Comments	This site had several large overstory roosting trees and a somewhat open understory, but the slopes were too gentle to provide cooler microhabitats typical of suitable nesting habitat in more incised drainages.

Plot Number	2
Date	3/17/2003
UTM East (NAD83 zone 13)	374821
UTM North (NAD83 zone 13)	3734788
Dominant Tree spp.	*Pinus edulis*, *Juniperus* spp.
Overstory trees (n)	3
Ave. overstory height (SD) (m)	9.3 (2.5)
Ave. overstory DBH (SD) (cm)	48 (17)
Understory trees/shrubs (n)	9
Dominant understory spp.	pinyon, juniper
Woody stems/ha	550
Comments	This site had several large overstory roosting trees, but the nearby open habitats and gentle slopes did not provide the cooler, protected conditions of suitable breeding habitat.

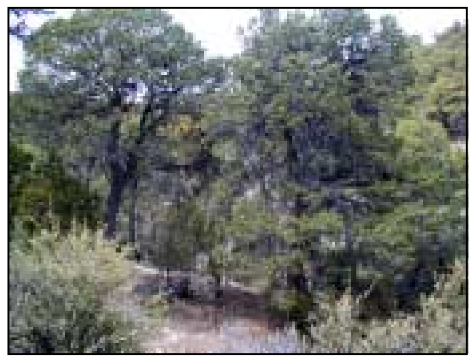
Plot Number	3
Date	3/17/2003
UTM East (NAD83 zone 13)	375270
UTM North (NAD83 zone 13)	373444
Dominant Tree spp.	*Pinus edulis*
Overstory trees (n)	3
Ave. overstory height (SD) (m)	10.3 (1.5)
Ave. overstory DBH (SD) (cm)	38 (18)
Understory trees/shrubs (n)	3
Dominant understory spp.	pinyon, juniper
Wood stems/ha	800
Comments	This site was generally sparse but did contain some suitable overstory roosting trees. However, slopes were too gentle to provide conditions for breeding habitat

No photo available

Plot Number	4
Date	3/17/2003
UTM East (NAD83 zone 13)	376128
UTM North (NAD83 zone 13)	3734405
Dominant Tree spp.	*Pinus edulis*
Overstory trees (n)	4
Ave. overstory height (SD) (m)	3
Ave. overstory DBH (SD) (cm)	8.7 (1.2)
Understory trees/shrubs (n)	34 (12)
Dominant understory spp.	pinyon, juniper
Wood stems/ha	850
Comments	This site had some larger overstory roosting trees but was too open and with slopes too gentle to provide suitable breeding habitat.

Plot Number	5
Date	4/11/2003
UTM East (NAD83 zone 13)	373543
UTM North (NAD83 zone 13)	3735255
Dominant Tree spp.	*Pinus edulis*, *Juniperus* spp.
Overstory trees (n)	7
Ave. overstory height (SD) (m)	7.7 (1.0)
Ave. overstory DBH (SD) (cm)	27 (9)
Understory trees/shrubs (n)	11
Dominant understory spp.	pinyon, juniper
Wood stems/ha	900
Comments	This site had some larger overstory trees suitable for roosting, but the understory was too dense and the canopy too open in places to provide conditions suitable for breeding.

Plot Number	6
Date	4/11/2003
UTM East (NAD83 zone 13)	373814
UTM North (NAD83 zone 13)	3735476
Dominant Tree spp.	*Pinus edulis*
Overstory trees (n)	2
Ave. overstory height (SD) (m)	11.5 (0.7)
Ave. overstory DBH (SD) (cm)	46 (9)
Understory trees/shrubs (n)	9
Dominant understory spp.	pinyon, juniper, agarita
Wood stems/ha	550
Comments	This site had some large overstory trees suitable for roosting, but the canopy was too patchy for breeding. The surrounding slopes were moderately steep but were generally too sparsely vegetated to provide suitable breeding habitat.



Plot Number	7
Date	4/11/2003
UTM East (NAD83 zone 13)	374232
UTM North (NAD83 zone 13)	3735340
Dominant Tree spp.	*Pinus edulis*
Overstory trees (n)	3
Ave. overstory height (SD) (m)	9.7 (1.5)
Ave. overstory DBH (SD) (cm)	35 (12)
Understory trees/shrubs (n)	10
Dominant understory spp.	pinyon, juniper, oak
Wood stems/ha	650
Comments	This site had several large overstory trees suitable for roosting, but the surrounding trees and forests in the area were generally too short to be suitable for roosting habitat. These conditions made the site overall unsuitable for breeding.

Plot Number	8
Date	4/11/2003
UTM East (NAD83 zone 13)	373874
UTM North (NAD83 zone 13)	3734878
Dominant Tree spp.	*Pinus edulis*, *Juniperus sp.*
Overstory trees (n)	6
Ave. overstory height (SD) (m)	8.2 (0.8)
Ave. overstory DBH (SD) (cm)	24 (4)
Understory trees/shrubs (n)	42
Dominant understory spp.	pinyon, juniper
Wood stems/ha	2400
Comments	This site had many larger overstory trees suitable for roosting but also had a very dense understory unsuitable for foraging. The slopes surrounding this site were also far too gentle to provide suitable microclimate conditions necessary for breeding.

No photo available

CSTE-DTC-WS-ES-ES 1 AUG 2003

MEMORANDUM THRU SD 14 Aug 03

FOR PA

SUBJECT: Report of Operations Security (OPSEC) Review: Mexican Spotted Owl (*Strix occidentalis lucida*) Habitat on White Sands Missile Range, Draft Final Report

1. Title of this presentation/paper is, "Mexican Spotted Owl (*Strix occidentalis lucida*) Habitat on White Sands Missile Range".

2. Authors' names, organizations, and phone numbers: Messrs. Giancarlo Sadoti, Justin T.H. Smith, and Dr. Kristine Johnson, University of New Mexico Museum of Southwest Biology-Natural Heritage Program New Mexico, 505-277-3822.

3. This material will be used as follows:

XX a. This material will be presented before various natural/biological resources professionals and in public presentations and publications on various dates following OPSEC approval. Composition of attendees includes biologists and other scientists, non-governmental organizations, individuals, state and federal agency personnel, academicians, etc. Foreign nationals from any and all countries may be in attendance. This meeting X will/_ will not be open to the public.

XX b. This paper will be published in various professional journals, popular press articles, and in reports.

4. The information has been reviewed for OPSEC implications by Daisan E. Taylor, Wildlife Biologist and Project Manager, WS-ES-ES, 678-6140, with results below.

XX a. The items contain no information considered OPSEC sensitive or FOR OFFICIAL USE ONLY. I, the undersigned, am aware of the foreign national intelligence interest in open source publications and in the subject matter of the information I have reviewed for OPSEC purposes. I certify that I have sufficient technical expertise in the subject matter of this paper and that, to the best of my knowledge, the net benefit of this public release outweighs the potential damage to the essential secrecy of all related ATEC, Army, or other DoD programs of which I am aware.

Daisan E. Taylor

Daisan E. Taylor, CWB
Wildlife Biologist/Project Manager, GS-13
678-6140

EWS FL 1042
30 Aug 03

Replaces EWS FL 1042, 17 Jan 01, which is obsolete

___ b. The item contains OPSEC sensitive unclassified information on the identification and designations of such information as being sensitive by ________________________ in the ____________________________ OPSEC Plan.

___ c. The item contains indications listed in the WSMR OPSEC Plan and Samples Indicators listed in Appendix B, AR 530-1, and as such, may contain OPSEC sensitive unclassified information. Your consideration and evaluation are requested prior to further dissemination to open publication, the public media, or individuals not normally authorized information of this nature.

___ d. Review of this item has included consideration for designation as "FOR OFFICIAL USE ONLY" outlined in AR 25-55, Army Freedom of Information Act Program.

5. The POC for this OPSEC review is Rita Bencomo, WS-ES, 678-8966.

NOTE: After all approvals have been obtained, the original and all copies of the document, presentation, etc., should be annotated with the following: "APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED. OPSEC REVIEW CONDUCTED ON (DATE)."

JUNIOR D. KERNS, CWB
Chief, Environmental Stewardship
Division