APPENDIX C - MANAGEMENT RECOMMENDATIONS

1. Assumptions and Guiding Principles

The recommendations proposed in this revised Recovery Plan are based on several key assumptions about habitat requirements of the Mexican spotted owl and a number of guiding principles. These assumptions and guiding principles are:

- Spotted owl distribution in forested and rocky-canyon environments (see definitions below) is limited primarily by the availability of habitat used for nesting and/or roosting. Owl distribution may also be limited by prey availability and competition for nest habitat among raptors.
- Landscape analyses must be conducted prior to initiating any management actions. These analyses should identify known owl sites, areas to be managed as replacement nest/roost habitat, potential foraging habitat, and prospective habitat corridors.
- Habitat used for nesting/roosting also provides adequate conditions for foraging and dispersal activities. Thus, sustaining nesting/roosting habitat meets other survival requirements. Some habitats not used for nesting/roosting may provide conditions for other activities such as foraging and dispersal. In forests, these habitats include forest types that do not typically support nesting/roosting and forest stands in seral stages younger than typical nesting/roosting habitat. In rocky canyons, these habitats canyon rims and/or adjacent plateau highlands.
- Nesting/roosting habitat typically occurs either in well-structured forests or in steep and narrow rocky canyons. Nesting/roosting habitat in forest environments is typified by certain structural features, including high canopy cover, large trees, and other late seral characteristics that are common in, but not restricted to, late-successional forests. Nesting/roosting habitat within rocky canyons is dominated by relatively narrow vertical-walled canyons formed by parallel cliffs with numerous caves and/or ledges within specific geologic formations. Large trees and late-seral features that are common in, but not restricted to, riparian and mixed-conifer forests are present in some rocky canyon habitats; however, steep cliffs with ledges and caves may provide adequate nest and roost structures in the absence of late-seral forest.
- Forested nesting/roosting habitat is typically found in mixed-conifer, pine-oak, and riparian forests, with some other types locally important (e.g., encinal oak woodlands). Other habitats are used primarily for foraging, dispersal, or wintering. Because of ecological conditions (e.g., mesic north facing slopes) and processes (e.g., fire) that tend to limit denser forest stands to particular locations on the landscape, the distribution of nesting/roosting habitat is naturally discontinuous and limited in some areas.
- Disturbance events leading to forest canopy gaps are important for maintaining a diversity of tree and understory species, particularly in mixed-conifer spotted owl nest/roost stands. Both shade-tolerant and shade-intolerant species contribute important diversity to both dry and wet mixed-conifer forests.
- Existing forested habitat used by Mexican spotted owls for nesting/roosting generally has not been developed through planned silvicultural treatments. That is, although owls may be found in managed stands, these stands were not treated specifically to enhance spotted owl habitat.

- Forest restoration and fuels-reduction treatments must be evaluated over time using appropriate modeling, rigorous monitoring, management experiments, and/or research to assess their effectiveness in maintaining or creating owl habitat and/or their effectiveness in reducing the threat of high severity or stand-replacing wildland fire.
- Recruitment of large trees in both forested and rocky-canyon habitats is a function of both time and ecological site-specific factors affecting productivity. Similarly, many late-seral characteristics typical of owl habitat, such as large snags and broken-topped trees, high canopy cover, large downed logs, and the sharing of growing space among multiple shade-tolerant and -intolerant species, are attained primarily through time and the operation of ecological processes such as fire and forest pathogens.
- This revised Recovery Plan represents a short-term (10 year) strategy, but management actions recommended herein will have long-term consequences. Therefore, care should be taken to preserve future options while designing management prescriptions.
- Ongoing climate change will result in unpredictable changes in habitat distribution and quality, and this creates considerable uncertainty in developing strategies to recover the owl. Again, this argues for preserving options where possible, as well as for attempting to account for potential changes in habitat distribution and quality.
- In general, management should strive to sustain and develop desired conditions for the owl (Tables C.2, C.3) where appropriate.
- We recognize that situation will arise when land managers may need to deviate from the recommendations. These deviations from the Recovery Plan should be addressed with the FWS through the ESA Section 7 consultation process.

2. Definitions of Forest Types and Canyon Habitat

In this Recovery Plan we propose specific guidelines for several forest cover types based on: 1) considerable evidence that these cover types provide habitat for nesting, roosting, and foraging activities by Mexican spotted owls; and, 2) our desire to target guidelines for the most appropriate habitats. In addition to a discussion on forest cover types, we revised this section from the 1995 Recovery Plan to include a discussion on canyon habitat. The following sections of this Appendix rely upon these definitions for implenting the Management Recommendations.

a. Forest Types

Numerous treatments deal with the concepts of classifying vegetation cover or habitat types (e.g., Daubenmire 1952, 1968; Pfister 1989). We do not review these concepts here. In general, we accept the view that the basic unit of classification of climax vegetation is the plant association (Küchler 1964, Daubenmire 1968, Pfister 1989). These associations are defined using information on species composition and successional pathways. However, under natural disturbance regimes, many southwestern forests may not attain climax conditions. For example, in an analysis of Mexican spotted owl habitat on the Alpine Ranger District, Apache-Sitgreaves National Forests, we determined that habitat classifications based on current and climax vegetation gave very different results. Based on current vegetation, important nesting and roosting habitat was classified as mixed-conifer forest. The same forests would be classified as spruce-fir based on potential natural vegetation type. This example demonstrates the need for

clear operational definitions of forest types to be used when applying guidelines under this Recovery Plan.

In this section, we provide operational definitions for forest types referred to in the plan, and a simple key to these types. This key will allow land managers to classify lands in a manner compatible with the recommendations we provide in this plan. A review of literature on classification of forest types in southwestern forests was provided in the 1995 Recovery Plan and is not repeated here.

b. Recovery Plan Definitions for Forest Types

This forest type classification scheme is primarily concerned with a subset of the available forest types in the southwestern U.S. We are interested in both potential and existing vegetation. Consequently, this forest typing scheme is a hybrid of classification schemes based on potential vegetation (series, association, and habitat type) and forest cover types based on existing vegetation.

Three terms we use in the forest typing scheme below require definition: pure, majority, and plurality. Various definitions have been used to describe a pure stand. Daniels et al. (1979) described pure stands as those where ≥90% of the dominant or co-dominant trees are of a single species. Dominant trees are those whose crown extends above the general level of the main canopy (Helms 1998). The crowns of co-dominant trees help to form the main canopy in even-aged stands. In uneven-aged stands, crowns of co-dominant trees are above the crowns of the tree's immediate neighbors and receive full light from above and partial light from the sides (Helms 1998). Under this definition, a stand may have an understory of other species without changing the pure designation. The key to this concept is the distinction between the dominant and co-dominant species and the understory component.

In contrast, Eyre (1980) defined a pure stand as one where ≥80% of the stocking is by one species. For purposes of this plan, we use the term pure to refer to any stand where a single species contributes ≥80% of the basal area (BA) of dominant and co-dominant trees.

We use the term majority to refer to the situation where a single species contributes ≥50% of the BA (Eyre 1980). We use the term plurality to refer to the situation where a species (or group of species of interest) comprises the largest proportion, but not a majority, of a mixed-species stand (Eyre 1980). With these definitions and concepts in mind, we provide definitions for specific forest types below.

i. Ponderosa Pine (Pinus ponderosa) Forest Type

The ponderosa pine forest type occurs in what Moir (1993) described as the Lower Montane Coniferous Forest. Forests in this zone are dominated by pines, sometimes co-occurring with junipers and oaks. The climate is sometimes not conducive for forests, with moisture becoming limiting in the upper portions of the soil profile during part of the long growing season. We define the ponderosa pine forest type as:

1) Any forested stand of the *Pinus ponderosa* series not included in the Pine-oak Forest Type (see below); or

2) Any stands that qualify as pure (Eyre 1980) ponderosa pine, regardless of the series or habitat type.

ii. Pine-oak Forest Type

A number of habitat types exist in the southwestern U.S. that could be described as pine-oak forests. Most of the stands relevant to the recovery of the Mexican spotted owl fall within two series, the Ponderosa pine series and the Chihuahuan pine series. Present evidence, however, suggests that the former series includes many areas that could never attain the type of forest structure sought by Mexican spotted owls for roosting and nesting. Therefore, we use the following operational definition for pine-oak forest under this plan:

1) Any stand within the Chihuahuan pine series.

2) Any stand within the Ponderosa pine series that meets the following criteria simultaneously:
   a. The stand is located in the UGM EMU, the BRW EMU, or the Zuni Mountains or Mount Taylor regions of the CP EMU.
   b. Habitat types that reflect Gambel oak or a Gambel oak phase of the habitat type.
   c. $\geq$10% of the stand BA or 4.6 m^2/ha (20 ft^2/ac) of BA consists of Gambel oak $\geq$13 cm (5 in) in diameter at root collar.

3) Any stand within the BRW EMU of any other series that meets the following criteria simultaneously:
   a. A plurality (Eyre 1980) of the BA exists in yellow pines: ponderosa pine, Arizona pine, Apache pine, or Chihuahuan pine.
   b. $\geq$10% of the stand BA or 4.6 m^2/ha (20 ft^2/ac) of BA consists of any oaks $\geq$13 cm (5 in) in diameter at root collar.

iii. Mixed-conifer Forest Type

Natural variability is high within this forest type. This variability is the result of mixed-conifer forest occupying a continuum of sites situated between drier and warmer ponderosa pine forests and wetter and cooler spruce-fir forests. Despite this variability, an extant classification scheme based on series and habitat types (Layser and Schubert 1979; Hanks et al. 1983; Alexander et al. 1984a, b; Youngblood and Mauk 1985; DeVelice et al. 1986; Alexander and Ronco 1987; Fitzhugh et al. 1987) is available. This classification system is in widespread use and has interagency support. Given that background, we propose using that system as a starting point in defining mixed-conifer forest, with some added refinements. Specifically, we propose that the definition of mixed-conifer forest generally be confined to the following series (Layser and Schubert 1979) and associated habitat types: white fir, Douglas-fir, limber pine, or blue spruce. Within this framework, we provide the following exceptions to the general guideline stated above:

1) Any stand within the bristlecone pine, Engelmann spruce, or corkbark fir series not having a majority (Eyre 1980) of BA in bristlecone pine, Engelmann spruce, corkbark fir, or ponderosa pine, singly or in combination should be classified as mixed-conifer.

2) Stands that can be described as pure (Eyre 1980) for coniferous species other than Douglas-fir, white fir, southwestern white pine, limber pine, or blue spruce should be excluded from the broad category of mixed conifer for the purposes of plan implementation regardless of the series or habitat type.

3) Stands of mixed species with >50% of the BA consisting of quaking aspen should be defined as quaking aspen for the purposes of Recovery Plan implementation regardless of the series or habitat type.

iv. High-elevation Forest Type

We define high-elevation forest as any stand of the bristlecone pine, Englemann spruce, or corkbark fir series that meets the following criteria:

1) The majority (Eyre 1980) of stand BA consists of any of the three species listed above, either singly or in combination, or

2) Any stands that qualify as a pure stand (Eyre 1980) of any of these species, regardless of the series or habitat type.

v. Quaking Aspen Forest Type

1) We define as quaking aspen forest type any stands with >50% of the total BA consisting of quaking aspen. In situations following stand replacing fire, where aspen is returning and may not yet have measurable BA, it should still be classified as aspen if it comprises >50% of the tree stems.

vi. Riparian Forest Type

We take our definition of riparian directly from FWS (2009) but restrict it to areas distinguished by the presence of trees. Riparian forests are plant communities affected by surface and subsurface hydrologic features of perennial or intermittent water bodies (e.g., rivers, streams, lakes). Riparian forests have one or both of these principle characteristics: 1) distinctively different tree and shrub species than the adjacent areas and/or 2) tree species similar to adjacent areas but exhibiting more vigorous or robust growth forms (FWS 2009). Riparian vegetation typically creates a transition between inundated and upland areas (Naiman and Décamps 1997, FWS 2009). Riparian habitats are among the most ecologically productive and diverse terrestrial environments in the West (Naiman et al. 1993). With respect to spotted owls, riparian forests can provide the habitat structure used for nesting, roosting, foraging, and dispersal (e.g., Ganey and Dick 1995, Stacey and Hodgson 1999).

Naiman and Décamps (1997) point out that delineating riparian zones can be problematic specifically because they are transition zones or ecotones from wet to upland areas and are generally more spatially heterogeneous due to increased disturbance and differing life-history strategies of the constituent plants. They suggest that the riparian zone "encompasses the stream channel between the low and high water marks and that portion of the terrestrial landscape from the high water mark toward the uplands where vegetation may be influenced by elevated water tables or flooding and by the ability of the soils to hold water". Within the range of the owl, riparian forests generally are characterized by:

1) Presence of riparian species, such as cottonwoods, maples, sycamores, or willows .

2) Presence of larger growth forms of species found in adjacent upland community, e.g., quaking aspen, Douglas fir. Prominence of these species is more extensive within higher elevation riparian forests.

3) Generally higher BA, stem densities, and above-ground biomass than adjacent upland communities (Naiman and Décamps 1997).

We distinguish between riparian forests that could frequently be used by owls for foraging, roosting, daily movements, dispersal, and potentially for nesting (Riparian Recovery Habitat) and riparian forests that are not regularly used by owls, but that may occasionally provide stepping stones for movement between population segments or be used by owls during the non-breeding season (Other Riparian Forest). Riparian Recovery Habitats are considered to be a key habitat for owl recovery. Other Riparian Forests may facilitate long-term gene flow, provide connections among EMUs, and/or facilitate survival of owls during winter.

c. Key to Forest Types Referenced in the Recovery Plan

Note: Bold-faced names on the right side of the key are identified forest cover types. Numbers on the right side refer the user to the corresponding number on the left side of the key.

1.	Trees deciduous and broadleaved, often confined to floodplain, drainage, or canyon bottom (Layser and Schubert 1979)	**Riparian Forest**
1.	Dominant trees evergreen and/or needle-leaved	2
2a.	Series = Douglas-fir, white fir, limber pine or blue spruce	3
2b.	Series not as above	5
3a.	>80% of dominant and codominant trees are species other than Douglas-fir, white fir, southwestern white pine, limber pine, or blue spruce	**Classify by Dominant Species**
3b.	Stand not as above	4

4a.	Aspen contributes >50% of stand BA	**Quaking Aspen Forest**
4b.	Not as above	**Mixed-Conifer Forest**
5a.	Series = Chihuahuan pine	**Pine-oak Forest**
5b.	Series not as above	6
6a.	Series = Ponderosa pine	7
6b.	Series not as above	10
7a.	Habitat type or phase includes Gambel oak	8
7b.	Not as above	**Ponderosa Pine Forest**
8a.	Area is located within UGM EMU, BRW EMU, or the southeastern portion of the CP EMU (Zuni Mountains, Mount Taylor)	9
8b.	Area not located as above	**Ponderosa Pine Forest**
9a.	>10% of stand BA or 4.6 m^2/ha (20 ft^2/ac) consists of Gambel oak >13 cm (5 in) in diameter at root collar	**Pine-oak Forest**
9b.	Not as above	**Ponderosa Pine Forest**
10a.	Series = bristlecone pine, Englemann spruce, or corkbark fir	11
10b.	Series not as above	13
11a.	Stand can be defined as pure for bristlecone pine, Englemann spruce, or corkbark fir	**Spruce-fir Forest**
11b.	Stand not as above	12
12a.	Bristlecone pine, Englemann spruce, or corkbark fir contribute >50% of the stand BA, either singly or in combination	**Spruce-fir Forest**
12b.	Stand not as above	**Mixed-conifer Forest**
13a.	Stand located in BRW EMU	14
13b.	Stand not located as above	**Other**

14a.	A plurality of stand BA is contributed by ponderosa pine, Englemann spruce, or Chihuahuan pine, either singly or in combination	15
14b.	Stand not as above	**Other**
15a.	>10% of stand BA or 4.6 m2/ha (20 ft^2 ac) consists of any oak >13 cm (5 in) in diameter at root collar	**Pine-oak Forest**
15b.	Stand not as above	**Other**

d. Defininition of Rocky-Canyon Habitat

Mexican spotted owls occupy rocky-canyon habitats that differ in many ways from forest habitats. Although rocky-canyon habitat is primarily located within the CP EMU, structurally similar canyon habitats also occur within other EMUs. Review of available studies suggests several habitat characteristics are closely associated with owl sites in rocky-canyon environments, especially steep canyon walls with large vertical cliffs. Cliff faces contain numerous caves and ledges that create protected microsites for nesting and roosting, and canyon walls are typically dissected by narrow, tributary canyons that provide relatively cool and humid roost and nest sites. In essence, rocky cliffs and slot canyons provide complex nesting and roosting habitat structure similar to that typically associated with late-seral forest (Rinkevich and Gutiérrez 1996, Johnson 1997, Willey 1998a).

Rocky-canyon environments that provide nest, roost, and foraging habitats for Mexican spotted owls are diverse, but also possess common emergent properties. These rocky-canyon habitats are associated with complex vertical and horizontal landscape structure, complex geomorphology, and canyon-forming geologic substrates. Rocky-canyon habitat is typically defined by:

1) Canyon walls comprised of steep cliffs that usually extend for at least 1 km (0.6 mi) along parallel sides of the canyon reach (Willey et al. 2007).

2) Relatively narrow canyon widths (<1 km rim to rim) (Willey 1998b).

3) Presence of large cliff faces (normally >15-m [16.25-yd] tall and ~ 90 deg. slopes) with complex vertical structuring including numerous ledges and caves that provide locations with cool and shaded microclimates (D. Willey, Montana State University, pers. comm.).

4) Key geologic layers that form steep, narrow entrenched canyon and cliff complexes. On the CP these formations generally consist of hard sandstones or limestone, but other forms of bedrock can create these conditions within the range of the owl.

5) Forest vegetation, when present, that includes riparian, mixed-conifer, ponderosa pine, pine-oak, or pinyon-juniper woodland. Late seral conditions including large trees and multi-storied canopies typically dominate.

Willey and Spotskey (2000) and Willey et al. (2007) developed Geographic Information Systems (GIS)-based regression models that predicted the potential distribution of nest and roost habitat in Utah. Those models were parameterized using variables that represented the habitat characteristics outlined above. GIS maps produced by these models provided an approximation of the distribution and extent of habitats that meet characteristics defining the rocky-canyon habitat. Similar GIS models are available for managers working in other areas where owls are using rocky-canyon habitat (e.g., Johnson 2003, Mullet 2008).

3. General Management Recommendations

Here, we provide general management recommendations for the Mexican spotted owl. These recommendations apply throughout the range of the owl, although specific recommendations will be more applicable to some locations than others. We provide additional management recommendations specific to particular threats below and emphasize management priorities in sections on individual EMUs (see Part II.C of Recovery Plan), when warranted by differences among EMUs.

General management recommendations focus on three categories relative to land management: Protected Activity Centers (PACs), Recovery Habitat, and Other Forest and Woodland Types. These categories are discussed below.

PACs are established around owl sites (defined below) and are intended to protect and maintain occupied owl habitat. Given our lack of experience and demonstrated expertise in purposely creating the forest structure used by owls, the recommendations for PACs focus on minimizing management. We recognize that these areas cannot be set aside and protected indefinitely, but we regard this as an appropriate interim strategy pending recovery of the species and development of a long-term management plan.

Recovery Habitat occurs in forest types and in rocky canyons used by owls for roosting, foraging, dispersal, and other life history needs, but outside of PACs. Recovery Habitat is intended to: 1) provide protection for areas that may be used by owls; 2) foster creation of roost/nest habitat; 3) simultaneously provide managers with greater management flexibility than is allowed in PACs; and, 4) facilitate development and testing of management strategies that could be applied in PACs.

Areas not classified as either PACs or Recovery Habitats are classified as “Other Forest and Woodland Types” and “Other Riparian Forest Types” for purposes of this plan. These generally include forest, woodland, or other habitat types that appear to be little used by nesting owls but are likely used for foraging and dispersal. Given their relatively limited importance to nesting owls, we propose no owl-specific recommendations in these forest types.

Thus, management recommendations proposed here are tightly targeted, with relatively strict guidelines proposed for occupied roost/nest habitat, flexible guidelines proposed for other areas with potential for use by owls, and no owl-specific guidelines proposed for large portions of the landscape little used by owls. Our intent is to protect the owl and its habitat while

simultaneously minimizing conflicts with management for other resource objectives. PACs and Recovery Habitat under this plan comprise only a portion of the landscape (Box C.2).

a. Protected Activity Centers (PACs)

PACs are intended to sustain and enhance areas that are presently, recently, or historically occupied by breeding Mexican spotted owls. Minimum PAC area is 243 ha (600 ac; see below) and is based on the median size of the adaptive kernel contour enclosing 75% of the foraging locations for 14 pairs of radio-marked owls (241 ha [595 ac)]; Ganey and Dick 1995). Thus, PACS protect activity centers used by owls rather than entire home ranges. Consequently, there is no upper limit for PAC sizes; managers may create larger PACs if it is deemed appropriate.

All PACS should contain a designated 40-ha (100 ac) nest/roost core area, designed to offer additional protection to the nest or primary roost areas (see below). We emphasize protection of habitat used for nesting and roosting within PACs because the owls are most selective for such habitat (Ganey and Dick 1995; Appendix B) and these forest conditions are most limited across the landscape. These areas also provide resources to meet other life-history needs of the owl.

Protection of owl habitat does not always mean a hands-off approach. In some situations, protection of PACs may require active management in forested habitat to reduce fuel loads and fuel continuity in areas adjacent to and within these areas to reduce potential for high severity and stand-replacement fires. Treatments should be located strategically and informed by fire behavior modeling across the greater landscape. Results of such modeling will allow managers to optimize placement of treatments, thus ensuring maximum reduction in risk of severe fires while simultaneously minimizing area treated in PACs. In many cases, strategic treatments on surrounding and/or adjoining lands will reduce fire risk sufficiently so that, in the short term, treatments are not needed within PACs (Ager et al. 2007, Finney et al. 2007, Ager et al. 2010). Where fuels treatments are deemed necessary within PACs, managers must balance fuels reduction goals with short- and long-term conservation of owl habitat, recognizing that drastic alterations to PACs may render them of lesser value for Mexican spotted owls, at least in the short term.

The following guidelines pertain to the designation and management of PACs and supersede all other guidelines within the 1995 Recovery Plan:

i. Where Should PACs Be Established?

Survey any area that could be occupied by nesting spotted owls (i.e., mixed-conifer, pine-oak, or riparian forest and/or rocky canyons) using the established survey protocol (Appendix D) before implementing any management action that will alter habitat structure or influence owl behavior. Establish PACs at all Mexican spotted owl sites (see Box C.1 for site definition) through the life of the Recovery Plan. Exceptions to PAC establishment or continuance are possible; we discuss these situations below. PACs also should be established at historical sites (i.e., sites documented by professional wildlife biologists) that meet our definition of an owl site. Historical sites that do not meet our definition of an owl site may not require a PAC (see below: f. Can PACs Be Decommissioned?).

BOX C.1. DEFINING OWL SITES

Our definition of a Mexican spotted owl site strives to achieve a balance between being overly inclusive and overly exclusive. An overly inclusive definition could result in Protected Activity Centers (PACs) where they are not needed; an example might be the detection of a transient owl. In contrast, an overly exclusive definition could result in failure to designate a PAC in an area occupied by ≥1 Mexican spotted owl. While recognizing the need for balance, we also recognize serious consequences of failing to properly manage occupied owl habitat as the result of an overly exclusive definition. With those considerations in mind, we consider an owl location to be a "site," and thus eligible for PAC designation, if any of the following scenarios occur:

1. One daytime location (visual or auditory) of ≥1 adult or subadult Mexican spotted owl(s) within the breeding season (Mar-Aug);
2. Two nighttime auditory detections within 500-m (0.31-mi) of each other during the breeding season (Mar-Aug), separated by at least one week;
3. Two owls of different sexes heard on the same night within 500-m (0.31-mi) of each other; or
4. Locating one or more owls hatched during that breeding season (young-of-the-year) prior to 1 September.

The above criteria assume that daytime detections provide stronger evidence of owl residency than nocturnal detections, and that little dispersal occurs during the survey season. These assumptions are supported in the literature. The 500-m (0.31-mi) distance seems reasonable based on current knowledge of movement patterns of radio-marked owls and results of demographic studies involving uniquely banded owls.

PACs are intended to protect the activity center of a single owl territory. Therefore, these criteria should *not* be interpreted to mean that multiple PACs need be drawn in areas where multiple detections may represent a single owl territory. In such cases, biologists should use their professional judgment in determining whether or not additional PACs are necessary or in creating PACs larger than 243 ha (600 ac). If biologists from land-management agencies are unsure how best to proceed, we encourage them to work with the appropriate FWS offices and the state wildlife agency in designating PACs.

A long-pending question has been whether high-elevation forest (>2,440 m [8,000 ft]) in CP and SRM EMUs should be surveyed or treated as potential habitat (see Box.C.3). We evaluated what is known about use by owls of high-elevation, mixed-conifer forest in the CP and SRM EMUs. Given information provided from the North Kaibab Ranger District, Dixie National Forest, Carson National Forest, and SRM-CO Working Team, it appears that use of high elevation forest varies. We know of few records of breeding owls above 2,740 m (9,000 ft) west of US Highway 191 in Arizona and Utah. Those found in CP tended to be on the Cibola National Forest in New Mexico, which is east of US Highway 191, but very few owls were found in the high-elevation forests of Utah. Records exist of owls breeding at elevations above 2,740 m (9,000 ft) in SRM EMU. Based on this information, surveys are not recommended for forested Mexican spotted owl habitat above 2,740 m (9,000 ft) occurring west of US Highway 191. Surveys in this region would still be required for forests below 2,740 m (9,000 ft). These areas should still be managed as Recovery Habitat (see discussion below) anticipating that owls and their habitat might shift both north and upwards in elevation as climate changes. Range-wide management recommendations (including the need to survey for owls) for mixed-conifer forest should remain in place for CP east of US Highway 191 and for SRM EMU.

ii. How Should PACs and Core Areas Within PACs Be Established?

1) Identify an activity center around which to designate a PAC. The activity center is defined here as a nest site or a roost grove or cliff area commonly used during the breeding season in absence of a verified nest site, or as the best potential roosting/nesting habitat if both nesting and roosting information are lacking. Site identification should be based on the best judgment of a biologist familiar with the area. Lacking radio-marked birds, spotted owl surveys conducted to locate nests, pairs, or young generally provide the best information for defining activity centers (Ward and Salas 2000).

2) Delineate a PAC at least 243 ha (600 ac) in area configured around the activity center. In areas that are mostly forested, construct PACs as compactly as possible to include the best owl habitat roughly centered on the activity center. Boundaries of the PAC should correspond to habitat polygons and/or topographic features, such as ridgelines or canyon rims, as appropriate. The PAC should include as much roost/nest habitat as is necessary to buffer the activity center, supplemented by potential foraging habitat. For example, in a forested area containing mixed conifer on north-facing slopes and ponderosa pine on south-facing slopes, it may be prudent to include some south-facing slopes as potential foraging habitat rather than 243 ha (600 ac) of north-slope habitat. In many rocky-canyon environments, more complex or linear PACs along the canyon axis will better represent owl habitat than creating circular PACs. The PAC polygons should include opposing canyon slopes and may include some habitat along canyon rims as well (e.g., Bowden 2008), but most PAC area should consist of area below the canyon rim where owls spend approximately 88% of their time (Willey and Van Riper 2007).

3) Within the PAC, designate 40 ha (100 ac) arranged around the activity center. This is identified in paragraph a. above. This nest/roost core area should include habitat that resembles the structural and/or floristic characteristics of the nest and/or roost sites as much as possible. The intent of the core area is to define parts of the PAC that should receive

maximum protection by limiting activities that have a high likelihood of disturbing owls or causing abandonment (primarily habitat alteration and certain forms of mechanical noise). The boundary of the core area should be drawn to include features commonly used by these owls for roosting and nesting (e.g., areas with concentration of conifers or oaks >46 cm [18 inches] diameter, or cliffs with ledges and caves or riparian vegetation, first or second order drainage basins [Ward and Salas 2000]). Cores should be one contiguous polygon unless site-specific information indicates that two or more areas would better meet the intent of core areas. In such cases, coordination with the appropriate FWS office is recommended. If a nest cannot be found, other evidence can be used to designate the core area (see Box C.4).

4) In general, boundaries of adjacent PACs may abut but not overlap. In some local areas of high owl density, this may be difficult to accomplish. In such cases, exceptions to this guideline can be negotiated in consultation with FWS.

5) PACs may be larger than 243 ha (600 ac) if deemed appropriate. Larger PACs may be needed to protect owls that shift activity centers across years or in other special situations. Over time, occupants of a PAC may be replaced by new owls, and the new owls may use different nest or roost groves or canyon sections. If the new owls are found outside of a nearby PAC and the former occupants are not located, the biologist must decide whether to establish a new PAC or enlarge the old one. Where owls are found outside of an unoccupied PAC but within 400 m (0.25 mi) of its boundary, the original PAC should be enlarged to include the new owls unless surveys verify that two PACs are needed for two different owls or pairs. If an owl or pair is found roosting beyond 400 m (0.25 mi) of an existing PAC boundary, a new PAC should be established. In this case, the former PAC should be retained as well, unless it meets criteria described in e, below.

iii. What Activities Are Allowed in PACs Outside of Core Areas?

1) All activities within PACs should be coordinated with the appropriate FWS office.

2) No mechanical or prescribed fire treatments should occur within PACs during the breeding season unless non-breeding is inferred or confirmed that year per the accepted protocol (Appendix D).

3) Removal of hardwoods, downed woody debris, snags, and other key habitat variables should occur only when compatible with owl habitat management objectives as documented through reasoned analysis.

4) Road or trail maintenance, repair, and building in PACs should be undertaken during the non-breeding season (1 Sep - 28 Feb) to minimize disturbance to owls unless non-breeding is inferred or confirmed that year per the accepted survey protocol (Appendix D). We recommend that no new roads or construction occur in PACs.

5) Within all PACs, light burning of surface and low-lying fuels may be allowed following careful review by biologists and fuel-management specialists. Generally, burns should be

done during the non-breeding season (1 Sep - 28 Feb) unless non-breeding is inferred or confirmed that year per the accepted protocol (Appendix D).

6) In some situations prescribed fire alone may be insufficient to reduce fuels and protect PACs. Mechanical treatments used singly or in combination with prescribe fire may be needed to reduce fire risk to owl nest/roost habitats and may enhance owl habitat. As a general guide, forest management programs in PACs should be structured as follows:

   Strategic Placement of Treatments. Conduct a landscape-level risk assessment to strategically locate and prioritize mechanical treatment units to mitigate the risk of large wildland fires while minimizing impact to PACs. Treatments should also strive to mimic natural mosaic patterns.

   Area Limitations. Mechanically treat as needed up to 20% of the non-core PAC area *within an EMU* identified through the landscape-level assessment. This landscape proportion may be allocated flexibly. That is, this does not mean that 20% of each PAC should be treated, or that only 20% of any PAC can be treated. Treatment placement and extent should be guided by fire modeling as discussed above.

   Designate Nest/Roost Core. Within each PAC identified for treatment, designate a 40-ha (100-ac) nest/roost core area as described above.

   Types of Treatments. Within the remaining PAC acreage (202+ ha [500+ ac]), combinations of mechanical and prescribed fire treatments may be used to reduce fire hazard while striving to maintain or improve habitat conditions for the owl and its prey (see desired conditions in Table C.2).

   Seasonal Restrictions. Treatments should occur during the non-breeding season (1 Sep - 28 Feb) to minimize disturbance to resident owls during the breeding season, unless non-breeding is inferred or confirmed that year per the accepted survey protocol (Appendix D).

   Monitoring Treatment Effects on Owls. Monitoring must be designed and implemented to evaluate effects of treatments on owls and retention of or movement towards desired conditions. The monitoring design must be rigorous and adhere to strict quality assurance/quality control standards. Designing such a monitoring study requires a coordinated effort across administrative units. Ideally, the monitoring design should be developed by a scientific committee and implemented by the action agencies. We do not advocate conducting this monitoring in every PAC that is treated; rather, subsets of the landscape (e.g., Four Forest Restoration Initiative, Sacramento Mountains) can be identified for the conduct of this monitoring and will inform fuels treatments within PACs in other locations. We recognize that there is much uncertainty regarding treatment effects and the risks to owl habitat with or without forest treatment. Box C.5 provides a framework for development of monitoring studies.

iv. What Activities Are Allowed Within Nest/Roost Core Areas in PACs?

1) All activities within PACs should be coordinated with the appropriate FWS office.

2) Management activities should be deferred from the nest/roost core during the breeding season (1 Mar - 31 Aug), except where non-breeding is confirmed or inferred that year per the accepted survey protocol (Appendix D).

3) Planned ignitions (prescribed fire) and unplanned ignitions (wildland fire) should be allowed to enter cores only if they are expected to burn with low fire severity and intensity. Fire lines, check-lines, backfiring, and similar fire management tactics can be used to reduce fire effects and to maintain key habitat elements (e.g., hardwoods, large downed logs, snags, and large trees).

4) Other activities should be conducted outside of the breeding season unless pressing reasons dictate otherwise. These activities include trail maintenance, road repair, removal of hazard trees, and utility-line maintenance. If the activity is conducted during the breeding season with owls present, owl locations should be known and documented during the conduct of the management action. Management actions should not be conducted in the vicinity of nesting owls, where vicinity is defined by the intensity of disturbance.

5) Research projects that evaluate effects of a specific activity on owl behavior or life history are allowed and in fact encouraged (see Part V.F). For example, determining the influence of noise disturbance would require that the activity is done close to roosting or nesting owls. These activities will require scientific permits from FWS and state or tribal wildlife agencies.

v. Should Salvage Logging Occur in PACs Impacted by Disturbance?

If a stand-replacing fire, windthrow event, or large-scale mortality due to insects or disease occurs within a PAC, timber salvage plans should be evaluated on a case-specific basis in consultation with the FWS. Salvage logging in PACs should be allowed only if sound ecological justification is provided and if the proposed actions meet the intent of this Recovery Plan, specifically to protect existing nest/roost habitat and accelerate the development of recovery nest/roost habitat. Management actions that do not protect soil integrity, that impede recovery of disturbed systems, or that fail to maintain and enhance native species and natural recovery processes should not be implemented (Betchta et al. 2004, Karr et al. 2004).

Fires within PACs are not always detrimental to owls. Patchy fires result in habitat heterogeneity and may benefit the owl and its prey (Bond et al. 2009). In such cases, adjustments to PAC boundaries are probably unnecessary and salvage should not be done. Salvage and boundary adjustments should be considered in PACs only when the disturbance is extensive in size and tree mortality is extensive and substantial. We make the following recommendations:

1) In all cases where salvage logging is being considered, the PAC and a buffer extending 400 m (433 yd) from the PAC boundary should be surveyed for owls before non-occupancy is inferred. This survey should occur during the breeding season following the fire or other large-scale mortality events and should adhere to the accepted protocol (Appendix D) except that it could be completed with four visits in a single season.

2) If owls are located within the PAC or within 400 m (433 yd) of the PAC boundary, then managers should evaluate the extent and severity of the disturbance and consider reconfiguring of PAC boundaries and potential modification of the proposed action in consultation with FWS.

3) If no owls are detected, Section 7 consultation should be used to evaluate the proposed salvage plans.

4) Salvage prescriptions should be designed to maintain or enhance the desired conditions described in Table C.2 and to minimize the spread of exotic invasive species.

5) New road construction should be avoided whenever possible, and temporary road and skid trail construction should be designed to minimize impacts on soil integrity and natural recovery processes. All new and temporary roads and skid trails should be decommissioned and obliterated after use.

vi. Can PACs Be Decommissioned?

In general, PACs should not be decommissioned. Once a PAC has been established it should remain in place, with a few exceptions discussed below. Site occupancy by Mexican spotted owls is related to owl density, and owl density changes over time (e.g., Seamans et al. 1999). As a result, a territory may be occupied during periods of high owl density and vacant during periods of lower density. Therefore, failure to detect owls in one or even a few years does not necessarily indicate that an area no longer provides useful habitat, or that protecting such habitat is inappropriate. Some circumstances may warrant removing areas from being managed as PACs, however. These situations are:

1) Situations where PACs were established or converted from previously established management territories using less stringent criteria than the criteria we recommend for defining owl sites (Box C.1) and surveys conducted post-establishment have failed to detect owls.

2) Situations where vegetation within a PAC was altered substantially by wildland fire, insect kill, windthrow, or similar disturbances to the extent that they would not be expected to support breeding owls, and non-occupancy is documented through surveys conducted to protocol (Appendix D).

vii. How Can PACs Be Decommissioned?

When PACs were designated based on information that does not meet the Recovery Plan definition for an owl site, then:

1) Coordinate with the appropriate FWS office when considering removing PAC status.

2) If surveys were conducted according to the accepted protocol (Appendix D) and owl-site criteria were not met, then no PAC is necessary. For historical locations that have not been surveyed according to the accepted protocol, surveys should be conducted following the accepted protocol.

   Retaining PAC Designation. If owls are detected and these detections meet Recovery Plan criteria for an owl site, PAC status should remain in place. In this situation, if new survey information supports adjusting PAC boundaries, adjustments should be made.

Removing PAC Designation. If no owls are detected during these surveys, PAC designation can be removed. Once the PAC is removed, the area should be managed according to other designations, namely Recovery Habitat or Other Forest and Woodland Types, as appropriate.

3) In areas that have undergone extensive vegetation change to the point that land managers question the ability of the area to function as a PAC, then:
   Contact FWS. Coordinate with the appropriate FWS office when considering removing PAC status.
   Survey for Owls. The area should be resurveyed for owls using the accepted survey protocol (Appendix D). If no owls are located, then changes in PAC designation should be considered on a case-specific basis. If owls are found, the PAC should remain, although adjustments to the boundaries can be considered where appropriate based on survey results and landscape configuration.

viii. Rationale Underlying PAC Guidelines

We recognize that landscapes are dynamic. The intent of these guidelines is not to preserve designated PACs forever, but to protect them until it can be demonstrated that recovery nest/roost habitat can be created through active management and/or the owl is delisted. In the following section (Recovery Habitat) we describe one approach for managing to create nest/roost habitat. Once that approach or other approaches have been shown to be effective in creating or enhancing the types of habitat structure used by owls, the PAC concept could be abandoned in favor of a long-term management plan based on maintaining owl habitat well-distributed across a dynamic landscape. Until such an approach has been tested and such a plan is in place, however, we believe it wise to continue to protect occupied owl habitat using the current approach.

We recognize that protection status carries some risk with respect to probabilities of stand-replacing fire. We believe that PACs can be afforded substantial protection by emphasizing fuels reduction and forest restoration in surrounding areas outside of PACs and nest/roost habitat. However, we recognize that in some cases protection of nest/roost habitat and human communities requires reduction of fuels loads and disruption of fuel continuity within PACs. We provide guidance for such treatments above, and urge a deliberate and cautious approach to such activities within PACs emphasizing monitoring and feedback loops to allow management to be adaptive.

b. Recovery Habitat

The PAC guidelines discussed above are intended to protect the core use or activity centers of resident owls. In focusing on activity centers, however, those guidelines do not provide protection to all areas within owl home ranges; most owl home ranges are considerably larger than 243 ha (600 ac). Further, owls may use areas outside of their usual home ranges at times. Examples include seasonal migration or adult and juvenile dispersal. Finally, it seems logical to strive to provide additional habitat in planning for recovery of a threatened species, as increasing population size is a logical goal of recovery efforts and providing additional habitat is one way to accomplish this. This is particularly true given uncertainty over the effects of climate change on

habitat quantity, quality, and distribution. Additional habitat well-distributed across the landscape may be needed to offset unpredictable changes in quantity, quality, and distribution of owl habitat. Consequently, here we provide additional guidelines focused on what we term Recovery Habitat. These guidelines are intended to maintain and develop nesting and roosting habitat now and into the future, and are stratified by two broad categories: Forested Recovery Habitat and Riparian Recovery Habitat.

i. Forested Recovery Habitat

Forested Recovery Habitat occurs in mixed-conifer and pine-oak forests (see definitions in Appendix C.2) that are not included in PACs. Our primary intent here is to maintain and create recovery nest/roost owl habitat where appropriate, while providing for both diversity in ecological conditions across the landscape and flexibility for managers. As noted earlier, we assume that the primary limiting factor for Mexican spotted owls in forests is the amount and distribution of nesting and rooting habitat, but we also assume that these habitats provide key foraging habitat as well. A logical conclusion from this premise is that the landscape should be managed to sustain owl nesting/roosting habitat that is well-distributed spatially. This does not mean that all forests should be managed as recovery nest/roost habitat. Rather, we recommend that a portion of the landscape should be managed for conditions suitable for nesting and roosting, and that portion differs among EMUs (see Tables C.2, C.3). We recognize that nest/roost habitat cannot be sustained in perpetuity at specific sites, and that nest/roost habitat will continue to be lost to senescence and human and natural disturbance. We assume that providing a dynamic supply of nesting and roosting habitat requires that various parts of the landscape be in various stages of ecological succession. Our goal is to allocate those stages so as to create a landscape mosaic that ensures adequate nesting, roosting, and foraging habitat for the owl, as well as providing habitats for its major prey.

Managing forested Recovery Habitat requires knowledge of both existing and desired conditions. Ideally, existing conditions should be assessed at multiple spatial scales (Kaufmann et al. 1994). We recognize that information needed to conduct assessments at larger spatial scales frequently is lacking. We encourage agencies to develop the types of information needed for such large-scale assessments, however, and note that such information will be necessary to move from recovery guidelines based on protecting habitat to guidelines based on managing dynamic landscapes.

In reality, most short-term assessments will focus on evaluating forest structure at the scale of individual forest stands. In particular, existing vegetative conditions within mature-old stands must be assessed to determine the treatment potentials within those stands. Given the relatively high frequency of recent stand-altering disturbances, many areas likely are deficient in mature to old-growth forests. Thus, any treatments to these stands should be applied judiciously.

1) Reference Conditions: Nesting and Roosting Conditions in Forested Environments

We defined reference conditions for management in Forested Recovery Habitat based on current knowledge of forests used by spotted owls. Forest stands used by spotted owls for nesting and roosting have certain structural features in common. These typically include relatively high tree

BA, large trees, multi-storied canopy, multi-aged trees, high canopy cover, and decadence in the form of downed logs and snags (Ganey and Dick 1995). Many stands also contain a prominent hardwood component. This is generally provided by Gambel oak in ponderosa pine-Gambel oak forests, by a variety of evergreen oaks and madrone in Madrean pine-oak forests, and by various species (e.g., oaks, maples, boxelder, aspen) in mixed-conifer and montane riparian forests.

We used tree BA and large tree (>46 cm [18 inches] dbh) density to describe minimum conditions for owl nesting/roosting habitat (Table C.3). Other structures such as canopy cover, snags, and downed logs are important as well. However, we assume that when tree BA and density approach the levels given in Table C.3, then adequate amounts of canopy cover, snags, and downed logs either exist already or will develop over time. See Box C.7 for a description of how Table C.3 parameters were developed.

2) Recovery Habitat Guidelines for Forest Habitats: General Approach

For planning purposes in Forested Recovery Habitat, there are two types of stands with respect to desired nest/roost conditions: those that meet or exceed the conditions and those that do not. The overriding goal is to manage a specified portion of the landscape (see Table C.3) as recovery nest/roost habitat. Thus, managers should identify and protect stands that meet or exceed nest/roost conditions and then assess whether or not these stands satisfy the area requirements in Table C.3. If these stands are not sufficient to meet the area requirements in Table C.3, managers should identify those stands in the planning area that come closest to meeting nest/roost conditions and manage those stands to develop nest/roost conditions as rapidly as reasonably possible to meet recommended percentages. Prescriptions may include thinning to promote growth of large trees. Stands that do not meet nest/roost conditions and are not designated for development of such can be managed to meet other resource objectives.

Because most project planning occurs at limited spatial scales, the percentages of area in Table C.3 should be regarded as a **minimum** level for a given planning area. If a deficit occurs within the planning area, additional stands should be identified and managed as described above. Even if the proportion of the planning area that meets nest/roost conditions is greater than the percentages in Table C.3, we recommend that no stands be lowered below these conditions until ecosystem assessments at larger spatial scales (e.g., landscape, subregion, and region) demonstrate that desired conditions occur in recommended amounts at these larger scales. Using watersheds in allocating percentages of area to manage for nest/roost conditions should reduce the potential for creating excessively fragmented nesting habitat.

3) Guidelines for Forested Recovery Habitat Managed as Nest/Roost Habitat

Treatments are allowed within Recovery Habitat stands identified as meeting nest/roost conditions, as long as stand conditions remain at or above the values given in Table C.3 in (but see discussion under "Treatments Within Recovery Nest/Roost Stands" below). This approach allows for treatments to reduce fire risks, lessen insect or disease problems, maintain seral species, or meet other ecosystem objectives. Management activities that influence the owl and its habitat should be conducted according to the following guidelines:

Manage for Nest/Roost Habitat. Manage mixed-conifer and pine-oak forest types in the designated proportions of Table C.3 to provide continuous nest/roost habitat over space and time. Management of particular stands should be based on their capability to attain the desired conditions (Table C.2).

Treatments Within Recovery Nest/Roost Stands. No stand that meets Table C.3 conditions should be treated in such a way as to lower that stand below those conditions until ecosystem assessments can document that a surplus of these stands exist at larger landscape levels (e.g., no less than the size of a FS District). This does not preclude use of treatments to reduce fire risks or lessen insect or disease problems, nor does it preclude management to meet other ecosystem objectives, as long as stand-level conditions remain at or above the values given in Table C.3.

Select Appropriate Stands to Manage. Management should emphasize attainment of nest/roost conditions as quickly as reasonably possible. Identify and assign stands that will reach these conditions soonest to satisfy area requirements in Table C.3.

Retain Large Trees. Stand conditions that provide the owl's nesting habitat frequently vary above the minimum values given in Table C.3. Further, important stand conditions cannot be replaced quickly. In particular, removing large trees in a stand identified as habitat could reduce its suitability as nesting habitat or increase the time required to develop suitable nesting habitat. Because it takes many years for trees to reach large size, we recommend that trees ≥46- cm (18 inches) dbh not be removed in stands designated as recovery nest/roost habitat unless there are compelling safety reasons to do so or if it can be demonstrated that removal of those trees will not be detrimental to owl habitat.

Strive for Spatial Heterogeneity. Incorporate natural variation, such as irregular tree spacing and various stand/patch/group/clump sizes, into management prescriptions. Strive for heterogeneity both within and between stands. Owls currently use uneven-aged stands, and we do not know if landscapes composed of even-aged clumps will provide suitable owl habitat; this idea should be evaluated as described in Box C.5 before wide-scale implementation of management based on even-aged clumps. Attempt to mimic natural disturbance patterns and natural landscape heterogeneity. Allow natural canopy gap processes to occur, or mimic those processes through active management, thus producing horizontal variation in stand structure.

Manage for Species Diversity. Maintain all species of native vegetation on the landscape, including early seral species. Allow for variation in existing stand structures and provide for species diversity.

Emphasize Large Hardwoods. Within pine-oak and other forest types where hardwoods are a component of owl habitat, emphasis should be placed on management that retains, and promotes the growth of additional, large hardwoods.

4) Guidelines for Forested Recovery Foraging/Non-breeding Habitat

The following guidelines are intended to minimize threats to Mexican spotted owls within Forested Recovery Habitat not managed as nest/roost habitat (i.e., habitat that does or could provide foraging, dispersal, or winter habitat). Although we emphasize fuels and restoration treatments, these guidelines are applicable to other management scenarios as well. Our intent is to manage Recovery Habitat so that important but difficult-to-replace habitat elements are conserved while allowing management flexibility. Management should strive to maintain

conditions where multiple components occur in proximity to one another. For example, if a stand contains large trees, logs, and snags, prescriptions should be designed to keep as many of these components as possible while achieving management objectives such as fuels reduction and ecosystem restoration. Such prescriptions can result in the short-term reductions of key habitat components, but they should strive to maintain some of these components within the stand. Unfortunately, specific targets or quantities of these components to maintain cannot be provided because research has not been conducted to address this information need. Ideally, research in the form of management experiments will address this knowledge gap. In the meantime, management should be based on the best judgment of the professionals involved to balance our intent with the objective(s) of the prescription.

We provide the following guidelines for Recovery foraging/non-breeding habitats:

Emphasize Large Hardwoods. Within pine-oak and other forest types where hardwoods are a component of owl habitat, emphasis should be placed on management that retains, and promotes the growth of additional, large hardwoods.

Retain Large Trees. Strive to retain (do not cut) all trees >61 cm (> 24 in) dbh, the average diameter of nest trees, unless overriding management situations require their removal to protect human safety and/or property (e.g., the removal of hazard trees along roads, in campgrounds, and along power lines), or in situations where leaving large trees precludes reducing threats to owl habitat (e.g., creating a fuel break). To the extent practical, fuel breaks should be designed to avoid the removal of larger trees (trees over 18 in [46 cm] dbh). We recognize that prescribed fire is an inexact tool and that applying prescribed fire may result in the loss of large trees. However, we strongly recommend that action agencies take reasonable steps to minimize the loss of trees >61 cm (24 in) dbh. Steps can include using light burn prescriptions and removal of ladder fuels proximal to large trees. Even with such actions, some large trees may be killed. This should not preclude proceeding with necessary treatments. Large trees killed by fire will provide a source for recruitment of large snags and eventual large logs; these snags should be retained unless their removal is necessary for public or worker safety.

Retain Key Owl Habitat Elements. Design and implement management treatments within Forested Recovery Foraging/Non-breeding habitat so that most hardwoods, large snags (>46 cm [18 in] dbh), large downed logs (>46 cm [18 in] diameter at any point), trees (>46 cm [18 in] dbh) are retained, unless this conflicts with forest restoration and/or owl habitat enhancement goals. Treatments adequate to meet fuels and restoration management objectives in Recovery Habitats may result in the short-term loss of some habitat components in areas that could be occupied by spotted owls. We view these losses as acceptable where they result from actions that otherwise further longer-term protection and sustainability of forests occupied by owls. When implementing this guideline, managers should strive to achieve a balance between retaining a sufficient density and distribution of important features that spotted owls may require and reducing the risk of losing existing roosting and nesting habitat from insect epidemics and stand-replacing fires. Previous wording of this guideline (USDI FWS 1995) was interpreted to mean that trees >46 cm (18-in) dbh may not be removed. That is not our intent. However, large trees are a key habitat correlate for owls, and removal of such trees should be done judiciously and only when truly necessary to meet specific resource objectives.

5) Rationale for Recovery Habitat Guidelines

The collective goal of guidelines for Forested Recovery Habitat is to provide spotted owl habitat that is well distributed over space and time. Accomplishing this goal requires maintaining or creating stand structures typical of nesting and roosting habitats, and sustaining them in sufficient amounts and distribution to support a healthy population of Mexican spotted owls. The approach outlined above provides a template for the development of a long-term management strategy that recognizes and incorporates landscape dynamics. If this approach can be validated, it may be possible to replace short-term protection of owl habitat with a longer-term approach that incorporates the dynamic nature of natural landscapes.

ii. Riparian Recovery Habitat

Riparian forests are plant communities affected by surface and subsurface hydrologic features of perennial or intermittent water bodies (e.g., rivers, streams, lakes). Riparian forests have one or both of these principle characteristics: 1) distinctively different tree and shrub species than the adjacent areas and/or 2) tree species similar to adjacent areas but exhibiting more vigorous or robust growth forms (FWS 2009). Riparian forests typically create transition zones or ecotones between water bodies and upland areas (Naiman and Décamps 1997, FWS 2009). These ecotones makes riparian habitats among the most ecologically productive and diverse terrestrial environments in the arid western United States and Mexico (Naiman et al. 1993). Because of their productivity and diversity, because they differ in important ways from other habitats occupied by spotted owls, and because recommendations for riparian habitats in the original Recovery Plan (USDI FWS 1995) were so broad that they caused considerable confusion, we discuss riparian communities separately here. Our primary focus is on forested riparian areas, because these areas are most likely to provide the habitat structure used for nesting, roosting, foraging, and dispersal (e.g., Ganey and Dick 1995, Stacey and Hodgson 1999).

We distinguish between Riparian Recovery Habitat and Other Riparian Forests. Riparian Recovery Habitat consists of riparian forests outside of PACs that could frequently be used by owls for foraging, roosting, daily movements, dispersal, and potentially for nesting. Riparian Recovery Habitat is considered to be a key habitat for owl recovery. Other Riparian Forests are not regularly used by owls, but may occasionally provide stepping stones for movement between population segments or be used by owls during the non-breeding season. These forests may facilitate long-term gene flow, provide connections among EMUs, and/or facilitate survival of owls during winter. We recommend that Other Riparian Forests be managed similarly to Other Forest and Woodland Types.

1) Threats to Riparian Recovery Habitat

Riparian habitats are threatened by a long list of anthropogenic activities and natural events (see discussion in II.H.3). Our focus is on the influences described in that section and that fall within the temporal scope of this plan. We also note that improper management of adjacent upland habitat types can threaten riparian habitats. However, management of adjacent upland forests for proper functioning ecological condition (e.g., soil retention) and Recovery Habitat removes this threat. While the definition of PFC for riparian areas may vary somewhat by management

agency, we provide the definition from USDI BLM (1998) as an example: "Proper Functioning Condition - Riparian-wetland areas are functioning properly when adequate vegetation, landform, or large woody debris is present to dissipate stream energy associated with high waterflows, thereby reducing erosion and improving water quality; filter sediment, capture bedload, and aid floodplain development; improve flood-water retention and ground-water recharge; develop root masses that stabilize streambanks against cutting action; develop diverse ponding and channel characteristics to provide the habitat and the water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses; and support greater biodiversity. The functioning condition of riparian-wetland areas is a result of interaction among geology, soil, water, and vegetation."

2) Guidelines for Riparian Recovery Habitat

Specific recommendations to address threats and maintain or restore riparian habitats include:

Manage for Proper Functioning Condition. Manage for PFC to attain the highest ecological status and potential natural community structure (i.e., mid- to late-seral conditions) possible within the capability and potential of the site. Attaining the goals described, dependent on site potential, should benefit habitat for the owl (e.g., regeneration of riparian tree cover) and its prey species (e.g., provide dense ground cover for small mammals).

Manage for Species Diversity. Manage for a diversity of age and size classes of native riparian trees and shrubs along with a diverse understory of native riparian herbaceous species to provide potential roost/nest sites for owls and cover for owl prey species.

Manage Grazing Effects. Where needed, minimize negative impacts of ungulate grazing on riparian vegetation by modifying livestock grazing systems (i.e., changing seasons and duration of use, establishment of riparian pastures, and providing periods of complete rest), reducing grazing pressure by livestock and wild ungulates through stocking and population management, and/or establishing riparian exclosures (i.e., either livestock or livestock/wildlife ungulate exclosures).

Minimize Construction Activities. Avoid construction activities (e.g., road or trail building) in recovery riparian areas except on a case-specific basis where pressing management needs can be demonstrated.

Selective Tree Removal. Minimize effects of tree removal by eliminating removal where possible or by restricting removal so that habitat components (e.g., large trees, snags, and large downed logs) are conserved. We support the use of vegetation manipulation, especially removal of non-native vegetation, as a tool to restore, enhance, or maintain riparian conditions. Thus, thinning trees and shrubs is encouraged where such thinning restores properly functioning condition and improves the habitat or protects it against stand-replacing fire.

c. Other Forest and Woodland and Other Riparian Forest Types

We propose no specific guidelines for several forest and woodland community and other riparian forest types where they occur outside PACs. These include ponderosa pine, spruce-fir, pinyon-juniper, aspen, and other riparian forest types (as defined above). However, the lack of specific

management guidelines within this plan does not imply that these forest and woodland and riparian types are unimportant to the Mexican spotted owl.

The lack of specific recommendations in other forest and woodland types is based on extant information on the natural history of the Mexican spotted owl as summarized in Appendix B and detailed in the original Recovery Plan (USDI FWS 1995). These other forests and woodlands typically are not used for nesting and roosting but do provide habitat for foraging, dispersing, and wintering spotted owls. Although information on habitat features needed for foraging, dispersing, and wintering is limited, it appears that owls use a broad array of conditions to meet these needs. Furthermore, some of the best foraging habitat should be protected in PACs and Recovery Habitat. Consequently, we can be less restrictive in these other forest and woodland community types without harming the owl or compromising its primary habitat.

We assume that existing and planned management for these forest and woodland types will maintain or improve habitat for these needs of the owl. Our assumption is based largely on the premise that existing, late-seral stands will be maintained or restored where necessary across the landscape, silvicultural practices will favor uneven-aged over even-aged cuts, and management will be guided by ecosystem approaches that strive to provide sustainable conditions, which fall within the natural range of variation, across the landscape. Guidelines developed for PACs and Recovery Habitat may have useful applications when judiciously administered in these other forest and woodland types. Such guidelines include managing for landscape diversity, mimicking natural disturbance patterns, incorporating natural variation in stand conditions, retaining special features such as snags and large trees, and utilizing fire as appropriate. We also emphasize the need for proactive fuels management where appropriate. Decreasing fire risks within these types, particularly ponderosa-pine forests, also will decrease fire risks to adjoining PACs and Recovery Habitats by reducing the probability of large, landscape-level crown fires that could impinge upon occupied or potential nesting habitat.

Other Riparian Forests currently do not appear to be used for nesting and breeding season roosting but may provide habitat for dispersing and wintering spotted owls. As such, and similar to recommendations for Other Forest and Woodland Types, we offer guidelines specific to Other Riparian Forest management. The goals of the guidelines for managing Other Riparian Forests are to: 1) maintain and/or restore riparian habitats to proper functioning ecological condition (USDI BLM 1993, 1994, 1998a, 1998b); and, 2) where ecologically feasible, provide a mix of size and age classes of both trees and shrubs that should include snags and large trees, vertical diversity, and other structural and floristic characteristics that typify riparian systems in proper functioning ecological condition.

Many riparian systems within the range of the Mexican spotted owl are extremely degraded as the result of past land-use practices (Stacey and Hodgson 1999). Our underlying premise is that if riparian systems are restored to properly functioning ecological conditions, they will meet the needs of the owl (and numerous other species). This is particularly true in canyon-bottom situations at middle and lower elevations where little other typical nesting or roosting habitat may be available. Because canyon bottoms are used extensively by the owl (Ganey and Dick 1995, Rinkevich and Gutiérrez 1996, Johnson 1997, Willey 1998a, Stacey and Hodgson 1999), it is important to preserve and increase the quality of such habitat. We anticipate that PACs will

include some of the best canyon riparian habitat that still exists, but increasing the quantity and distribution of properly functioning riparian habitats provides the potential for increasing the amount and extent of spotted owl habitat.

Table C.1. Summary of recommended management actions in Core Areas, PACs, and Recovery Habitats.

Mexican spotted owl Management Categories	Summarized Recommended Management Measures*
*****Please review Appendix C for detailed information regarding this summary table.*****	
Core Area: 40 ha (100 ac) established within PACs to protect Mexican spotted owl nests or primary roost areas.	• All activities within the core area should undergo consultation with the appropriate FWS office. • All management activities should be deferred from the core during the breeding season (March 1 through August 31), except when non-breeding is confirmed or inferred that year per the accepted survey protocol. • Planned or unplanned fires should be allowed to enter core areas only if they are expected to burn at low intensity with low severity effects.
Protected Activity Center (PAC): ≥243 ha (600 ac) established around Mexican spotted owl nest/roost sites (core areas). This refers to activities located outside the core area. See Box C.1 for establishing PACs.	• All activities within the PAC should undergo consultation with the appropriate FWS office. • Mechanical treatments can be conducted in up to 20% of the total non-core PAC area within each EMU (treatments can exceed 20% of the non-core acreage within a single PAC) • No mechanical or prescribed fire treatments, or road or trail maintenance should occur within PACs during the breeding season unless it has been determined that the PAC is unoccupied or the owls are not nesting that year as inferred from results of surveys conducted according to protocol. • Removal of hardwoods, downed woody debris, snags, and other key habitat variables should occur only when compatible with owl habitat management objectives as documented through reasoned analysis. • New road or trail construction is not recommended in PACs • Monitor treatment effects as described in Appendix C. • See Table C.2 for desired conditions for PACs.
Recovery Habitats: Currently unoccupied Mexican spotted owl habitat occurring in pine-oak, mixed conifer, and riparian forests and/or rocky canyons. These habitats may be or have the potential to be used by owls for nesting, roosting, foraging, dispersal, and/or other life history needs.	
Forested Recovery Habitat: Forested habitat occurring in mixed-conifer and pine-oak forests outside of PACs (see next page).	

Recovery Nest/Roost Habitat: Forested stands identified as meeting or exceeding owl nest/roost conditions.	Guidance provided in Tables C.2 & C.3 • Manage for nest/roost replacement habitat. • Do not treat stands in such a way as to lower stand conditions below thresholds in Table C.2 • Emphasize attainment of nest/roost conditions as quickly as reasonably possible. • Retain large trees. • Strive for spatial heterogeneity. • Manage for species diversity. • Retain key owl habitat elements (large trees, snags, large logs, hardwoods, etc.). • Emphasize large hardwoods, where appropriate
Recovery Foraging/Non-breeding Habitat: Forested stands managed to provide foraging, dispersal, wintering, or other habitat needs.	• Emphasize large hardwoods, where appropriate • Retain key owl habitat elements (e.g., large trees, large snags, large logs, hardwoods, etc.). • Minimize tree removal.
Riparian Recovery Habitat: Riparian forests are plant communities affected by surface and subsurface hydrologic features of perennial or intermittent water bodies. Riparian forests are: 1) distinctively different tree and shrub species than the adjacent areas; and/or, 2) tree species similar to adjacent areas but exhibiting more vigorous or robust growth forms.	• Manage for proper functioning ecological conditions. • Manage for species diversity. • Manage grazing effects. • Minimize construction activities. • Maintain key habitat components (e.g., large trees, large snags, large logs, hardwoods, etc.). • Minimize tree removal.
Other Forest and Woodland Types and Other Riparian Habitat: Forest, woodland, or other habitat types that appear to be little used by nesting Mexican spotted owls, but are likely used for foraging and dispersal.	No specific guidelines are provided for several forest and woodland community types (ponderosa pine, spruce-fir, pinyon-juniper, and aspen) where they occur outside of PACs.

*This box provides a summary of management recommendations for Mexican spotted owl habitat. For more detail, see Appendix C.

Table C.2. (Below) Generalized description of key habitat variables comprising Desired Conditions in forest, riparian, canyon, and woodland cover types typically used by Mexican spotted owls for nesting and roosting. **Desired conditions should guide management within PACs and recovery nest/roost habitats.** The ecological relevance of each desired condition to this owl subspecies and examples of variables that may be useful to quantify desired conditions are also shown. Where possible numbers are derived from past research, where information was unavailable we used the collective best professional knowledge of the Recovery Team.

Desired Condition	Relevance to Owl	Potential Variables (Examples)
Strive for a diversity of patch sizes with minimum contiguous patch size of 1 ha (2.5 ac) with larger patches near activity center; mix of sizes towards periphery (Peery et al 1999; Grubb et al 1997; May and Gutiérrez 2002). Forest type may dictate patch size (i.e., mixed conifer forests have larger and fewer patches than pine-oak forest). Strive for between patch heterogeneity.	Nest/roost habitat patches are the most limiting habitat for the owl. Patches should enhance spatial heterogeneity, provide nest/roost options, provide varied microclimates (thermoregulation) options, and create edges for prey species (e.g., *Neotoma*).	Size, cumulative acreage, density of patches, % of landscape, amount of edge habitat, average patch canopy cover, average age of dominant overstory component of patch. Frequency distribution of patches by size class, total edge, core to edge distance, fractal index of patch (area to edge ratios).
Horizontal and vertical habitat heterogeneity within patches, including tree species composition.* Patches are contiguous and consist of trees of all sizes, unevenly spaced, with interlocking crowns and high canopy cover (Ganey et al. 2003).*	Provides roosting options, thermal and hiding cover for the owl, and habitat for a variety of prey species.	Patch size and configuration (shape), juxtaposition (topology of patches), interspersion, edge length; canopy cover by height strata; number of vegetation strata present (herbaceous, shrub, sapling, pole, mature trees); uneven tree spacing.
Tree species diversity, especially with a mixture of hardwoods and shade-tolerant species (Willey 1998).* For example, Gambel oak provides important habitat for woodrats and brush mice (Block et al. 2005, Ward 2001)	Provides habitat and food sources for a diversity of prey, roosting options, and perches and hiding cover for young owls during early flight development. Large tree-form Gambel oaks are an important nesting substrate for owls (Ganey et al 1992; SWCA 1992; May and Gutiérrez 2002). Diversity increases probability of some tree species setting seed in a given year. Owls use hardwoods (e.g., big-toothed maple, western hop hornbeam and chinkapin oak) for roosting (Mullet and Ward 2010)	Species occurrence (presence), diversity indices (including richness and equitability), BA by species, density/species.
Diverse composition of vigorous native herbaceous and shrub species (Ward 2001).*	Provides sustainable habitat for a variety of prey; fine fuels to carry surface fire.	Cover/plant group; plant height; vertical density profile; diversity measure (e.g., richness and equitability); vertical distribution; maximum height.
Opening sizes between 0.04 - 1 ha (0.1 - 2.5 ac).* Openings within a forest are different than natural meadows. Small canopy gaps within forested patches provide for prey habitat diversity. Openings should be small in nest/roost patches, may be larger in rest of PAC.	Openings provide habitat for a variety of prey and can slow or reduce fire severity by breaking the continuity of dense tree canopies and ladder fuels.	Frequency distribution of openings by size class, % of landscape in openings. Grass and herbaceous cover in openings (Daubenmire plots for coverage percent).
Minimum canopy cover of 40% in pine-oak and 60% in mixed conifer (Ganey et al. 2003).* Measure canopy cover within stands.	Provides thermal environment needed for nesting/roosting and prey habitat.	Canopy cover line or point intercept method).

Diversity of tree sizes with goal of having trees ≥16" DBH contributing ≥50% of the stand BA (Willey 1998, May and Gutiérrez 2002, Ganey et al. 2003, May et al. 2004)	All life history needs (nesting, roosting, foraging). By emphasizing large trees, should provide for large snags and logs (Ganey et al. 2003).	Patch size/tree stage; vegetation strata;; tree size distribution.

*Rocky Canyon Recovery Habitat: results from habitat studies suggest these desired conditions are important in canyon environments where forest, woodland, and riparian habitats are present (e.g., Zion National Park).

Table C.3. Minimum desired conditions for mixed-conifer and pine-oak forest areas managed for Recovery nesting/roosting habitat. Forest types are defined in Appendix C, above. Parameter values are based on averages among plots sampled within forest stands. Numbers of stands included in analysis: 74 for Basin and Range-East (BRE), 27 for mixed-conifer forest in other EMUs, and 47 for pine-oak forest.

EMU(s) Forest Type	% of area[1]	% BA by size class		Minimum tree BA[2]	Minimum density of large trees[3]
		30-46 cm dbh (12-18 in)	>46 cm dbh (>18 in)		
BRE Mixed-conifer	20	>30	>30	33.3 (145)	37 (15)
CP, UGM, SRM, BRW Mixed-conifer	25	>30	>30	27.5 (120)	30 (12)
CP[4], UGM, BRW Pine-oak	10	>30	>30	25.3 (110)	30 (12)

[1] % of area pertains to the percent of the planning area, subregion, and/or region in the specified forest type that should be managed for threshold conditions.

[2]BAs in m^2/ha (ft^2/acre), and include all trees >1 inch dbh (i.e., any species). We emphasize that values shown are **minimums**, not targets.

[3]Trees > 46 cm (18 inches) dbh. Density is tree/ha (trees/acre). Again, values shown are minimums rather than targets. We encourage retention of large trees.

[4]Pine-oak forest type: ≥10% of the stand BA or 4.6 m^2/ha (20 ft^2/ac) of BA consist of Gambel oak ≥ 13 cm (5 in) drc.

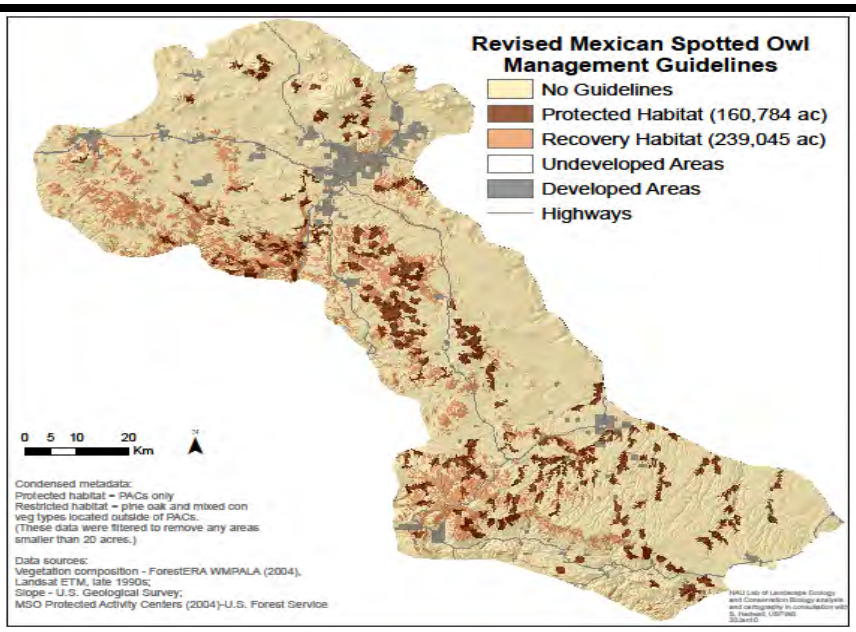
[5]Pine-oak recommendations apply only to the Mount Taylor and/or Zuni Mountains regions within the CP EMU.

BOX C.2. SPATIAL INTERPRETATION OF MEXICAN SPOTTED OWL MANAGEMENT GUIDELINES

Figure 1, below, shows a spatial interpretation of the current Mexican spotted owl management guidelines (i.e., guidelines in this revised Recovery Plan) across the western Mogollon Plateau, Arizona. This interpretation was created by the ForestERA project using spatial data layers collected by or created by project members.

The spatial extent of the map includes approximately 812,000 ha (2.04 million ac) within the belt of continuous ponderosa pine forest (and associated vegetation types) extending from north and west of the city of Flagstaff, south along the plateau to the edge of the 2002 Rodeo-Chediski Fire. Approximately 75% of the land within this area is managed by the FS (Coconino, Kaibab, Apache-Sitgreaves, and Tonto National Forests). The remainder of the land is a patchwork of private, state, and military lands.

PACs (referred to as "Protected Habitat" in Figure 1 below) cover approximately 8% (65,067 ha [160,784 ac]) and recovery habitat covers 12% (96,738 ha [239,045 ac]) of the area analyzed,. Thus, approximately 80% of the land base covered falls in areas not subject to specific Recovery Plan guidelines.



Box C.2: Figure 1. Habitat map produced for the Mexican spotted owl Recovery Team by ForestERA Project (see www.forestera.nau.edu) showing the distribution of lands in 2010 within the western portion of the UGM EMU covered by Recovery Plan designations.

BOX C.3. HIGH-ELEVATION, MIXED-CONIFER FOREST

The greater use of canyons and reduced use of upland forests in the northern part of the owl's range has raised questions about whether high-elevation (>2,440 m [8,000 ft]), mixed-conifer forests provide breeding habitat for spotted owls in these areas. This in turn has raised the issue of whether or not these areas should be surveyed and managed for owls. Under the original Recovery Plan (USDI FWS 1995), these areas were subject to the same management guidelines as mixed-conifer forests elsewhere within the owl's range.

Based on past discussions with Working Teams and land-management agencies in these areas, the Recovery Team recommended an amendment to the original Recovery Plan to deal with this situation. This amendment was approved by the FWS's Regional Director for the Southwestern Region in 1999. This amendment did not provide an elegant solution to this issue and pleased no one, including the Recovery Team. Consequently, the issue still exists. Therefore, we re-evaluated what is known about owl use of high-elevation, mixed-conifer forest. Specifically, we requested data on extent of surveys within the former SRM-Colorado, SRM-New Mexico, and CP EMUs. We received useful, but not necessarily conclusive information, from SRM-Colorado EMU, Carson National Forest, Kaibab National Forest, and the FS's Intermountain Region (Region 4).

Data on survey extent and results in Colorado were provided by the working team for that EMU. The Kaibab National Forest provided results of survey data for the North Kaibab Ranger District, the Carson National Forest provided results of survey on that forest, and FS Region 4 provided information on surveys conducted on multiple forests in that region. T. H. Johnson (Yomi Enterprises) performed the analysis for all EMUs by overlaying known owl records on 7.5 min digital elevation models and determining elevation at these locations (see Table 1, below).

Based on the available data, we conclude that owls in parts of the northeastern extent of the range use high-elevation, mixed-conifer forests. Therefore, blanket exemptions of such forests from range-wide management recommendations are not warranted. Data provided from Colorado recorded owls in high-elevation forests and that several PACs are at elevations >2,440 m (8,000 ft).

Given the use by owls of areas above 2,440 m (8,000 ft) and even 2,740 m (9,000 ft) in the northeastern part of their range, we recommend that range-wide management recommendations for mixed-conifer forest remain in place for these areas. If agencies within these EMUs believe that these high-elevation forests do not provide suitable habitat, they should compile the data to support that contention. Specifically, data provided should include:

1. For all future surveys conducted, action agencies create GIS coverage maps of areas surveyed; these should include forest types, survey points or routes, and survey results (spotted owl locations and associated attribute data).
2. In conjunction with the previous point, interested agencies could work with the Working Teams to compile currently available information on past survey efforts and results within their EMU. Minimum information required for this assessment includes: 1) total acres of mixed-conifer forest above 2,440 m (8,000 ft) in elevation; 2) acres of the

aforementioned mixed-conifer that were surveyed to protocol; 3) how many years areas were surveyed; and, 4) owl locations with associated attribute data. It may also be helpful to provide similar information for other cover types, if possible. For example, if a unit has surveyed 40,080 ha (100,000 ac) of high-elevation, mixed-conifer and 20,040 ha (50,000 ac) of rocky canyons, and found all owls in canyons, that information presented together is more convincing than simply presenting acres of mixed-conifer surveyed.

Box C.3: Table 1. Summary of elevation data based on daytime records of Mexican spotted owls in the database compiled in 1993 by the recovery team, based on agency survey data. Elevation data were compiled by T. H. Johnson (Yomi Enterprises), by overlaying owl locations on 7.5-min digital elevation maps (DEMs).

Ecological Management Unit	N	% above 2,440 m (8,000 ft)	% above 2,743 m (9,000 ft)
Colorado Plateau	69	15.9	7.2[a]
Southern Rocky Mountains	30	46.6	10

[a] Represents detections only on the Cibola NF.

BOX C.4. CRITERIA USEFUL IN DESIGNATING CORE AREAS IN THE ABSENCE OF NEST LOCATIONS

If no nest location is known, the following criteria (after Ward and Salas 2000) may be useful in determining where to locate the core area within a PAC:

- A circle with a 359 m (1,179 ft) radius centered on a location of one young-of-the-year Mexican spotted owl observed during the day prior to 1 August of any year.
- A 40 ha (100 ac) area that surrounds daytime observations of adult or subadult Mexican spotted owls documented over four different breeding seasons.
- Lacking this information, managers should rely on experienced spotted owl biologists to exercise their best professional judgment to identify likely habitat for nest/roost cores and delineate the 40 ha (100 acre) area.

Once designated, cores should remain in place and not be moved without sound biological rationale for making any adjustments.

BOX C.5. ASSESSING TREATMENT ACTIVITIES WITHIN PACs, OUTSIDE OF CORE AREAS

Several types of restoration activities (e.g., various silvicultural prescriptions and burning) are allowed in portions of landscapes that include Mexican spotted owl PACs. The effects of these treatments are not fully known and well-designed monitoring can provide valuable information on the effects of these activities on the owls and their habitat. The following recommendations provide general guidance for monitoring forest and fire management treatments that will occur in PACs but outside of nest-roost core areas. This monitoring should be designed, implemented, and analyzed in cooperation with scientists to ensure adequate sampling procedures and reliable inferences about potential effects of planned treatments on the owls and their habitats.

General Guidance for Monitoring and Estimating Effects of Treatments in PACs

Guiding Questions (these are not a complete list of potential questions; local managers will likely develop additional, site-specific questions of interest)***:***

- Do planned treatments (e.g., thinning, prescribed fire) affect key spotted owl responses (identified below)?
- How do identified effects vary among potential treatment types (e.g., fire severity and duration, total area affected, thinning acreage and intensity)?

Response Variables:

- Owl occupancy rate (corrected for detection probability; the percent of PACs occupied before and after treatments).
- Owl reproductive output (the number of fledglings observed per adequately checked pair before and after treatments).
- Habitat change (the immediate effect of a treatment type on key variables selected from Table C.1 showing description of desired conditions [DCs]) in forest and woodland cover types typically used by Mexican spotted owls for nesting and roosting. Analysis should incorporate what is retained as well as extent of change.

Planned Treatments:

- We assume these will vary by EMU and be agency defined at local scale, but they may also require regional EMU coordination across agencies.
- Treatments will likely be variable in spatial extent and intensity (intensity measured by degree of change in key habitat variables related to DCs [see Table C.1]).

General Study Design Approach:

- For each planned treatment(s), monitoring should be designed to robustly contrast a set of reference PACs (with no planned treatments) to a set of treatment PACs.
- PACs may be stratified by treatment type.
- Reference PACs should match the environmental conditions in PACs where treatments are planned, as closely as possible.

BOX C.5, Continued

Sampling Considerations:

- Identify set of PACs for a planned type of treatment.
- Identify set of reference PACs for each geographic area and cover type.
- Sample response variables for owls each year, using a design that allows estimation of effects to occupancy, detection probability, reproductive output, and habitat DCs.
- Sample timing: one year pre-treatment, during treatment year, and one, three, and five years post-treatment.
- Identify DC variables (Table C.1) that measure habitat change to calibrate treatment effects.

Potential Analytic Approaches

- Will depend on sample size.
- Possibilities include:
  - Simple treatment effect stratified by treatment type and geographic area/cover type. Two-sample tests, ANOVA, regression-based approaches, power dependent on sample size and variability.
  - Subsequent analyses only if treatment effects are apparent – gradient analysis, AIC based model selection if sample size permits use of treatment/habitat covariates.

Quality Control / Assurance

- A monitoring plan should be written that includes the details for sample selection, treatment specifics, measurement protocols including timing, and planned analyses.
- The monitoring plan should be reviewed as part of the consultation process for treatments planned to occur within PACs.

BOX C.6. DEFINING AND USING REFERENCE CONDITIONS FOR MEXICAN SPOTTED OWL NESTING/ROOSTING HABITAT

In the original 1995 Recovery Plan, two primary types of information were used to formulate recommendations for habitat management. In one analysis, quantitative descriptions of site- and stand-scale habitat conditions were used to describe characteristics of nesting/roosting habitat. In a second analysis, forest vegetation simulators were used to estimate the proportion of the landscape that could sustain those conditions through time (see USDI FWS 1995). Thus, information developed was used to define both desired forest structure at the scale of individual stands or patches, and the desired proportion of the landscape to manage for that structure.

Much of the information used to describe forest structure in the original 1995 Recovery Plan was derived from samples at relatively fine scales (i.e., sub-stand scales). Forest management typically is focused at larger scales such as forest stands, however, and stands are not entirely homogeneous. Owls locate and use distinct patches within stands, and stand descriptors based on characteristics of those used sites may not be representative of overall stand characteristics. To be most useful, descriptors of stand characteristics should be based on the same type of sampling and data that will be available to land managers faced with assessing stands. Consequently, we revised values in Table C.2 based on an analysis of nest stands used by Mexican spotted owls in Arizona and New Mexico as described by existing FS stand-exam data.

We queried the FS Southwest Region's database of common stand exams for data representing identified spotted owl nest stands. We then summarized these data in a two-step process. In step one, we aggregated values across plots *within* individual stands, to estimate average characteristics within individual stands. In step two, we averaged stand parameters *across* nest stands, to estimate mean stand characteristics and 95% confidence intervals around those mean values. We conducted analyses in step two separately for mixed-conifer and pine-oak forests. In addition, we analyzed mixed conifer separately for the BRE vs. other EMUs due to the relatively high density of owls in the Sacramento Mountains (BRE), and thus the high percentage of that landscape protected with existing PACs.

The values provided in Table C.2 define desired conditions to be achieved with time and management, or to be maintained where they already exist. **These values are based on the lower bound of 95% confidence intervals around estimates of means computed across stands.** Consequently, we view these values as minimum targets for managers. We also stress that values in Table C.2 must be met simultaneously. Management can occur within stands that exceed these minimum conditions, but such activities should not lower stand characteristics below these levels unless large-scale assessments demonstrate that such conditions occur in a surplus across the landscape (see below).

BOX C.6, Continued

We reiterate that we developed the table values from analyses that first averaged stand characteristics across plots within stands. Owl nest stands are not homogeneous. A typical nest stand may contain both pockets of large trees and greater basal area and areas of more open forest. We suspect that this heterogeneity and within-stand diversity is valuable (Ganey and Dick 1995), and we encourage managers to retain that variability. In particular, small areas with high basal area, canopy cover, and densities of large trees appear to be important for providing suitable nest and roost sites (Ganey and Dick 1995, Ganey et al. 2003), and such patches should be retained where they exist.

A frequent criticism levied at the precursor to Table C.3 in the original Recovery Plan (USDI FWS 1995:Table III.B.1) was that the specified stand conditions could not be sustained on the landscape. The portions of the landscape specified for management in this table were based on simulations using table parameter values and established models of forest succession and stand prognosis conducted by FS personnel with expertise in the use of such models (USDI FWS 1995). These simulations clearly demonstrated that such conditions are sustainable on the portions of the landscape specified, and to date no empirical data or modeling results have surfaced to support the claim that the specified stand conditions cannot be supported on the landscape in the indicated amounts. A more recent, spatially explicit analysis evaluated possible constraints imposed by the 1995 Recovery Plan on conducting fuels-reduction treatments (Prather et al. 2008). Results indicated that 1995 Recovery Plan guidelines applied to less than one third of an 811,000 ha study region, and that the majority of the forest even in these conflict areas could be managed to reduce fire hazard without eliminating owl habitat (Prather et al. 2008).

We did not repeat the modeling efforts used in the original Recovery Plan to generate percentages of the landscape capable of sustaining nest/roost conditions. In most cases, we reduced values for describing required stand parameters in the revised Table C.3 relative to values in the original Recovery Plan. Logically, if it was possible to sustain the conditions in the original Recovery Plan over a specified portion of the landscape, it should be possible to sustain the revised, and more lenient, conditions over that same portion of the landscape.

As in the original Recovery Plan, the percentage of landscape area recommended for management for nest/roost conditions is lower in the BRE EMU than it is in other EMUs. This is based on the observed high density of owls in the Sacramento Mountains, which effectively places a large proportion of that landscape in protected status. Also as before, we do not provide guidance on how to allocate future owl habitat across the landscape. Although this is a critically important issue, we lacked the information and resources to accomplish this allocation.

4. Threat-specific Management Recommendations

In this section, we provide recommendations as they relate to specific threats or activities. Some recommendations are similar to those presented in the General Recommendations, but we repeat them here for clarity.

a. Fire Management

Overarching forest management goals should embrace the restoration of ecosystem health, historical and/or natural conditions, and the range of variability in forest structure, composition, and function. In places, these restoration goals may likely include the ecological role of fire and the emulation of past fire regimes and ecological processes. Fortunately, the Southwest has one of the largest compilations of ecological research that documents and reconstructs historical reference conditions such as past stand structure, density, and fire frequencies for many forest types, with research sites throughout the region. These references along with our recommendations should help guide and quantify future restoration activities.

Guidelines

The appropriate management of prescribed fire and wildland fire outside of PACs to moderate fire severity and the potential for stand-replacing fire may provide most alternatives to mitigate severe fire threats. Mechanical treatments, however, may be necessary in some areas before fire can be effectively and safely applied to meet management objectives. The focus of mechanical thinning will likely be concentrated in the WUI communities at risk to fire, where fires are a greater threat to people and property and where fire applications have much greater risk and liabilities. Planning and implementing fire risk-reduction activities should balance the intensity and arrangement of treatments needed to reduce the landscape risk of high-severity fire yet maintain owl habitat. Due to the current magnitude of forest fuel accumulations, some preliminary treatments (e.g., thinning combined with pile and low intensity prescription burning) will be required to reduce the severity of wildland fires and to allow for the safer management of prescribed fire and wildland fires. Cumulative effects of multiple treatments across the watershed, downstream effects, and effects to spotted owl habitat will need to be evaluated through landscape analyses and modeling, and effects should be moderated to promote Mexican spotted owl recovery.

i. Wildland fire Suppression

Protect Public Safety and Property. Fire fighter safety and community protection are the utmost priorities during ES and BAR activities.

Wildland fire Behavior and Incident Planning. Conduct landscape-level fire behavior assessments to strategically locate and prioritize fire suppression activities/tactics to mitigate the effects of high-severity fire and suppression activities on PACs and recovery habitat. Potential strategies include locating fire-line construction and other suppression activities where possible outside of PACs, and conducting night burning ahead of approaching moderate-high severity wildland fire in areas surrounding PACs to reduce wildland fire severity within PACs.

Retain Key Habitat Elements. Where possible, wildland fire suppression activities should be applied that limit high-severity fire and loss of key habitat elements within PACs and recovery habitats.

Applied Research. Research should be conducted to evaluate the short- and long-term correlates of wildland fire severities and their spatial extent on Mexican spotted owls and their habitat.

ii. Burned Area Emergency Response (BAER - FS), Burned Area Emergency Stabilization (ES-DOI) and Burned Area Rehabilitation (BAR-DOI).

Protect Public Health, Safety, and Property. Personnel safety and community protection are the utmost priorities during ES and BAR activities.

Seasonal Restrictions. BAR treatments where deemed necessary in or near PACs should occur during the non-breeding season (1 Sep - 28 Feb) to minimize disturbance to resident owls during the breeding season, unless non-breeding is inferred or confirmed that year per the accepted survey protocol (Appendix D).

Treatment Priorities. ES and BAR treatments should be only be considered when critical to stabilize soils, retain key habitat elements, and enhance ecosystem recovery. Soil stabilization should be considered only where crucial and implemented through local biomass mulching or other seed-free mulching materials to minimize risk of introduced exotic species. Seeding is not recommended due to its limited effectiveness, lack of local genetically compatible seed stock, and exotic contaminants found in most seed mixes (Peppin et al. 2010a, 2010b; Dodson et al. 2010; Stella et al. 2010). Measures to protect remaining green trees from insect and disease may also be necessary.

iii. Prescribed Fire, Hazardous Fuels Treatments, and Wildland Urban Interface (WUI).

We propose the following recommendations for prescribed fire and hazardous fuels treatments. Much of the work needed to reduce broad-scale fire risk to owl habitat can be accomplished by first treating areas down-slope from and surrounding PACs. We recognize, however, that other management considerations like WUI may require treatments within PACs. In these situations, treatments should be done with adequate safeguards to minimize loss of key habitat components for owls and their prey.

Protect Public Health, Safety and Property. Fire fighter safety and community protection are the utmost priorities during prescribed fire and hazardous fuels treatment activities.

Area Limitations. Mechanically treat as needed up to 20% of the non-core PAC area within an EMU identified through the landscape-level assessment (see above Assumptions and Guiding Principles).

Seasonal Restrictions. Light burning of surface and low-lying fuels may be conducted within PACs following careful review by biologists and fuel-management specialists on a case-specific basis. Mechanical or prescribed fire treatments should occur during the non-breeding season (1 Sep - 28 Feb) to minimize disturbance to resident owls, unless non-breeding is inferred or confirmed that year per the accepted survey protocol (Appendix D). Treatments should be planned when environmental conditions provide enhanced opportunities to achieve fuel reduction and forest-restoration objectives. These

activities however should be deferred in severe drought years and times of high-to-extreme wildland fire risk.

Types of Treatments. Combinations of mechanical and prescribed fire treatments may be used to minimize risk of high-severity fire effects while striving to maintain or improve habitat conditions for the owl and its prey.

Strategic Placement of Treatments. Treatments should be placed strategically to minimize risk of high-severity fire effects to the nest core while mimicking natural mosaic patterns.

Treatment Priorities. Emphasize treatments in other forest and woodland types over those of PACs and recovery habitats to the extent practicable. Treatments in these areas might buffer owl habitat as well as provide fire risk reduction to WUI communities. Where appropriate, areas surrounding PACs could be treated with higher prescribed fire and mechanical treatment intensities to better achieve management objectives (e.g., reduction of hazardous fuels and potential for stand-replacing fires, enhancement of landscape, and forest structural diversity).

Landscape Assessment. A landscape-level assessment should be conducted to strategically locate and prioritize prescribed and hazardous fuels treatments to best mitigate the risk of stand replacing fires and high severity fire effects to current and future spotted owl habitat elements (Tables C.2, C.3).

Monitoring. Monitoring should be designed and implemented to evaluate the effects of prescribed fire and hazardous fuel reduction treatments on spotted owl habitat, and to retain or move towards Mexican spotted owl desired conditions (Table C.2). Box C.5 provides a framework for development of monitoring studies.

Applied Research Experiments. Management experiments should be conducted in places to evaluate the short-term, long- term, cumulative, and watershed effects of these activities on Mexican spotted owls and their habitats.

These recommendations, when implemented, should help reduce high-severity fire effects across broader forest landscapes and help protect Mexican spotted owl PACs, potential habitats, and suitable nesting/roosting habitat locations from future stand-replacing wildland fires and enhance landscape-level forest resiliency to climate variability. Additionally, these recommendations are supported by current research and monitoring on Mexican spotted owl fire effects that show limited, short-term effects from moderate- to high-severity fires (Bond et al. 2002, 2009; Jenness et al. 2004).

b. Insects and Disease

Biotic disturbance agents most influential to forest habitat of the Mexican spotted owl are bark beetles, defoliating insects, dwarf mistletoes, root disease fungi, and rust fungi (USDA FS 2004). Many agents act in concert with abiotic factors; the current aspen decline in northern Arizona is an example of a complex disturbance. The course of an outbreak can be characterized by its rate of increase and spread, duration, and spatial scale. Impacts consider the spatial extent and intensity of tree mortality as well as the values of killed and remaining trees ("value" can be in the sense of ecosystem function).

Although knowledge of forest condition and predisposition allows managers to assess the risk and potential impacts of an insect or disease outbreak, control is difficult (Holling and Meffe

1996). Management has limitations in techniques, resources, and reaction time; social and natural systems are complex and dynamic. Nonetheless, management intervention can be useful to change forest conditions predisposing areas to outbreak and to influence the extent, course, and impact of outbreaks. Effective treatments are generally tailored for a specific insect or pathogen, instituted early, executed in multiple stages, monitored, and modified as needed to achieve objectives (adaptive management).

Guidelines

1) Resource managers should work with forest insect and disease specialists to develop ecological assessments of these kinds of disturbances at various scales. Evaluations should be based on the role these organisms play in directing succession toward, or away from, desired conditions at different spatial-temporal scales.

2) Managers, in consultation with specialists, can use these organisms to strategic advantage in creating, enhancing, or maintaining habitats for owls (and associated biota) in accord with landscape goals.

When considered a threat to owl or prey habitat, various tools—prescribed fire, thinning, other silvicultural treatments—can be used to limit the spread of insects or diseases. Management actions include sanitation, thinning, maintenance of mixed species stands (coarse-filter techniques), chemical protection of individual trees, and use of insect-behavior modifying chemicals (fine-filter techniques). Methods used are often specific to the organism and should be done in consultation with owl biologists, insect and disease specialists, fire personnel, and silviculturists.

c. Grazing

As discussed in II.9.D.a.vii, improperly managed grazing can adversely affect spotted owls primarily through four indirect effects: 1) diminished prey availability and abundance (Ward 2004, Willey 2007, Willey and Willey 2010); 2) increased susceptibility of habitat to destructive fires; 3) degradation of riparian and meadow plant communities; and, 4) impaired ability of plant communities to recover or develop into more suitable spotted owl habitat. These indirect effects flow from the livestock management practices that result in long-term alterations in plant species composition, density, vigor, and vegetation structure. Therefore, in order to provide for recovery of the spotted owl and adequate protection of its habitat, livestock management within the owl habitat should be designed with the following objectives: 1) to maintain or enhance prey availability; 2) to maintain potential for beneficial surface fires while inhibiting potential for destructive stand-replacing fire; and 3) to promote natural and healthy riparian, meadow, and upland plant communities including their functional processes.

Guidelines

Appropriate grazing management should be designed to provide a target level of residual vegetation that would attain or sustain moderate to high similarity to potential natural vegetation,

or otherwise favorable habitat characteristics for the spotted owl and its prey. "Key areas[1]," "critical areas[2]" and "key species[3]," as defined by the Society for Range Management (1998), should be identified for the purposes of managing grazing and monitoring its effects on herbaceous and woody vegetation. The following guidelines are provided for grazing management in all PACs and recovery habitats:

1) Resource managers should conduct site-specific assessments, utilizing pertinent research information and standardized monitoring techniques to identify: a) habitat conditions for availability of prey species to Mexican spotted owl; b) conditions of riparian and meadow habitats including their functional processes (USDI BLM 1996*a*,*b*; Ruyle et. al. 2000); and, c) conditions and processes required for the restoration and maintenance of historical fire regimes and native plant communities where fire has historically influenced habitat structure and plant composition. These assessments should be conducted during both dormant and growing seasons to provide favorable habitat characteristics throughout the year.

2) Resource managers should establish and enforce residual vegetation (e.g., residual leaf length or stubble height) targets during plant growth and dormant periods that are consistent with light to moderate grazing intensity within protected and recovery habitats. Established targets should be: a) attained at a minimum in at least four out of every five years; b) reviewed by resource managers periodically (every five to seven years) to determine if desired vegetation conditions are being achieved or maintained; and, c) modified appropriately when vegetation conditions indicate the need.

3) Resource managers should coordinate to implement grazing and other management strategies for livestock and wild ungulates that will improve degraded riparian communities in owl habitats to proper functioning ecological condition as soon as possible and implement monitoring programs to evaluate improvement in habitat conditions (USDI FWS 1995, Winward 2000). Management strategies may include (Kennedy 1977; Rickard and Cushing 1982; Clary and Webster 1989; Platts 1990; Chaney et.al. 1990, 1993; Krueger 1995; Leonard et al. 1997):

- *Reduce Grazing Pressure*. Reductions in grazing intensity in riparian areas through the use and enforcement of appropriate vegetation utilization or residual vegetation standards and timely livestock removal;
- *Seasonal Grazing.* Changes in seasons of grazing use (e.g., allow livestock grazing in riparian areas only during plant dormancy periods where possible);
- *Reduce Numbers.* Reduction in numbers of grazing animals (i.e., both livestock and wild ungulates if needed) to attain sufficient residual riparian vegetation levels and improvement in riparian habitat conditions; and,
- *Exclusion of Grazing.* Total exclusion of ungulate grazing use from sensitive riparian areas for extended time periods (e.g., multiple years) through the use of exclusion fencing

[1] Key Area - A relatively small portion of a range selected because of its location, use, or grazing value as a monitoring point for grazing use. It is assumed that key areas, if properly selected, will reflect the overall acceptability of current grazing management over the range (SRM 1998).
[2] Critical Area - An area that must be treated with special consideration because of inherent site factors, size, location, condition, values, or significant potential conflicts among uses (SRM 1998).
[3] Key Species - (1) Forage species whose use serves as an indicator to the degree of use of associated species. (2) Those species which must, because of their importance, be considered in the management program. (SRM 1998)

to improve riparian herbaceous plant cover, promote regeneration of riparian shrub and tree cover, and protect stream banks and channels.

4) Resource managers should coordinate to implement livestock and elk population management strategies that will reduce browsing impacts on upland deciduous woody species in areas where the recruitment of these species into the overstory is lacking due to browsing pressure within owl habitats. Strategies developed under this guideline should not be focused solely on domestic livestock management, rather they should be focused on reducing the impacts of all browsers that contribute to the identified threat.

d. Energy-Related Development

We provide general recommendations related to energy development below. However, in most cases, specific recommendations will depend on case-by-case evaluations of the timing and duration of the proposed action. The timing of an action is pertinent in that a disturbance during the breeding season (1 Mar - 31 Aug) is more likely to impact owls than a disturbance outside the breeding season. Pertaining to length of disturbance, actions should be categorized as temporary or long-term according to the following definitions:

- *Temporary:* An action that leaves no long-term structure or long-term habitat loss and does not result in persistent noise pollution (e.g., occasional helicopter overflights).
- *Long-term:* An action that causes a loss of owl habitat, increases the probability of mortality through collision, increases human access to an area, or creates a persistent owl disturbance from noise (i.e., noise above 69 dBA at 50 m [165 ft] from nest or PAC if nest site is not known; e.g., creation of long-term facilities such as utility lines, mines, pits, well pads, roads, pipelines, compressor stations).

<u>Guidelines</u>

The following guidelines pertain to PACs and Recovery Habitats. In most cases, temporary actions that occur outside of the breeding season will require no occupancy surveys and no mitigating actions. If activities will be long-term or take place during the breeding season, conduct occupancy surveys according to the standard protocol approved by FWS. Where owls are found, PACs should be established and the PAC guidelines should be followed. Where owls are not found, temporary actions may be allowed either during or outside of the breeding season. Long-term actions may, on a case-by-case basis, be allowed to proceed in Recovery Habitats outside of PACs, provided that the actions avoid detrimental habitat alteration, minimize the risk of owl mortality from collision, and conform to the recommendations for Recovery Habitats. Collision risk is best minimized through proper siting of structures (e.g., away from likely owl travel corridors).

The following guidelines apply to areas within PACs during the breeding season (1 Mar - 31 Aug) unless otherwise stated. If owls are not detected in a PAC, restrictions on temporary activities may be relaxed depending on the nature and extent of the proposed action.

1) No seismic activities or construction of new facilities or expansion of existing facilities should take place during the breeding season. Any construction within PACs during the non-

breeding season should be considered on a case-specific basis (see item b below). Modifications to existing facilities pertaining to public health, safety, and routine maintenance are excepted. However, when implementing such activities, those conducting the work should use all measures possible to avoid potential effects on owls (e.g., use least disruptive machinery, time project to minimize disturbance).

2) Construction and seismic activities may take place outside of the breeding season or during the breeding season if non-occupancy or non-breeding is inferred through protocol surveys. Long-term activities should avoid loss of habitat through, for example, use of directional or multi-lateral drilling and locating new facilities within existing rights of way. Long-term activities that increase the risk of owl collision with structures (e.g., turbines, power lines) should not be allowed in PACs.

3) The potential for noise disturbance to nesting owls should be assessed on a case-specific basis. Breeding season restrictions should be considered if noise levels are estimated to exceed 69 dBA (~80 dBO) [owl-weighted noise level, Delaney et al. 1999a]) consistently (>twice/hour) or for an extended period of time (>1 hr) within 50 m (165 ft) of nesting sites (if known) or within entire PACs if nesting sites are not known. Noise reduction may be accomplished through proper placement of facilities and use of noise dampening equipment (e.g., hospital-grade mufflers, electric pump motors) as well as other techniques.

e. Land Development

The following guidelines are provided to mitigate potential threats to owls due to land development. Guidelines are based on the assumption that most land development threats to Mexican spotted owls are edge effects influencing adjacent Federal lands, and that mitigation of threats following guidelines for WUI treatments and recreation on applicable lands, combined with implementation of the general recommendations, will maintain current levels of owl habitat.

<u>Guidelines</u>

1) Managers are encouraged to pursue coordination on a case-by-case basis with local governments and developers to encourage development in areas least likely to directly influence habitat use of known owls. When possible, managers should encourage maintenance of existing habitat conditions on private lands. Development of positive incentive programs may be a feasible approach.

2) Managers should implement recreation-disturbance guidelines (below).

f. Water Development

Water development includes dams, permanent flooding of riparian habitats, bed degradation below dams, stream and spring dewatering, water diversions, and altered-flow regimes of streams and springs. Effects of water development on spotted owls vary, depending upon the size of the water development, and can range from loss or degradation of habitat to habitat fragmentation, disruption of migration corridors, inhibited gene flow, altered prey habitat, and

altered grazing patterns by wild and domestic ungulates. Recommendations for addressing water development vary. In some situations, options are limited for addressing effects of established water developments on spotted owls (e.g., Lake Powell). Greater flexibility exists for addressing developments before they occur or for slightly modifying practices that might reduce effects on the owl.

Guidelines

1) If considering development of large water projects assess the potential effects on spotted owl movement.

2) Discharge water from dams in such a way to sustain and enhance native riparian vegetation.

3) Conduct surveys following accepted survey protocol prior to initiating any water development that would modify owl habitat or result in effects to nesting owls. Implementation of projects should be done in consultation with the FWS.

g. Recreational Exploitation

Recreational exploitation can result in harm, harassment, and even mortality of Mexican spotted owls. Management, education, and/or enforcement actions may be needed to protect spotted owls from this threat.

Guidelines

1) Calling, hooting, or playing of taped recordings to elicit responses from or to locate owls is prohibited without a section 10(a)(1)(A) recovery permit from the FWS. Where recreational exploitation is known to be a problem, managers should report continued issues to the appropriate FWS Law Enforcement Office.

h. Recreation Disturbance

The following guidelines apply to PACs during the breeding season, (1 Mar - 31 Aug). If non-breeding is inferred or confirmed that year per the accepted survey protocol, restrictions on noise disturbances can be relaxed depending on the nature and extent of the proposed disturbance. Recommendations are based in part on Swarthout and Steidl (2001, 2003). Guidelines for noise management related to recreation are provided below in the noise management recommendations.

Guidelines

1) No construction of new facilities (e.g., trailheads, OHV trails) or expansion of existing facilities should take place in PACs during the breeding season. Any construction within PACs should be considered on a case-specific basis. Modifications to existing facilities pertaining to public health, safety, and routine maintenance are excepted (e.g., removal of dangerous trees in a campground; replacement of road culverts within campgrounds, etc.). However, when

implementing such activities, those conducting the work should use all measures possible to avoid potential effects on owls (e.g., use least disruptive machinery; timing of the project to minimize disturbance).

2) Managers should, on a case-specific basis, assess the presence and intensity of currently allowed (permitted and non-permitted) recreational activities. The assessment should include distance, frequency, duration, and source of the disturbance. If recreation is determined to be a problem (e.g., increased OHV or hiking use), limit human activities during the breeding season in areas occupied by owls (timing may vary depending on local nest chronology). Disturbance here is defined as the presence of 1 -12 people; group sizes exceeding 12 people should not be allowed. In areas where nest and roost sites are not identified, human disturbance should be limited to ≤2 disturbances per hour (averaged over a 24 hour period) throughout the PAC. Where nest and roost sites are known, disturbance should be limited to ≤2 disturbances per hour (averaged over a 24 hour period) within line of sight of the nest/roost sites. In some cases, disturbances may be avoided by routing trails and recreational uses (e.g., OHV use) outside of PACs through signing in order to designate zones free from human disturbances during critical periods.

3) Seasonal closures of specifically designated recreational activities (e.g., OHV use, rock climbing, or biking) should be considered where disturbance to breeding owls seems likely.

4) Conduct education through signing, interpretation events, access permitting, or other information sources to inform the public of proper and legal behaviors when encountering owls. For example, land managers in some areas are maintaining permanent, all-weather signs that inform the public that the area is home to a sensitive species; visitors should stay on the trail and be as quiet and unobtrusive as possible.

5) If owls are not detected in a PAC during the breeding season, restrictions on non-habitat-altering recreation can be relaxed depending on the nature and extent of the proposed disturbance.

i. Scientific Exploitation

Although we do not view research and monitoring activities as a significant threat to the Mexican spotted owl (see Part II.H.3.b of Recovery Plan), such activities may on occasion alter owl habitat, influence owl behavior, or harm or kill owls. Whereas long-term benefits to owls from these activities can be substantial, safeguards are needed to ensure that any negative short-term effects are acceptable.

<u>Guidelines</u>

1) Quality assurance and quality control procedures should be applied to all scientific studies that may directly or indirectly affect owls or owl habitat. Quality assurance requires that study plans undergo appropriate levels of review, revision, and approval. Quality control means that methods of data collection adhere to prescribed standards.

2) All scientific activities that have potential to harm owls or owl habitat should undergo FWS review and concurrence. Concurrence is demonstrated by granting appropriate permits. Applications for these permits routinely requires a review of the techniques to be used and a finding that those techniques are generally acceptable and have a low risk of causing harm or death.

3) Contingency plans (e.g., how an injured owl will be treated or transported and where an injured owl will be taken) for dealing with injured owls should be included as part of the study proposal submitted with the permit application. In addition, many researchers must undergo approval of animal care and use by their employing institutions.

4) Annual reports are required from all permit holders.

5) All owl mortalities are reported to FWS within 48 hours of being discovered. If a particular study or a particular activity results in an undue number of mortalities, FWS will convene an independent expert panel to evaluate the situation and propose recommendations to continue, adjust, or cease the activity resulting in mortalities.

6) Radio-marking spotted owls likely poses the highest risk among typical research activities. This risk may be alleviated partially by adhering to marking requirements issued by the Bird Banding Lab. For example, these guidelines restrict transmitter packages (includes the transmitter, antenna, and attachment materials) to ≤3% of body weight. We endorse that restriction but also note that past studies have demonstrated that spotted owl body mass can fluctuate by up to 5% between years and/or seasons. Therefore, we recommend that transmitter packages used on Mexican spotted owls not exceed 16 g for female owls and 14 g for male owls. These guidelines should ensure that transmitter packages are light enough to be tolerated even if owls undergo significant loss of body mass.

7) Radio transmitters have been attached to spotted owls successfully using both backpack and tailmount attachments. Any other attachment methods should be viewed as experimental and should be tested on captive spotted owls before deployment in the field, if possible. If captive spotted owls are not available, experimental attachment methods should be tested on captive barred owls, with transmitter weight adjusted to account for increased body mass of barred owls. If neither of the above options are possible, then experimental attachments should be tested on a very small sample of wild spotted owls, and results should be monitored before allowing widescale use of the method.

8) All radios should be attached by researchers with demonstrated expertise in handling raptors and attaching transmitter packages to raptors. Experience with spotted owls and the specific attachment method in use is preferable here.

j. Noise

The following guideline applies to areas within PACs during the breeding season (1 Mar - 31 Aug). If non-breeding is inferred or confirmed that year per the accepted survey protocol, restrictions on noise disturbances should be relaxed depending on the nature and extent of the

proposed disturbance. The recommendation is based in part on Delaney et al. (1999a,b), Delaney and Grubb (2003), and Pater et al. (2009).

Guidelines

1) Managers should, on a case-specific basis, assess the potential for noise disturbance to nesting owls.

2) Breeding-season restrictions should be considered if noise levels are estimated to exceed 69 dBA (A-weighted noise level) (~80 dBO [owl-weighted noise level, Delaney et al. 1999b]) consistently (i.e., >twice/hour) or for an extended period of time (>1 hr) within 50 m (165 ft) of nesting sites (if known) or within entire PAC if nesting sites are not known.

3) If owls are not detected during approved-protocol surveys in a PAC during the breeding season, restrictions on noise disturbances can be relaxed depending on the nature and extent of the proposed disturbance.

k. Climate Change

Given mounting empirical evidence and model-based predictions for effects of climate change in the United States, a central dictum, under an uncertain future, is that no single management approach for intervention will fit all situations (Spittlehouse and Stewart 2003, Hobbs et al. 2006). A toolbox approach, from which various treatments and practices can be selected and combined to fit unique local settings, will be most useful (Millar et al. 2007). Our recommendations for addressing the effects of climate change on the owl are primarily based on the Intergovernmental Panel on Climate Change's *Climate Change and Biodiversity* technical paper (Gitay et al. 2002), Mawdsley et al. (2009) adaptation strategies for wildlife management, and the Millar et al. (2007) conceptual framework for managing forested ecosystems. Our recommendations include mitigation strategies (i.e., actions that reduce causes of stress) and adaptation strategies (i.e., actions that help forested ecosystems accommodate change). Our recommendations for climate change are consistent with all other guidelines and recommendations for the owl within this plan.

Mitigation Strategies

1) *Reduce Non-Climate Stressors*. Reduce or remove other non-climate stressors, including: scientific exploitation, noise disturbance, recreation disturbance, negative effects from grazing, and land development (see specific recommendations). Ameliorating non-climate stressors will provide the owl sufficient time to respond to local effects of climate change, including, for example, future range shifts or modifications in home range boundaries.

2) *Prioritize Forest Management*. Increased fire severity and incidence of stand replacing wildland fire, and extensive tree mortality as a result of insect and disease, are predicted to be primary sources of unintentional carbon emissions from forests in the western U.S. (Stephans et al. 2005). We support management strategies that will decrease release of carbon from forests and increase forest resistance to fire, drought, and disease. Priority-setting approaches (e.g.,

triage) will be necessary for rapidly changing conditions, for example, reducing the density of small trees (see our recommendations for thinning in PACs), increasing BA of large trees, and protecting old-growth stands following Table C.3.

Adaptation Strategies

1) *Promote Forest Resistance*. Resistance strategies forestall impacts and protect highly valued resources. Resistance practices are recommended because they have potential to improve forest defense against direct and indirect effects of rapid environmental changes. An obvious strategy to promote resistance that will benefit the owl would include reducing undesirable or extreme effects of fires, insects, and disease through active forest management (see our recommendations and guidelines regarding fire management, WUI, and insect and disease).

2) *Promote Forest Resilience*. Resilience strategies improve the capacity of ecosystems to return to desired conditions after disturbance. Promoting resilience is the most commonly suggested adaptive option discussed in a climate-change context. Resilient forests are those that not only accommodate gradual changes related to climate but tend to return toward a prior condition after disturbance either naturally or with management assistance. This strategy intentionally accommodates change rather than resisting it but has the goal of enabling or facilitating forest ecosystems to respond adaptively as environmental changes accrue. The strategic goal is to encourage gradual adaption and transition to inevitable change, and thereby to avoid rapid threshold or catastrophic conversion that may occur otherwise. One way to achieve resilience is to promote diverse age classes and species mixes both within-stand and across landscapes and reduce stressors to forest habitat (i.e., by thinning overstocked stands and restoring fire-adapted ecosystems). Treatments implemented should mimic, assist, or enable ongoing adaptive processes such as owl dispersal and range expansion, for example promoting connected landscapes and minimizing physical and biotic impediments to movements (see our recommendations for Recovery Areas).

3) *Anticipate Surprises*. Evidence is accumulating that species interactions and competitive responses under changing climates can be complex and unexpected. Abrupt invasions, changes in population dynamics, and long-distance movements of native and nonnative species are expected in response to changing climates. Managers should strive to anticipate events outside the range of conditions in recent history. For example, changes in barred owl distribution and abundance should be monitored for potential effects on spotted owls.

4) *Use Adaptive Management and Monitor.* Given long-term uncertainty, it is imperative to "learn-as-you-go," following an adaptive management strategy. Although general principles will hopefully emerge, the best preparation is for managers and planners to remain informed about emerging climate science as well as land-use changes in the Southwest, and to use that knowledge to shape effective management decisions for owl habitat. Following our General Management Recommendations, we recommend that vegetation manipulations be designed within an adaptive management framework. Rigorous monitoring systems will provide information that managers can use to adjust or modify objectives and activities. Long-term monitoring of owl site occupancy, extinction, and recolonization rates using appropriate designs will be imperative in light of climate change and evaluating efficacy of management objectives.

l. West Nile Virus

The Recovery Team does not currently view West Nile virus (WNV) as a threat to Mexican spotted owls, as the virus has never been detected in this subspecies to our knowledge. However, given the fact that the virus occurs within the range of the Mexican spotted owl and that spotted owls have shown vulnerability to it, we believe the following measures are prudent.

Guidelines

1) As suggested by Hull et al. (2010) in reference to their work on California spotted owls in the Sierra Nevada, estimating spotted owl survival rates and identifying causes of death would help determine whether WNV is a significant threat to the population. We recommend that well-distributed demographic studies be carried out and that populations exhibiting significant downward population trends, especially in absence of other identifiable causes, be investigated for the possibility of WNV-caused epizootics.

2) Similarly, if routine spotted owl surveillance indicates the disappearance of birds from a given area, the possibility of WNV should be investigated.

3) Local biologists should monitor reports of avian mortality on the Centers for Disease Control and Prevention (CDC) website (www.cdc.gov) as well as those of state and county health departments.

4) If any of the above situations lead to suspicion of a WNV epizootic, conduct surveillance for the disease using standard arbovirus surveillance techniques. The CDC website contains a wealth of information on this subject, and state and county public health agencies can also be of assistance.

5) Finally, although we do not recommend that spotted owls be captured and sampled specifically for WNV absent the exigent circumstances described above, biologists who become aware of spotted owl captures for other purposes should look into asking researchers to collect saliva swabs or other minimally invasive samples. If researchers are also collecting blood or other tissue samples, testing of those for WNV antibodies is advised. Again, state and county health departments can provide information on this process.