The number of known owl individuals and owl sites has increased since the MSO was listed as threatened in 1993. However, the FWS has cautioned that this increase in known individuals and sites does not reflect an increase in abundance or an upward population trend. Rather, the increase "is mainly a product of new surveys being completed within previously unsurveyed areas." *** 12RP vi.

Success of the Recovery Plan hinges on the commitment and coordination among the Mexican government, U.S. Federal and state land-management organizations, sovereign Indian nations, and the private sector to ensure that the proposed population and habitat monitoring are implemented. 12 RP vii.

Without careful and rigorous application of the proposed population monitoring, there would be no objective basis for delisting the owl. 12 RP vii.

Given that the owl is a widespread subspecies with a disjunct and somewhat fragmented distribution, management of the owl and its habitat must be conducted at the landscape scale. Landscape modeling and analysis are critical in evaluating the distribution of owls and habitats, identifying areas where threats are greatest, and then applying Recovery Plan recommendations in such a way as to sustain and improve owl habitat. 12RP viii.

As management proceeds, monitoring assesses the efficacy of management actions. Thus, it is critically important to monitor owl populations and habitat to determine whether both are stable or improving. Monitoring population trends provides a real-time assessment of the owl's status, whereas habitat monitoring allows us to predict if there will be adequate habitat to support a viable owl population in the future. 12RP p. ix.

The Recovery Plan sets forth recommendations for management and monitoring of the Mexican spotted owl and its habitat. Both are key to the eventual recovery of the owl as management proceeds within an adaptive framework whereby monitoring is used to assess the efficacy of management actions. 12RP p.3

The Recovery Plan promotes a landscape scale approach to implementing owl recovery actions. Landscape modeling and analysis are critical in evaluating the distribution of owls and habitats, identifying areas where threats are greatest, and then applying plan recommendations in such a way as to sustain and improve owl habitat. Pp.3-4

Juvenile Mexican spotted owls move through a wide variety of habitats during the dispersal period (Ganey and Block 2005b), and many of these habitats differ greatly from typical breeding habitat and have no formal protective measures under the 1995 Recovery Plan or this revision (i.e., they fall under the category of other forest and woodland types). P. 27

Low winter detection rates make it difficult to locate migratory or wintering areas, and thus, we are left with no rigorous methods to identify such areas for protection (Ganey and Block 2005a). The types of lowland areas in which wintering owls have been observed cover vast areas, and we presently have no evidence that suitable wintering areas are limiting. Nevertheless, this is a topic on which further research would be valuable. P. 27

Mexican spotted owl population trends remain unclear. P. 30

Because these owls are long-lived, population trend studies must be long-term (i.e., at least 10 years). P. 30.

Data on trends in populations or occupancy rates are few, and methods and sample sizes differ among studies, making comparisons difficult. However, **results from these study areas have all noted that the study populations have declined in the recent past** (Seamans et al. 1999, Stacey and Peery 2002, Gutiérrez et al. 2003). P. 30

Further, range-wide conclusions cannot be reliably inferred from the limited data available. P. 30.

[U]nderstanding how the owl responds to environmental variation is critical to its recovery. **Despite concerted efforts to understand the influence of environmental variation on owl vital rates, considerable uncertainty remains.** P. 30

We have learned a great deal about the Mexican spotted owl in the last decade, but significant information gaps remain. P. 31

Most studies of the owl have been descriptive rather than experimental. P. 31

Although we have identified patterns with respect to some aspects of the owl's ecology (e.g., habitat use), **cause and effect relationships have not been documented.** Much more information is needed on how specific factors alone and in combination affect change in Mexican spotted owl abundance. P. 31

[M]anagement recommendations in the near-term must deal with high levels of uncertainty. P. 31

Only two projects resulted in biological opinions that the proposed action would likely jeopardize the continued existence of the Mexican spotted owl: 1) implementation of the Region 3 Forest Plans without adopting the Recovery Plan (an action that was never implemented); p. 33

High-severity burns have the most negative long-term effects on spotted owl nest and roost habitats but could enhance foraging habitats used by owl prey species (e.g., woodrats or deer mice) (Franklin et al. 2000, Kyle and Block 2000). P. 35

They concluded that when relatively large wildland fires burned known nest and roost sites, the fires appeared to have a short-term effect on survival, site fidelity, mate fidelity, and reproductive success (see also Jenness et al. 2004). P. 36

Furthermore, within 1 km (0.6 mi) of the center of foraging areas, foraging owls selected all severities of burned forest and avoided unburned forest. Further, anecdotal evidence from Mexican spotted owl monitoring suggests that PACs burned with moderate-to-high fire severity continue to be occupied by reproductive owls (S. Hedwall, FWS, pers. obs.; J.P. Ward, Jr, FWS, pers. obs.). Conversely, owl surveys conducted two years post-wildland fire in some previously occupied, but severely burned areas (e.g., within some areas of the Rodeo-Chedeski Fire on the Mogollon Rim in Arizona), failed to locate Mexican spotted owls (S. Hedwall, FWS, pes. comm.). P. 36

However, despite the variability of fire effects and existing gaps in knowledge regarding short- and long-term effects on habitat and owl responses to wildland fire, we believe that stand-replacing crown fires pose a threat to Mexican spotted owls. P. 36-37

The effects of different severities of wildland fire (Question 4 above) on Mexican spotted owls are still poorly understood. P. 99

Although a variety of threats may affect owls within the WUI, our focus is on the effects of intensive fuels reduction treatments on the owl and its habitat. Fuels reduction treatments in the WUI typically aim to reduce tree BA to 30 to 60 sq. ft/ac and change forest structure (e.g., reduce canopy cover by 35 to 75%) to significantly modify fire behavior (USDA, USDI 2001). P. 37

On the Lincoln National Forest in New Mexico forest personnel conducted an assessment of fuels treatments needed to ensure community protection, firefighter safety, and ecological functionality in the WUI. The Lincoln National Forest Capability Assessment evaluated several options, including intensive treatments applied across essentially the entire forest landscape (because most all of the Lincoln National Forest is considered to be WUI), including owl nest stands. This approach could involve significant risk to the Mexican spotted owl population in the Sacramento Mountains. This owl population comprises the bulk of the population in the BRE EMU (Ward et al. 1995). The BRE EMU appears to receive little if any immigration from other populations (Barrowclough et al. 1999), but it may serve as a source population for smaller populations within the region. Thus, implementation of this approach to fuels reduction in the WUI could seriously endanger owls within this EMU. P. 38

Although we lack direct information relating livestock grazing to spotted owls, we can draw inferences based various pieces of information. P. 42

Seamans et al. (1999) estimated that two populations within the conifer forests of the UGM EMU (formerly RU) were declining at roughly 10% per year, but the causes of the declines were unknown. P. 62

many owls continue to occupy burned areas, at least in the short term (summarized in Appendix B), p. 73

Unfortunately, empirical data on the effects of thinning and other mechanical forest treatments on Mexican spotted owls are nonexistent, and empirical data on effects of forest treatments on other subspecies of spotted owls (summarized in Appendix B) are sparse and difficult to interpret. Understanding how these treatments affect Mexican spotted owls is one of the major questions faced in integrating recovering this owl with plans for restoring southwestern forests. Although this has been clearly noted for years (e.g., USDI FWS 1995, Beier and Maschinski 2003, Ganey et al. 2011), no studies on this topic have been funded to date. Consequently, we can only extrapolate from the sparse data available on this topic resulting from studies of other subspecies of spotted owls. Collectively, these studies suggest that at least some kinds of mechanical forest treatments may negatively affect spotted owls. No clear guidance emerges from these studies relative to types, extents, or spatial arrangement of treatment that might minimize effects to owls. Such information is needed if management is to proceed in owl habitat. Lacking such information, managers should proceed cautiously in terms of treatment intensity and extent. That is, initial treatments should be limited in spatial extent and treatment intensity, and should be aimed at balancing reduced fire risk with maintaining the mature forest structure that seems to be favored by spotted owls. Treatments in owl habitat should be linked to rigorous monitoring of owl response, to allow us to evaluate the effects of different types and extents of treatments in an adaptive management context (see Box C.6 for details on how such monitoring might be structured). **The Recovery Team recommends mechanical treatment in PACs only if such monitoring occurs**. P. 73

In USDI FWS (1995), we advocated a population monitoring scheme based on mark-recapture sampling. That design would provide rigorous demographic data on spotted owls as well as estimates of population trend. However, a pilot study conducted to evaluate those methods identified several potential problems. These included high cost and difficulty in finding sufficient numbers of highly qualified field workers. Perhaps more importantly, the mark-recapture approach required capture and banding of large numbers of owls. Although capture techniques for spotted owls are relatively safe, they are not risk-free. Further, many captures likely would be carried out by seasonal field crews, and many of these individuals likely would be inexperienced. As a result, the risk of injury to owls was deemed unacceptable. P. 93

Consequently, we propose a monitoring program based on occupancy monitoring. Such a program will not provide the detailed demographic data that mark-recapture sampling would provide, but it should be safer and cheaper to implement while still providing valid population trend estimates. P. 93

We assume that occupancy rate provides a valid index of population size, although the exact relationship between abundance and occupancy rate remains unknown (Royle and Nichols 2003). Presumably, however, monitoring site-occupancy rates will allow detection of important changes in the owl population. P. 95

Accurate and efficient protocols for monitoring owl occupancy will require pilot studies to estimate occupancy rates and detection probabilities and their statistical variances. These estimates then can be used to determine variables such as the number of plots required and number of call points required per plot, and to evaluate tradeoffs between greater numbers of visits per plot versus increasing spatial replication by sampling more plots fewer times. Given sample data, all of these factors can be optimized to design a monitoring program that will most efficiently satisfy the quantitative targets in the delisting criterion for population monitoring. P. 96

Despite the considerable interest in and research on the ecology of the Mexican spotted owl, much remains unknown, particularly in Mexico. P. 97

We are assuming that the existing owl population is adequate in numbers and distribution to maintain the viability of the species (see Part III.D. Objective and Measurable Recovery Criteria, to explain this assumption) P. 93

Empirical data on the effects of thinning and other mechanical forest treatments on Mexican spotted owls are nonexistent. This is unfortunate, because thinning and other mechanical forest treatments are emphasized heavily in plans for landscape-restoration of southwestern forests (e.g., USDA FS 2011), and these activities could affect large areas of Mexican spotted owl habitat. Consequently, understanding how these treatments affect Mexican spotted owls is one of the major questions faced in integrating recovering this owl with plans for restoring southwestern forests. **Although this has been clearly noted for years (e.g., USDI FWS 1995, Beier and Maschinski 2003, Ganey et al. 2011), no studies on this topic have been funded to date.** Consequently, we can only extrapolate from the sparse data available on this topic resulting from studies of other subspecies of spotted owls, which we summarize below. P. 204

Knowing how and why populations change over time is a fundamental requisite for forecasting and developing strategies for species recovery. P. 213

Only a single study (Seamans et al. 1999, updated in Gutiérrez et al. 2003) has been conducted long and effectively enough to quantify trends in Mexican spotted owl abundance and population change.
Based on estimates of vital rates and a Leslie stage-projection matrix model, Seamans et al. (1999) reported declining populations for two study areas in Arizona and New Mexico. P. 215

In the Arizona study area, mean λ(0.995, 95% confidence interval = 0.836–1.155) indicated a stable population (i.e., $\lambda \approx 1$) over this period. In contrast, the population of Mexican spotted owls from the New Mexico study area appeared to be declining (i.e., $\lambda < 1$) by approximately 6% per year during this period (mean $\lambda = 0.937$, 95% confidence interval = 0.895–0.979). P. 215

They estimated that the owl populations remaining in their Arizona and New Mexico study areas in the year 2000 were 69.1 and 60.8% as large, respectively, as the 1993 populations. In other words, they estimated declines of >30% in both populations from 1993 (the first year in which they could estimate λ) to 2000. P. 215

Stacey and Peery (2002, see also Stacey 2010: Table 35.1) also reported declining trends in owl populations in the Black Range and Zuni, San Mateo, and Magdalena Mountains, New Mexico, based on data from 1991 to 1999. Declining trends were evident in all ranges studied, as well as when populations from these ranges were combined for an overall analysis (overall $\lambda = 0.803$, 95% confidence interval = 0.73 to 0.89). Populations in the Zuni and Magdalena Mountains apparently declined to zero during the study. P. 215

local extirpations occurred in the Sandia and Manzano Mountains, and possibly in the Datil and LaDronnes Mountains, New Mexico. Seamans and Gutiérrez (2006; see also Seamans and Gutiérrez 2007 for effect of mates on breeding dispersal) p. 215

Lavier's (2006) study showed a dynamic but generally stable or slightly declining pattern of site occupancy by territorial owl-pairs in the Sacramento Mountains from 1989 to 2004. Estimated site occupancy by pairs in this population ranged from a high of 85.4% (SE = 0.03%) in 1992 to a low of 54.4% (SE = 0.05%) in 2000. Site occupancy was estimated at 71.0% (SE = 0.05) in 2004, the last year of the study. P. 216

Numerous additional xeric sites located in Capitol Reef and the Paria River that were occupied during the 1990s (Willey 1998, 2007) were no longer occupied during surveys conducted during 2007 and 2008, suggesting that populations in xeric locations may have declined in southern Utah. P. 216

In summary, data on trends in populations or occupancy rates are sparse, and methods and sample sizes differ among studies, making comparisons difficult. In general, however, results suggest that most populations of Mexican spotted owls studied either have declined in the recent past or are still declining. Further, some evidence suggests that owls may be slow to re-colonize areas where such declines have occurred (Seamans and Gutiérrez 2006, Stacey 2010, Willey and Willey 2010). P. 217

The ability of Mexican spotted owls to move within and among habitats or across a landscape is a key factor for assessing function and viability of populations over time. For example, small populations often require recruitment from larger (core) populations to persist for long periods. Understanding how frequently and under what conditions owls are successful in completing movements can allow better predictions about long-term or local viability. Knowledge for mobile organisms like Mexican spotted owls is often difficult to obtain, however, and details about conditions that allow for successful dispersal or explanations for periodic migrations are limited. Nonetheless, a few studies have documented movements of this owl. This section summarizes existing knowledge about movement patterns of the owl and the processes that influence its movements. P. 238

Also presently unknown is how and why migrating owls select particular wintering areas, as we have little information on specific habitat features that migrating Mexican spotted owls use in wintering areas (but see Peterson 2003). Further, owls use these areas at a time of year when they are unlikely to vocalize (Ganey 1990), making it difficult to locate such areas through calling surveys. From a conservation perspective, some migrating owls occupy cover types that have no protected status under the original recovery plan for the Mexican spotted owl (USDI FWS 1995) or this revised Recovery Plan. P. 239

Natal dispersers move through a wide variety of habitats during the dispersal period, many of which differ greatly from typical breeding habitat and have no formal protective measures under USDI FWS (1995; see also Ganey and Block 2005a) or this revised Recovery Plan. There is little evidence from study of movements that would allow us to identify common dispersal directions, movement corridors, or important areas or habitats. Many Mexican spotted owls appear to occupy territories at one to two years of age, while others may settle when older. Some of this variation may be driven by trends in owl density and fecundity, manifested through trends in numbers of territory vacancies. **In general, however, we know little about dispersal behavior, and especially about dispersal movements of Mexican spotted owls during and**

following their second summer of life. P. 244

At this scale, the landscape consists of a set of large, more-or-less discrete habitat clusters. For example, most of the Mogollon Rim functions as a single cluster, the SRM as another single cluster, and so on. This suggests that owls could successfully disperse within habitat clusters with very high probability and disperse between clusters with much lower probability. Thus, we would expect owls to disperse within clusters most of the time and between clusters rarely, which is consistent with the definition of a metapopulation. This finding suggests that habitat connectivity should be maintained (or increased) across the owl's range. Habitat connectivity buffers a population from stochastic variability through time by providing the opportunity for local population failures to be "rescued" by immigration from other populations, and it also facilitates gene flow among populations (Barrowclough et al. 2006). P. 245

In summary, the distribution of Mexican spotted owls throughout their range suggests a spatial distribution congruent with a group of subpopulations that may function as a metapopulation. The UGM EMU includes the largest contiguous area of habitat for Mexican spotted owls, which is reflected in the large number of documented owls in that EMU (e.g., Ganey et al. 2004, see also Table B.1). Because of its size and central location to other areas inhabited by Mexican spotted owls, the larger subpopulation in this EMU likely serves as a core, source population for supplying new recruits to proximal outlying locations. Other subpopulations, particularly those occurring in the BRE, appear isolated enough that recruitment must come primarily from reproduction within the local subpopulation. Limited evidence from simulation models and genetic analysis supports these aspects of metapopulation function and spatially structured population dynamics. P. 247

More information is needed to identify the magnitude of numerical exchange of individuals among subpopulations and the relative influence on local, EMU-wide, and rangewide population viability. P. 247

In addition, because of its disjunct distributional pattern, dispersal among subpopulations of Mexican spotted owls is an important consideration. Thus, habitat management plans may need to consider not only areas occupied by owls but also intervening areas, even where such areas are very different in habitat structure from those typically occupied by Mexican spotted owls. P. 248

We have learned a great deal about the Mexican spotted owl in the last three decades, but significant information gaps still remain. Most studies of the owl to date have been descriptive rather than experimental. Although we have identified patterns with respect to some aspects of this owl's ecology (e.g. habitat use), cause and effect relationships have not been documented. Much more information is needed on how specific factors alone and in combination affect change in Mexican spotted owl abundance. These considerations suggest that much additional research is needed, and that management recommendations in the near term must deal with extremely high levels of uncertainty. P. 248

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. P. 262

Although we support the idea of estimating population size directly and collecting associated demographic data as described in USDI FWS (1995), the results of the pilot study suggest that the costs for such a monitoring program are daunting. Therefore, we propose this alternative monitoring program based on monitoring occupancy rates as an index of population size. P. 324

Unfortunately, for logistic reasons we describe above, this revision of the Recovery Plan shifts from direct monitoring of population size to monitoring site occupancy. This modification in monitoring approach reduces our ability to detect impacts of management on owl populations because occupancy is not as sensitive a measure of the response of the owl population to manipulations as is the measurement of population change. P. 333

***adaptive management* –** A deliberate and iterative process to optimize management strategies. The process entails formation of a management model, management implementation, monitoring and interpretation of system responses, and ultimately refinement of management model given lessons learned. P. 379