MEXICAN SPOTTED OWL RECOVERY PLAN,
FIRST REVISION
(Strix occidentalis lucida)

Original Approval Date: October 16, 1995

Southwest Region
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

September 2012

Approved

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Regional Director, Region 2
U.S. Fish and Wildlife Service
RECOVERY PLAN FOR THE MEXICAN SPOTTED OWL, FIRST REVISION
(Strix occidentalis lucida)

Prepared by:
Mexican Spotted Owl Recovery Team

Prepared for:
Region 2, Southwest Region
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

Original Approval Date: October 16, 1995
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DISCLAIMER

The Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 et seq.), requires the development of recovery plans for listed species, unless such a plan would not promote the conservation of a particular species. In accordance with Section 4(f)(1) of the Act and to the maximum extent practicable, recovery plans delineate actions that the best available science indicates are required to recover and protect listed species. Recovery plans are published by the U.S. Fish and Wildlife Service (FWS), and are sometimes prepared with the assistance of recovery teams, contractors, state agencies, and others. Objectives will be attained and any necessary funds made available subject to budgetary and other constraints affecting the parties involved, as well as the need to address other priorities. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Recovery plans do not necessarily represent the views or the official positions or approval of any individuals or agencies involved in the plan formulation, other than the FWS. They represent the official position of FWS only after they have been signed by the Regional Director. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions. Please check for updates or revisions at www.fws.gov/southwest/es/arizona before using.

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Recovery Unit Working Teams: Since publication of the 1995 Mexican Spotted Owl Recovery Plan, Working Teams representing each of the 6 U.S. Ecological Management Units (EMUs; formerly referred to as Recovery Units) have been instrumental in transferring the spirit and intent of the plan to land managers, noting parts of the plan that were difficult to implement, and reviewing earlier drafts of this revision. Their assistance and feedback has been invaluable. Members of Working Teams are too numerous to list, but we acknowledge each and every one and are grateful for their contributions.

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EXECUTIVE SUMMARY

Current Species’ Status: In 1993 the U.S. Fish and Wildlife Service (FWS) listed the Mexican spotted owl (Strix occidentalis lucida; “owl”) as threatened under the Endangered Species Act (ESA). Critical habitat for the Mexican spotted owl was designated in 2004, comprising approximately 3.5 million hectares (ha) (8.6 million acres [ac]) on Federal lands in Arizona, Colorado, New Mexico, and Utah (69 FR 53182). Within the critical habitat boundaries, critical habitat includes protected and restricted habitats as defined in the original Mexican Spotted Owl Recovery Plan, completed in 1995. The species’ recovery priority number is 9C, pursuant to the Endangered and Threatened Species Listing and Recovery Priority Guidelines (48 FR 43098). The Mexican spotted owl meets the species recovery priority 9C category due to its moderate degree of threat, high recovery potential, taxonomic classification as a subspecies, and conflict with construction or other economic activities. Surveys since the 1995 Recovery Plan have increased our knowledge of owl distribution but not necessarily of owl abundance. An owl site is an area with a high probability of being used by a single or a pair of adult or subadult owls for nesting, roosting, or foraging. For the current revision, the Recovery Team compiled over 1,300 owl sites known today in the U.S. portion of the owl’s range (Table II.1; Table B.1 in Appendix B). The increase in the number of owl sites is mainly a product of new surveys being completed within previously unsurveyed areas (e.g., several National Parks within southern Utah, Grand Canyon in Arizona, Guadalupe National Park in West Texas, Guadalupe Mountains in southeastern New Mexico and West Texas, Dinosaur National Monument in Colorado, and Cibola National Forest in New Mexico), with only a few additions to numbers of sites recorded for previously well-surveyed National Forests. Thus, an increase in abundance cannot be inferred from these data.

Habitat Requirements and Limiting Factors: Two primary reasons were cited for the original listing of the Mexican spotted owl in 1993: historical alteration of its habitat as the result of timber-management practices; and, the threat of these practices continuing as evidenced in existing national forest plans. The danger of stand-replacing wildland fire was also cited as a threat at that time. Since publication of the 1995 Recovery Plan, we have acquired new information on the biology, threats, and habitat needs of the spotted owl. The primary threats to its population in the U.S. (but likely not in Mexico) have transitioned from timber harvest to an increased risk of stand-replacing wildland fire. Recent forest management now emphasizes sustainable ecological function and a return toward pre-settlement fire regimes, both of which are more compatible with maintenance of spotted owl habitat conditions than the even-aged management regime practiced at the time of listing. Conversely, southwestern forests have experienced larger and more severe wildland fires from 1995 to the present than previous to 1995. Climate variability combined with current forest conditions may also synergistically result in increased loss of habitat from fire. The intensification of natural drought cycles and the ensuing stress placed upon forested habitats could result in even larger and more severe wildland fires in owl habitat.

Within the Forest Service’s Region 3, Southwest Region (Arizona and New Mexico), National Forest Plans were amended in 1996 to incorporate management recommendations presented in the 1995 Recovery Plan for the Mexican spotted owl. Since the Recovery Plan was published, our knowledge has increased. Given these changes and new information, it became timely to
revisit and revise the 1995 Recovery Plan. The recommendations contained within this revised Recovery Plan supersede those provided in the 1995 Recovery Plan.

**Recovery Strategy:** This Recovery Plan presents realistic and attainable goals for recovering the owl and its ultimate delisting, involving forest habitat management and vigilant monitoring. The goals are flexible in that they allow local land managers to make site-specific decisions. To accomplish the recovery of the Mexican spotted owl, the recovery strategy has five key elements designed to conserve the subspecies throughout its range: 1) protecting existing populations; 2) managing for habitat into the future; 3) managing threats; 4) monitoring population and habitat; and, 5) building partnerships to facilitate recovery.

**Recovery Goal:** The ultimate goal of the Recovery Plan is to recover owl populations to the point that the owl can be removed from the Federal list of endangered and threatened species. 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. Without careful and rigorous application of the proposed population monitoring, there would be no objective basis for delisting the owl. Under the proposed recovery criteria, the owl could be delisted within 10 years of implementing the revised Recovery Plan, though we acknowledge that this is an ambitious goal.

**Recovery Objectives:** To support the Mexican spotted owl throughout its range into the foreseeable future, and to maintain habitat conditions necessary to provide roosting and nesting habitat for the Mexican spotted owl.

**Recovery Criteria:** Two criteria (addressing Listing Factors A, C, and E) must be met before the Mexican spotted owl can be delisted:

1. **Owl occupancy rates must show a stable or increasing trend after 10 years of monitoring.** The study design to verify this criterion must have a power of 90% (Type II error rate $\beta = 0.10$) to detect a 25% decline in occupancy rate over the 10-year period with a Type I error rate ($\alpha$) of 0.10. The monitoring approach recommended in Part V.B and in Appendix E describes a framework for accomplishing these study objectives.

2. **Indicators of habitat conditions (key habitat variables) are stable or improving for 10 years in roosting and nesting habitat** (for key habitat variables, see Table C.2 or C.3 in Appendix C). Habitat monitoring should be conducted concurrently with owl occupancy monitoring. Trends in all key habitat variables must be shown stable or increasing with a power of 90% (Type II error rate $\beta = 0.10$) to detect a 25% decline over the 10-year period with a Type I error rate ($\alpha$) of 0.10.

To delist the owl, we recommend both criteria be met. Once the two criteria have been met, we would then review the regulations and known distribution of Mexican spotted owls to determine if the delisting process should proceed. At this time, we cannot describe the future desired distribution of owls across their range. For example, changes in the species’ range may occur due to factors such as climate change which could result in shifts in the owl population to the
northern portion of its range. In addition, anthropogenic and non-anthropogenic threats to the Mexican spotted owl must be sufficiently moderated and/or regulated for the foreseeable future, as evidenced by the best scientific information available. The best scientific information is derived from research, management experiments, and monitoring conducted at the appropriate scales and intensity. An analysis of the five ESA listing factors must be conducted to verify that threat levels are acceptable for likely persistence of owl populations into the future.

**Actions Needed:** Actions required to ensure the recovery of the Mexican spotted owl include:

1. **Management.** 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. Three levels of management are recommended in this Recovery Plan:

   - **Protected Activity Centers (PACs).** PACs encompass a minimum of 600 acres surrounding known owl nest/roost sites. Management recommendations are most conservative within PACs, but by no means advocate a “hands-off” approach. The Recovery Team recognizes situations exist where management is needed to sustain or enhance desired conditions for the owl, including fire-risk reduction, as well as monitoring owl response. Mechanical treatments in some PACs may be needed to achieve these objectives; determining which PACs may benefit from mechanical treatments requires a landscape analysis to determine where the needs of fire risk reduction and habitat enhancement are greatest. PACs are the only form of protected habitat included in this revised Plan.

   - **Recovery habitat.** This habitat is primarily ponderosa pine-Gambel oak, mixed-conifer, and riparian forest that either currently is, or has the potential for becoming, nest/roost habitat or does or could provide foraging, dispersal, or wintering habitats. Nesting/roosting habitat typically occurs either in well-structured forests with high canopy cover, large trees, and other late seral characteristics, or in steep and narrow rocky canyons formed by parallel cliffs with numerous caves and/or ledges within specific geologic formations. Ten to 25 percent of forested recovery habitat should be managed as recovery nest/roost habitat varying by forest type and Ecological Management Unit (EMU) (formerly called Recovery Units). This habitat should be managed to replace nest/roost habitat lost due to disturbance (e.g., fire) or senescence and to provide additional nest/roost habitat to facilitate recovery of the owl. The remainder of forested recovery habitat should be managed for other needs (such as foraging, dispersing, or wintering) provided that key habitat elements are retained across the landscape.

   - **Other forest and woodland types,** such as ponderosa pine forest, spruce-fir forest, and pinyon-juniper woodland. No specific management is suggested for these habitat types, recognizing that current emphasis for sustainable and resilient forests should be compatible with needs of the owl.
2. Monitoring. 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. As a surrogate for evaluating trends in actual owl numbers, owl occupancy will be monitored at a sample of fixed sites randomly selected throughout the U.S. range of the Mexican spotted owl. We also recommend that Mexico undertake a monitoring effort consistent with the one recommended for the U.S. No specific design is proposed for monitoring habitat, although Forest Inventory and Assessment data might have application to the owl. Combining owl occupancy and habitat monitoring provides an opportunity to examine relationships between habitat features and owl populations to assess whether a review of current management is warranted.

3. Research. The Recovery Team used available data, published papers, unpublished reports, and scientific expertise covering the U.S. and Mexico when developing the Recovery Plan. During the process, it became clear that critical knowledge gaps exist. Four general areas require additional research: 1) habitat relationships, 2) biological interactions, 3) population structure, and 4) ecosystem structure. Under each of these subjects, the Recovery Team has provided specific research recommendations. This research would increase our understanding of the effects of the Recovery Plan management recommendations on the owl and ecosystem composition, structure, and function.

4. Implementation. An implementation schedule is provided that details recovery tasks, the entities responsible for implementing them, and the estimated costs. The Recovery Team recommends that a working team be assembled for each EMU to oversee implementation and to provide feedback on successes and failures of the Recovery Plan.

Estimated Date and Cost to Recovery:

Estimated date: 2022

Total Cost of Recovery (minimum): $42,628,000

Costs, in thousands of dollars:

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Date of Recovery: The date of recovery for the Mexican spotted owl is estimated at 2022 if actions delineated in this recovery plan are implemented.
RESUMEN EJECUTIVO

Estado actual de la especie: En 1993, el Servicio de Pesca y Vida Silvestre de los Estados Unidos (FWS, por sus siglas en inglés) incluyó al búho moteado mexicano en la categoría de amenazado en el Acta de Especies Amenazadas (ESA, por sus siglas en inglés). En 2004 se designaron aproximadamente 3.5 millones de hectáreas (8.6 millones de acres) de hábitat crítico para la especie en terrenos federales en Arizona, Colorado, Nuevo México y Utah (69 FR 53182). Dentro de sus límites, cada hábitat crítico sólo incluye hábitats protegidos y restringidos definidos en el Plan de Recuperación del Búho Moteado Mexicano, concluido en 1995. El número de prioridad de recuperación de la especie es 9C, de acuerdo a las Directrices para Enlistado y Priorización de la Recuperación de Especies En Peligro y Amenazadas (48 FR 43098). El búho moteado mexicano tiene la categoría de prioridad de recuperación 9C debido al grado moderado de sus amenazas, su alto potencial de recuperación, su clasificación taxonómica como subespecie, y su conflicto con la construcción y otras actividades productivas. Estudios elaborados a partir de la elaboración del Plan de Recuperación en 1995 han incrementado nuestro conocimiento sobre la distribución del búho, aunque no necesariamente sobre su abundancia. Un sitio con presencia de búhos es un área usada repetidamente para anidamiento, perchado o forrajeo por un individuo o una pareja de búhos (Recuadro 1). Para esta revisión, el Equipo de Recuperación compiló información sobre 1,301 sitios con presencia de búhos registrados a la fecha en la porción estadounidense del rango de distribución de esta especie (Tabla II.1; Tabla B.1 en el Apéndice B). Este incremento se debe principalmente a los resultados de información generada en áreas no estudiadas previamente (parques nacionales en el sur de Utah, el Gran Cañón en Arizona, Parque Nacional Guadalupe y Montañas de Guadalupe en el sureste de Nuevo México y el oeste de Texas, el Monumento Nacional del Dinosaurio en Colorado, y el Bosque Nacional de Cibola en Nuevo México), que resultó en la adición de pocos sitios nuevos a los registrados previamente en los bosques nacionales. Por esta razón, no es posible inferir incrementos en la abundancia a partir de estos datos.

Requisitos de hábitat y factores limitantes: Las dos razones principales para incluir al búho moteado mexicano en la lista de especies amenazadas en 1993 fueron: alteración histórica de su hábitat como resultado de las prácticas de manejo para producción de madera y la amenaza continua de estas prácticas presentes en los planes de manejo existentes para los bosques nacionales. El riesgo de incendios catastróficos fue citado como una amenaza en aquel momento. A partir de la publicación de Plan de Recuperación de 1995, se ha obtenido nueva información sobre la biología, amenazas y requerimientos de hábitat del búho moteado. Las principales amenazas a las poblaciones en Estados Unidos (pero aparentemente no en México) han cambiado al aprovechamiento forestal al incremento del riesgo de incendios moteado catastróficos. El reciente manejo forestal ahora enfatiza la función ecológica sustentable, y un regreso a los regímenes de fuegos previos a los asentamientos, en ambos casos son más compatibles con el mantenimiento de las condiciones de hábitat de la especie que el régimen de manejo practicado en el momento en que se enlistó. Desde 1995 hasta la actualidad los bosques del suroeste de los Estados Unidos han experimentado incendios catastróficos más grandes y severos que aquéllos registrados en el pasado. La variación climática combinada con condiciones no saludables del bosque pueden sinérgicamente resultar en un aumento de efectos negativos en el hábitat debido a incendios. La intensificación de ciclos de sequía naturales y el estrés resultante en el hábitat de bosque densos podría resultar en incendios aún más grandes y
severos en hábitat del búho.


Estrategia de Recuperación: Este Plan de Recuperación presenta metas realistas y obtenibles para la recuperación del búho y su retiro de la lista de especies en peligro de extinción, a través del manejo del hábitat forestal y el monitoreo continuo. Las metas son flexibles, ya que permiten que los manejadores locales tomen decisiones específicas a nivel de sitio. Para realizar la recuperación del búho moteado mexicano, la estrategia de recuperación tiene cinco elementos claves diseñados para conservar la especie en todo su rango de distribución: 1) proteger poblaciones existentes, 2) manejo por el hábitat en el futuro, 3) manejo de amenazas, 4) de poblaciones y hábitat, y 5) construyendo alianzas para facilitar recuperación.

Meta de Recuperación: La meta final del Plan de Recuperación es que las poblaciones de búho sean sostenibles al punto de que la subespecie pueda ser removida de la lista de especies amenazadas y en peligro de extinción.

Sin embargo, el éxito del plan, depende del compromiso y la coordinación entre el gobierno de México, las agencias de manejo de tierras federales y estatales en los EEUU, las naciones indígenas soberanas, y el sector privado. De acuerdo con los criterios de recuperación propuestos en el Pan, el Búho podría ser removido del Acta de Especies Amenazadas, en un periodo de diez años a partir de la implementación de este Plan de Recuperación revisado, aunque se considera una meta ambiciosa.

Objetivos de Recuperación: Apoyar la conservación del búho moteado mexicano a través de su rango de distribución en un futuro predecible, y mantener las condiciones de hábitat necesarias para proporcionar hábitat de perchado y anidamiento a la especie.

Criterios de Recuperación: Para remover al búho moteado mexicano de la lista de especies en peligro de extinción deben de cumplirse dos criterios (relacionados con los Criterios de Enlistado A, C y E):

1. Las tasas de ocupación de los búhos deben de mostrar una tendencia estable o incremento después de 10 años. El diseño de los estudios para verificar este criterio debe de tener una confiabilidad de 90% (tasa de error Tipo II ó (β = 0.10) para detectar una declinación de 25% en la ocupación con una tasa de error Tipo I (α) de 0.10. El enfoque del monitoreo recomendado en la Parte V.2 y el Apéndice F describe un marco de trabajo para alcanzar los objetivos de estos estudios.

2. Los indicadores de las condiciones de hábitat (variables clave de hábitat) son estables y mejorando por 10 años en el hábitat de perchado y anidamiento (por las variables clave
de hábitat ver Tabla C.2 o C.3 el Apéndice C). El monitoreo de hábitat deberá llevarse a cabo de forma simultánea con el monitoreo de ocupación de hábitat del búho. Las tendencias de todas las variables clave de hábitat deberán de tener valores estables o incrementar con una confiabilidad del 90% (tasa de error Tipo II β = 0.10) para detectar una declinación de 25% con una tasa de error Tipo I (α) de 0.10.

Para remover el búho de la lista de especies amenazadas y en peligro de extinción, recomendamos que se cumpla con ambos criterios. Al cumplirse los dos criterios, revisaríamos los reglamentos y la distribución conocida del búho moteado mexicano para determinar si la remoción debe proceder. En este momento no podemos describir la futura deseada distribución del búho a través de su rango. Por ejemplo, cambios en la distribución de la especie podrán ocurrir debido a factores como el cambio climático, el cual podría resultar en un desplazamiento en la población del búho hacia la parte norte de su rango. Además, las amenazas para la especie, antropogénicas y no antropogénicas, deberán de ser moderadas o reguladas lo suficiente en el futuro inmediato con base en mejor información científica disponible. Esta información científica deriva de experimentos de investigación, experimentos de manejo y monitoreo conducido a escalas e intensidades adecuadas. Se deberá llevar a cabo un análisis de los cinco factores de la inclusión en el listado de especies amenazadas, para verificar que los niveles de amenaza son aceptables para incrementar la probabilidad de persistencia en el futuro de las poblaciones de búhos moteados mexicanos.

Acciones necesarias: Las acciones requeridas para asegurar la recuperación del búho moteado mexicano incluyen:

1. **Manejo.** Dado que el búho es una especie generalista con una distribución dispersa y algo fragmentada, su manejo debe de tener un enfoque de paisaje. Los modelos y análisis de paisaje son críticos para la evaluación de la distribución del búho y su hábitat, identificando áreas en las que las amenazas son mayores, utilizando las recomendaciones del plan de forma que se mantenga y mejore el hábitat del búho. Tres niveles de manejo son recomendados en el Plan de Recuperación:

- **Centros de Actividades de Protección (PACs, por sus siglas en inglés).** Estos cubren aproximadamente 600 acres alrededor de sitios con presencia de búhos. Las medidas de manejo son en su mayoría conservadoras, lo cual no significa avocarse a una aproximación “manos fuera”. El Equipo de Recuperación reconoce que existen situaciones en las que es necesario desarrollar actividades de manejo para mantener o mejorar las condiciones deseadas para el búho, incluyendo la reducción del riesgo de incendios, y el monitoreo de la respuesta del búho. Tratamientos mecánicos pueden ser requeridos en algunos PAC’s para lograr estos objetivos; para determinar cuáles PAC’s pueden beneficiarse de estos tratamientos, se requiere efectuar un análisis del paisaje que identifique las zonas donde más se requiere reducción de riesgo de incendios y mejoramiento de hábitat. PACs son el único tipo de hábitat protegido que se incluye en este Plan revisado.

- **Hábitat de recuperación.** Estos son principalmente bosques de pino Ponderosa-encino de Gambel, coníferas mixtas y bosques riparios que tienen potencial para convertirse en...
hábitat de anidamiento y perchado o para proporcionar hábitat de forrajeo, dispersión o hibernación. Hábitat de anidamiento y perchado usualmente ocurre en bosques bien estructurados con una copa alta, árboles grandes, y otras características de sucesiones tardías, o en cañones rocosas muy inclinadas y angostas formados por acantilados paralelos con varias cuevas y/o salientes dentro de formaciones geológicas muy específicas. De un 10 a 25% del hábitat de bosque de recuperación deberá de ser manejado como reemplazo del hábitat de anidación y perchado, con variaciones de acuerdo al tipo de bosque y la Unidad Ecológica de Manejo (EMU, por sus siglas en inglés). Este hábitat debe de ser manejado como si fuese un remplazo del hábitat de anidación y percha perdido debido a la perturbación (e.g. por incendios) o a su antigüedad y con el fin de proveer hábitat de anidación y percha adicional, facilitando así la recuperación del búho moteado. El remanente de hábitat del bosque recuperado puede manejarse para otras necesidades, siempre y cuando se mantengan elementos clave del hábitat a lo largo del paisaje.

- Otros tipos de bosque y vegetación forestal, como bosque de pino ponderosa, picea-abeto y pino piñonero-junípero. No existen recomendaciones específicas para estos tipos de bosque, reconociendo que el énfasis actual para la restauración ecológica debe de ser compatible con las necesidades de los búhos.

2. **Monitoreo.** A medida que se avanza en el manejo, el monitoreo permite evaluar la eficacia de las acciones. El monitoreo del estado de las poblaciones de búhos y su hábitat es crítico para determinar si éstas son estables o mejoran. El monitoreo del estado de la población proporciona una evaluación en tiempo real de la situación del búho, mientras que el monitoreo del hábitat permite determinar a futuro, si habrá hábitat adecuado para mantener poblaciones viables de búhos. Para sustituir la evaluación de tendencias a través de cifras reales de las poblaciones de búhos, su ocupación será monitoreada a través de una muestra de sitios fijos seleccionados aleatoriamente a lo largo del rango de distribución del búho en los Estados Unidos. También recomendamos que México inicie un esfuerzo de monitoreo consistente con el recomendado en los Estados Unidos. No se proporciona un diseño específico para el monitoreo de hábitat, aunque los datos de la Evaluación e Inventario Forestal podrá tener aplicaciones para búho. La combinación de los modelos de ocupación del búho y el monitoreo de su hábitat proporciona una oportunidad para examinar relaciones entre las características del hábitat y las poblaciones de la especie para indicar si se justifica la revisión del manejo actual.

3. **Investigación.** El Equipo de Recuperación utilizó los datos disponibles, artículos científicos publicados, reportes no publicados e información de expertos científicos en los Estados Unidos y México para el desarrollo del Plan de Recuperación. Durante el proceso, se determinó que existen vacíos críticos de conocimiento. Cuatro áreas generales que requieren investigación adicional en los Estados Unidos son: 1) relaciones de hábitat, 2) interacciones biológicas, 3) estructura de las poblaciones, y 4) estructura de los ecosistemas. Dentro de estas áreas generales existen recomendaciones definidas por el equipo de recuperación, de investigación para entender mejor los efectos de la implementación de las recomendaciones de manejo sobre los búhos y la composición, estructura y función de los ecosistemas.
4. *Implementación*. Un calendario de implementación es proporcionado con detalles de las tareas de recuperación, las entidades responsables de su implementación y los costos estimados. El Equipo de Recuperación recomienda que un equipo de trabajo sea conformado para cada EMU, para supervisar la y proporcionar retroalimentación en los éxitos y fracasos del Plan de Recuperación.

**Fecha y Costos Estimados de la Recuperación:**

Fecha aproximada: 2022

Costo total de la Recuperación (mínimo): $42,628,000

Costos, en miles de dólares

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</table>

Fecha de recuperación: La fecha de recuperación del búho moteado mexicano se estimada para el 2022 si las acciones indicadas en este plan de recuperación son implementadas.
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PART I. RECOVERY PLANS AND PLAN REVISIONS

A. Recovery Plans

The purposes of the ESA are to provide a means whereby the ecosystems upon which threatened and endangered species depend may be conserved and to provide a program for the conservation of such threatened and endangered species. Section 4(f)(1) of the ESA of 1973, as amended (ESA; 16 U.S.C. 1531), requires a recovery plan be prepared for each listed species, unless such plan will not promote its conservation.

Recovery plans describe the process by which the decline of a threatened or endangered species can be reversed and threats to its survival neutralized so that long-term survival can be assured. Section 4(f)(1)(B) of the ESA specifies the contents of a recovery plan. Sections of this Revised Recovery Plan meeting these requirements are:

1) A description of such site-specific management actions as may be necessary to achieve the Plan’s goal for the conservation and survival of the species (Appendix C);
2) Objective, measurable criteria that, when met, would result in a determination that the species be removed from the list (Part III); and,
3) Estimates of the time required and the cost to carry out those measures needed to achieve the Plan’s goal and intermediate steps toward that goal (Part V.1).

Recovery plans are neither self-implementing nor legally binding. Rather, approved recovery plans effectively constitute a FWS guidance document on that listed species or group of species, thereby serving as a logical path from what is known about the species’ biology, life history, and threats to a recovery strategy and program. In some cases, recovery plans are followed by other Federal agencies in order to meet the provisions of 2(c)(1) and 7(a)(1) of the ESA, which require Federal agencies to utilize their authorities in carrying out programs for the conservation of endangered and threatened species. Agency regulations and policies (e.g., those implementing the National Forest Management Act) may also encourage management under recovery plan guidelines. In addition, foreign, state, and local governments often follow the recommendations of recovery plans in species-conservation efforts.

B. Recovery Teams

To develop scientifically credible recovery plans for listed species, the FWS may appoint recovery teams comprised of scientists and resource specialists with expertise either on the species being considered or with other relevant knowledge. In the case of the Mexican spotted owl, the FWS appointed the Mexican Spotted Owl Recovery Team (Recovery Team). A list of Recovery Team members and their areas of expertise can be found in Appendix A.

C. Recovery Plan Revisions

The recovery planning guidance states: “A revision is a substantial rewrite of at least a portion of a recovery plan and is usually required if major changes are required in the recovery strategy, objectives, criteria, or actions” (USDC NMFS and USDI FWS 2010). A revision may be required when new threats to the species are identified, when research uncovers new life history
traits or threats that have significant recovery ramifications, or when the current plan is not achieving its objectives. In some cases, a revision may be undertaken when a significant amount of time has passed and a number of updates have been completed. Section 4(f)(4) of the ESA requires that, prior to approval of a revised recovery plan, the public shall be notified and allowed the opportunity to review and comment on the revision.

D. Revised Mexican Spotted Owl Recovery Plan

The subject of this plan is the Mexican spotted owl. The U.S. Department of the Interior (USDI) FWS added the Mexican spotted owl (Strix occidentalis lucida; also “owl” and “spotted owl”; scientific names of all organisms are provided in Appendix I) to the List of Threatened and Endangered Wildlife (50 CFR 17.11) as a threatened species, effective 15 April 1993. The Recovery Plan for the Mexican Spotted Owl (Recovery Plan; USDI FWS 1995) was completed by FWS Region 2 (Southwest Region) in December 1995. Since that time, we have acquired new information on the biology, status, distribution, and other aspects of the Mexican spotted owl’s life history. This Recovery Plan for the Mexican Spotted Owl, First Revision, revises the 1995 Recovery Plan, incorporating new information on the owl’s biology, threats, and recovery needs, and outlines a comprehensive program for its recovery. We intend that this revised Recovery Plan be a stand-alone document. In other words, although the original Recovery Plan is referenced throughout this revised version, everything needed to inform recovery of the Mexican spotted owl is included herein.

Implementing the recovery actions in the original Recovery Plan has resulted in various updates, clarifications, and changes to Recovery Plan recommendations that will lead the species to recovery (see E, below). There have been changes in land-management emphasis, relevant statutes and regulations, and specific threats to the species necessitating re-examination and, ultimately, further revision of the management recommendations (Appendix C). Population and range-wide habitat monitoring recommendations in the original Recovery Plan have been modified (Part V.B and Appendix E), and the implementation and cost schedule has been updated (Table V.1). A summary of changes and associated rationales are provided below.

E. Primary Differences From the 1995 Recovery Plan

With new knowledge and experience garnered from implementation of the 1995 Recovery Plan, a number of substantive changes were made in the revision. These include:

Part II:
- Includes an ESA five-factor threats analysis.
- Changes RUs to EMUs to conform to FWS policy.
- Provides a more explicit definition of an owl site.
- Merges Southern Rocky Mountain (SRM)-Colorado and SRM-New Mexico EMUs into one (SRM).
- Revises boundary between Colorado Plateau (CP) and SRM to reflect ecological differences between the two EMUs.
- Extends boundary of Basin and Range East (BRE) EMU into Texas to incorporate verified sightings and suspected habitat.
• Reduces the size of the Basin and Range West (BRW) EMU by removing much of the western part where there are no records of owls and little, if any, known owl habitat
• Adds descriptions of canyon cover types as they relate to the owl.
• Provides a clearer definition of riparian habitats as they relate to the owl.

Parts III-V:
• Revises delisting criteria to reflect changes in monitoring requirements (Part III).

Appendices A – G:
• Provides a more explicit definition of an owl site (Appendix C).
• Updates management recommendations given new information (Appendix C).
• Removes reserved lands from automatic inclusion as protected areas (Appendix C).
• Removes steep slopes from automatic inclusion as protected areas (Appendix C).
• Delineates activities that can be conducted inside of PACs and further specifies activities to occur within and outside of nest/roost core areas. Specifically, allows up to 20% of the total PAC area (external to the core) within an EMU to be treated to meet ecological restoration and fuels-reduction objectives if the appropriate monitoring is conducted.
• Provides guidance for removing PAC status from areas so designated.
• Renames “restricted habitat” to “recovery habitat” to more appropriately reflect the intent.
• Develops desired conditions for owls as targets to guide management.
• Provides threat-specific management recommendations for noise, recreation, energy development, land development, water development, grazing, insects and disease, fire suppression and related activities, prescribed fire and wildland fire, research, climate change, and West Nile virus (Appendix C).
• Describes a new approach to monitor owl populations based on owl occupancy (Appendix E).
• Describes a new approach to monitor range-wide owl habitat using Forest Inventory Assessment (FIA) data (Part V.2 and Appendix E).
• Includes a survey protocol (Appendix D).

F. Final Remarks on this Recovery Plan

The Mexican Spotted Owl Recovery Plan is based on the best available science. When published papers were not available, the Recovery Team conducted analyses and modeling to inform the development of management recommendations. The management recommendations should not be considered the end point. Rather, they represent a starting point and can be adjusted and improved as new information is acquired.

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. 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.

Management recommendations represent a combination of protective and proactive measures. Areas currently occupied by owls require the greatest protection to ensure continued occupancy, reproduction, and survival. By no means, however, does this translate to a hands-off approach. In some cases, protection of these areas requires active intervention to sustain desired conditions and to reduce risk of habitat-reducing wildland fire. These interventions should be done after careful analysis and planning to ensure that actions taken are necessary and prudent.

Forests do not retain their characteristics in perpetuity. They become established, grow, and then enter senescence and lose characteristics favored by owls. As a result, landscapes are dynamic and management must look into the future. As nest/roost habitats are lost to natural and unnatural causes, recovery habitats should be in the queue ready for owls to occupy them. This is the intent of replacement nest/roost habitat within recovery habitats. Their development will require a balance between intervention and being allowed to develop naturally in absence of intervention. Management should strive to plan well into the future to ensure that an adequate proportion of the landscape remains in suitable nest/roost conditions to sustain owl populations.

PART II. BACKGROUND

The following summarizes the biology and ecological relationships of Mexican spotted owls. We intend for this to be an overview of biological characteristics of this subspecies, including those germane to recovering its populations. We emphasize information developed since the original Recovery Plan was published (USDI FWS 1995). Although information gaps still exist, our understanding of the Mexican spotted owl’s natural history has increased since 1995. For example, the number of owls known to dwell in rocky canyon environments has increased greatly. We also have new information on how to predict habitat, effects of fire on owls and their habitat, and demographic parameters for a few owl populations. Because the following summary is a brief overview, we urge interested readers to explore Appendix B for a more comprehensive review of scientific literature addressing ecological relationships of Mexican spotted owls.

A. Taxonomy

The Mexican spotted owl is one of three subspecies of spotted owl recognized by the American Ornithologists’ Union (AOU) in the last checklist to include subspecies designations (AOU 1957:285). The other two subspecies are the northern and the California spotted owls (Appendix B, Fig. B.1). The Mexican subspecies is geographically isolated from both the California and northern subspecies. Studies suggest that the Mexican spotted owl is genetically isolated from the other subspecies (Barrowclough and Gutiérrez 1990; but see also Funk et al. 2008).

Two other species within the genus Strix occur north of Mexico, the great gray and barred owls. The great gray owl is a northern species that does not occur within the range of the Mexican spotted owl. Historically, barred owls did not occur sympatrically with Mexican spotted owls within the United States. However, unconfirmed sightings of both species have been reported
from the vicinity of Big Bend National Park in southern Texas in recent times (Wauer 1996) and there are recent confirmed records of barred owls in northern (Williams 2005, cited in Cartron 2010) and eastern (H.Walker pers. comm.) New Mexico. Whether these confirmed records indicate a range expansion by barred owls or vagrancy is unknown.

Barred owls recently have expanded their range into the Pacific Northwest and California (Gutiérrez et al. 2004, Haig et al. 2004b); they appear to be both displacing territorial spotted owls and hybridizing with spotted owls, and are seen as a significant threat to the continued viability of northern spotted owls (Gutiérrez et al. 2004, Forsman et al. 2011). Given hybridization between northern spotted and barred owls in the Pacific Northwest, it seems likely that hybridization between Mexican spotted and barred owls would occur if barred owls expand their range into that of the Mexican spotted owl.

In Mexico, barred owls and another member of the Strix genus, fulvous owls, are found. The ranges of the Mexican spotted and barred owl may overlap in Mexico (Williams and Skaggs 1993, Howell and Webb 1995); little is known about local distributional patterns and habitats occupied in this zone of apparent overlap (Enriquez-Rocha et al. 1993). The fulvous owl does not appear to be sympatric with Mexican spotted owls in Mexico (but its distribution may overlap that of the barred owl to a small extent; Holt et al. 1999).

**B. Description**

1. **Appearance**
   The Mexican spotted owl is a medium-sized owl without ear tufts. They are mottled with irregular white spots on its brown abdomen, back, and head (Appendix B, Fig. B.2). The Mexican spotted owl differs from the two other subspecies of spotted owls in plumage coloration; the white spots of the Mexican spotted owl are generally larger and more numerous than in the other two subspecies, giving it a lighter appearance. Wing and tail feathers are dark brown barred with lighter brown and white and, unlike most owls in North America, spotted owls have dark eyes (Gutiérrez et al. 1995).

   Adult male and female Mexican spotted owls are similar in plumage; however, females are larger, on average, than males. Juveniles, subadults, and adults can be distinguished by plumage characteristics (Forsman 1981, Moen et al. 1991). Juvenile owls (hatchling to approximately five months) have a downy appearance (Appendix B, Fig. B.2). Subadult owls (5 to approximately 26 months) closely resemble adults, but they have pointed tail feathers with a pure white terminal band (Forsman 1981, Moen et al. 1991). The tail feathers of adults (>27 months) have rounded tips, and the terminal band is mottled brown and white (Appendix B, Fig. B.3).

2. **Vocalizations**
   The Mexican spotted owl, being territorial and primarily nocturnal, is heard more often than seen. It has a wide repertoire of calls (Forsman et al. 1984, Ganey 1990). Most calls are relatively low in pitch and composed of pure tones (Fitton 1991), and thus are well-suited for accurate, long-distance communication through areas of relatively dense vegetation (Fitton 1991, see also Morton 1975, Forsman et al. 1984). Male and female owls can be distinguished by their calls. Males have a deeper voice than females (Forsman et al. 1984) and generally call more
frequently than females (Ganey 1990). The most common vocalization, used more often by males than females (Ganey 1990, Kuntz and Stacey 1997), is a series of four unevenly spaced hoots (Forsman et al. 1984, Fitton 1991). Females frequently use a clear whistle ending with an upward inflection as well as a series of sharp barks (Forsman et al. 1984, Ganey 1990).

Mexican spotted owls call mainly during March to November and are relatively silent from December to February (Ganey 1990), although spontaneous calling has been heard during all months (J. L. Ganey, Rocky Mountain Research Station, unpublished data). Calling activity increases from March through May (although nesting females are largely silent during April and early May) and then declines from June through November (Ganey 1990:Fig. 3). Ganey (1990:Fig. 4) reported that calling activity was greatest during a two-hour period following sunset, with smaller peaks in calling activity four to eight hours after sunset and again just before sunrise.

C. Distribution

The Mexican spotted owl occurs in forested mountains and canyonlands throughout the southwestern U.S. and Mexico (Gutiérrez et al. 1995, Ward et al. 1995; Appendix B). It ranges from Utah, Colorado, Arizona, New Mexico, and the western portions of Texas south into several States of Mexico (Appendix B, Fig. B.1). Whereas this owl occupies a broad geographic area, it does not occur uniformly throughout its range (USDI FWS 1995). Instead, the owl occurs in disjunct areas that correspond with isolated mountain ranges and canyon systems. In the U.S., the majority of owls are found on National Forest System (NFS) lands; however, in some areas of the Colorado Plateau EMU, owls are found only in rocky-canyon habitats, which primarily occur on NPS- and BLM-administered lands (Appendix B, Fig. B.4).

The current distribution of Mexican spotted owls generally follows its historical extent, with a few exceptions (Ward et al. 1995). For one, there are early records of spotted owls in lowland riparian areas along major rivers, such as the San Pedro in Arizona and the Rio Grande in New Mexico; but the species has not been documented in these areas recently (i.e., since the early 1900s) (Williams 1993, Ward et al. 1995). In addition, previously occupied riparian communities in the southwestern U.S. and southern Mexico have undergone significant habitat alteration since the historical sightings (USDI FWS 1993). For example, in southern Utah and northern Arizona, inundation of Glen Canyon by Lake Powell created a 299-kilometer (km) (186-mile [mi]) long and 40-km (25-mi) wide reservoir that may have flooded habitat for a potentially large population in the canyonlands region (McDonald et al. 1991, Willey and Spotskey 2000).

In Mexico, information on the status of Mexican spotted owls is limited (Tarango et al. 2001). As in the U.S., owl distribution in Mexico appears disjunct (Williams 1993, USDI FWS 1995). The majority of Mexican spotted owls has been located in the Sierra Madre Occidental Mountain range (Williams 1993), which includes the states of Chihuahua, Sonora, Sinaloa, Durango, San Luis Potosi, Aguascalientes, Zacatecas, Jalisco, Nayarit, Queretaro, and Guanajuato. It is not
known if the distribution of Mexican spotted owls in Mexico has changed nor how many additional sites have been recorded since 1995.

1. Ecological Management Units (EMUs)

The Mexican spotted owl occupies many habitat types scattered across a diversity of landscapes. In addition to this natural variability in owl habitat, human activities also vary across the owl’s range. The combination of natural variability, human influences on owls, international boundaries, and logistics of implementing the Recovery Plan necessitates subdivision of the owl range into smaller management areas. The 1995 Recovery Plan subdivided the owl’s range into 11 “Recovery Units” (RUs): six in the U.S. and five in Mexico. In this revision of the Recovery Plan, we renamed RUs as EMUs to be in agreement with current FWS guidelines (USDC NMFS and USDI FWS 2010). We divide the owl range within the U.S. into five EMUs: Colorado Plateau (CP), Southern Rocky Mountains (SRM), Upper Gila Mountains (UGM), Basin and Range-West (BRW), and Basin and Range-East (BRE) (Fig. II.1). The SRM EMU was created by merging the former SRM-New Mexico and SRM-Colorado RUs. We also continue to recognize the five EMUs identified in the original Recovery Plan (USDI FWS 1995) for Mexico: Sierra Madre Occidental-Norte, Sierra Madre Oriental-Norte, Sierra Madre Occidental-Sur, Sierra Madre Oriental-Sur, and Eje Neovolcanico (Fig. II.7).

As with RUs in the original Recovery Plan, we use EMUs as geographical subdivisions of the owl range to organize owl recovery efforts. The EMUs allow localized Working Teams of resource managers to coordinate their efforts and share information about owls and owl habitat across administrative boundaries. These Working Teams (see Part V.C) provide an opportunity for interested parties to participate in discussions affecting owl management at a more local level. In addition to activities described in this Recovery Plan, the Working Teams may choose to develop and recommend actions they deem necessary to locally gather information or further owl recovery.

The boundaries of the 1995 RUs and the estimate of the species’ range extent were based on the best information available when the Recovery Plan was written. Since 1995, additional information has clarified the expected extent of the species’ range and led to changes in U.S. EMU boundaries. These changes are discussed below.

a. United States

In the following sections, we describe dominant physical and biotic characteristics, patterns of owl distribution and habitat use, and the dominant patterns of land ownership and land use within each EMU. We primarily emphasize the U.S. portion of the owl range, with briefer discussion of the Mexico portion. To assist with the transition from the 1995 Recovery Plan to this new version, each narrative starts with a brief description of the changes to the EMU configuration since 1995.
We identified the five EMUs based on the following considerations (in order of importance):
1) physiographic provinces;
2) biotic regimes;
3) perceived threats to owls or their habitat;
4) administrative boundaries; and,
5) known patterns of owl distribution.

It is important to note that owl distributional patterns were a minor consideration in EMU
delineation, and EMUs do not necessarily represent discrete populations of owls. In fact,
movement of individuals between EMUs has been documented (Ganey and Dick 1995).
We used four major physiographic provinces in delineating EMUs in the U.S.: the Colorado
Plateau, Basin and Range, Southern Rocky Mountains, and Upper Gila Mountains (Wilson 1962,
Bailey 1980). We considered both administrative boundaries of Federal agencies and locations
of major highways to simplify implementation of the Recovery Plan for the Working Teams
described above.
Figure II.1. Ecological Management Units for the Mexican spotted owl in the southwestern United States.
i. Colorado Plateau (CP)

In this revision of the 1995 Recovery Plan, we have significantly enlarged the CP EMU (Fig. II.2). We moved the eastern boundary farther east to approximate a physiographic province line in Colorado. We based this change on our premise that the EMUs should reflect areas of similar habitat, if possible. We moved the northern extent of the EMU to include known owls at Dinosaur National Monument and in similar canyon habitats nearby.

The CP EMU roughly coincides with the Colorado Plateau Physiographic Province (Bailey 1980), with the exception that the southern end of the plateau is included in the Upper Gila Mountains EMU (see below). This EMU includes most of eastern and southern Utah plus portions of northern Arizona, northwestern New Mexico, and western Colorado. Major landforms are interior basins and high plateaus dissected by deep canyons, including the canyons of the Colorado River and its tributaries (Williams 1986).

Grasslands and shrubsteppes dominate the CP EMU at lower elevations, with woodlands and forests predominant at higher elevations (Bailey 1980, West 1983). Pinyon pine and various juniper species are the primary tree types in the woodland zone (see Appendix I for scientific names of tree species). A montane zone extends over areas on the high plateaus and mountains (Bailey 1980). Forest types in this zone include ponderosa pine, mixed-conifer, and spruce-fir. Conifers may extend to lower elevations in canyons. Deciduous woody species dominate riparian communities found along streams.

Figure II.2 illustrates the currently known distribution of Mexican spotted owls in this EMU; the owl reaches the northern limit of its documented range here. Owl habitat appears to be naturally fragmented in this EMU, with most owls found in disjunct canyon systems or on isolated mountain ranges in wilderness and roadless areas. In Utah, breeding owls primarily inhabit deep, steep-walled canyons and hanging canyons. These canyons typically are surrounded by terrain that does not appear to provide nest/roost habitat but may provide foraging habitat for owls (Willey 1993). Owls also apparently prefer canyon terrain in southwestern Colorado, such as the known owl locations in and around Mesa Verde National Park. In northern Arizona and northwest New Mexico, owls have been reported in both canyon and montane forest situations (Ganey and Dick 1995).

Looking solely at land ownership, and not at presumed owl habitat, Federal lands account for 46% of the CP EMU (Table G.2, Fig. II.2). Tribal lands collectively total 27%, with the largest tribal entity being the Navajo Nation. Private ownership accounts for 19%, and state lands 4%. Approximately 15% of all known owl sites recorded since 1989 occur in the CP EMU. Of the 206 owl sites documented for this EMU (Table II.1), most have been located on NPS-administered lands (64%), followed by BLM-administered lands (22%), and then FS-administered lands (13.5%; Appendix B, Table B.1). One owl site has been documented on Utah Division of Wildlife Resources (UDWR) lands and an unknown number occur on tribal lands.

Recreation ranks as a primary land use within the CP EMU because of high recreation pressure on public lands. The potential for recreation to affect owl presence and recovery is compounded by the terrain, with owls established in narrow canyons having less opportunity to move away
from human activity. Activities such as hiking, camping, hunting, rock climbing, mountain biking, and off-road vehicle (OHV) use occur in owl habitat within the EMU. Forest and fire management are important land activities on FS-administered, NPS-administered, and Tribal lands. In addition, commercial enterprises take place in the EMU; particularly important are livestock grazing, timber cutting, coal and uranium mining, and oil and natural gas development. Clearing of vegetation and human disturbance are coincident with these activities and have the potential to impact owls here.

ii. Southern Rocky Mountains (SRM)

We made two principal changes to the SRM EMU in this revision. First, we merged the former SRM – Colorado and the SRM – New Mexico EMUs (Fig. II.3). This change was deemed appropriate because management of owls and their habitat did not differ significantly between the two states, and the habitat is similar enough to allow managers to find common solutions to owl-management issues. Second, we adjusted the new boundary on the western extent to better follow ecological breaks in habitat between the SRM and CP EMUs.

The SRM EMU falls partly within the Southern Rocky Mountains Physiographic Province and partly within the Colorado Plateau Ecoregion (Bailey 1980). Mountain ranges characterize the EMU. Vegetation varies from grasslands at low elevations through pinyon-juniper woodlands, interior shrublands, ponderosa pine, mixed-conifer and spruce-fir forests, to alpine tundra on the highest peaks (Daubenmire 1943).

This EMU boundary extends almost to the Wyoming state line based on historical owl records and similarity of habitat (Webb 1983); further owl surveys would help define a more ecologically appropriate range delineation here. Though found primarily in canyons in this EMU, the owls also occupy forest habitat types. The canyon habitat often has mature Douglas-fir, white fir, and ponderosa pine in canyon bottoms and on the north- and east-facing slopes. Ponderosa pine grows on the more xeric south and west-facing slopes, with pinyon-juniper growing on the mesa tops.

Federal lands encompass 50% of the SRM EMU, with the majority administered by the FS, followed by the BLM, and NPS (Table G.2 and Fig. II.3). Approximately 43% is private lands, 4% is state lands, and 3% is Tribal lands. Approximately 6% of all Mexican spotted owl sites occur in SRM EMU (Table II.1; Appendix B, Table B.1). Most of the 74 owl sites reported for this EMU were documented on FS-administered lands (79.7%), followed by BLM-administered lands (13.5%) and NPS-administered lands (4.1%). Two sites are known for privately owned lands (Appendix B, Table B.1). We do not know how many occur on Tribal lands.

Land-use practices throughout the SRM EMU include recreation, ecological restoration, firewood cutting, livestock production, mining, forest fuels management, and energy development, including the associated human presence and development that are coincident with these uses. Recreational activities such as off-road driving and rock climbing could result in disturbance as well. Transportation and urban development are also considered likely threats to owl habitat in the SRM EMU. In particular, urban development along the Front Range of Colorado may threaten owl wintering habitat.
iii. Upper Gila Mountains (UGM)

We did not deem any changes necessary to the configuration of the UGM EMU in this revision.

The UGM EMU (Fig. II.4) is based primarily on the Upper Gila Mountains Forest Province (Bailey 1980), but also includes the southern end of the Colorado Plateau Ecoregion. Williams (1986) refers to this area as the Datil-Mogollon Section, part of a physiographic subdivision transitional between the Basin and Range and Colorado Plateau Provinces. This complex area consists of steep mountains and deep, entrenched river drainages dissecting high plateaus. The Mogollon Rim, a prominent fault scarp, bisects the UGM EMU.

McLaughlin (1986) described a “Mogollon” floral element in this region. The vegetation ranges from grasslands at lower elevations through pinyon-juniper woodlands, ponderosa pine, mixed-conifer, and spruce-fir forests at higher elevations. Many canyons contain stringers of deciduous riparian forests, particularly at low and middle elevations. The UGM EMU contains the largest contiguous ponderosa pine forest in North America, an unbroken band of forest 40- to 64-km (25- to 40-mi) wide and approximately 483-km (300-mi) long extending from north-central Arizona to west-central New Mexico (Cooper 1960).

Mexican spotted owls are widely distributed and use a variety of habitats within the UGM EMU, but are most common in mixed-conifer forests dominated by Douglas-fir and/or white fir and canyons with varying degrees of forest cover (Ganey and Balda 1989a, Ganey and Dick 1995, Ward et al. 1995). Owls also occur in ponderosa pine-Gambel oak forest, where they are typically found in stands containing well-developed understories of Gambel oak (Ganey and Dick 1995, Ganey et al. 1999). Ganey et al. (2011) summarized our current knowledge of spotted owls in this EMU in greater detail.

Federal lands, mostly FS, encompass 67% of the UGM EMU (Table G.2 and Fig. II.4). Tribal lands account for 17%, privately owned lands 12%, and state lands 4%. The largest known population of Mexican spotted owls occurs in this EMU, accounting for approximately 52% of all known owl sites (Table II.1; Appendix B, Table B.1). Of the 688 known owl sites in this EMU, 684 are designated on FS-administered lands and 4 are designated on NPS-administered lands. Many Mexican spotted owls are found in wilderness areas in this EMU; the Gila Wilderness supports the largest known wilderness population (Ganey et al. 2008). An unknown number of owl sites occur on tribal lands.

Major land uses within the UGM EMU include fuels reduction, ecological restoration, livestock production, and recreation. Timber and fuelwood harvest, for both personal and commercial use, occurs across much of the UGM EMU. Livestock grazing is common on FS-administered lands and large portions of Fort Apache and San Carlos tribal lands. In addition, recreational activities such as OHV use, hiking, camping, and hunting attract many people to this EMU.

iv. Basin and Range-West (BRW)

We made one significant change to the BRW EMU in this revision. Because the southwestern extent of the previous BRW EMU included large areas that did not provide Mexican spotted owl
habitat, we modified the EMU boundary to omit this area (Fig. II.5). For convenience, we used highways to define the new southwestern boundary. This boundary does not necessarily denote the true ecological extent of owl occurrence, but the boundary does encompass all recorded owl locations.

The Basin and Range Area Province (Bailey 1980) provided the basis for delineating two EMUs. We subdivided the Basin and Range area into eastern and western EMUs using the Continental Divide as the partition. We based the division on differences in climatic and floristic characteristics between these areas. The BRW EMU flora is dominated by Madrean elements, while the BRE EMU shows more Rocky Mountain affinities (Brown et al. 1980, Dick-Peddie 1993).

Geologically, the BRW EMU exhibits numerous fault-block mountains separated by valleys (Wilson 1962). Complex faulting and canyon carving define the physical landscape within these mountains. Vegetation transitions from desert scrubland and semi-desert grassland in the valleys upward to montane forests. Montane vegetation includes interior chaparral, encinal (evergreen oak) woodlands, and Madrean pine-oak woodlands at low and middle elevations, with ponderosa pine, mixed-conifer, and spruce-fir forests at higher elevations (Brown et al. 1980). Isolated mountain ranges are surrounded by Sonoran and Chihuahuan desert basins.

Mexican spotted owls occupy a wide range of habitat types within the BRW EMU. The majority of owls occur in isolated mountain ranges where they inhabit encinal oak woodlands; mixed-conifer, pine-oak, riparian forests; and, rocky canyons (Ganey and Balda 1989a, Duncan and Taiz 1992, Ganey et al. 1992, Ganey and Dick 1995).

Federal lands encompass 40% of the BRW EMU, mostly administered by the FS followed by the BLM and a small portion by Department of Defense (DoD) and NPS (Table G.2 and Fig. II.5). Privately owned lands amount to 27%, State lands 25%, and Tribal lands (mainly the San Carlos Apache Reservation) 7%. Approximately 13% of all owl sites documented for the U.S. are found within this EMU (Table II.1). Of the 174 owl sites in this EMU, most occur on FS-administered lands (89%), and the majority of these sites occur in the Coronado National Forest within wilderness. There are 11 owl sites designated on DoD lands on Fort Huachuca and eight sites designated on NPS-administered lands (Appendix B, Table B.1). An unknown number of owl sites occur on tribal lands.

Recreation dominates land use within the BRW EMU. Activities such as hiking, bird-watching, camping, off-road driving, and hunting are particularly popular. Livestock grazing is widespread, but it is most intensive at low and middle elevations. Urban and rural development and mining activities occur in portions of the EMU. Timber harvest occurs mainly on the San Carlos Apache Indian Reservation. The Coronado, Prescott, and Tonto national forests have active fuels-reduction and forest-management programs in place to reduce fire hazard, implement ecological restoration, and provide community protection. Military training maneuvers take place in and around Mexican spotted owl habitat on the Fort Huachuca Army Base.
We extended the southeastern boundary of the BRE EMU to incorporate portions of West Texas. This change was based primarily on recent sightings of Mexican spotted owls in the Davis and Chisos mountains of Texas (Bryan and Karges 2001, J. P. Ward, unpubl. data). There also are unverified sightings of Strix owls in and near Big Bend National Park, and there may be potential owl habitat along the Rio Grande in that area that has not been effectively surveyed for owls (Peterson and Zimmer 1998).

We delineated the BRE EMU (Fig. II.6) based on the Basin and Range Area Province and the Desert and Steppic Ecoregions (Bailey 1980). This EMU is characterized by numerous parallel mountain ranges separated by alluvial valleys and broad, flat basins. The climate features mild winters, as indicated by the presence of broad-leaved evergreen plants at relatively high elevations (USDA FS 1991).

Regional vegetation transitions from Chihuahuan desert scrubland and Great Basin grasslands at lower elevations, through Great Basin woodland (pinyon-juniper) at middle elevations, to petran montane coniferous forests at high elevations (Brown et al. 1980, Dick-Peddie 1993). Montane habitat includes ponderosa pine, mixed-conifer, Madrean pine-oak, and spruce-fir forests and is patchily distributed throughout the higher mountain ranges. Cottonwood bosques as well as other riparian vegetation exist along the Rio Grande corridor. Montane and especially riparian plant communities have been altered considerably by human activities.

Mexican spotted owls occur in the isolated mountain ranges and in deep reticulated canyons scattered across this EMU. They are most common in mixed-conifer forest but are also found in ponderosa pine and Madrean pine-oak forests, riparian habitats, and pinyon-juniper woodland (Skaggs and Raitt 1988, Ward et al. 1995, Bryan and Karges 2001, Mullet 2008). The owl has been found within mixed-conifer and deep rocky canyon habitat in Guadalupe Mountains National Park (McDonald et al. 1991, Mullett 2008).

Of the BRE EMU land area, Federal lands comprise 35%, private lands 38%, State lands 13%, and Tribal lands 4% (Table G.2 and Fig. II.6). Approximately 14% of all owl sites reported for U.S. lands occur in the BRE EMU (Appendix B, Table B.1). Of the 182 known sites recorded for this EMU (Table II.1), most occur on FS-administered lands (82.9%) and are primarily concentrated in the Sacramento Mountains in the Lincoln National Forest in New Mexico. Another 14.2% of these sites are on NPS-administered lands (Appendix B, Table B.1). Five sites are on private lands, primarily The Nature Conservancy, and an unknown number occur on tribal lands.

Dominant land uses within the BRE EMU include forest management and livestock grazing. Recreational activities such as off-road driving, skiing, hiking, camping, and hunting also are locally common within this EMU.
Figure II.2. Colorado Plateau Ecological Management Unit for the Mexican spotted owl in the southwestern United States. The lack of mapped sites within potential owl habitat is an artifact of a lack of data and does not necessarily indicate absence of owl sites.
Figure II.3. Southern Rocky Mountains Ecological Management Unit for the Mexican spotted owl in the southwestern United States. The lack of mapped sites within potential owl habitat is an artifact of a lack of data and does not necessarily indicate absence of owls sites.
Figure II.4. Upper Gila Mountains Ecological Management Unit for the Mexican spotted owl in the southwestern United States. The lack of mapped sites within potential owl habitat is an artifact of a lack of data and does not necessarily indicate absence of owl sites.
Figure II.5. Basin and Range-West Ecological Management Unit for the Mexican spotted owl in the southwestern United States. The lack of mapped sites within potential owl habitat is an artifact of a lack of data and does not necessarily indicate absence of owl sites.
Figure II.6. Basin and Range-East Ecological Management Unit for the Mexican spotted owl in the southwestern United States. The lack of mapped sites within potential owl habitat is an artifact of a lack of data and does not necessarily indicate absence of owl sites.
b. Mexico

The five EMUs in Mexico include: Sierra Madre Occidental – Norte; Sierra Madre Oriental – Norte; Sierra Madre Occidental – Sur; Sierra Madre Oriental – Sur; and Eje Neovolcanico (Fig. II.7). We used three major physiographic provinces in the delineation: Sierra Madre Occidental, Sierra Madre Oriental, and Sistema Volcanico Transversal (Cuanalo et al. 1989). Criteria we used to delineate EMUs in Mexico were similar to those used in the U.S. These criteria, listed in order of importance, were:

1) distribution of the Mexican spotted owl;
2) local vegetation;
3) physiographic features;
4) administrative boundaries; and,
5) potential threats to the conservation of the owl and its habitat.

Mexican spotted owl distribution is disjunct across Mexico. Williams and Skaggs (1993) located Mexican spotted owls at 53 locations in 11 mainland Mexican States. These were partitioned by Ward et al. (1995) into 35 historical (pre-1989) and 18 current (since 1989) locations (see Young 1996 for additional sites discovered in the Mexican State of Chihuahua). Although vegetation types differ throughout each EMU, oak and pine-oak forest types appear to be commonly associated with owl habitat in most or all EMUs. These oak species include *Quercus resinosa* (no common name), Gentry’s oak, Mexican red oak, gray oak, Chihuahua oak, Mexican white oak, and red oak. Aztec pine is the most common pine species occurring on upper mesas and occasionally on north-facing slopes in some areas where owls are found. Land uses within all EMUs include timber cutting, cattle and sheep grazing, fuelwood gathering, and clearing forested areas for agriculture. Although these land uses are practiced at different degrees throughout each EMU, the majority occur within ejidos (communally-operated land).

Several Natural Protected Areas (Áreas Naturales Protegidas) in Mexico have records of this species (Table G.3) and others have potential habitat but no records of Mexican spotted owls (Table G.4). The Zona Sujeta a Conservación Ecológica “Sierra Fría” in Aguascalientes is a state-protected area where pairs of owls have been documented in six different localities: Barranca El Tiznado, Cueva Prieta, El Carrizal, El Pinal, El Tejamanil, and La Angostura. Because nests have not been found, it is unclear if the Mexican spotted owl nests in the Zona Sujeta a Conservación Ecológica (Márquez-Olivas et al. 2002).

There are also records of Mexican spotted owls in the Reserva de la Biosfera de la Michilía, a federally protected area in southeastern Durango. According to Garza-Herrera (1999), the species distribution in this Reserve is above 2,330 m (7,700 ft) in conifer and pine-oak forest. He also mentions a crude density of 0.054 owls/km² (0.021 owls/mi²), which is lower than previously reported elsewhere in its range (0.105 to 0.273 owls/km², or 0.041 to 0.105 owls/mi²; Garza-Herrera 1999).

The following narratives describe dominant physical and biotic attributes, distribution of owls, and land administration and ownership of each unit. Where available, we provide a brief description of potential threats to the owl.
Figure II.7. Ecological Management Units for the Mexican spotted owl in Mexico (showing adjacent U.S. EMUs for reference).
i. *Sierra Madre Occidental-Norte*

Covering an enormous area, the Sierra Madre Occidental - Norte includes parts of the States of Chihuahua, Sinaloa, Durango, and Sonora. In general, this area is characterized by isolated mountain ranges surrounded by both narrow and wide valleys. Vegetation communities consist of pine-oak forest, tropical deciduous forest, oak forest, microphyll shrub, and grassland.

Mexican spotted owls have been reported in the northern and western portions of this EMU. A recent study in Sonora found 12 locations in isolated mountain ranges (Cirett-Galan and Diaz 1993). The owls occupied canyons and slopes with various exposures, and most were found in pine-oak forest. In portions of Chihuahua, 25 owls were located at 13 different localities in several mountain ranges (Tarango et al. 1997). Most owls were found in small, isolated patches of pine-oak forest in canyons. Records for the State of Sinaloa are limited. There are at least two records from the high-elevation Rancho Liebre Barranca, near the Sinaloa-Durango state boundaries (Williams and Skaggs 1993). These sites were described as deep canyons containing pine-oak and subtropical vegetation (Alden 1969).

A study by CONANP (National Commission on Natural Protected Areas) and Pronatura Sur in 2008 concluded that large-scale logging operations in the Sierra Madre Occidental have significantly reduced pine forest coverage to supply paper and to clear forests in order to reduce the risk of wildland fires and the spread of pests (CONANP-Pronatura Sur 2008). These studies from the Sierra Madre Occidental have not quantified the exact amount of forest lost to these operations. However, it is believed that from 1976-2000, temperate forest in Mexico was being lost at a rate of 0.25%, or about 86,718 ha (214,285 ac) per year (Bray et al. 2007). Several researchers also have suggested that the clearing of trees, especially cutting of mature forests, has resulted in the disappearance of the imperial woodpecker and declines in western thick-billed parrot (CONANP-Pronatura Sur 2008). Other recent analysis suggests that throughout Mexico, current pine forest cover consists of 75% of the potential original distribution, and that 48.4% of the remaining pine forests are “well-conserved” (CONABIO 2008).

ii. *Sierra Madre Oriental-Norte*

The Sierra Madre Oriental-Norte includes the central portion of the State of Coahuila. This area is characterized by broad mountain ranges surrounded by valleys. Vegetation consists of grasslands, mesquite woodland, dwarf oak groves, submontane shrubland, desert shrubland, crasicaule shrub, and pine-oak and oak forests.

Two owl records are reported for this EMU. At one of these locations an owl was observed roosting in a canyon bottom under a dense canopy of maples and oaks. Vegetation in the other canyon was described as “garden-like,” containing pines, oaks, and madrones (Williams and Skaggs 1993).
iii. **Sierra Madre Occidental-Sur**

The Sierra Madre Occidental-Sur EMU includes parts of the States of Durango, Zacatecas, San Luis Potosi, Aguascalientes, Jalisco, Nayarit, Queretaro, and Guanajuato. In general, this area is characterized by isolated mountains, valleys, and severely dissected canyons and gorges. Vegetation includes mesquite woodland, submontane shrub, grasslands, pine-oak forest, crasicaule shrub, low tropical deciduous forest, and desert shrubland.

Records exist for Mexican spotted owls in La Michilia Biosphere Reserve. In addition, Mexican spotted owls have been found in Aguascalientes near the border of Zacatecas, in the Sierra Fria (Williams and Skaggs 1993, Márquez-Olivas et al. 2002), and in Zacatecas State near Valparaiso (Bravo-Vinaja et al. 2005). Owl records also exist within Guanajuato State. Logging is prohibited in Sierra Fría and security guards inspect every vehicle driving through the area to stop illegal timber harvest as part of the protected area management (Tarango et al. 2001).

iv. **Sierra Madre Oriental-Sur**

The Sierra Madre Oriental - Sur includes parts of the States of Coahuila, Nuevo Leon, and Tamaulipas. This EMU is characterized by long ridges with sharp pinnacles, narrow valleys, and a few plateaus. Vegetation consists of pine, pine-oak, and mixed-conifer forests, submontane shrublands, dwarf oak, and desert rosetofilo shrublands.

Mexican spotted owls have been found in the southern portions of the northern states of Coahuila (Williams and Skaggs 1993) and Tamaulipas (Ward et al. 1995). The owls were found in oak, pine, juniper, and mixed-conifer forests. They were reported to use cliff sites for nesting and roosting. Five locations have been reported in Nuevo Leon. These locations were described as pine-oak and mixed-conifer forests with large cliffs having northeast exposures.

In the Sierra Madre Oriental, devastating wildland fires have resulted in the loss of old-growth forests. Within natural protected areas, management actions to prevent wildland fires have promoted the heavy accumulation of coarse woody debris. This situation has generated several problems in Mexico in recent years; during 2011 more than 424,000 ha (1,047,727 ac) were burned by fires just in Coahuila, and in Chihuahua, 1,680 fires burned 87,888 ha (217,176 ac), just to mention the most affected states in Mexico (CONAFOR 2011). The spread of bark beetles during the dry season has also increased the wildland fire risk. In 2006, 200 ha (494 ac) of mature forest were lost in El Taray, and in 2008, 400 ha (988 ac) were lost in the Municipio de Santiago Nuevo León (CONANP-Pronatura Noreste 2008). These mature forests areas must be maintained if biodiversity in the Eastern Sierra Madre, including the Mexican spotted owl, is to be protected.

v. **Eje Neovolcanico**

The Eje Neovolcanico EMU covers portions of the States of Jalisco, Michoacan, Guanajuato, Queretaro, Hidalgo, Guerrero, Puebla, Morelaos, Tlaxcala Veracruz, Oaxaca, and Mexico City. This EMU is characterized by volcanic cones severely dissected by ravines. The EMU also includes rounded hills, slopes, and plateaus. Vegetation communities include pine-oak forest,
grassland, low tropical deciduous forest, crasicaule shrub, oak forest, juniper forest, pine forest, mesquite woodlands, and desert shrublands.

Mexican spotted owls have been reported in Jalisco on the volcano of Cerro Nevado de Colima (Voacan de Nieve). Vegetation in this area consists of pine-oak forest. One Mexican spotted owl was collected near the city of Uruapan in the State of Michoacan at Cerro de Tancitaro. However, this area is now developed and no longer contains owl habitat. Although other states in this EMU appear to contain suitable owl habitat, Jalisco is the only state known to have recent records of Mexican spotted owls.

In this EMU, increased habitat modifications in proximity to urban areas pose threats to the owl (Navarro-Sigüenza et al. 2007). Human overpopulation and associated activities such as agriculture, cattle production, and other land-uses threaten native species (Navarro-Sigüenza et al. 2007). This area also faces deforestation, illegal mining, illegal hunting and poaching, burning of natural vegetation to increase cattle forage, and wildland fires by arson, all of which increase threats to the Mexican spotted owl (Navarro-Sigüenza et al. 2007).

Table II.1. Known Mexican spotted owl sites in the United States and in Mexico by EMU as of 2011.

<table>
<thead>
<tr>
<th>Ecological Management Area</th>
<th>Number of Owl Sites</th>
<th>Percent of Total Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>United States</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UGM EMU</td>
<td>688 sites</td>
<td>52%</td>
</tr>
<tr>
<td>CP EMU</td>
<td>206 sites</td>
<td>15.6%</td>
</tr>
<tr>
<td>BRE EMU</td>
<td>182 sites</td>
<td>13.7%</td>
</tr>
<tr>
<td>BRW EMU</td>
<td>174 sites</td>
<td>13.1%</td>
</tr>
<tr>
<td>SRM EMU</td>
<td>74 sites</td>
<td>5.6%</td>
</tr>
<tr>
<td><strong>Mexico</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sierra Madre Occidental - Norte</td>
<td>27 sites</td>
<td>Unknown</td>
</tr>
<tr>
<td>Sierra Madre Oriental - Sur</td>
<td>5 sites</td>
<td>Unknown</td>
</tr>
<tr>
<td>Sierra Madre Oriental - Norte</td>
<td>2 sites</td>
<td>Unknown</td>
</tr>
<tr>
<td>Sierra Madre Occidental - Sur</td>
<td>extant</td>
<td>Unknown</td>
</tr>
<tr>
<td>Eje Neovolcanico</td>
<td>extant</td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,324 known sites in the U.S.</td>
<td>34+ known sites in Mexico</td>
</tr>
</tbody>
</table>
D. Habitat Use

Although Mexican spotted owls have been observed to nest, roost, forage, and disperse among a diverse array of biotic communities, the owl is typically considered a “habitat specialist” in that roost and nest habitats classically occur in late seral forests or rocky canyon habitats. Some Mexican spotted owls undergo altitudinal migrations during winter to areas where habitat structure and composition differ from that used during breeding (refer to Appendix B for a more comprehensive discussion).

1. Nesting and Roosting Habitat
Owls occur in both forested and rocky-canyon habitats. Forests used for roosting and nesting often contain mature or old-growth stands with complex structure (USDI FWS 1995:26). Forests used by spotted owls are typically uneven-aged, are multistoried, and have high canopy cover (USDI FWS 1995:27). In these areas, nest trees are typically large (average diameter of nest trees is 61 cm [24 in]), although owls roost in both large and small trees (Ganey 1988, Seamans and Gutiérrez 1995, Willey 1998b, Ganey et al. 2000, May and Gutiérrez 2002, May et al. 2004). Tree species used for nesting vary somewhat among areas and cover types, but Douglas-fir is the most common nest tree in many areas (SWCA, Inc. 1992, Willey 1998b).

In parts of its range, the Mexican spotted owl occupies a variety of steep, rocky-canyon habitats (Ganey and Balda 1989b, Rinkevich and Gutiérrez 1996, Willey 1998a, Willey and Van Riper 2007). For example, the rocky-canyon habitats of Utah typically include landscapes with
complex tributary canyons, a variety of desert scrub and riparian vegetation communities (Brown et al. 1980), and prominent vertical cliffs (Rinkevich and Gutiérrez 1996, Willey 1998a, Willey et al. 2007, Mullet 2008). Within these canyons, owls nest in protected caves and roost in caves and on rocky ledges as well as in trees (Willey 1998a).

In northern New Mexico, the volcanic-tuff canyons of Bandelier National Monument also provide many pot-holes, ledges, and small caves for owls to use as daytime roosts and nests (Johnson and Johnson 1985). Mexican spotted owls also occur within the complex canyon networks of the Guadalupe Mountains in southern New Mexico and west Texas. Mullet and Ward (2010) quantified 21 microhabitat features surrounding known nest and roost sites to characterize conditions within canyon habitats in the Guadalupe Mountains. Mexican spotted owl nest and roost sites were associated with steep-walled and relatively narrow canyons, high canopy cover, saplings in the understory, and rocky outcrops.

2. Foraging Habitat
Mexican spotted owls appear to use a wider variety of cover types for foraging than for roosting or nesting (Ganey and Balda 1994, Ganey et al. 2003). Radio-marked owls in Arizona foraged more than expected (in relation to its proportion on the landscape) in unlogged forest (Ganey and Balda 1994), and Ward (2001) found that woodrats (an important prey item for Mexican spotted owls) were more abundant in late-seral mixed-conifer forests. However, owls forage in a variety of habitats: managed and unmanaged forests, pinyon-juniper woodlands, mixed-conifer and ponderosa pine forests, cliff faces and terraces between cliffs, and riparian zones (Ganey and Balda 1994, Willey 1998a,b; Ganey et al. 2003, Willey and Van Riper 2007).

3. Home Range and Territoriality
Mexican spotted owls are territorial in the sense that mated pairs defend a breeding territory within a larger home range (or use area). Fidelity to these territories is relatively high in Mexican spotted owls, with most owls remaining on the same territory year after year (Ganey 1988, Gutiérrez et al. 1995). Mexican spotted owls use relatively large home ranges, and home-range size appears to vary among geographic areas and habitats (Ganey and Balda 1989a, Zwank et al. 1994, Willey 1998b, Ganey et al. 2005, Willey and Van Riper 2007, Bowden 2008). Some of this variation may be due to differences in methods, but some of the observed variation is likely real. However, at this time, the relative influences of biogeographic regions versus local differences in habitat quality on home-range size of Mexican spotted owls remain unclear, although limited information suggests that local differences can be important (Ganey et al. 2005, see also Carey et al. 1992, Zabel et al. 1995).

4. Juvenile Dispersal
Mexican spotted owls appear to be obligate dispersers, with all juveniles dispersing from natal areas. Most radio-marked juvenile Mexican spotted owls were observed to disperse in September and October, with the majority dispersing in September (Arsenault et al. 1997, Ganey et al. 1998, Willey and Van Riper 2000). Like the other spotted owl subspecies, juvenile Mexican spotted owls are capable of moving long distances (Ganey et al. 1998, Willey and Van Riper 2000). Distance from the natal site to the last observed location for radio-marked juveniles observed by Ganey et al. (1998) ranged from 1 to 92 km (0.6 to 57 mi). However, based primarily on work on northern spotted owls (Forsman et al. 2002), we believe that most
successfully dispersing juveniles occupy territories near their natal territories. 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).

5. Migration and Wintering Areas
Although most radio-marked adult Mexican spotted owls have been found to remain on or near their breeding territory throughout the year, some territorial owls migrated during winter. This migration generally entailed a change in elevation as Mexican spotted owls moved down slope in winter (Willey 1998a, Ganey and Block 2005b). Migrating radio-marked owls typically left study areas in November or December and returned from January to April. Distances moved typically ranged from 5 to 50 km (3 to 31 mi), although Gutiérrez et al. (1996) recorded a color-banded adult moving >160 km (>99 mi) south of its breeding territory. At present, there is little information on specific habitat features that migratory Mexican spotted owls use in wintering areas. Further, wintering owls are unlikely to vocalize (Ganey 1990), thus reducing detection. 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.

6. Key Habitat Variables
Throughout its lifetime, a Mexican spotted owl will use a variety of habitats to meet different life-history needs. To maintain a diversity of habitat types for the various activities of the owl, key habitat variables are required. These include nesting, roosting, and foraging habitat patches with structural, compositional, and successional diversity, as well as connectivity among suitable patches. Specifics regarding key habitat variables are found in Appendix C describing desired conditions.

E. Life History

1. Prey
Mexican spotted owls consume a variety of prey throughout their range. They commonly eat small- and medium-sized rodents such as woodrats, deer mice, pocket gophers, and voles, but they also consume bats, birds, reptiles, and arthropods (Ward and Block 1995). Their diet varies by geographic location (Ward and Block 1995). For example, Mexican spotted owls dwelling in canyons of the CP EMU take more woodrats and fewer birds than do spotted owls from other areas (Ward and Block 1995). In contrast, spotted owls occupying montane forests with forest-meadow interfaces, as found within the BRE EMU, consume more voles (Ward and Block 1995). Regional differences in the owl’s diet likely reflect geographic variation in presence and population densities of prey and across owl habitats. Forsman et al. (2001) also documented spatial variation in a regional analysis of diets of northern spotted owls. For additional information on food habits and prey selection see Appendix B.
2. Reproductive History

Mexican spotted owls nest in caves, in stick nests built by other birds, on debris platforms in trees, and in tree cavities (Johnson and Johnson 1985, Ganey 1988, Gutiérrez et al. 1995, Seamans and Gutiérrez 1995, Johnson 1997, Willey 1998a). They do not build nests; instead they rely on existing structures. Spotted owls exhibit one of the lowest clutch sizes among North American owls (Johnsgard 1988, Gutiérrez et al. 1995). Females normally lay one to three eggs, two being most common, and four observed rarely (LaHaye 1997, Gutiérrez et al. 2003). Re-nesting following nest failure is uncommon, but has been observed (Kroel and Zwank 1992, Gutiérrez et al. 1995).

Knowledge of the annual reproductive cycle of the Mexican spotted owl is important both in an ecological context and for placing seasonal restrictions on management or on other activities that could disturb nesting owls. Mexican spotted owls have distinct annual breeding periods, with timing that may vary slightly throughout their range but is generally consistent overall. In Arizona, courtship begins in March with pairs roosting together during the day and calling to each other at dusk (Ganey 1988). Eggs are laid in late March or, more typically, early April. Incubation begins shortly after the first egg is laid, is performed entirely by the female, and lasts approximately 30 days. During incubation and the first half of the brooding period, the female leaves the nest only to defecate, regurgitate pellets, or to receive prey delivered by the male, who does most or all of the foraging (Forsman et al. 1984, Ganey 1988). Eggs usually hatch in early May (Ganey 1988). Females brood their young almost constantly for the first few weeks after the eggs hatch, but then begin to spend time hunting at night, leaving chicks unattended for up to several hours (Forsman et al. 1984, Delaney et al. 1999a). Nestling owls (owlets) generally fledge in early- to mid-June, four to five weeks after hatching (Ganey 1988). Owlets usually leave the nest before they can fly, jumping from the nest to surrounding tree branches or the ground (Forsman et al. 1984, Ganey 1988). Fledglings depend on their parents for food early in the fledgling period. Hungry fledglings give a persistent, raspy “begging call,” especially when adults appear with food or call nearby (Forsman et al. 1984, Ganey 1988). Begging behavior declines in late August, but it may continue at low levels until dispersal occurs, usually from mid-September to early October (Arsenault et al. 1997, Ganey et al. 1998, Willey and Van Riper 2000).

Mexican spotted owls are sporadic breeders. Most of the population nests successfully in good years, whereas only a small proportion of pairs will nest successfully in poor years (Fletcher and Hollis 1994; Gutiérrez et al. 1995, 2003). This life history strategy allows owls to reproduce when conditions are favorable and to survive by reducing reproduction during unfavorable periods.
3. Fatality Factors

Several fatality factors have been identified as potentially important to the Mexican spotted owl, including predation, starvation, accidents, disease, and parasites. Although some owl carcasses have been found and examined by field biologists and laboratory personnel, most owls that die are not collected for sampling purposes. Even when dead owls are recovered, the cause of death is often difficult or impossible to determine because carcasses are often too decomposed. Consequently, we know little about the extent or relative importance of these fatality factors.

Predation. Mexican spotted owls are preyed upon by great horned owls, northern goshawks, red-tailed hawks, and golden eagles. Some of these predators occupy the same general habitats as the Mexican spotted owl, but there is little direct evidence that they prey on owls (Gutiérrez et al. 1995). Ganey (1988) reported one instance of apparent great horned owl predation on an adult spotted owl, but Ganey et al. (1997) did not document predation on Mexican spotted owls in a study involving radio-marked, sympatric spotted and great horned owls. We know of one report of a golden eagle preying on a Mexican spotted owl (R. Reynolds, RMRS, pers.comm.).

Starvation. When starvation occurs in resident adults, it is likely due to synchronous declines in prey populations which can result in impacts to a number of owls at one time. When low survival is combined with lack of reproduction, population decrease can be rapid. There is evidence that this occurs in some Mexican spotted owl populations (Seamans et al. 1999, Ward 2001, Gutiérrez et al. 2003). Starvation or hunger could predispose owls to accidents or predation if it drives them to hunt along roadsides or in other unfamiliar areas or in weakened condition.

Accidents. Instances of spotted owls being hit by cars have been documented (R. Skaggs, Glenwood, New Mexico, pers.comm.; R. Duncan, Southwestern Field Biologists, Tucson, Arizona, pers. comm.; S. Hedwall, FWS, pers. comm.; J. L Ganey, RMRS, unpubl.data). Roads involved in these accidents ranged from unpaved forest roads to paved highways. Owls flying at night also might collide with utility lines, tree branches, or other obstacles. This might be particularly true for birds migrating or dispersing through unfamiliar terrain (Martin 1986) or if new structures (such as fences) have been constructed since an owl occupied an area. Little information is available on how frequently collisions might occur or when they occur.

Research. Owl fatalities also can occur when capturing and handling owls for research purposes. Given the limited extent of research studies on Mexican spotted owls, such impacts are likely limited. Similarly, widespread inventory and monitoring surveys may impact Mexican spotted owl behavior to some unknown extent, but likely do not result in fatalities.

West Nile virus. Little is known about how disease and parasites contribute to fatality of spotted owls. One disease of particular concern is West Nile virus (WNV). This virus was first isolated in Africa, and it first appeared in the U.S. in 1999, in New York (see review in Blakesley et al. 2004). It spread rapidly across the country, and it has now reached the range of the Mexican spotted owl. Millions of birds have died from WNV since its arrival in the U.S., and all owl species appear to be susceptible (Fitzgerald et al. 2003, McLean 2006). The impact of WNV on Mexican spotted owls is difficult to ascertain. The WNV is an arbovirus that is transmitted primarily by mosquito vectors. In general, we know little about the abundance and behavior of
the relevant vectors in areas occupied by Mexican spotted owls. Thus, it is difficult to predict infection rates. We also do not know how many of the owls infected by WNV will die or suffer reduced viability, or whether or not owls develop some level of immunity to the disease following initial exposure. Recent surveillance in the Sierra Nevada of California failed to detect antibodies to WNV in California spotted owls (Hull et al. 2010). However, this could indicate lack of exposure, sampling error, or high mortality rates of infected individuals, leaving no survivors. Thus, all we can say with certainty at this time is that WNV occurs within the Mexican spotted owl’s range, and it has the potential to impact population viability of the owls.

Competition. Several other species of owls occur within the range of the Mexican spotted owl. In general, we know little about potential competitive relationships among these owl species. Logically, the two species most likely to compete directly with Mexican spotted owls are the great horned owl and the barred owl, based on their relative size, natural history, and, in the case of the barred owl, genetic similarity. Throughout much of the range of the Mexican spotted owl, the most likely competitor is the great horned owl (Forsman et al. 1984, USDI FWS 1995). This owl is larger than the Mexican spotted owl, and is sympatric with Mexican spotted owls throughout their range, and both owls are active at night, suggesting that they could compete for nocturnally active prey (Gutiérrez et al. 1995, Houston et al. 1998, Ganey and Block 2005b).

F. Population Trends

Mexican spotted owl population trends remain unclear. However, Mexican spotted owl population size for a specific area and time can be modeled using the combined effects of births, deaths, immigration, and emigration, which influence the viability of the population and its long-term persistence. Because these owls are long-lived, population trend studies must be long-term (i.e., at least 10 years). 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). Further, range-wide conclusions cannot be reliably inferred from the limited data available.

Environmental conditions greatly affect reproduction and/or survival of Mexican spotted owls, and environmental variability across space and time is pronounced within the range of the Mexican spotted owl (Gutiérrez et al. 2003). Consequently, understanding 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. In general, temporal variation in owl vital rates appears to be influenced by climatic factors, especially precipitation. Because estimated vital rates appear responsive to precipitation several months prior to the estimation period, Gutiérrez et al. (2003) suggested that precipitation influences vital rates through an indirect mechanism. They further proposed that this mechanism might involve precipitation influencing primary productivity, prey population dynamics and, ultimately, owl vital rates. A greater understanding of these interactions will be required to project the effects of climate change on Mexican spotted owls. For detailed information regarding specific studies of population trends and factors affecting Mexican spotted owl populations, see Appendix B.
We have learned a great deal about the Mexican spotted owl in the last decade, but significant information gaps remain. Most studies of the owl have been descriptive rather than experimental. 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. These considerations suggest that additional research would contribute greatly to our understanding of the owl (see Part V.F), and that management recommendations in the near-term must deal with high levels of uncertainty.

G. Critical Habitat

On 31 August 2004, the FWS designated approximately 3.5 million ha (8.6 million ac) of critical habitat for the Mexican spotted owl on Federal lands in Arizona, Colorado, New Mexico, and Utah (69 FR 53181). Within the critical habitat boundaries, critical habitat includes only protected and restricted habitats as defined in the original Recovery Plan (USDI FWS 1995). Similarly, the primary constituent elements of critical habitat were listed as those habitat features recognized in the 1995 Recovery Plan as associated with Mexican spotted owl occupancy, as follows:

1. Primary Constituent Elements Related to Forest Structure:
   - A range of tree species, including mixed-conifer, pine-oak, and riparian forest types, composed of different tree sizes reflecting different ages of trees, 30-45% of which are large trees with a trunk diameter of ≥0.3 m (12 in) when measured at 1.4 m (4.5 ft) from the ground;
   - A shaded canopy created by the tree branches and foliage covering ≥40% of the ground; and,
   - Large, dead trees (i.e., snags) with a trunk diameter of at least 0.3 m (12 in) when measured at 1.4 m (4.5 ft) from the ground.

2. Primary Constituent Elements Related to Maintenance of Adequate Prey Species:
   - High volumes of fallen trees and other woody debris;
   - A wide range of tree and plant species, including hardwoods; and,
   - Adequate levels of residual plant cover to maintain fruits, seeds, and allow plant regeneration.

3. Primary Constituent Elements Related to Canyon Habitat (one or more of the following):
   - Presence of water (often providing cooler air temperature and often higher humidity than the surrounding areas);
   - Clumps or stringers of mixed-conifer, pine-oak, pinyon-juniper, and/or riparian vegetation;
   - Canyon walls containing crevices, ledges, or caves; and,
   - High percentage of ground litter and woody debris.
H. Threats and Threats Assessment

1. Reasons for Listing

The Mexican spotted owl, listed as a threatened species under the ESA in 1993 (58 FR 14248), is one of three subspecies of spotted owl. Under Section 3 of the ESA, the term species includes “...any subspecies of fish or wildlife...” Although the Mexican spotted owl is a subspecies, it is sometimes referred to as a species in the Recovery Plan when discussed in the context of the ESA or other laws and regulations. An endangered species is defined under the ESA as “...any species which is in danger of becoming extinct throughout all or a significant portion of its range...” A threatened species is one “...which is likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range.” Section 4(A)(1) of the ESA lists five factors that can, either singly or collectively, result in listing a species as endangered or threatened provided their effects are significant enough that the species meets one of the above definitions. We summarize those five factors below, as they were discussed in the 1993 final listing rule (58 FR 14248). Our assessment of the current situation with regard to the subspecies’ status and threats is reflected, below.

a. Present or Threatened Destruction, Modification, or Curtailment of the Mexican Spotted Owl’s Habitat or Range (Factor A)

Timber-harvest practices in the Southwestern Region (Region 3 of the FS; within Region 2 of the FWS) were cited as the primary factors threatening the continued existence of the owl. The final rule stated that the FS managed timber primarily under a shelterwood harvest regime. This harvest method produces even-aged stands rather than the uneven-aged, multi-layered stands that are most often used by owls for nesting and roosting. In addition, the shelterwood silvicultural system calls for even-aged conditions in perpetuity. Thus, stands already changed from “suitable” (i.e., presently supporting Mexican spotted owls) to “capable” (i.e., not currently supporting Mexican spotted owls but with the potential to support them in the future) would not be allowed to return to a suitable condition. Acreage slated for future harvest would be similarly rendered perpetually unsuitable for owl nesting and roosting.

The final listing rule stated that “...significant portions of spotted owl habitat have been lost or modified,” and it cited Fletcher (1990) in estimating that 420,000 ha (1,037,000 ac) of habitat on FS-administered lands were converted from suitable to capable. Of this, about 78.7%, or 330,000 ha (816,000 ac) was converted as a result of human activities, whereas the remainder was converted primarily by wildland fire. We were not aware of similar data for Mexico, so could not provide information about habitat change in Mexico. According to the final rule, forest plans in FS Region 3 allowed up to 95% of commercial forest (59% of suitable Mexican spotted owl habitat) to be managed under a shelterwood system. The final rule also cited the loss of lower- and middle-elevation riparian habitat plus habitat lost to recreation developments as factors in habitat loss.
b. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (Factor B)

The final listing rule stated that scientific research had the greatest potential for overutilization of the Mexican spotted owl, whereas overutilization for birding and education were likely to increase as the owl became better known. The effects of these activities, either chronically or acutely, were unknown.

c. Disease or Predation (Factor C)

The final listing rule stated that great horned owls and other raptors are predators of Mexican spotted owls. The rule implied that forest management created transition habitats (i.e., ecotones) favored by great horned owls, thus creating an increased likelihood of contact between the two owl species.

d. Inadequacy of Existing Regulatory Mechanisms (Factor D)

The final listing rule discussed various Federal and state laws and agency management policies, concluding that existing regulatory mechanisms were inadequate to protect the owl. Specifically cited was the conflict between attaining assigned timber-volume targets and management of occupied and unoccupied Mexican spotted owl habitat.

e. Other Natural or Manmade Factors Affecting the Mexican Spotted Owl’s Continued Existence (Factor E)

The final listing rule cited wildland fires as a threat to owl habitat. The potential for increasing malicious and accidental anthropogenic harm to the species was also cited as a possible threat. In addition, the final listing rule recognized the potential for the barred owl to expand its range into that of the Mexican spotted owl, resulting in possible competition and/or hybridization. It was speculated that habitat fragmentation may encourage and hasten this expansion.

2. Federal Actions Affecting the Mexican Spotted Owl

Since the Mexican spotted owl was listed as threatened, the FWS has completed numerous formal consultations on actions affecting this subspecies. These formal consultations have reviewed Federal agency actions affecting over 400 PACs (S. Hedwall, FWS, pers. comm.). Agencies initiating consultation have included the FS, Bureau of Indian Affairs (BIA), DOD (including Air Force, Army, and Navy), Department of Energy (DOE), NPS, BLM, and Federal Highway Administration (FHwA). Proposed projects have included timber sales, road construction, fuels treatments, fire/ecosystem management projects (including prescribed natural and management-ignited fires), livestock grazing, recreation activities, utility corridors, military and sightseeing overflights, oil and gas exploration and extraction, and other activities. 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); and, 2) the release of site-specific owl location information (that information was ultimately released under the
Freedom of Information Act, but the release is not known to have resulted in adverse effects to the owl).

3. Factors Affecting the Mexican Spotted Owl in the United States

Section 4 of the ESA requires consideration of five factors when determining whether a species should be listed, delisted, or reclassified under the ESA. Thus, in this revised Recovery Plan, we included an up-to-date five-factor analysis (Part II.H) to ensure that recommended recovery actions (Appendix C) address the factors responsible for the species’ threatened status.

In this section we analyze factors currently influencing the species. The activities we discuss may not necessarily be threats *per se*, depending on their level of intensity, duration, or geographic extent. The activities and situations we discuss are potential influencing factors on the owl and/or its habitat, and we evaluate their impacts herein.

a. Present or Threatened Destruction, Modification, or Curtailment of the Mexican Spotted Owl’s Habitat or Range (Factor A)

Human-managed alteration of forests in the southwestern U.S. has resulted in extensive areas of Mexican spotted owl habitat that are now more vulnerable to the effects of stand-replacing wildland fires. A plethora of ecological and historical research has documented intensified land-use in southwestern U.S. forests beginning in the 1880s with European-American settlement (Weaver 1951; Cooper 1960; Bahre 1991, 1995; Swetnam et al. 1999). Livestock grazing and selective timber harvesting were identified as management practices that resulted in substantial changes to forests (e.g., Fulé et al. 1997, Kaufman et al. 1998, Swetnam and Baisan 2003). Furthermore, human land-use practices resulted in fire exclusion, altering pre-settlement forest ecology throughout the Southwest.

Frequent, low-intensity surface fire regimes played an important role in the evolution and ecology of pine-oak, ponderosa pine, and mixed-conifer forests prior to European-American settlement (Weaver 1951, Cooper 1960, Grissino-Mayer et al. 1995a, Swetnam and Baisan 2003). The primary fuels for these low-intensity surface fires included conifer needles, leaf litter, grasses, and forbs. During pre-settlement, low-intensity surface fires burned regularly across southwestern forests (Swetnam 1990, Swetnam and Baisan 1996a).

Pine-oak and ponderosa pine forest fire-scarred trees have recorded mean fire intervals of every 2–14 years, while dry mixed-conifer-site intervals ranged from 9–30 years (Dieterich 1983; Kaib et al. 1996; Swetnam and Baisan 1996b; Swetnam et al. 1999; Brown et al. 2001; Grissino-Mayer et al. 1995a, 1995b; Heinlein et al. 2005; Brown and Wu 2005; Fulé et al. 2009). The more frequent fire intervals occurred in the lower elevations and on southern slope-aspects in the pine-oak, ponderosa, and dry mixed-conifer forests. In the higher elevations and on northern aspects with wetter mixed-conifer forests, mean fire intervals were longer with greater variation, and fire effects included mixed severities with surface and stand-replacing fire characteristics often discernible within existing aspen stands (e.g., Brown et al. 2001, Fulé et al. 2004, 2009; Margolis et al. 2007, Margolis and Belmat 2009). Fires were less frequent in arid and rocky-
canyon habitats, where natural fire barriers and limited fuels existed (Swetnam and Baisan 1996a, 1996b; Brown et al. 2001; Swetnam et al. 2001; Fulé et al. 2003a, 2003b).

Historical descriptions of mixed-conifer forests 100 or more years before present included a variety of conditions depending on the time since and severity of the most recent fire incidents. Accounts of mixed-conifer forest described large old Douglas-fir trees and understories composed of vigorous ponderosa pines and regeneration cohorts of Douglas-fir. Fulé et al. (2004, 2009) found that mixed-conifer forest composition and structural changes between 1880 and 2004 included >50% increases in basal area (BA) from smaller diameter age classes, declines in ponderosa pine, increases in white fir, subalpine fir, and spruce, and a decline in early seral habitats at higher elevations. Others have noted similar changes to mixed-conifer forest in different mountain ranges of the Southwest (Heinlein et al. 2005, Margolis et al. 2007, Margolis and Belmat 2009).

i. Stand-replacing Fire

Current forest conditions have the potential to sustain landscape-scale stand-replacing fires that would positively or negatively alter owl habitat over extensive landscapes in a single fire incident, depending on certain conditions discussed below. Indeed, several large fires—Whitewater-Baldy, Wallow, Las Conchas, Cerro Grande, Rodeo-Chediski, Hayman as examples—have burned in owl habitat since 1996. Thus, broad-scale, high-severity, stand-replacing fires have had, and will likely continue to have, long-term effects on both watershed and forest function (Fulé et al. 2004). Wildland fires can cause direct and indirect effects from combustion, charring, heating, smoke, and biophysical changes to the burned area. Dense forests with heavy fuel accumulations, like many forests in the southwestern U.S., are at greater risk to high-severity and stand-replacing fires (Fulé et al. 2004). The potential effects of fire and related activities on owls depend upon:

- whether or not the fire and/or suppression activities are within owl habitat;
- type of habitat involved (e.g., nest/roost, foraging, dispersal habitat);
- severity and intensity of the wildland fire;
- areal extent, location, and intensity of suppression activities;
- frequency and cumulative effects of the suppression activities; and,
- time of year.

Direct and indirect fire effects on habitat include the alteration of vegetation structure, soil, and watershed conditions. These effects can be detrimental, beneficial, or both depending on the six factors we list above. Evaluation of effects is also dependent on temporal scale; effects that are detrimental in the near-term may have long-term beneficial effects. Conversely, fires may provide short-term benefits, but result in stand degradation over time. The fire-severity class is directly related to the magnitude of these effects, and it also influences whether such effects are positive or negative on owl habitat. 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). Bond et
al. (2002) monitored the fate of 21 color-marked owls representing all three (northern, California, and Mexican) spotted owl subspecies. 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).

Bond et al. (2009) evaluated wildland fire effects on seven radio-marked California spotted owls and found that owls roosting during the breeding season selected low-severity burned forest and avoided moderate- and high-severity burned areas. Bond et al. (2009) also found that most owls foraged in high-severity burned forest more than other burned-forest categories. 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-Chediski Fire on the Mogollon Rim in Arizona), failed to locate Mexican spotted owls (S. Hedwall, FWS, pes. comm.).

The Recovery Team examined the rate of fire burning at different severities in the owl’s habitat in the U.S. during a recent (1996-2005) period and then used the rate of high-severity fire to project the potential for habitat alteration and loss by high-severity wildland fire. This analysis indicated that the effects of future fire on the owl’s habitat will very likely depend on the type of habitat that is occupied. Owl populations dwelling in canyon habitats may be at less risk than those dwelling in forested habitats. 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. This is especially true when considering that 55 spotted owl PACs experienced some degree of high-severity stand-replacing fire in the 2002 Rodeo-Chediski Fire, including approximately 33,000 PAC acres that were reduced to an early successional stage. In 2011, the largest wildland fire in Arizona history, the Wallow Fire, impacted 76 PACs. As of this time, we do not have fire severity data for owl habitat within the Wallow Fire, nor do we have information yet for the 2012 Whitewater-Baldy fire impacts to owls in New Mexico. Furthermore, most climate-change models predict hotter and drier conditions in the southwestern U.S. in future decades, which will increase susceptibility of forests to large-scale, stand-replacing fires. Therefore, this Recovery Plan provides management recommendations to reduce fire risk to PACs and recovery habitat valuable to spotted owls while maintaining the integrity of nest/roost core areas (see Appendix C).

### ii. Fire Suppression

Fire-suppression activities can result in habitat loss through building of fire lines, construction of support areas such as helipads and fire camps, and ignition of backfires and burnouts to reduce the amount of fuel available to the wildland fire. Whether the habitat effects of fire-suppression activities cause more or less impact to habitat than the benefits gained by controlling the fire can only be determined site-specifically, and then only to the extent that with-suppression and without-suppression scenarios can be accurately evaluated. Fire-management teams typically include resource advisors whose responsibility is to assess and attempt to minimize potential
effects to threatened, endangered, and sensitive species habitats. Although fire-suppression activities can have significant negative effects on owl habitat, at least locally, fire suppression tactics like backfires and burnouts can also be used to reduce fire severity and canopy losses. Management recommendations to minimize adverse effects of fire-suppression activities are provided in Appendix C.

iii. Burned Area Response

Emergency stabilization (ES) and burned area rehabilitation (BAR) treatments are applied to stabilize and rehabilitate a burned area so that it can recover more rapidly. ES is performed within one year of the wildland fire to stabilize and prevent unacceptable degradation to natural and cultural resources, to minimize threats to life or property resulting from the effects of a fire, or to repair/replace/construct physical improvements necessary to prevent degradation of land or resources (USDA and USDI 2006). BAR is undertaken within three years of wildland fire containment to repair or improve fire-damaged lands unlikely to recover naturally to management-approved conditions, or to repair or replace minor facilities damaged by fire (USDA and USDI 2006). Methods of ES and BAR include aerial mulching and seeding, tree planting, and construction of water/soil control structures (e.g., gabions, water bars, straw bales). From a habitat standpoint, ES and BAR activities are probably beneficial in that they provide protection of soils, thereby reducing the likelihood of permanent soil loss in preparation for longer-term rehabilitation efforts. Use of non-native species, however, for post-fire seeding is often ineffective at meeting management objectives and may have long-term implications on forest ecology (Peppin et al. 2010).

ES and BAR activities probably do not constitute a significant threat to spotted owls, but treatments instituted post-fire can have an effect on stand structure well into the future. We therefore provide management recommendations for this activity in Appendix C.

iv. Wildland Urban Interface (WUI) Treatments

Guidance for Implementation of Federal Wildland Fire Management Policy (Fire Executive Council 2009) defined the WUI as the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels. These areas may include critical communications sites, municipal watersheds, high-voltage transmission lines, observatories, camps, research facilities, and other structures that, if destroyed by fire, would result in hardship to people and communities. The WUI often is defined to encompass these sites and a buffer that includes continuous slopes and fuels that lead directly to the sites, regardless of distance. The amount of area included can be substantial. For example, the WUI within the Sacramento Ranger District of the Lincoln National Forest in New Mexico encompasses over 80% of the district as defined by Otero County under the auspices of the Healthy Forests Restoration Act (HFRA; see discussion in 8.B.d, below). 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).
Analyses for the purpose of planning WUI treatments consider the “condition class” of the vegetation. Condition classes are a function of the degree of departure from historical fire regimes resulting in alterations of key ecosystem components such as species composition, structural stage, stand age, and canopy closure. One or more of the following activities may have caused this departure: fire exclusion, timber harvesting, grazing, introduction and establishment of exotic plant species, insects and disease (introduced or native), or other past management activities. Condition class one means that fire regimes are within or near historical range. In condition class two, the fire regime and vegetation structure and composition have been moderately altered; that is, >1 fire cycle has been missed, allowing for denser stocking and an increase in understory woody species. Areas in condition class two primarily include pinyon/juniper woodlands and mixed-conifer stands. Fire condition class three indicates that the fire regime and vegetation structure and composition are substantially altered; that is, multiple fire cycles have been missed. Forests and woodlands are now densely stocked, and there is a greater risk from uncharacteristic high-severity wildland fire effects. This typically applies to pine and pine-oak stands. Of the forested areas identified for treatment in the WUI within the FS Southwestern Region, 85% (or 650,000 ha [1.6 million ac] of the 730,000 ha [1.86 million ac]) occur in fire condition class two and three.

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.

In summary, large blocks of land are scheduled to be treated to reduce fire risk and protect human communities throughout the Mexican spotted owl’s range within the U.S. (USDA, USDI 2001). Prather et al. (2008) evaluated potential conflicts between fuels-reduction treatments and spotted owls in the western Mogollon Plateau and concluded that there were ample opportunities to treat forests without compromising owl habitat. In the Sacramento Mountains of New Mexico, however, intensive landscape-wide treatments aimed at ensuring community protection, public health and safety, and ecological functionality have the potential to impact a large percentage of the known PACs in the BRE EMU. As proposed, the intensity of many of these treatments may affect owls and owl habitat negatively. Also, note that many proposed treatments within the WUI were not consistent with guidelines in the 1995 Recovery Plan. As such, some WUI treatments may represent a threat to the owl, and we address these threats in Appendix C.
v. Silvicultural Treatments

A review of recent harvest data from the 11 National Forests in Arizona and New Mexico (i.e., FS Region 3) shows a shift in the type of harvest activities performed over the past few decades. Prior to the 1980s, but post World War II, harvesting throughout the Southwest tended to cover large, contiguous areas. The number of trees per acre removed was highly variable and generally consisted of removing trees that were unhealthy and expected to die in the near future, old-growth trees, and/or trees that overtopped/shaded vigorous regeneration. It was not uncommon to utilize the same harvest methods and systems on thousands of contiguous acres. This type of harvest activity could neither be clearly classified as even-aged or uneven-aged forest management, because there was no real area control (even-aged) or volume control (uneven-aged) associated with this harvesting approach.

By the mid 1980s, all 11 National Forests in FS’s Region 3 had either completed or were close to completing their individual forest plans. All of the plans at that time emphasized: 1) even-aged management; 2) discrete stand-size treatment units; and, 3) short rotation ages, generally 100-140 years. This management regime called into question whether old growth could be developed and maintained in large blocks scattered over the landscape. Although even-aged management applied in stand-size areas across the landscape might provide horizontal vegetative structural diversity, within-stand vertical diversity could not have been maintained.

In the early 1980s, timber harvesting approached 80,000 ha/yr (200,000 ac/yr) across Region 3 of the Forest Service. By the time the last forest plan was completed in 1987, annual harvest rates throughout Region 3 had dropped to approximately 60,000 ha/yr (150,000 ac/yr). By 1990, total harvest rates in the region dropped to approximately 40,000 ha/yr (100,000 ac/yr), or half what it was in the early 1980s. Since the early 1990s, commercial harvest rates have steadily declined to their current level of approximately 4,000 ha/yr (10,000 ac/yr).

With the incorporation of the Goshawk Management Guidelines into all 11 southwestern forest plans in 1996, management of most of the ponderosa pine type and much of the mixed conifer type outside of areas managed for spotted owls shifted to 0.04- to 1.6-ha (0.1- to 4-ac) groups consisting of 6 vegetative structural stages (Reynolds et al. 1992). Since this time, Region 3 has developed desired conditions for forest management. These desired conditions are not finalized at the time of this writing, and how they will translate into on the ground management, particularly for the owl, is unknown.

Beginning in the early 2000s after the Cerro Grande, Rodeo Chedeski, and other large destructive wildland fires, and after completion of the National Fire Plan, most silvicultural treatments within the region were designed to reduce BA and the number of trees per acre by thinning forests from below (removing most smaller-diameter trees) within the WUI areas (see discussion above).

Another form of intermediate cut performed in the FS’s Region 3 is sanitation/salvage cutting. Sanitation/salvage has been performed since commercial logging first began prior to the 1900s. This type of intermediate treatment has declined in recent years; however, today salvage harvesting treatment is getting greater attention due to the increasing number of large, stand-replacing fires and increased insect-induced mortality in ponderosa pine and mixed conifer.
forests. Those treatments are generally located in high severity burned areas and areas of extensive beetle-killed trees. In addition, FS Region 3 salvage operations generally involve no new road construction, logging only on slopes <30–40%, and removing only trees that are completely dead or determined to be dying. Region 3 data show that, between 2000 and 2009, 18,259 ha (45,100 ac) of harvested timber were sold as salvage sales.

There is considerable controversy over the effects of salvage logging following stand-replacing fire, and most salvage projects are appealed and/or litigated in the courts (Karr et al. 2004). Proponents of salvage logging believe that harvesting dead trees will reduce the need to harvest live trees and see the failure to log some of the dead trees as a waste of a valuable natural resource; many also see salvage logging as a way to help reduce future burn severity or provide biomass to the forest floor to help minimize erosion. Others think that the severe fire had already caused substantial environmental harm and that salvage logging may result in more environmental damage (e.g., Donato et al. 2006, Lindenmayer et al. 2008).

In summary, non-salvage even-aged timber-harvest activities that were the primary threat leading to listing of the owl as a threatened species have been greatly reduced in extent and severity since 1996 from the levels implemented at the time of listing in the FS’s Region 3. The majority, but not all, of selection harvesting in Region 3 is group selection where small (0.04- to 1.62-ha [0.1- to 4-ac]) openings are created to encourage natural regeneration. These group openings generally comprise 10-20% of the stand. The remaining 80-90% of the stand is either thinned to encourage more vigorous tree growth or treated to reduce stocking by use of group selection to favor more seral tree species, or to reduce existing fuel loading. We have no definitive information on harvest levels and prescriptions on non-NFS lands; however, based on the current situation in the FS’s Region 3, we do not consider even-aged timber harvest (i.e., activities designed to capture wood volume or provide for even-aged stand regeneration) to be a significant threat to the species.

Fuelwood collection for personal and commercial use occurs throughout the forested range of the Mexican spotted owl in both coniferous and riparian forests. Fuelwood harvest can result in the loss of habitat components such as hardwoods (especially Gambel oak), snags, large logs, and large woody riparian vegetation. Owl researchers have recommended the prohibition of this activity in owl habitat to protect these habitat components (Seamans and Gutiérrez 1999, May and Gutiérrez 2002, Block et al. 2005). We do not have information regarding the scale of this activity, but provide some management recommendations in Appendix C.

vi. Insects and Disease

Native forest insects and diseases are natural ecosystem processes with which the owl has evolved. The influences of these ecosystem processes on owls can be either negative or positive, depending on intensity and extent, both within and among forest-pathogen types. For example, patches of mixed conifer subjected to bark beetle outbreaks can deteriorate to the point that they are of little use to Mexican spotted owls and are vulnerable to severe wildland fire. This may be especially significant in areas, such as those described above, where significant habitat has already been lost and where remaining habitat is under environmental stress. However, scattered patches of beetle-infested forest may provide for forest heterogeneity, resulting in abundant and
diverse prey. Similarly, dwarf mistletoe likely has some beneficial effect in providing nest sites for spotted owls as well as supporting the life-history requirements of spotted owl prey, while it also acts synergistically with other forest stressors to induce tree mortality (Lundquist and Ward 2005, Stubblefield et al. 2005, Hedwall and Mathiason 2006, Hedwall et al. 2006).

Native insects and disease likely are an issue for owl habitat only when they reach epidemic levels. Species of primary interest in this context in the southwestern U.S. include several species of bark beetles and defoliating insects (names given below), dwarf mistletoe, and root decay fungi (USDA FS 2004). An intensive and ongoing drought-induced bark beetle outbreak has caused extensive fatalities in pinyon-juniper woodlands and ponderosa pine and mixed-conifer forests (Breshears et al. 2005, 2011; Negrón et al. 2009). In some cases tree fatality has been nonrandom, with greater mortality rates in the larger trees favored by owls than in smaller trees (Mueller et al. 2005; J. L. Ganey, RMRS, unpubl. data).

Defoliators, sapsuckers, and beetles have reached outbreak proportions in areas such as the White and Pinaleno mountains, Arizona, and Sacramento Mountains, New Mexico. The Pinaleno outbreak included spruce aphid (Koprowski et al. 2005, Lynch 2009), Janet’s looper (Lynch 2007), spruce beetle, and western balsam bark beetle. The Pinaleno event covered at least 162 ha (400 ac) with an estimated mortality in affected areas of 85%; mortality rates ranged from 15-20% in the Sacramento and White mountains, respectively (Lynch 2004, Koprowski et al. 2005, Lynch 2007). There is some evidence that outbreaks were associated with increasingly warm temperature regimes (Lynch 2003), suggesting that such outbreaks may increase if the climate becomes warmer in the Southwest (e.g., Seager et al. 2007).

Douglas fir dwarf mistletoe induced witches’ brooms can be beneficial to owls in mixed conifer forest by providing nest-site platforms (Ganey 1988, Fletcher and Hollis 1994, Seamans and Gutiérrez 1995, May et al. 2004) and supporting important prey species (Hedwall and Mathiasen 2006, Hedwall et al. 2006). As stated above, in many areas across the Southwest dwarf mistletoe levels have likely increased over the last century due to greater tree density resulting from fire suppression and cattle grazing (Conklin and Fairweather 2010). This greater density allows for easier tree-to-tree spread of mistletoe (Mathiasen et al. 1990) and lack of surface fire allows more branches to exist in the lower crowns of trees than would be present if these forests burned frequently. These lower branches help to increase levels of dwarf mistletoe infection, and the resulting witches brooms provide fuel ladders that allow fire to move into the canopy more easily. So, though dwarf mistletoe is a positive feature of Mexican spotted owl habitat, it can also increase the risk of high-severity fire in owl habitat.

Decay fungi can kill trees or predispose trees to death by other agents. However, heartrot fungi, which decay the inner core of living trees, are essential in providing cavities for owl nests in both snags and living trees. Decay levels by heartrot fungi are typically proportional to tree and stand age (Lightle and Andrews 1968, Abella 2008, Worral and Fairweather 2009), so retaining old trees on the landscape with this type of decay is essential to maintaining owl habitat.

In summary, insects and diseases, while naturally occurring, can pose some risk to spotted owls when they involve exotic species or when native-species infestations are exacerbated by unnatural stand conditions, drought, climate change, or other factors. If the range of the owl becomes hotter and drier (see Part II.H.3.e.iv below), insect and disease outbreaks can be
expected to increase in frequency, extent, intensity, and duration. We provide recommendations to manage this potential threat in Appendix C.

vii. Grazing

Effects on Mexican spotted owls from grazing by wild ungulates and domestic livestock are complex, and multiple factors may determine specific influences. These factors include local and regional climatic patterns, biotic community associations and ecology, soil types and conditions, and the timing, intensity, and duration of vegetation removal associated with the presence of grazing animals. Adding to the complexity are the interrelationships of grazing and other ecological processes, such as changes in herbaceous plant composition, woody vegetation structure, soil stability and ecology, and fire regimes. Although the effects of grazing on owls are complex, they generally fall into two categories: 1) those that result in relatively short-term effects requiring short recovery periods to restore suitable habitat characteristics; and, 2) those that result in long-term alterations in plant-species composition and vegetation structure. For example, properly managed grazing in key owl foraging areas that consistently maintains residual herbaceous biomass of forage species, sufficient to allow for individual plants to recover and reproduce during most growing seasons, should provide cover and food sources for some prey species (especially during drought periods). In contrast, grazing that allows for moderate-to high-intensity grazing throughout several successive growing seasons may result in impaired vegetation productivity and ultimate changes in species composition, density, and vigor, which can degrade spotted owl prey habitat characteristics over the long-term.

Although we lack direct information relating livestock grazing to spotted owls, we can draw inferences based various pieces of information. Improper management of livestock grazing may adversely affect the owl 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 fire; 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 impacts are most likely to affect owls where individual owls forage in or adjacent to grazed areas preferred by wild and domestic ungulates, including montane meadows, riparian corridors, or canyon bottoms (Ward and Block 1995, Willey 2007, Willey and Willey 2010).

Similar effects occur where large wild ungulates, such as elk, congregate or remain with little or no seasonal migration. Browsing impacts of wild ungulates on deciduous woody species (e.g. maple, locust and aspen) have been shown to be greater in areas where wild ungulates overwinter (Martin 2007). Seasonal migration of elk is greatly influenced by winter snowfall (Martin 2007), resulting in situations where higher elevation summer ranges may receive little if any seasonal deferment from elk grazing and browsing pressure during low snowfall winters. The impacts of elk browsing on aspen communities has been studied extensively (Bartos et al. 1994, Rolf 2001, Kaye et al. 2005, Bailey et al. 2007, Fairweather et al. 2007, Beschta and Ripple 2010, ), and is less seasonally influenced than the predominantly winter browsing on other deciduous species (Martin 2007). Browsing impacts on heavily utilized elk ranges have compounded the effects of historical fire suppression policies and resulted in forest stand structures that are more susceptible stand-replacing wildland fires (Cocke et al. 2005).
Domestic livestock and wild ungulate management that results in consistent heavy to severe utilization levels during the growing season reduces height and horizontal distribution of herbaceous plants that serve as protective cover and food sources for some of the owl’s prey species, most notably voles (Birney et al. 1976, Getz 1985, Peles and Barrett 1996). Reduction of herbaceous plant biomass may also influence the food of other prey species (e.g., Peromyscus spp.) by removing or reducing the availability of plant seeds. Over time, without sufficient opportunities for growing season biomass recovery and seed production within these plant communities, their ecological condition will not be maintained or improved (Holechek et al. 2001), and some sites may fall into a degraded ecological condition (Kothmann 2009). Where limited herbaceous cover and seed production persist in preferred owl foraging areas over several breeding seasons, reduction of prey availability can limit the energy intake of those owls, particularly when other prey species are concurrently limited. These conditions can contribute to reduced reproduction and declines in some owl populations (Willey and Willey 2010).

In areas that are heavily grazed over long periods of time, reductions in herbaceous ground cover and increased density of shrubs and small trees can decrease the potential for beneficial low-intensity surface fires while increasing the potential for destructive, high-intensity crown fires (Zimmerman and Neuenschwander 1984). Likewise, in areas where continuous heavy browsing has occurred as a result of reduced snowpack observed over the past 20 years, suppression of juvenile hardwood and aspen recruitment into the overstory of riparian and upland forests has contributed to ecological changes in forest structure (Martin 2007).

Heavy grazing intensity in riparian areas, particularly within canyons, can reduce or eliminate important shrub, tree, forb, and grass cover, all of which in some capacity support the owl or its prey. Poorly managed grazing of riparian plant communities can also physically damage stream channels and banks (Ames 1977, Kennedy 1977, Kauffman et al. 1983, Blackburn 1984, Clary and Webster 1989, Platts 1990). Deterioration of riparian vegetation structure can allow channel widening. This event, in turn, elevates water and soil temperatures and thus evaporation and lowering of water tables, as well as significantly increasing the potential for accelerated flood damage (Platts 1990). These processes alter the microclimate and vegetative development of riparian areas, potentially impairing its use by spotted owls. Prolonged use of these key habitats by large ungulates can alter plant reproduction and recruitment (e.g., cottonwoods, oaks), along with other negative habitat impacts including alteration of stream corridor morphology and hydrology, compaction of soil, and removal of stabilizing vegetation such as willows, sedges, and other native plants (Kennedy 1977, Rickard and Cushing 1982, Kauffman and Krueger 1984, Fleischner 1994, Krueper 1996). These impacts retard development of riparian, oak, and other plant communities into habitat that can be used by owls for roosting, nesting, or dispersal. Where riparian areas act as refuges for small mammals during drought periods, the impacts of grazing also may influence future prey abundance.

In summary, we view grazing by domestic and wild ungulates as a potential threat to spotted owls when managed insufficiently as to its effects on prey species habitat (e.g., reducing herbaceous ground cover), nest/roost habitat (e.g., limiting regeneration of important tree species, especially in riparian areas), and the capacity for resource managers to restore and maintain conditions supporting natural fire regimes within an array of habitat types. Grazing by domestic and wild ungulates is prevalent and recurring within most Mexican spotted owl habitat
types. Thus, this potential threat occurs throughout the owl’s range and often during periods of its reproductive cycle when prey availability is most critical. The magnitude of the threat is greatly dependent on the duration, timing, and intensity of grazing, and if insufficiently managed, both short-term and long-term adverse affects on the owl’s habitat and that of its prey species may occur in the future. We provide management recommendations (Appendices C and D) because management of both domestic and wild large ungulates will likely continue in the owl’s habitat.

viii. Energy Development

Energy development includes oil, gas, wind, and solar extraction/harvest activities, exploration, and associated infrastructure developments (e.g., construction, maintenance, and expansion of power lines, pipelines, and roads). These activities may affect owls through alteration of habitat (effects from electrocutions, collisions, and disturbance are discussed under the relevant threat factors). Habitat alteration may be caused by facility (e.g., well pads, pipelines, power lines, wind turbines) and/or road construction, as well as exploration equipment and, rarely, by subsidence (e.g., collapsing of caves). Construction activities often involve use of large equipment potentially directly impacting habitat through removal of large trees, dead and down materials, etc. Such activities may also increase accessibility, opening areas to increased human disturbance.

There is little information on the extent of energy development activities in Mexican spotted owl habitat; however, information on oil and gas activities and wind energy development is available for the four states that make up the majority of the Mexican spotted owl’s range. This information is only reported by state, and therefore includes information from outside of the owl’s range (e.g., Colorado plains east of the Rocky Mountains). We include this information here as a crude (but the best available) index of current trends and relative magnitude of oil, gas, solar, and wind energy activities.

In the four-corner states, the number of active oil and gas wells increased by approximately 86% between 1993 (when the owl was listed) and 2009 (the most recent year for which data are available). In 2009, there were an estimated 110,021 wells, up from 59,200 wells in 1993 (Energy Information Administration 2011). The harvest of wind energy is also growing rapidly in the western U.S.; as of September 2009, there were 794 wind turbines either built or under construction in the four-corner states (AWEA 2009). We are unable to quantify the acreage of owl habitat impacted by these development activities, but make recommendations to address the effects of oil, gas, and wind energy development in Appendix C.

Another component of energy development is the construction and long-term maintenance of utility lines. Construction of utility lines can result in removal of owl habitat (e.g., trees, snags, logs) and disturbance to breeding owl from vegetation removal and construction activities. In addition, power line maintenance involves low-level air flights to inspect lines, tree and vegetation clearing to protect lines, and removal of coarse woody debris to reduce fire risk. These actions can result in loss or modification of nest/roost habitat and disturbance. We cannot quantify the extent of habitat lost to powerline construction and maintenance, but the FWS
consulted on powerline maintenance activities on four National Forests in Arizona that resulted in incidental take of owls associated with 16 PACs.

ix. Roads and Trails

Construction of roads and trails can indirectly affect Mexican spotted owls through loss and fragmentation of habitat (we discuss the effects of increased noise potential, human access, and direct fatality in Part II.H.3.e.iii below). In general, habitat loss to road construction is minor on a rangewide scale when compared to more massive habitat losses observed from other causes (e.g., wildland fires, past harvest practices); however, on a local scale, roads and trails through PACs may fragment habitat continuity, alter natural movement patterns, and increase disturbance to resident owls. Roads in nest/roost, forested, and riparian recovery habitat may also result in loss of habitat components (e.g., large logs, large snags, hardwoods) as people access these areas for fuelwood cutting, and in sensitive riparian areas, roads and trail can inhibit hydrological processes that affect proper functioning ecological conditions. Management recommendations regarding roads are provided in Appendix C.

x. Land Development

Land development is the conversion of natural land covers to non-natural surfaces for human use, including housing, commercial enterprises, and the associated infrastructure such as roads, trails, and utility structures. Land development occurs along a gradient from urban development to exurban and rural development. Exurban development is defined by either population or housing density, but it is commonly considered to be low-density, large lot residential development (i.e., one house per 0.4–1.6 ha [1–4 ac]; Theobald 2004). Exurban development probably poses a greater threat to Mexican spotted owl populations than other forms of land development, particularly in forest environments where private lands are adjacent to or located within Federal lands, although the extent of this threat is unknown. In addition, several studies have suggested that housing development threatens species occurring within many “protected” areas within the U.S. (e.g., Radeloff et al. 2010, Wade and Theobald 2010). Nationally, 80% of all developed land is at exurban densities (Wade and Theobald 2010), and exurban development is increasing at a greater rate in forested lands of the western U.S. than any other form of development, or in other regions of the country (Brown et al. 2005, Theobald and Romme 2007). This rapid growth away from urban areas, termed “rural sprawl,” appears to be due to the attractions of the environmental and recreational amenities of these areas, retirement of “baby boomers,” and the increasing separation of home and work locations due to better communications networks (Hansen et al. 2002, Brown et al. 2005, Radeloff et al. 2010).

Much of this exurban development is occurring in proximity to NFS and other Federal lands. Housing development within 1 km (0.6 mi) of National Forests increased by an average of 20.8% per decade from 1940-2000 and has been above the national average for housing growth since the 1970s (Radeloff et al. 2010). This pattern of greater-than-average development near and within Federal lands is expected to continue within the range of the owl, with a greater than 25% increase projected for the states of Arizona, Colorado, New Mexico, and Utah from 2000 to 2030 (Wade and Theobald 2010).
Exurban development is a potential threat in all Mexican spotted owl EMUs in the U.S. In an analysis of WUI, Radeloff et al. (2005) provide county-level data on area developed at several intensities and arrangements. Based on this information, 2.6% of all land area in counties with designated PACs falls within their definition of WUI, with 64.5% of this development being low-density intermix development. The SRM and BRE EMUs have the highest proportion of land area as WUI (5% and 4%, respectively), although the BRW EMU has the largest areal extent of land affected by this form of development. By restricting analysis to counties with at least 10 designated PACs, the BRW EMU still ranks highest in amount of land impacted by WUI development, with the UGM EMU lands also substantially impacted.

Land development adjacent to non-developed areas can influence species distribution and abundance, as well as ecological function, within those areas by a number of mechanisms, most notably by reduction in effective size of the area, alteration of ecological processes (e.g., predation, competitive interactions), loss of important habitat features or seasonally important use areas for the species, and disturbance (Hansen and DeFries 2007). Habitat loss and fragmentation due to development usually impacts species on a landscape-scale, but development also has local-scale impacts, particularly due to disturbance and vegetation change (Schlesinger et al. 2008).

No studies have evaluated the influence of land development on use of habitat by spotted owls or effects on habitat quality. Although most known owls occur on Federal lands, specific developments in Arizona and New Mexico have been suspected to impact spotted owl habitat. In addition, the extent to which these owls forage or winter on lands subject to development is unknown, but it is likely that the development of private lands within and surrounding Federal lands directly affects habitat used by spotted owls. Further, there have been a number of land exchanges, both completed and proposed, where the primary economic driver was to acquire Federal lands for development. Working with California spotted owls, Manley et al. (2009) projected that current levels of development in the Tahoe Basin has reduced the amount of area that met “territory” criteria by 28% to 38%. The majority of this loss was the result of indirect changes to the landscape that are typical of exurban development, rather than the actual conversion of area to structures. Development leads to declines in vegetative features important to owls, especially dead woody debris (Fraterrigo and Wiens 2005, Heckmann et al. 2008). In addition, fragmentation by development may lead to owls requiring larger areas. For example, working with northern spotted owls, Carey et al. (1992) found that owls utilized three times the amount of mixed-conifer forest in areas of high fragmentation than in areas of limited fragmentation.

Ecological processes influencing Mexican spotted owl populations might be altered by development. Forest fragmentation may lead to increases in potential predators, such as great horned owls, which increase in abundance with high levels of habitat heterogeneity caused by fragmentation (Grossman et al. 2008). Fragmentation was found to increase the spatial overlap between great horned owls and barred owls, and it may increase the threat of predation on barred owls by great horned owls (Laidig and Dobkin 1995). Development also alters ecological processes associated with fire regimes, by increasing the probability of fire and activities associated with suppression or mitigation of risk (e.g., WUI). The threats from these activities are discussed elsewhere in this five-factor analysis (e.g., see Part II.H.3.a.i and ii).
Increasing development leads to greater impacts on species due to increased use of surrounding areas by humans (Riebsame et al. 1996). Behavioral responses can be a more important factor in loss of species to development than habitat alteration (Schlesinger et al. 2008). The threat of recreation disturbance to Mexican spotted owls is evaluated elsewhere in this five-factor analysis (see Part II.H.3.a.xi).

A major question not answered at present is the extent and importance of wintering habitat for Mexican spotted owls, particularly in the northern periphery of their range. In Colorado, this question may have substantial bearing on whether land development is a serious threat to continued presence of the species, as land development may disproportionately affect wintering areas there. These lower-elevation areas are more likely to be privately owned and impacted by exurban development, and in these areas exurban housing densities have shown the greatest increase (Riebsame et al. 1996, Theobald 2000).

In summary, land development poses a potential threat to Mexican spotted owls primarily through habitat fragmentation, alteration of ecological processes (e.g., predation, fire regimes), and increased potential for disturbance. The threat exists in all EMUs but the magnitude is highly variable due to the variation in amount and configuration of developable land in proximity to current spotted owl habitat. Land development probably threatens foraging and wintering habitat more than nest/roost habitat, although the level of threat is unknown. We provide management recommendations (Appendix C) to mitigate threat of land development to the spotted owl.

xi. Recreation

Recreational activities may affect owls directly through disturbances caused by human activity (e.g., hiking, shooting, and OHV use at nesting, roosting, or foraging sites; discussed under other sections of this five-factor analysis) or indirectly through alteration of habitats such as damage to vegetation, soil compaction, illegal trail creation, and increased risk of wildland fires. Whether managed or unmanaged (i.e., user-created), development of new recreational facilities (e.g., trailheads, and OHV and mountain bike trails) and expansion of existing facilities (e.g., campgrounds and hiking trails) may alter owl habitat.

The potential for recreation-related impacts to the owl is relatively high. Visitation at the 18 national parks, monuments, and recreation areas within the owl’s U.S. range has doubled from approximately 7 million to over 14 million visits from 1971 (representing the first year data were available for all 18 park units) to 2009 (USDI NPS 2010). NPS-administered lands make up approximately 2.5% of the owl’s U.S. range (USDI FWS 1995). While only a fraction of visitors are likely to recreate in PACs, the overall high level of visitation demonstrates the scale of recreation-related human activities within the owl’s range.

Depending on the extent, intensity, and duration, recreational disturbance may have negative impacts on owl habitat. For example, the number of people who drive OHVs off road has increased over 109% in the U.S. since completing the 1995 Recovery Plan (Cordell 2004). In addition, from 1997 to 2001, the number of OHVs in use increased by almost 40%, OHV drivers increased by 36%, and OHV driving hours increased by 50% (68 FR 19975; April 23, 2003).
The significant increase in OHV use, OHV-associated impacts to natural resources, and a desire to provide better OHV management have precipitated development of Travel Management Plans for all NFS lands as well as implementation of a 2009 Arizona OHV Law (SB1167). These actions illustrate that both Federal and state agencies have identified OHV recreational activity as a concern.

There have been significant increases in the extent and intensity of recreational activities within the owl’s range since the development of the original Recovery Plan (USDI FWS 1995). Impacts are most likely to occur at the level of individual owls and/or PACs. Since the owl’s listing in 1993, the canyonlands in southern Utah have experienced a steady increase in visitation and, as a result, a significant increase in canyoneering. This sport encompasses boulder scrambling and rock-climbing to descend through canyons, including those where Mexican spotted owls are known to nest (USDI FWS 1995, Rinkevich and Gutiérrez 1996, Swarthout and Steidl 2001). For example, human recreational-use levels were measured for canyons by the NPS in Zion National Park by quantifying requests for use permits. Canyoneering permits for popular canyons occupied by the owl increased significantly between 1998 and 2002 (Zion National Park, unpubl.data). Recreational use of canyons has continued to rise; the number of permits issued for narrow slot canyon day use has increased 42% and overnight permits increased 26% since 2003. Currently, however, recreation disturbances such as these are not known to affect regional or range-wide owl populations. Management recommendations to address the threat posed by recreation are provided in Appendix C.

xii. Water Development

Water development includes dams, permanent flooding of riparian habitats, bed degradation below dams, stream dewatering, diversions, altered-flow regimes, and artificial watering ponds (e.g., stock tanks). Effects of development on owls vary, but can include loss or degradation of habitat, habitat fragmentation, disruption of migration corridors, inhibited gene flow, and altered grazing patterns by wild and domestic ungulates.

Previously occupied riparian communities in the southwestern U.S. and Mexico have undergone significant habitat alteration since the historical owl sightings (USDI FWS 1993). For example, in southern Utah and northern Arizona, inundation of Glen Canyon by Lake Powell in 1963 created a 299-km (187-mi) long and 40-km (25-mi) wide reservoir that flooded habitat for a potentially large population of owls (McDonald et al. 1991, Willey and Spotskey 2000). In addition to inundating habitat, dams can alter hydrologic conditions below the dam and strongly influence the structure and function of riparian ecosystems (Poff et al. 1997). Dams often regulate the timing, magnitude, and duration of floods that are the primary natural disturbances in riparian ecosystems (Poff et al. 1997). Natural floods deposit sediment on flood plains that create seed beds for riparian plants, and they flush salts and redistribute nutrients. Regulation of floods below dams can reduce or eliminate these critical processes. Salinity increases can be biologically significant. Most native willows and cottonwoods are relatively intolerant of salt (Jackson et al. 1990, Shafroth et al. 1995), whereas germination of the non-native tamarisk increases with salinity (Busch and Smith 1995, Smith et al. 1998). Thus, it has a competitive
advantage over native cottonwoods and willows on regulated rivers. Increase in tamarisk and decline in native vegetation may have implications for owl habitat quality.

Stock tanks are artificial watering holes established primarily for domestic livestock that also are used by wild ungulates such as deer and elk. Effectively, these tanks have allowed both domestic and wild ungulates to expand their geographic range, thereby allowing them to graze over a wider area than they might have with limited water. Depending on the intensity, seasonality, and location of where these animals graze, potential exists for them to affect habitat for owls and their prey (see II.H.3.a.vii).

In summary, effects of water development can range from site-specific habitat loss or degradation to habitat fragmentation through inundation and altered hydrological function, disruption of migration corridors, and inhibited gene flow across larger landscapes. Much of our knowledge concerning effects is indirect and inferential given that no studies have specifically addressed these threats. For example, studies in Grand Canyon National Park have recorded a number of owl sites and have resulted in predictions of potential owl habitat (Bowden 2008). Many of the canyons inundated by Lake Powell likely possessed similar characteristics as those occupied by owls in Grand Canyon, thus it is conceivable that some would have been occupied. Not only was there probable habitat loss but given the size of the lake, movements of birds between Grand Canyon and other parts of the CP EMU may have been disrupted. Effects of dams on downstream habitat have not been investigated, but the replacement of native cottonwood forests with non-native tamarisk stands may effectively represent a loss of owl habitat. The extent and severity of this threat warrant additional study. We provide management recommendations specific to this threat in Appendix C.

b. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (Factor B)

i. Commercial Exploitation

We are unaware of any commercial exploitation of Mexican spotted owls.

ii. Recreational Exploitation

The southwestern U.S., particularly southeastern Arizona, is one of the premier destinations in the U.S. for birdwatching. Unfortunately, the high visitation level of birdwatchers has begun to result in recreational exploitation of Mexican spotted owls as birders attempt to “collect” sightings and/or pictures of rare species for their life lists. Recreational birders have been observed regularly visiting several owl territories in the Huachuca and Chiricahua Mountains of southern Arizona. The FWS frequently receives reports of people continuously playing audio recordings of spotted owls to elicit responses, shining lights repeatedly at owls to take pictures, and other acts of harassment. Though it is unlikely that these actions are impacting large numbers of owls, it is a threat at the site-specific level and is usually illegal absent appropriate Federal and state or Tribal permits issued for research or inventory purposes. We therefore provide management recommendations in Appendix C, that address management, education, and enforcement actions to minimize effects of recreational exploitation.
iii. Scientific Exploitation

The information obtained through scientific studies is instrumental in devising appropriate recovery strategies for threatened and endangered species, as well as in monitoring progress toward recovery goals. In the case of the Mexican spotted owl, obtaining the types of ecological information required sometimes involves trapping, handling, and marking owls either with color bands or radio transmitters. These activities have been conducted for many years on all three subspecies of spotted owls. Many hundreds of owls have been trapped and handled, with a limited number of injuries or mortalities resulting from these activities. Therefore, we generally consider these activities to be acceptable for the study of owls and do not consider research and monitoring activities to pose a significant threat to population persistence. Nevertheless, trapping and handling wildlife has certain inherent risks that can never be eliminated entirely, and efforts should be undertaken to minimize any potential impacts to the owl. To aid in this process, we provide management recommendations in Appendix C. These recommendations address permitting and reporting requirements, as well as essential safeguards to minimize potential impacts of the research activities.

iv. Educational Exploitation

We are unaware of any exploitation of Mexican spotted owls for educational purposes.

c. Disease or Predation (Factor C)

i. West Nile Virus (WNV)

Mexican spotted owls are not known to have suffered population declines from disease. However, The U.S. Center for Disease Control (CDC) has identified over 300 avian species (both native and non-native, wild and captive) in which dead specimens have tested positive for infection by WNV in the U.S. (www.cdc.gov). The virus first appeared in North America in 1999, with encephalitis reported in horses and humans. It has since been documented in all U.S states except Alaska and Hawaii (www.cdc.gov).

The virus is commonly spread by transmission between mosquito vectors and bird reservoir hosts. However, birds can also become infected by means other than arthropod transmission (Marra et al. 2004). Komar et al. (2003) reported that ingestion of WNV in aqueous solution resulted in infection in several bird species, including great horned owls. It is not known whether ingestion of infected prey by raptors has resulted in bird fatality, but the risk exists (Marra et al. 2004). Finally, contact transmission has been documented in the laboratory in caged birds (McLean et al. 2001; Komar et al. 2003), perhaps from such behaviors as mutual preening and beak-to-beak contact.

Avian fatality from WNV has been extensive in North America (www.cdc.gov). Natural fatal infections were detected between 1999 and 2002 in over 28,000 bird carcasses representing 198 species, including a captive spotted owl (subspecies not identified; www.cdc.gov). However, we are unaware of any records of wild spotted owls being infected with WNV. Hull et al. (2010) tested 209 California spotted owls in the Sierra Nevada of California between 2004 and 2007 and detected no antibodies in those specimens. The authors remarked that these results were
“somewhat unexpected” given that the California Department of Public Health had recorded numerous infection incidences in other avian species in the region during that time. Hull et al. (2010) expressed doubt that this absence of detection was simply an inadequate sampling scheme; rather, given the large number of specimens sampled, they conclude that WNV infection is absent in the area’s spotted owls. However, they alternatively hypothesize that an absence of detections could be because spotted owls exhibit such a high mortality rate that they do not survive long enough to develop a detectable immune response.

We are unaware of any incidence of WNV in Mexican spotted owls, or of any surveillance program (systematic or otherwise) for this disease. Nonetheless, the potential impact of the disease on threatened species and those of ecological importance is of great concern (Joyner et al. 2006). Marra et al. (2004) point out that, although no regional declines of imperiled avian species have been documented, species already affected by other population stressors may be at particular risk of extinction from WNV. They further state that determining a given species’ susceptibility to WNV is critical for understanding the pathogen’s ecology and protecting threatened wildlife populations.

The scientific panel that reviewed the status of and threats to the northern spotted owl was unanimous in regarding WNV as a potential future threat (Courtney et al. 2004). Their concern was based on the spread of the disease to within the range of that subspecies and the fact that the disease has been fatal to spotted owls. However, that conclusion predates the work of Hull et al. (2010) and we do not know if the panel would reach the same conclusion considering Hull et al.’s results. In addition, the final Recovery Plan for the Northern Spotted Owl (USDI FWS 2008) does not recognize WNV as a current threat and recommends only monitoring for the disease as a recovery action. We also do not consider this disease to be a significant threat to the owl at this time. However, there remains much uncertainty about the potential impact of this disease in the future, particularly when considering the effects such as climate change on ecological variables of events such as mosquito distribution. We, therefore, make management recommendations similar to those in the northern spotted owl plan (Appendix C).

### ii. Predation

Predation is a common mortality factor of spotted owls, accounting for at least 5 of 11 deaths documented among radio-marked adult and subadult owls (Ganey et al. 2011), and 14 of 29 documented mortalities of radiomarked juveniles (Ganey et al. 1998, Willey and Van Riper 2000). Predation may account for more deaths than indicated because the cause of death of recovered spotted owls is often unknown. The specific predator involved is also typically unknown. Procyonid mammals were observed attempting to raid cliff-site nests occupied by spotted owls in southern Arizona (R. Duncan, Southwestern Field Biologists, pers. comm.), suggesting that they may prey on spotted owls. However, avian predation is suspected to be the main form of predation. Potential avian predators of Mexican spotted owls include great horned owls, northern goshawks, red-tailed hawks, golden eagles, and barred owls (where they are sympatric; Leskiw and Gutiérrez 1998). Some of these predators occupy the same general habitats as the Mexican spotted owl, but there is little direct evidence that they prey on spotted owls (Gutiérrez et al. 1995). Ganey (1988) reported one instance of apparent great horned owl predation on an adult spotted owl, but Ganey et al. (1997) did not document predation on spotted
owls in a study involving sympatric spotted and great horned owls. Reynolds (RMRS, pers. comm.) reported a golden eagle preying on a spotted owl.

Results from radiomarked Mexican spotted owls indicate that all age classes are preyed upon (Ganey 1988, Ganey et al. 1998, 2005; Willey 1998b, Willey and Van Riper 2000). We suspect that predation may have localized effects on spotted owl abundance, particularly due to effects on fledging rates and post-fledging juvenile survival. While predation is a documented fatality factor, there is no evidence that current predation rates are abnormally high. In summary, we do not view predation as a significant threat and provide no threat-specific management recommendations.

d. Inadequacy of Existing Regulatory Mechanisms (Factor D)

The National Environmental Policy Act (NEPA), land-management statutes like the National Forest Management Act, and state regulations governing direct taking of species were evaluated in the final rule listing the Mexican spotted owl. We discuss these statutes and regulations further in Appendix F of this Recovery Plan, and we incorporate them here by reference. We are unaware of any changes in these statutes and regulations other than those we specify below, and the previous conclusion that they convey little protection of habitat, in absence of ESA influence, remains valid. We also note that the discussion below merely describes the relevant laws influencing spotted owls and their habitat, and inclusion of these laws does not necessarily imply inadequacy. We discuss several recent laws, regulations, and policies potentially influencing forest management below.

i. National Fire Plan and Policy

The interagency Federal Wildland Fire Policy, adopted by the FS, FWS, BLM, BIA, and NPS in 1995 states, “Fire, as a critical natural process, will be integrated into land and resource management plans and activities on a landscape scale, and across agency boundaries. Response to wildland fire is based on ecological, social, and legal consequences of fire.” The National Fire Plan was developed in August 2000 with the intent of improving active response to wildland fires and their impacts to communities through development of a 10-year strategy and goals in 5 key areas: firefighting, rehabilitation, hazardous fuels reduction, community assistance, and accountability. The plan consists of a report to the President of the U.S., the subsequent comprehensive strategy plan, and congressional appropriations. The strategy is to reduce wildland fire risks to communities and the environment by correcting problems stemming from the long-term disruption of natural fire cycles.

A 2009 revision of the 2003 Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy distinguished between two kinds of wildland fire: prescribed fire (planned ignitions), and wildland fire (unplanned ignitions). The revision allows fire managers to manage a wildland fire for multiple objectives to increase managers’ flexibility in responding to changing incident conditions and firefighting capabilities, while strengthening strategic and tactical decision implementation to support public safety and resource management objectives. Hazardous fuels reduction treatments are designed to reduce the risks of wildland fire to firefighters, people, communities, and natural resources while restoring forest and rangeland
ecosystems to their historical structure, function, diversity, and dynamics. Although the intent of the National Fire Plan and Policy is also to protect habitats for the owl and other species over the long-term by reducing habitat loss from severe fire, short-term effects to owls may occur during and following treatments, and cumulative effects may possibly occur in more intensely WUI-managed landscapes. Our fire- and fuels-management recommendations in Appendix C are compatible with the National Fire Plan.

ii. Healthy Forests Initiative

President George W. Bush announced the Healthy Forests Initiative in August 2002 to streamline regulatory processes for Federal agencies, to provide for more timely decisions and greater efficiency in reducing fire risk through increased fuels-reduction treatments. The initiative consists of administrative changes related to fire and fuels treatment projects, including the establishment of two new categorical exclusions from NEPA analysis, changes to administrative appeal rules, and new Council for Environmental Quality guidance for environmental assessments. Administrative actions that may affect management and treatment of owl habitat include:

- Joint counterpart regulations were developed that eliminated required consultation with and written concurrence from FWS and National Marine Fisheries Service (collectively “the Services”) for National Fire Plan projects that the action agency had determined would not adversely affect listed species. The action agencies took on the responsibilities of the Services for these projects (USDI FWS and USDC NOAA 2004). However, those regulations were withdrawn and are no longer in effect.

- Guidance was developed to evaluate net benefits of hazardous fuels treatment projects. During consultations, the Services evaluate the long-term benefits of these projects, including benefits of restoring natural fire regimes and native vegetation and long-term risks of severe wildland fire, against the short- or long-term adverse effects of these projects (USDI FWS and USDC NOAA 2002).

Our fire- and fuels-management recommendations in Appendix C are compatible with the Healthy Forests Initiative.

iii. Healthy Forests Restoration Act of 2003

The Healthy Forests Restoration Act of 2003 (HFRA; P.L. 108-148) applies to hazardous-fuels-reduction projects on National Forest System and BLM lands. The objectives of the HFRA are to reduce wildland fire risk to communities and municipal water supplies; authorize grant programs to improve the commercial value of forest biomass; enhance efforts to protect watersheds and address threats to forest and rangeland health; identify and address the impact of insect and disease infestations on forest and rangeland health; and protect, restore, and enhance forest ecosystem components, including promoting the recovery of threatened and endangered species (HFRA 2003). The HFRA does not authorize treatments in federally designated wilderness, wilderness study areas, or other areas where vegetation removal is prohibited through congressional or Presidential protection.
Title I requires the Secretaries of Interior and Commerce to comply with any applicable guidelines specified in any management or recovery plan for threatened and endangered species. It requires that HFRA projects maintain or contribute toward restoration of the structure and composition of old-growth stands according to pre-fire-suppression, old-growth conditions. It also requires that projects maximize retention of larger trees in areas other than old-growth stands, consistent with the objective of restoring fire-resilient stands and protecting at-risk communities. Other aspects of the HFRA provide for expedited environmental review and administrative review of proposed projects. It also requires collaboration between Federal agencies and local communities in development of Community Wildfire Protection Plans that identify and prioritize areas for hazardous-fuels-reduction treatments, recommend treatment methods, and recommend measures to reduce ignition of structures in the at-risk community.

Title III provides grant programs to states, tribes, small communities, and individuals for projects that provide watershed restoration and conservation, wetland restoration, and establishment of riparian vegetative buffers. Title V established the Healthy Forests Reserve Program. Private landowners may enroll their lands in this program if their lands will restore, enhance, or otherwise measurably increase the likelihood of recovery of federally listed, candidate, or state-listed species or special-concern species. Landowners who enroll may receive financial assistance to restore or enhance habitat for these species.

Fire- and fuels-management recommendations are given in Appendix C and are compatible with the HFRA.

iv.  *Omnibus Public Land Management Act of 2009, Title IV Forest Landscape Restoration Act*

The purpose of the Collaborative Forest Landscape Restoration Act (CFLRA) is to encourage the collaborative, science-based ecosystem restoration of priority forest landscapes through a process that encourages ecological, economic, and social sustainability; leverages local resources with national and private resources; facilitates the reduction of wildland-fire management costs, including through reestablishing natural fire regimes and reducing the risk of uncharacteristic wildland fire; and demonstrates the degree to which various ecological restoration techniques achieve ecological and watershed health objectives. To be eligible to receive funding, a collaborative forest-landscape-restoration proposal must be based on a landscape-restoration strategy that identifies and prioritizes ecological restoration for a 10-year period on a landscape that is at least 20,243 ha (50,000 ac). The CFLRA states that vegetation treatments should focus on removal of small-diameter trees, retain large trees to the extent that the trees promote fire-resilient stands, and improve fish and wildlife habitat, including for endangered, threatened, and sensitive species.

The Southwestern Region of the FS is currently developing landscape-scale restoration projects that qualify for CFLRA funding. One example of this is the Four Forest Restoration Initiative. The Apache-Sitgreaves, Coconino, Kaibab, and Tonto National Forests are working with stakeholders to develop a collaborative restoration plan in the ponderosa pine forest type across the four forests. These four forests include a significant portion of the UGM EMU and will likely include a considerable amount of Mexican spotted owl PAC and recovery habitat. Fire- and fuels-management recommendations in Appendix C should facilitate implementation of such
large-scale treatments as envisioned under the CFLRA. Examples of other projects receiving CFLRA funding within the range of the owl include the Southwest Jemez Mountains Landscape Restoration Project in the Southwestern Region of the FS, and the Colorado Front Range Collaborative Forest Restoration Project in the Rocky Mountain Region of the FS.

**iiiv. Stewardship Contracting Authority**

Through the Consolidated Appropriations Resolution of 2003, Congress enacted legislation expanding stewardship contracting authority for the FS and BLM. This authority allows these agencies to enter into long-term (up to 10 yrs) contracts with small businesses, communities, and nonprofit organizations to reduce wildland fire risk and improve forest resiliency. Stewardship contracts can be used for projects that will provide benefits to local and rural communities and meet goals such as road or trail maintenance to improve water quality; improvement of soil productivity; improvement or protection of habitat for wildlife and fisheries or other resource values; use of prescribed fire or other treatments to improve forest health or wildlife habitat and reduce fire hazards; restoration and maintenance of watersheds; and control of noxious and exotic weeds coupled with reestablishment of native plant species. This stewardship authority can be useful in implementing the management recommendations in Appendix C.

**e. Other Natural or Manmade Factors Affecting the Mexican Spotted Owl’s Continued Existence (Factor E)**

**i. Noise and Disturbance**

Infrequent, noise-producing activities are generally assumed to have relatively little long-term impact on spotted owls. However, owls will react to noise disturbances by changing behavior and/or flushing from their perches (Delaney et al. 1999a; Swarthout and Steidl 2001, 2003). These behavioral responses may alter nesting and roosting activities, thus increasing vulnerability to predators and heat-related stress.

Variables such as distance to and frequency of a noise disturbance, habitat type, topography, and sound source may influence spotted owl responses (Delaney and Grubb 2004). For example, noises close to nests are likely to be more disruptive than those far from nests (Delaney et al. 1999a) and noise disturbances close (96 m [315 ft]) to owl nests may have affected prey delivery rates Delaney et al. (1999b).

Also with respect to distance and noise levels, Delaney et al. (1999a) determined that the proportion of owls flushing was negatively related to distance (owls flushed more often to closer sounds) and positively related to noise level (owls flushed more often to louder sounds). Pater et al. (2009) quantified this in part by determining that noises ≥80 dBO (i.e., decibels weighted for middle sound frequencies where owl hearing is the most sensitive), had a greater than 0.60 probability of causing an owl to flush. This noise level (80 dBO) is roughly equivalent to 69 dBA (i.e., decibels weighted for human hearing) or approximately twice as loud as ordinary conversation.
The origin or type of noise may also be a factor in disturbing owls. Mexican spotted owls in forested environments reacted more to chainsaws (operated out of sight of owls) than to the sound of helicopters at the same distance (Delaney et al. 1999a). While little research is available comparing the relative impact of various noise types, it is likely that persistent noises are more disruptive than infrequent disturbances, and intensity of disturbance is proportional to noise level (i.e., sound volume).

There is also the potential for noise pollution (i.e., consistent noise-causing activities as opposed to the sporadic noise disturbances discussed above) to impact spotted owl nocturnal breeding and foraging habits. Because owls are active at night when it is difficult or impossible to see other owls, audio communication is a critical component of the owl’s social system (Frid and Dill 2002; e.g., territorial defense, pair bonding and maintenance, feeding nestlings, and post-fledging activities). Further, owls depend heavily on sound to locate and capture prey in near darkness (Payne 1971, Martin 1986, Norberg 1987).

No studies have been conducted on the influence of habitat type (canyon vs. forest) on noise disturbance to owls. While both forest- and canyon-dwelling owls respond to human presence, potentially disruptive interactions between humans and owls may be more likely in canyons because canyons can amplify noises (especially in caves) and provide limited escape routes for owls. In addition, the number of sites in canyons that afford spotted owls adequate thermal protection for nesting and roosting may be more limited than in forested environments. Finally, canyons may lack visual barriers between owls and noise sources that are common in dense forests, and this also may influence owl responses.

Noise impacts are most likely to occur at the level of individual owls and/or PACs, and they may be important to small isolated populations. We believe that disturbance should be avoided when practicable during the nesting season (see noise disturbance recommendation in Appendix C).

ii. Barred Owls

Prior to the twentieth century, the barred owl was restricted to eastern North America, from southeastern Canada, through the eastern U.S., and into eastern Mexico (Mazur and James 2000). Over the past 100 years, and particularly over the past few decades, the nominate subspecies of the barred owl has expanded its range westward across Canada to the Northern Rocky Mountains and the Pacific Northwest, where it has rapidly invaded the range of the northern spotted owl (Dark et al. 1998, Mazur and James 2000, Courtney et al. 2004). The barred owl was recognized as a potential threat of considerable concern in the Final Rule listing the northern spotted owl (55 FR 26114) and it was addressed as a threat in the Draft Recovery Plan for that taxon (USDI FWS 1992). More recently, the barred owl has been judged as representing an even greater threat to the northern spotted owl than earlier believed and, currently, it is negatively impacting the subspecies in some areas where the two owls overlap (Courtney et al. 2004). Compared to the spotted owl, the larger, more aggressive barred owl appears to be at a competitive advantage because it feeds on a broader range of prey, occupies a wider range of habitats, and has been recorded displacing (and even killing) northern spotted owls (Dark et al. 1998, Mazur and James 2000, Hamer et al. 2001, Courtney et al. 2004, Gutiérrez et al. 2007). In addition, interbreeding
between the two has been documented (Hamer et al. 1994) and such hybridization is a further threat to the northern spotted owl.

Historically, the barred owl was unknown within the U.S. range of the Mexican spotted owl. Hence, it was not considered a threat when the taxon was listed and was not addressed in the 1995 Recovery Plan (USDI FWS 1995). However, barred owls have been verified within three of the five states where the Mexican spotted owl occurs: Colorado, Texas, and New Mexico. In addition, there have been two unconfirmed reports of barred owls in Utah. The first verified record of a barred owl in Colorado is from 1897, when an adult and a set of two eggs were collected on the plains of northeastern Colorado in the Town of Holyoke, Phillips County (L. Semo, Chair, Colorado Bird Record Committee, pers. comm.). Another verified record was of two barred owls observed in January 2000 a few miles from the Oklahoma border along the Cimarron River in Baca County (L. Semo, pers. comm.). There are also two unconfirmed reports of barred owls from Colorado: two were reported on 21 May 1960 from Bonny Reservoir, Yuma County (near the Kansas border), and another was reported nearby on 16 May 1964 (L. Semo, pers. comm.). None of the Colorado barred owl records was within the range of the Mexican spotted owl; most spotted owl records in that state have been from the central and southern mountain ranges.

Similarly, no barred owls have been detected within the spotted owl’s range in Texas, although the barred owl is common in parts of that state (C. Shackelford, Texas Parks and Wildlife Department, pers. comm.). Spotted owls have been documented only in three mountain ranges in the Trans-Pecos region of Texas (Guadalupe, Davis, and Chisos mountains), while the barred owl is common only in the eastern half of the state and reaches its range limits well east of the Pecos River. The treeless areas east of 100°W longitude appear to be limiting the barred owl’s expansion into western mountains occupied by spotted owls (C. Shackelford, Texas Parks and Wildlife Department, pers. comm.).

Unlike barred owl detections in Colorado and Texas, in New Mexico, a barred owl has been verified in proximity to occupied Mexican spotted owl habitat. The barred owl was discovered in May 2004 in cottonwood riparian habitat along Galisteo Creek at Galisteo, Santa Fe County (Williams 2004). The location is only approximately 24 km (15 mi) from the southern Sangre de Cristo Mountains and 48 km (30 mi) from the Jemez Mountains, and it is within flying distance of occupied Mexican spotted owl habitat in both mountain ranges. The barred owl, which was occasionally vocal, remained in that area at least through early October 2004. In addition, an apparent New Mexico record from 1993 resulted from a freshly dead barred owl that was hit by a truck, perhaps somewhere from Albuquerque north to Raton (Williams 1993). Examination indicated that the owl was not the nominate subspecies, but instead a geographically closer barred owl subspecies, of adjacent Texas and Oklahoma.

In Mexico, the range of the Mexican subspecies of the barred owl is known to overlap the southern extremity of the Mexican spotted owl, but both owls are apparently scarce in that area. The ecological relationship between the two owls where they might overlap in Mexico has not been investigated; they might or might not occupy similar elevation and/or habitat zones.
Given that few barred owls have been detected within the range of the Mexican spotted owl, that even fewer barred owls have been verified where spotted owls are known to occur, and that there does not appear to be a trend of increasing abundance of barred owls in the southwestern U.S., we currently do not recognize an incursion of barred owls as being imminent. However, we believe the situation warrants observation, because barred owls could extend their distribution into the range of the Mexican spotted owl if there are additional increases in their required habitats, but we make no management recommendations associated with barred owls.

iii. Direct Fatalities

Causes of fatalities other than those we previously discussed include vehicle collisions, electrocution, and possibly direct effects associated with wildland fires. Direct fatality from collisions with vehicles has been documented (R. Skaggs, Glenwood, New Mexico, pers. comm.; R. Duncan, Southwestern Field Biologists, pers. comm.; E. Brekke, BLM Royal Gorge Field Office, pers. comm.; J. L Ganey, RMRS, unpubl. data: S. Hedwall, FWS, unpubl. data), but the extent of this is unknown. There is at least one record of electrocution, where a color-banded adult female owl was found electrocuted near Deming, New Mexico (Gutiérrez et al. 1996). There is also a documented fatality from an encounter with a pasture fence (S. Hedwall, FWS, unpubl. data). Fatality from wildland fires through heat and smoke exposure may include, in order of increasing vulnerability, loss of eggs, nestlings, and fledglings. Deaths at active roost sites and nests from fire suppression activities (e.g., water and retardant drops) also may have occurred (D. Salas, Lincoln National Forest, pers. comm.). In summary, fatalities from these causes are not likely a substantial influence on Mexican spotted owl persistence.

iv. Climate Change

Strong evidence exists that global climates are changing in response to increasing emissions of greenhouse gases (IPCC 2007), and that changing climates are affecting forest ecosystems throughout the world either directly or indirectly through altered disturbance regimes (e.g., Ayres and Lombardero 2000; Breshears et al. 2005, 2009; Bonan 2008; Hogg et al. 2008; Raffa et al. 2008; Floyd et al. 2009; Negrón et al. 2009; van Mantgem et al. 2009; Allen et al. 2010). Understanding the effects of climate change on forests is critical to informing forest management and conservation planning for the future (Allen et al. 2010). This includes recovery planning for the Mexican spotted owl, which inhabits forests throughout much of its range.

Models of projected climate change typically focus on two variables: temperature and precipitation. In general, model predictions appear to be more robust with respect to temperature than precipitation (Sheppard et al. 2002). How climate change will affect summer monsoonal precipitation in the southwestern U.S. is even less certain, because precipitation predictions are based on continental-scale general circulation models (GCMs) that do not yet account for regional phenomena such as those that control monsoonal rainfall (Weiss and Overpeck 2005, Archer and Predick 2008).

The southwestern U.S. exhibits high climatic complexity and variability in general. This is due to both complex topography and proximity to the Pacific Ocean, the Gulf of California, and the Gulf of Mexico (Sheppard et al. 2002, Brown and Comrie 2002). Because of this complexity
and steep environmental gradients, many ecosystems within the southwestern U.S. may be particularly vulnerable to climate change (Archer and Predick 2008). For example, recent temperature increase in the southwest is among the most rapid in the nation, and is significantly greater than the global average (Guido et al. 2008). Projections for the southern Colorado Plateau area describe a warmer future climate, with annual temperatures likely increasing by 1.5\(^\circ\) to 3.6\(^\circ\) C by mid-century (Garfin et al. 2010). Predicted climate change impacts in the southwest include warmer temperatures, fewer frost days, greater water demand by plants, and an increased frequency of extreme weather events such as heat waves, droughts, and floods (Weiss and Overpeck 2005, Archer and Predick 2008). Further, warmer nights and projected declines in snow pack, coupled with earlier spring snow melt, will reduce water supply, lengthen the dry season, create conditions for drought and insect outbreaks, and increase the frequency and intensity of wildland fires as well as the duration of the wildland fire season (Allen et al. 2010). Areas within the southwest are currently experiencing a severe, multiple-year drought, and current models suggest that a 10 to 20 year (or longer) drought is anticipated (Woodhouse and Overpeck 1998, McCabe et al. 2004, Seager et al. 2007). Prolonged drought, combined with warmer temperatures, may cause increases in insect outbreaks and increased wildland fires in southwestern forests (Betancourt 2004, Allen et al. 2010). Severe or prolonged drought may cause mature trees to be more susceptible to insects and disease (Hanson and Weltzin 2000, Mueller et al. 2005, Floyd et al. 2009, van Mantgem et al. 2009; see also Negrón et al. 2009: Fig. 3; Ganey and Vojta 2011).

The effects of climate change on rare, endangered, and endemic species are highly variable (Galbraith and Price 2009) and will differ depending upon life-history characteristics (Travis 2003) and dispersal abilities. Climate change has already resulted in significant effects on species and ecosystems (Gitay et al. 2002, Hannah and Lovejoy 2003, Root et al. 2003, Harris et al. 2006, Parmesan 2006). Mawdsley et al. (2009) identified a number of effects that could impact the Mexican spotted owl. These include: 1) shifts in the distribution of the owl itself, along with major prey species and potential competitors and predators, possibly along elevational or latitudinal gradients; 2) effects on demographic rates, such as survival and reproduction; 3) changes in coevolved interactions, such as prey-predator relationships; 4) direct loss of habitat due to increased fire severity, bark beetle outbreaks, and direct warming of habitats; 5) increased population or range expansion of species that are direct competitors; and, 6) reductions in population size. All of these effects are addressed in Appendix C.

**Shifts in Distribution.** Shifts in Mexican spotted owl distribution could occur in response to predicted warming in the southwestern U.S. that may cause elevation shifts in tree species distribution, with many forest and woodland types requiring less precipitation moving up in elevation in response to warmer and drier conditions. This could lead to the local loss of some tree species and/or forest types in much of the southwest, because these forest types frequently occur at the highest elevations available and thus would have no local refugia to which to migrate (DeGomez and Lenart 2006, Archer and Predick 2008). Owls occur in mixed-conifer and pine-oak forests at the tops of many of the Sky Island ranges in Arizona and New Mexico. Conifers within some of the Sky Islands may be eliminated as temperatures increase and snowpack runoff decreases (Archer and Predick 2008). Loss of these forest types would eliminate or greatly reduce habitat for owls in these ranges. This in turn could reduce connectivity and viability of Mexican spotted owl populations (e.g., Keitt et al. 1995, 1997;
Barrowclough et al. 2006; see also Ganey et al. 2008). To date however, there is more evidence for species-range expansion than for range contraction driven by climate change (see Dawson et al. 2011). Climate change may also impact owls in canyons if these areas become hotter and drier. Owls in canyons may move up in elevation and microhabitats change, possibly into mixed conifer forest habitat adjacent to canyons and/or northward into currently unoccupied canyon habitat.

**Changes in Demographic Rates.** Climate change also could affect demography of spotted owls as well as their prey, competitors, and predators. Annual weather patterns are known to affect survival and reproduction of spotted owls (Franklin et al. 2000, 2004; North et al. 2000; Seamans et al. 2002; LaHaye et al. 2004; Olson et al. 2004; Dugger et al. 2005). For example, Seamans et al. (2002) found positive relationships between precipitation (i.e., precipitation during the previous year, during the previous winter, or during the previous monsoon season) and survival and reproductive output in two populations of Mexican spotted owls.

Temperature and precipitation may influence the owl’s reproductive output directly, or indirectly through effects on prey abundance. Examples of direct effects could include: 1) negative effects of increased temperature on energy and water use (e.g., Ganey et al. 1993, Weathers et al. 2001), or 2) negative effects of increased precipitation during the nesting period on survival and especially reproduction (e.g., Franklin et al. 2000, North et al. 2000, LaHaye et al. 2004; note that this has not been documented in Mexican spotted owls). Seamans et al. (2002) speculate that precipitation was probably important in providing indirect benefits to Mexican spotted owls. Specifically, germination and sprouting of annual plants during the monsoon may extend the breeding season of small mammals in the Southwest, and may increase overwinter survival and therefore abundance of prey. Principal prey species in habitats occupied by Mexican spotted owls typically exhibit high temporal variability in abundance (Ward and Block 1995, Ward 2001, Block et al. 2005), and Ward and Block (1995) noted that a year of high reproductive output by spotted owls in the Sacramento Mountains of New Mexico was accompanied by an irruption of deer mice. Interactions among temperature and moisture regimes may differ across elevational gradients, thus affecting small mammal populations differently in different areas (Seamans et al. 2002).

Perry et al. (2011) modeled how population dynamics and extinction risk might be affected by climate change for three spotted owl populations in the southwest. The authors used stochastic, stage-based matrix models parameterized with vital rates linked to annual variation in temperature and precipitation to project owl populations forward in time under three IPCC emission scenarios relative to contemporary climate. Their results suggested that Mexican spotted owls may be highly vulnerable to climate change, even in the core of the subspecies range in central Arizona and west-central New Mexico, whereas California spotted owls in southern California may be comparatively more resilient to climate change. Warm temperatures and low precipitation appeared to have a negative influence on both reproduction output and survival rates in Arizona and New Mexico. Perry et al (2011) conclude that fecundity and survival generally were more sensitive to increases in temperature than declines in precipitation.

**Changes in Co-evolved Interactions.** Changing climates also could influence distribution patterns and abundance of major prey species, as well as potential competitors with and
predators on spotted owls. It seems likely that prey species, which are strongly influenced by weather (Vickery and Bider 1981) and have shorter generation times than spotted owls, would respond to such changes more quickly than would the owls themselves. The magnitude and direction of such potential changes remain unknown at this time, however. Similarly, changes in forest composition could strongly influence abundance and distribution of owl competitors and predators (see below). Again, however, the magnitude and direction of such potential changes remain unknown at this time.

In rocky canyon habitats in southern Utah, Willey (2007) conducted demographic studies of potential spotted owl prey within three owl territories in the Paria River watershed. Severe drought occurred during the onset of research (2000-2003), followed by significant increases in local precipitation during 2004-2006. Prey abundance and species richness increased with increased precipitation. During the 2000-2003 dry period, spotted owl reproduction dropped, females were no longer detected, and by 2003, only males were detected at the sites. Increased precipitation during 2004-2006 resulted in recolonization of all three sites by females. Thus, precipitation appeared to exert strong effect on prey abundance, site occupancy, and reproductive rates by owls (Willey 2007).

**Direct Loss of Habitat.** Mexican spotted owls may experience direct loss of habitat due to increased frequency of high severity fires (Westerling et al. 2006), bark beetle outbreaks, and direct warming of habitats as a result of climate change. Using tree-ring data, Swetnam and Lynch (1993) and Ryerson et al. (2003) examined the relationships between western spruce budworm outbreaks and climate variability over multi-century periods. They found that periods of increased and decreased budworm activity coincided with wetter and drier periods, respectively. Allen et al. (2010) and Breshears et al. (2009) documented recent examples of drought- and heat-related forest stress and dieback (defined as tree mortality noticeably above usual mortality levels) from all forested continents. Drought-related mortality occurred in forest types with tree species that included conifer and hardwood tree species found within spotted owl habitat. Ganey and Vojta (2011) documented high and accelerating tree mortality in mixed-conifer and ponderosa pine forests within the range of Mexican spotted owls in northern Arizona. This drought-mediated mortality was nonrandom with respect to tree species and size classes, and is rapidly changing the composition of these forests. Increasing levels of drought, along with associated insect outbreaks and wildland fires, could rapidly and dramatically affect the distribution, amount, and composition of spotted owl habitat.

**Interactions with Competitors and Predators.** As discussed above, northern spotted owls are being affected by a direct competitor, the barred owl, which recently expanded its range into the Pacific Northwest and California (Dark et al. 1998, Courtney et al. 2004, Monahan and Hijmans 2007, Livezey 2009a). Barred owls appear to be competitively excluding northern spotted owls from preferred habitats in parts of their range and hybridize with spotted owls, and barred owls have been identified as a serious threat to continued persistence of northern spotted owls. Reasons for the recent range expansion by barred owls are unclear. Some authors have implicated climate change as a significant factor facilitating the range expansion (Monahan and Hijmans 2007), whereas other authors dispute this conclusion, citing anthropogenic changes as likely drivers (Livezey 2009a, b). In addition, it is possible that warmer, drier conditions might
favor such potential predators as great-horned owls (see predation discussion under Factor C, in II.H.3.c. above).

**Reduction in Population Size.** At this time, little evidence exists suggesting that climate change is causing reductions in Mexican spotted owl population size. 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. The owl remains well distributed in the area, suggesting that this estimated decline has not been borne out in subsequent years. As mentioned above, however, both survival and reproduction were positively correlated with precipitation in two populations studied (Seamans et al. 1999). This suggests that increasingly warmer and drier climates may not benefit spotted owls.

We explored the vulnerability of Mexican spotted owls to climate change using current knowledge of Mexican spotted owl ecology and three tools designed to allow assessment of effects of climate change on species of interest. The assessment tools used included: 1) NatureServe *Climate Change Vulnerability Index* (see Young et al. 2010); 2) Environmental Protection Agency *Framework for Categorizing the Relative Vulnerability of Threatened and Endangered Species to Climate Change* (Galbraith and Price 2009); and, 3) Rocky Mountain Research Station’s *Species Vulnerability Assessment Method* (Bagne and Finch 2008). These tools use different approaches to evaluate vulnerability to climate change, and results varied somewhat among tools. All three tools indicated at least moderate vulnerability to climate change for the Mexican spotted owl, however, along with fairly high uncertainty in the ratings. Thus, these assessments, although crude, provide further support for the hypothesis that the owl and its habitat are vulnerable to changing climates.

In summary, climate change will likely influence spotted owl habitat significantly, but the nature of such influence is difficult to predict. Further, addressing the causes of climate change is beyond the scope of this Recovery Plan. Therefore, our recommendations in Appendix C include mitigation strategies (i.e., actions that reduce causes of stress) and adaptation strategies (i.e., actions that help forested ecosystems accommodate change) designed to enhance forest resiliency and provide sustainable habitat so that Mexican spotted owls may better withstand the impacts of climate variability.

4. Factors Affecting the Status of the Mexican Spotted Owl in Mexico

Habitat modification is the main threat to biodiversity in Mexico and in many parts of the world. Data through 1993 show that primary vegetation has decreased 54% in the entire country, considering the original potential coverage of primary vegetation (CONABIO 2009). Based on this, habitat loss and fragmentation are the main threats to the Mexican spotted owl (Márquez-Olivas et al., 2002). Habitat modifications include land-use changes for agriculture and cattle production, wildland fires, and illegal logging, which have negative effects on its reproduction and dispersal (Márquez-Olivas et al. 2002, CONABIO 2009).

In southwestern Chihuahua and the rest of the Sierra Madre Occidental, activities by local residents are the main threats to the Mexican spotted owl; e.g., legal and illegal logging, overgrazing, and firewood harvest (Tarango et al. 1997). A study by CONANP and
PRONATURA-SUR in 2008 concluded that in the Sierra Madre Occidental, large-scale logging operations have destroyed large areas of tree coverage to supply the cellulose industry (paper production) and forest clearing has been conducted to prevent wildland fires and the spread of pests (CONANP-Pronatura Sur, 2008). Several researchers also had suggested that the clearing of trees on this area, especially cutting of mature forests, caused the disappearance of the imperial woodpecker and declines in western thick-billed parrot populations (CONANP-Pronatura Sur, 2008).

In the Sierra Madre Oriental, wildland fires scorched areas of old-growth forests. Two hundred ha (494 ac) of mature forest were lost in El Taray in 2006, and 400 ha (988 ac) were burned in the Municipio de Santiago Nuevo León in 2008 (CONANP-Pronatura Noreste, 2008).

In some areas like the Parque Nacional Sierra de San Pedro Mártir, another threat to forest habitat of *Strix occidentalis lucida* is the spread of bark beetles during the dry season. Since these insects are part of the ecology of the area, the full scope of this problem should be studied (CONANP 2006).

In the area in the Transvolcanic Range where this species is reported, it faces problems related to the proximity to urban areas and increased habitat modification and decreased original tree coverage (Navarro-Sigüenza et al. 2007). Human over-population and anthropogenic activities like agriculture and cattle raising and other land-use changes are threats to the different species of birds and other organisms on this area (Navarro-Sigüenza et al. 2007). This area also faces deforestation, illegal mining, poaching, burning of natural vegetation to increase cattle forage, and wildland fires by arson, all of which increase damage to the region (Navarro-Sigüenza et al. 2007).

There is extensive overlap between the range and habitat used by the Mexican spotted owls and thick-billed parrots in Mexico, and potentially in the United States. As an obligate cavity nester, the thick-billed parrot uses large-diameter trees and snags within mixed conifer forests for nesting. As described in this Recovery Plan, the maintenance and creation of large diameter trees and snags is an important factor in managing for nesting and roosting habitat for the owl. There is potential for collaboration regarding the implementation of conservation actions, particularly in Mexico, for the spotted owl and the thick-billed parrot, as actions taken to promote and maintain habitat in mature mixed conifer forest and reduce the risk of high-severity fire will benefit both species where their ranges overlap.

**B. Crosswalk Between Threats and Management Recommendations** (see table below)
## Table 11.2. Crosswalk Between Threats and Management Recommendations

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### Table of Crosswalk Between Threats and Management Recommendations

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