PART IV. RECOVERY PROGRAM

A. Recovery Action Outline and Narrative

This outline contains *abbreviated* descriptions of actions recommended to achieve recovery as specified in the Mexican Spotted Owl Recovery Plan-First Revision. **Users should refer to the indicated section of Appendix C for detailed recommendations.** Only those recommendations implemented specifically as recovery tasks for the owl are captured in this outline; recommendations designed to lessen or avoid adverse effects of standard operational activities (e.g., minimizing erosion during road-construction activities) are not listed here. Further, specific threats with only general guidelines (see 1-5 below) are not specifically listed, but are covered under the general guidelines.

1. Establish or amend, as appropriate, land-management-planning documents to adopt the Recovery Plan recommendations as agency policy.

2. Survey planned project areas for Mexican spotted owl presence before conducting activities that may affect the Mexican spotted owl, following the Survey Protocol (Appendix D). See Appendix C for when and where surveys are recommended.

3. Maintain or enhance existing nesting/roosting habitat for Mexican spotted owls.
   - 3.1. Establish PACs at known owl sites from 1989 through the life of the Recovery Plan, including new sites located during surveys (see Appendix C for PAC-establishment procedures). Exceptions to PAC establishment or continuance are possible and are discussed in detail in Appendix C. PACs should be at least 243 ha (600 ac) in size.
   - 3.2. Conduct fuels-reduction treatments or other management actions to reduce the risk of compromising the ability of PACs to provide for successful owl nesting, following the procedures outlined in sections Appendix C (see Box III.1 for rationale). Much of the work needed to reduce fire risk in and to owl habitat can be achieved by treating areas around owl habitat.
     - 3.2.1. Conduct restoration/fuels treatments in up to 20% of the total non-core PAC area within each EMU that exhibits high fire-risk conditions, following the guidelines in section Appendix C.
     - 3.2.2. Establish a scientific committee to develop a plan for monitoring the effects of mechanical treatments on PACs.
   - 3.3. Avoid conducting activities that may disturb nesting spotted owls during the breeding season unless protocol surveys allow inference of non-nesting.

4. Manage for nesting/roosting habitat on the landscape.
   - 4.1. Identify and map nest/roost recovery habitat throughout each planning area, subregion, and/or region (see Appendix C). Recovery nest/roost habitat should be identified so that the landscape percentages recommended in Appendix C - Table C.3 are delineated.
     - 4.1.1. Where appropriate, implement management actions necessary to move recovery nest/roost habitat toward the component values recommended in Appendix C - Table C.3. The Recovery Team suspects that most nest/roost stands will achieve those values with minimal manipulation, but acknowledges that treatment may be desirable in some circumstances.

4.1.2. Conduct fuels-reduction treatments or other management actions to reduce the risk of losing important components for future spotted owl nesting/roosting habitat. Much of the work needed to reduce fire risk in and to owl habitat can be achieved by treating areas around owl habitat.

5. Manage for foraging and dispersal habitat.
   5.1. Identify and map foraging/dispersal recovery habitat (mixed-conifer, pine-oak, and riparian forests) outside of PACs and nest/roost recovery habitat (see Appendix C).
      5.1.2. Conduct fuels-reduction treatments or other management actions to reduce the risk of losing important components of owl foraging and dispersal habitat as described in Appendix C. Much of the work needed to reduce fire risk in and to owl habitat can be achieved by treating areas around owl habitat.

6. Manage specific threats as described in Appendix C – Threat-specific management recommendations.
   6.1. Implement fire-management recommendations (other than those for fuels-reduction purposes).
      6.1.1. Implement fire-suppression recommendations as described in section Appendix C.
         6.1.1.1. Conduct landscape-level fire behavior assessments to strategically locate and prioritize fire suppression activities/tactics to mitigate the effects of high-severity fire and suppression activities on PACs and recovery habitat.
         6.1.1.2. Where possible, wildland fire suppression activities should be applied that limit high-severity fire and loss of key habitat elements within PACs and recovery habitats.
         6.1.1.3. Research should be conducted to evaluate the short- and long-term correlates of wildland fire severities and their spatial extent on Mexican spotted owls and their habitat.
      6.1.2. Implement post-fire rehabilitation recommendations as described in sections Appendix C.
   6.2. Implement recommendations for forest insects and diseases as described in Appendix C.
      6.2.1. When considered a threat to owl or prey habitat, various tools—prescribed fire, thinning, other silvicultural treatments—should be used to limit the spread of insects or diseases.
   6.3. Manage livestock-grazing operations and wild ungulate impacts as described in Appendix C.
      6.3.1. As detailed in Appendix C, conduct site-specific assessments to determine appropriate utilization and/or residual levels of forage.
      6.3.2. Using the information gathered under 6.3.1. above, establish allowable-use criteria through allotment-management plans, annual operating instructions, or other appropriate mechanism, to achieve the goals described in Appendix C.
      6.3.3. Implement monitoring as described in Appendix C.
      6.3.4. Implement management actions regarding livestock and wild ungulate grazing to promote riparian health as described in Appendix C.
   6.4. Implement the land-development recommendations as described in Appendix C.

6.4.1. Managers are encouraged to pursue voluntary consultation on a case-by-case basis with local governments and developers to encourage development in areas least likely to directly influence habitat use of known owls. Development of positive incentive programs may be a feasible approach.

6.5. Implement recommendations for water development (see Appendix C).

6.5.1. Collect materials for genetic analyses to evaluate if large water developments are impeding movements and gene flow.

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

6.6. Manage against recreational exploitation (see Appendix C).

6.6.1. Report continued issues due to recreational exploitation of owls to the appropriate FWS Law Enforcement Office.

6.7. Minimize recreation disturbance in PACs.

6.7.1. Any construction within PACs during the non-breeding season should be considered on a case-specific basis. Modifications to existing facilities pertaining to public health, safety, and routine maintenance are excepted; however, when implementing such activities, those conducting the work should use all measures possible to avoid potential effects on owls.

6.7.2. In areas of owl occupancy, assess the impacts of currently allowed (both permitted and non-permitted) recreational activities and institute limitations as described in section Appendix C.

6.7.3. Seasonal closures of specifically designated recreational activities should be considered where disturbance to breeding owls seems likely.

6.7.4. Conduct education through signing, interpretation events, access permitting, or other information sources to inform the public of proper and legal behaviors when encountering owls.

6.8. Monitor and minimize effects of scientific exploitation as described in section Appendix C.

6.8.1. Quality-assurance and quality-control procedures should be applied to all scientific studies that may directly or indirectly affect owls or owl habitat. Quality assurance requires that study plans undergo appropriate levels of review, revision, and approval.

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

6.8.3. If a particular study or a particular activity results in an undue number of mortalities, FWS should convene an independent expert panel to evaluate the situation and propose recommendations to continue, adjust, or cease the activity resulting in fatalities.

6.8.4. Radio-marking spotted owls likely poses the highest risk among typical research activities. This risk may be alleviated partially by adhering to marking requirements issued by the Bird Banding Lab. We recommend that transmitter packages used on Mexican spotted owls not exceed 16 g for female owls and 14 g for male owls.

6.8.5. Any attachment methods other than backpack and tail mounts should be viewed as experimental and should be tested on captive owls before deployment in the field. If this option is not available, then experimental attachments should be tested on a very small sample of wild spotted owls, and results should be monitored before allowing widescale use of the method.

6.8.6. All radios should be attached by researchers with demonstrated expertise in handling raptors and attaching transmitter packages to raptors.

6.9. Implement actions to minimize noise disturbance within PACs during the breeding season (1 Mar - 31 Aug). If non-breeding is inferred or confirmed during approved-protocol surveys in a PAC during the breeding season, restrictions on noise disturbances should be relaxed depending on the nature and extent of the proposed disturbance.

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

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

6.10. Implement actions to detect and, if present, monitor WNV activity as described in Appendix C.

6.10.1. Carry out well-distributed demographic studies to detect significant downward population trends.

6.10.2. Conduct spotted owl surveillance to detect the disappearance of birds from a given area.

6.10.3. Local biologists should monitor reports of avian mortality on the CDC website (www.cdc.gov) as well as those of state and county health departments.

6.10.4. If any of the above situations lead to suspicion of a WNV epizootic, conduct surveillance for the disease using standard arbovirus surveillance techniques.

6.10.5. Biologists who become aware of spotted owl captures for other purposes should look into asking researchers to collect saliva swabs or other minimally invasive samples. If researchers are also collecting blood or other tissue samples, testing of those for WNV antibodies is advised.

7. Monitor owl population as described in Part V.B and Appendix E – Monitoring.

7.1. Coordinate among administrative units to develop occupancy-monitoring design and secure funding. FWS will assume the initial lead role by convening representatives from appropriate administrative units in addition to appropriate scientific expertise.

7.2. Conduct a landscape analysis to define the sampling frame to include all possible owl habitat.

7.3. Develop sampling strata for the allocation of samples to reduce sampling variance.

7.4. Develop sampling protocols.

7.5. Have monitoring design reviewed by scientific experts and revise accordingly.

7.6. Implement the monitoring design.

8. Develop and implement habitat monitoring as described in Appendix E – Monitoring.

8.1. Coordinate among administrative units and FIA to develop habitat-monitoring design

and secure funding.

8.2. Conduct a landscape analysis to define the sampling frame to include all possible owl habitat.
8.3. Develop sampling strata for the allocation of samples to reduce sampling variance.
8.4. Develop sampling protocols.
8.5. Have monitoring design reviewed by scientific experts and revise accordingly.
8.6. Implement the monitoring design.

9. Implement research to inform recovery as described in Part V.F in the U.S. and Mexico.
   9.1. Conduct research to answer questions related to habitat.
      9.1.1. Which habitat features directly influence reproduction and/or survival of Mexican spotted owls?
      9.1.2. Which habitat features indirectly influence reproduction and/or survival of Mexican spotted owls by enhancing prey availability?
      9.1.3. How should these features be arranged spatially on the landscape to optimize owl fitness and habitat quality?
      9.1.4. How do stochastic environmental disturbances (particularly unplanned wildland fire) alter key habitat constituents and owl demography?
      9.1.5. Which habitat features help buffer the influence of weather effects on reproduction and survival?
      9.1.6. How do various planned management activities alter key habitat constituents (including prey) and owl demography?
      9.1.7. What is the probability that nest/roost conditions recommended in the plan will become recovery habitat for roosting and/or nesting by Mexican spotted owls?
      9.1.8. Which silvicultural prescriptions are best suited for creating and sustaining habitats used by Mexican spotted owls for various activities like roosting, nesting, foraging, and dispersal?
      9.1.9. Which types of planned burning regimes and methods will promote development of the owl's roosting, nesting, and foraging habitat?
      9.1.10. What proportion of Mexican spotted owl populations migrate seasonally, where are winter habitats located, what habitat features do owls use to select these areas, and how important are these areas for owl dispersal and survival?
      9.1.11. How will climate change alter distribution, structure, and composition of owl habitat?
      9.1.12. How will climate change influence owl and prey distribution and abundance?
      9.1.13. If livestock grazing occurs within owl nesting, roosting, and foraging habitats, what livestock grazing strategies can be implemented to best maintain suitable habitat conditions for owl prey species and alleviate grazing impacts on the development of future owl nesting/roosting habitats (e.g., oak/cottonwood/willow/alder trees)?
      9.1.14. What are the effects of various recreational activities (hiking, climbing, OHV use) on Mexican spotted owl behavior, habitat use and demography? How can managers mitigate potential effects in high-use areas?

9.1.15. If salvage logging is needed after a disturbance event (e.g., fire, insect/disease outbreak), how can it be implemented to maintain and protect existing habitat features or accelerate the development of future owl habitat?

9.2. Conduct research related to biological community interactions.

9.2.1. Are parasites, disease, predation, and competition limiting Mexican spotted owl populations?

9.2.2. What are the effects of invasive pathogens like WNV?

9.2.3. What is the relative influence of other predators on common prey of the Mexican spotted owl?

9.2.4. What environmental conditions will lead to increased effects of community-level interactions?

9.2.5. What types of management actions are necessary to alleviate deleterious community-level interactions?

9.2.6. How might climate change alter these factors and/or their impacts on Mexican spotted owls?

9.2.7. How will planned habitat treatments influence different biological interactions that can limit Mexican spotted owl populations, and how do these effects vary across spatial and temporal scales?

9.3. Conduct research involving population structure.

9.3.1. What are the relative numerical and genetic contributions of core and exterior populations?

9.3.2. Are subpopulations within and between EMUs connected?

9.3.3. What habitats and large-scale habitat configurations are required to maintain adequate survival rates during juvenile dispersal or adult migration?

9.3.4. What is the optimal arrangement of owl numbers and genetic mix that will lead to persistent populations at various time scales?

9.3.5. Which management activities help to ensure a well distributed set of functioning subpopulations? Which hinder this goal?

9.3.6. What are the potential impacts of climate change on connectivity of owl populations throughout their range?

9.4. Conduct research involving ecosystem function.

9.4.1. What are the effects of implementing this Recovery Plan on ecosystem structure and functions like soil erosion, water yield, and nutrient flow?

9.4.2. What are the effects of implementing this Recovery Plan on plant community structure, composition, and sustainability?

9.4.3. How has the implementation of this Recovery Plan affected long-term restoration of forested systems?

9.4.4. How are other focal wildlife species responding to conservation guidelines in this Recovery Plan?

9.4.5. How might this Recovery Plan be adjusted to mitigate potentially deleterious effects on other ecosystem attributes?

9.4.6. What are the potential implications of climate change to resilience of the ecosystems that support Mexican spotted owls, and how can we best balance increasing resilience in those systems with maintaining owl habitat?

9.5. Conduct research specific to Mexico, where less research has been conducted.

9.5.1. What is the range, distribution, and abundance of the Mexican spotted owl in Mexico?
9.5.2. What is the population trend in Mexico?
9.5.3. What factors are threatening the status of the Mexican spotted owl in Mexico?
9.5.4. What actions can remedy factors negatively affecting the Mexican spotted owl and encourage factors positively affecting the species?
9.5.5. What is the most effective approach to creating an education and outreach program about the Mexican spotted owl in Mexico?

10. Develop and conduct plan implementation oversight and coordination.
    10.1. Ensure that EMU Working Teams have primary implementation oversight.
        10.1.1. Review current Working Team membership and broaden as appropriate.
        10.1.2. Develop charter and operating procedures.
        10.1.3. Meet with members of the Recovery Team to ensure consistent interpretation of the Recovery Plan.
        10.1.4. Conduct workshops with parties responsible for implementing the Recovery Plan.
        10.1.5. Provide feedback to FWS and the Recovery Team on implementation of the Recovery Plan, including impediments and recommendations.
    10.2. Implement continuing functions of the Recovery Team.
        10.2.1. Coordinate regularly with Working Teams to receive feedback on Recovery Plan implementation.
        10.2.2. Meet annually or as needed to consider Working Team recommendations, review new research findings, and generally assess plan implementation.
        10.2.3. Make recommendations to FWS on plan clarifications and adjustments.
    10.3. Establish a centralized Mexican spotted owl information repository.

PART V. IMPLEMENTATION AND OVERSIGHT

A. Implementation Schedule

Disclaimer: The Implementation Schedule that follows outlines actions and estimated costs for the Recovery Plan for the Mexican spotted owl, as set forth in this Recovery Plan. It is a guide for meeting the recovery goals outlined in this plan. This schedule indicates action priorities, action numbers, action descriptions, duration of actions, the parties responsible for actions (either funding or carrying out), and estimated costs. Parties with authority, responsibility, or expressed interest to implement a specific recovery action are identified in the Implementation Schedule. When more than one party has been identified, the proposed lead party is indicated by an (*). The listing of a party in the Implementation Schedule does not require the identified party to implement the action(s) or to secure funding for implementing the action(s). For further information on selected columns see the Key to the Implementation Schedule (Table V.1) by Column (below).

Key to the Implementation Schedule (Table V.1) by Column:

Priority Number:

1) Actions necessary to prevent extinction or irreversible decline.
2) Actions necessary to prevent extinction or a significant decline in population or habitat, or other effect short of extinction.
3) All other actions necessary to provide for full recovery.

Action Number:

Refers to corresponding action number in the Recovery Action Outline and in Appendices.

Recovery Criterion Number:

Corresponds to the appropriate recovery criteria which the action will help achieve.

Action Duration:

Continual, Ongoing, Unknown, or actual number of consecutive years. If periodic, then the frequency should be noted under Comments (e.g., "every 3 years"). Numerical values are the anticipated number of years to complete the action. “Ongoing” refers to actions that are currently being implemented and are recommended to continue. “Continuous” actions are those not currently being implemented, but that are recommended to be implemented over the course of Recovery Plan implementation.

Responsible Party:

All = all interested parties, as applicable
BLM = Bureau of Land Management
BR = Bureau of Reclamation
Counties = applicable counties within the range of the Mexican spotted owl
FS = U.S. Forest Service
RMRS = Rocky Mountain Research Station, Forest Service
FWS = U.S. Fish and Wildlife Service
MX = Mexico

NPS = National Park Service
RT = Mexican Spotted Owl Recovery Team
States = States of AZ, CO, NM, TX, and UT as applicable via their agencies:
- AGFD = Arizona Game and Fish Department
- CDOW = Colorado Department of Wildlife
- NMDGF = New Mexico Department of Game and Fish
- TXPWD = Texas Parks and Wildlife Department
- UDWR = Utah Division of Wildlife Resources

Tr. = Native American Tribes
Univ. = Universities
USGS = U.S. Geological Survey
WTs = Ecological Management Unit Working Teams

Cost Estimate:

Figures given may vary substantially depending on scope of implementation.

When zero cost is shown it is under the assumption that the action is part of ongoing land-management activities to which owl considerations add little or no cost.

"Costs captured below" indicates that costs of an activity are broken down into the costs for the relevant subactivities.

"Costs captured above" indicates that costs for individual subactivities are aggregated into a total cost for the larger activity, since the subactivities have no independent utility apart from collectively supporting the larger effort.

Table V.1. Implementation Schedule for the Mexican Spotted Owl Recovery Plan, First Revision

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
2	1.	Adopt Recovery Plan recommendations through land-management-planning documents.	1, 2	1	FS, NPS, BLM, MX, Tr.	No	1,000	1,000	0	0	0	0	
2	2.	Survey project areas for Mexican Spotted Owls.	1, 2	Ongoing	Feds, Tr., MX	No	2,500	250	250	250	250	250	
1	3.	Maintain/enhance nesting/roosting habitat.	1, 2	Ongoing		No	0	0	0	0	0	0	
1	3.1.	Establish PACs.	1, 2	Ongoing	Feds, Tr., MX	No	1,000	100	100	100	100	100	
1	3.2.	Conduct treatments to reduce fire risk.	1, 2	Ongoing	FS, NPS, Tr., MX	No	0	0	0	0	0	0	
1	3.2.1.	Treat up to 20% of high risk PAC areas.	1, 2	Continuous	FS, MX, NPS, Tr.	No	0	0	0	0	0	0	
2	3.2.2.	Scientific committee to develop monitoring plan for treated PACs	1, 2	Continuous	FWS	Yes	0	0	0	0	0	0	
2	3.3.	Avoid disturbing nesting owls (seasonal restriction).	1	Ongoing	Feds, Tr., MX	No	1,000	100	100	100	100	100	
2	4.	Manage for nesting/roosting recovery habitat.	2	Ongoing		No							Costs captured below.
2	4.1.	Identify and map recovery nest/roost habitat.	2	Ongoing	BLM, FS, NPS, Tr., MX	No	2,000	200	200	200	200	200	

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
2	4.1.2.	Manage fuels in recovery habitat.	2	Ongoing	FS, NPS, Tr., MX	No	0	0	0	0	0	0	
2	5.	Manage for recovery foraging/non-breeding habitat.	2	Ongoing	BLM, FS, NPS, Tr., MX	No							Costs captured below.
2	5.1.	Identfy and map foraging/non-breeding recovery habitat.	2	Ongoing	BLM, FS, NPS, Tr., MX	No	2,000	200	200	200	200	200	
2	5.1.2.	Conduct treatments to improve resiliency of foraging/non-breeding components.	1, 2	Ongoing	BLM, FS, NPS, Tr., MX	No	0	0	0	0	0	0	
2	6.	Manage specific threats.	1, 2	Ongoing									Costs captured below.
2	6.1.	Implement fire-management recommendations.	1, 2	Continuous	FS, NPS, Tr., MX	No							Costs captured below.
2	6.1.1.	Implement fire-supression recommendations.	1, 2	Continuous	FS, NPS, Tr., MX	No							Costs captured below.
3	6.1.1.1.	Conduct landscape-level fire-behavior assessments.	1, 2	5	All	No	1,000	200	200	200	200	200	
3	6.1.1.2.	Limit supression activities within PACs and recovery habitats.	1, 2	Ongoing	BLM, FS, NPS, Tr., MX	No	1,000	100	100	100	100	100	
3	6.1.1.3.	Conduct research to evaluate fire severities related to owl habitat.	1, 2	5	FS, NPS, Tr., MX	No	500	100	100	100	100	100	

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
3	6.1.2.	Implement post-fire rehabilitation recommendations.	2	Continuous	FS, NPS, Tr., MX	No	100	10	10	10	10	10	
2	6.2.	Implement forest insects and diseases recommendations.	1, 2	Ongoing									No costs (see below)
2	6.2.1.	Implement actions to limit spread of deleterious insects and diseases.	1, 2	Ongoing	FS, NPS, Tr., MX	No	0	0	0	0	0	0	
2	6.3.	Manage livestock-grazing operations and wild ungulate impacts.	1, 2	Ongoing									Costs captured below.
2	6.3.1.	Conduct assessments to determine appropriate utilization and/or residual levels of forage.	1, 2	Ongoing	FS, BLM, Tr., MX	No	0	0	0	0	0	0	
2	6.3.2.	Establish allowable-use criteria.	1, 2	Continuous	FS, BLM, Tr., MX	No	0	0	0	0	0	0	
2	6.3.3.	Implement range monitoring.	1, 2	Ongoing	FS, BLM, Tr., MX	No	0	0	0	0	0	0	
2	6.3.4.	Implement actions to promote riparian health.	1, 2	Ongoing	Feds, States, Tr., MX	No	500	50	50	50	50	50	
2	6.4.	Implement land-development recommendations.	1, 2	Continuous									Costs captured below.
2	6.4.1.	Pursue voluntary measures to reduce development impacts.	1, 2	Continuous	States, Counties	No	200	20	20	20	20	20	

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
3	6.5.	Implement recommendations for water development.	1, 2	Continuous									Costs captured below.
3	6.5.1.	Conduct studies to evaluate impediment of movement and gene flow.	1	3	USGS	No	300	100	100	100	0	0	
2	6.5.2.	Discharge water from dams to sustain/enhance native riparian vegetation.	1, 2	Continuous	BR	No	100	10	10	10	10	10	
3	6.6.	Manage against recreational exploitation.	1	Ongoing									Costs captured below.
3	6.6.1.	Report continued issues due to recreational exploitation of owls to FWS Law Enforcement Office.	1	Ongoing	Feds	Yes	10	1	1	1	1	1	
3	6.7.	Minimize recreational disturbance in PACs.	1	Ongoing									Costs captured below.
2	6.7.1.	Evaluate construction within PACs on a case-specific basis.	1	Ongoing	FS, NPS, BLM, Tr., MX	No	100	10	10	10	10	10	
2	6.7.2.	Assess the impacts of currently allowed recreational activities and institute limitations.	1	Ongoing	FS, NPS, BLM, Tr., MX	No	100	10	10	10	10	10	

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility			Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?	Total Cost ($1,000s)	FY12	FY13	FY14	FY15	FY16	
2	6.7.3.	Consider seasonal closures of specifically designated recreational activities.	1	Ongoing	FS, NPS, BLM, Tr., MX	No	100	10	10	10	10	10	
3	6.7.4.	Inform the public of proper and legal behaviors when encountering owls.	1	Continuous	FWS, FS, NPS, BLM, Tr., MX	No	10	1	1	1	1	1	
2	6.8.	Monitor and minimize effects of scientific exploitation.	1	Continuous									Costs captured below.
2	6.8.1.	Apply quality-control procedures to scientific studies.	1	Continuous	FWS	Yes	10	1	1	1	1	1	
3	6.8.2.	Require contingency plans for dealing with injured owls.	1	1	FWS	Yes	20	20	0	0	0	0	
2	6.8.3.	Convene an independent expert panel to evaluate mortalities, make adjustments.	1	2	FWS	Yes	20	10	10	0	0	0	
2	6.8.4.	Ensure that radio-marking adheres to FWS Bird Banding Lab recommendations.	1	1	FWS	Yes	5	5	0	0	0	0	
2	6.8.5.	Ensure that attachment methods other than tail and backpack mounts are tested on captive owls then a small sample of wild spotted owls.	1	2	FWS	Yes	20	10	10	0	0	0	

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
2	6.8.6.	Ensure that only experienced personnel attach radios.	1	Continuous	FWS	Yes	0	0	0	0	0	0	
2	6.9.	Implement actions to minimize noise disturbance within PACs during breeding season.	1	Ongoing									Costs captured below.
2	6.9.1.	Assess potential for noise disturbance to nesting owls.	1	Ongoing	FS, NPS, BLM, Tr., MX	No	100	10	10	10	10	10	
2	6.9.2.	Consider breeding-season restrictions.	1	Ongoing	FS, NPS, BLM, Tr., MX	No	100	10	10	10	10	10	
3	6.10.	Implement actions to detect/monitor West Nile Virus activity.	1	Continuous									Costs captured below.
3	6.10.1.	Carry out demographic studies to detect possibility of downward population trends.	1	10	FS-RMRS, FWS	No	2,000	200	200	200	200	200	
3	6.10.2.	Conduct owl surveillance and report extirpations.	1	Ongoing	FS, NPS, BLM, Tr., MX	No	500	50	50	50	50	50	
3	6.10.3.	Monitor avian mortality on CDC, state, and county health department websites.	1	Continuous	Counties	No	10	1	1	1	1	1	
2	6.10.4.	If suspicion of West Nile Virus presence, implement arborvirus surveillance techniques.	1	Continuous	Counties	No	0	0	0	0	0	0	Likely done for human health purposes.

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
3	6.10.5.	Request collection of samples from captured owls and test for West Nile Virus antibodies.	1	Continuous	FWS	Yes	10	1	1	1	1	1	
2	7.	Monitor owl occupancy.	1	10			11,900	200	1,300	1,300	1,300	1,300	
2	7.1.	Develop occupancy-monitoring design and secure funding.	1	Continuous	FS, RMRS, FWS, NPS, BLM, Tr., MX	No							Costs captured above.
2	7.2.	Conduct a landscape analysis to define the sampling frame.	1	1	FS, RMRS, FWS, NPS, BLM, Tr., MX	No							Costs captured above.
2	7.3.	Develop sampling strata.	1	1	FS, RMRS, FWS, NPS, BLM, Tr., MX	No							Costs captured above.
2	7.4.	Develop sampling protocols.	1	1	FS, RMRS, FWS, NPS, BLM, Tr., MX	No							Costs captured above.
2	7.5.	Have monitoring design reviewed and revised accordingly.	1	1	FS, RMRS, FWS, NPS, BLM, Tr., MX	No							Costs captured above.
2	7.6.	Implement the monitoring design.	1	10	FS, NPS, BLM, Tr., MX, RMRS	No							Costs captured above.
2	8.	Develop and implement habitat monitoring.	2	Continuous			8,750	200	75	75	75	75	
2	8.1.	Develop FIA-based monitoring design and secure funding.	2	Continuous	FS, FWS, NPS, BLM, Tr., MX	No							Costs captured above.

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
2	8.2.	Conduct a landscape analysis to define the sampling frame.	2	1	FS, FWS, NPS, BLM, Tr., MX	No							Costs captured above.
2	8.3.	Develop sampling strata.	2	1	FS, NPS, BLM, Tr., MX	No							Costs captured above.
2	8.4.	Develop sampling protocols.	2	1	FS, NPS, BLM, Tr., MX	No							Costs captured above.
2	8.5.	Have monitoring design reviewed and revised accordingly.	2	1	FS, NPS, BLM, Tr., MX	No							Costs captured above.
2	8.6.	Implement the monitoring design.	2	10	FS, NPS, BLM, Tr., MX	No							Costs captured above.
3	9.	Implement research.	1, 2	Continuous									Costs captured below.
3	9.1.	Conduct research related to habitat.	2	10	FS, NPS, BLM, Univ, USGS, States, Tr., RMRS, MX	No	1,000	100	100	100	100	100	
3	9.2.	Conduct research related to biological community interactions.	1	10	FS, NPS, BLM, Univ, USGS, States, Tr., RMRS, MX	No	500	50	50	50	50	50	
3	9.3.	Conduct research involving population structure.	1	10	FS, NPS, BLM, Univ, USGS, States, Tr., RMRS, MX	No	1,500	150	150	150	150	150	
3	9.4.	Conduct research involving ecosystem function.	1, 2	10	FS, NPS, BLM, Univ, USGS, States, Tr., RMRS, MX	No	1,500	150	150	150	150	150	

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
3	9.5.	Conduct research specific to Mexico.	1, 2	10	MX	No	1,000	100	100	100	100	100	
3	10.	Develop and conduct plan implementation oversight and coordination.	1,2	Ongoing									Costs captured below.
3	10.1.	Ensure that EMU Working Teams have primary oversight.	1,2	1	FWS	Yes	0	0	0	0	0	0	
3	10.1.1.	Review current Working Teams and broaden as appropriate.	1,2	1	FWS	Yes	2	2	0	0	0	0	
3	10.1.2.	Develop charter and operating procedures.	1,2	1	WTs	No	3	3	0	0	0	0	
3	10.1.3.	Meet with Recovery Team to ensure consistent interpretation of Recovery Plan.	1,2	Continuous	WTs	No	30	3	3	3	3	3	
3	10.1.4.	Conduct workshops with parties responsible for implementing the Recovery Plan.	1,2	1	FWS, RT	Yes	10	10	0	0	0	0	

Priority Number	Action Number	Action Description	Recovery Criterion Number	Action Duration (Years)	Responsibility		Total Cost ($1,000s)	Cost Estimate by FY (by $1,000s)					Comments
					Parties	Is FWS Lead?		FY12	FY13	FY14	FY15	FY16	
3	10.1.5.	Provide feedback to Recovery Team including impediments and recommendations.	1,2	Continuous	WTs	No	20	2	2	2	2	2	
3	10.2.	Implement continuing functions of the Recovery Team.	1,2	Continuous	RT	Yes							Costs captured below.
3	10.2.1.	Coordinate regularly with Working Teams to receive feedback on Recovery Plan implementation.	1,2	Continuous	RT	Yes	10	1	1	1	1	1	
3	10.2.2.	Meet annually or as needed to consider Working Team recommendations, review new research findings, generally assess plan implementation.	1,2	Continuous	RT	Yes	50	5	5	5	5	5	
3	10.2.3.	Make recommendations to FWS on plan clarifications and adjustments.	1,2	Continuous	RT	Yes	10	1	1	1	1	1	
3	10.3.	Establish and maintain a centralized Mexican spotted owl information repository.	1,2	Continuous	FWS	Yes	28	10	2	2	2	2	

B. Population and Rangewide Habitat Monitoring Procedures

Part III of this Recovery Plan lists specific criteria that must be met before the Mexican spotted owl can be delisted. Meeting two of these criteria will require large-scale monitoring of trends in owl abundance (or a surrogate for owl abundance) and habitat quantity and distribution. Here, we provide a brief overview of one approach that might be used to implement such monitoring, with technical details provided in Appendix E. We provide this approach as an example, noting that other approaches are possible and that future advances in monitoring techniques may result in other, more efficient approaches. Ultimately, any approach that can satisfactorily address the recovery criteria should be acceptable.

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

Fortunately, advances in monitoring techniques since 1995 provide a viable alternative to mark-recapture sampling, specifically occupancy monitoring (e.g., MacKenzie et al. 2006). Occupancy monitoring does not require capture and banding of owls but is based on mark-recapture theory and does allow for estimation of detection probability. This is a critical detail, because (1) it is likely that not all resident owls will be detected in a given year, and (2) detection probabilities may change over time. Such changes in detectability of owls could result in erroneous trend estimates and misguided conservation efforts. Consequently, we propose a monitoring program based on occupancy monitoring. Such a program will not provide the detailed demographic data that mark-recapture sampling would provide, but it should be safer and cheaper to implement while still providing valid population trend estimates.

Before describing the proposed monitoring program further, we repeat the following statements to summarize pertinent discussion from elsewhere in the Plan:

- While monitoring habitat is important, numerous factors other than habitat conditions can influence owl populations. Therefore, it is necessary to monitor trends in both habitat and the owl population.
- We are assuming that the existing owl population is adequate in numbers and distribution to maintain the viability of the species (see Part III.D. Objective and Measurable Recovery Criteria, to explain this assumption). However, we are willing to accept a stable or increasing population or site occupancy trend over a period ≥10 years as evidence that the owl population is sustaining itself and therefore is likely to persist. The selection of a 10-year period is explained in Part V.B.1.b below.
- A number of approaches are possible for monitoring owl habitat. One possibility is to use data from the USDA Forest Inventory and Analysis (FIA; http://fia.fs.fed.us)

program. The FIA program is attractive because it is an existing and well-funded program that provides repeat sampling of habitat conditions throughout the range of the owl. We explain details of the FIA sampling protocols and resulting data in Appendix E - Monitoring.

- How ever habitat data is obtained, we envision: 1) using habitat data to aid in stratifying the sample of areas where owl occupancy rates are estimated, and 2) relating habitat data to owl occupancy rates, to allow for better understanding of relationships between specific habitat features and/or landscape composition and owl population trends (see Appendix E for further details).
- The proposed monitoring of owl occupancy rates likely will monitor only the territorial population of owls. The non-territorial portion of the owl population likely will not be sampled adequately (see below for further discussion of this issue).
- We think the minimum trend period of 10 years is a reasonable time span for monitoring the trend in owl occupancy (see discussion below).

1. Monitoring Mexican Spotted Owl Occupancy Rates

Although we support the idea of estimating population size directly and collecting associated demographic data as described in USDI FWS (1995), we propose this alternative monitoring program based on monitoring occupancy rates as an index of population size and distribution, for reasons discussed above. We define occupancy rate for Mexican spotted owls as the proportion of sample plots occupied by the species. The sample plots will consist of square blocks of 100 ha (247 ac). We propose using existing Universal Transverse Mercator (UTM) blocks that can be easily mapped using GIS. Appendix E - Monitoring provides a detailed discussion of the statistical aspects of using the occupancy rate to estimate owl population trend, as well as a discussion of how the owl occupancy rate would be related to habitat conditions.

One limitation of the proposed monitoring is that owl occupancy monitoring (and all known approaches) likely will monitor primarily territorial birds. This is because non-territorial "floaters" (Franklin 1992) may not respond readily and consistently during calling surveys. The proportion of non-territorial floaters in the population of Mexican spotted owls remains unknown, but may not be large. Evidence for Mexican spotted owls suggests that: (1) the proportion of birds <2 years old (i.e., subadults) holding territories is relatively high, (2) territory vacancies typically are filled by birds 1 to 2 yrs old, and (3) density of territorial Mexican spotted owls appears to track reproduction with a short lag period (Seamans et al. 1999: Fig. 5; Gutiérrez et al. 2003, J. P. Ward and J. L. Ganey, unpublished data). All of these factors suggest that large numbers of non-territorial floaters typically are not present within the range of the Mexican spotted owl. Consequently, we do not view this limitation as fatal to the monitoring program.

a. Steps to Population Monitoring

We envision monitoring a random sample of blocks (see above) for the presence of owls. Non-detection of owls within a sample does not always imply owls are absent. In some situations observers fail to detect owls when present because owls may not vocalize or an observer fails to hear them. Thus, probability of detecting an owl or owls must be estimated as part of the

monitoring process. Recent models (MacKenzie et al. 2002, 2003, 2006) provide viable methods to estimate detection probability and thus rigorously monitor site occupancy.

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

In Appendix E, we outline a suitable framework and statistical estimation approach for monitoring owl populations via directly estimating the site occupancy rate of territorial owls, and we discuss how FIA measurements could be incorporated into the occupancy monitoring plan so that microhabitat variables can be related to owl occupancy rates. Accurate and efficient protocols for monitoring owl occupancy will require pilot studies to estimate occupancy rates and detection probabilities and their statistical variances. These estimates then can be used to determine variables such as the number of plots required and number of call points required per plot, and to evaluate tradeoffs between greater numbers of visits per plot versus increasing spatial replication by sampling more plots fewer times. Given sample data, all of these factors can be optimized to design a monitoring program that will most efficiently satisfy the quantitative targets in the delisting criterion for population monitoring.

b. Time Period for Population Monitoring

Recovery criterion 1 for delisting (Part III) specifies that the owl population trend should be monitored for at least 10 years. Monitoring for a longer period is desirable, given the owl's long lifespan, the fact that it frequently occurs in forested and canyon ecosystems that change slowly, and the pronounced temporal variability in climate that characterizes the American southwest. We believe that 10 years is a reasonable minimum time span for owl occupancy monitoring for the following reasons. First, given current estimates of owl survival rates, more than half of the adult population should turn over during a 10-year period. Vacancies created by deaths of territorial resident owls may be filled by unpaired, non-territorial birds or, more likely, by subadult birds recruited from the previous year or two. The extent to which new owls fill territory vacancies will provide evidence on whether or not sufficient reproduction is occurring to sustain the owl population. A 10-year period should be sufficient to test whether adequate recruitment is occurring.

Second, we expect that the owl population will be subjected to considerable environmental variation during this 10-year period, including both dry and wet years and major fire events.

Third, even if occupancy rates are stable or increasing and the species is delisted, the ESA requires a minimum additional five years of monitoring post-delisting. This time period would provide further opportunity for evaluating population and distribution trends.

Fourth, we hope that the 10-year period will appear achievable to managers and thus provide incentive to implement population monitoring and acquire the monitoring data required to evaluate the potential for proposing to delist the owl.

2. Monitoring Mexican Spotted Owl Rangewide Habitat

The primary objective of habitat monitoring is to validate results of occupancy monitoring. For example, if occupancy monitoring indicates stable (or increasing) occupancy rates, habitat monitoring will provide a general measure of whether there will be sufficient nest and roost habitat for occupancy rates to remain stable. We advocate no specific method for habitat monitoring and leave it up to management agencies to determine the best method(s) to use. Again, one possible approach is to use data from the existing FIA program. We provide a brief overview of that program in Appendix E.

C. Ecological Management Unit Working Teams

The FWS intends to continue or reform Working Teams whose responsibility would be to oversee and guide implementation of the Recovery Plan. These Working Teams would coordinate with and report to the Recovery Team, which would consider and evaluate Working Team recommendations before passing them on to FWS. Working Teams for each EMU should be appointed by FWS as subunits under the Recovery Team umbrella. Working Teams should include as a minimum of one representative from each of the following:

1) Each involved FWS Ecological Services Office
2) Each involved FS Region
3) Each involved state
4) Each involved Indian nation
5) Any other involved agency (e.g., BLM, NPS)
6) At least one researcher/scientist who can provide specialized expertise related to owl biology, forest ecology, fire ecology, monitoring, or other relevant topics.

Working Teams should recommend to FWS the appointment of additional members as needed or desired. For example, representatives of local governments, affected industries, and conservation advocacy groups should be considered for appointment. If other interested parties express interest in participating on a Working Team, they should be allowed to do so pending FWS approval. Working Teams should strive to have a diversity of members to represent ecological, economic, social, conservation, and management interests.

Functions of Working Teams should include, but not be limited to, the following:

1) Provide technical assistance to agencies and landowners on topics related to project designs, spotted owl management, and Recovery Plan implementation. The Recovery Team encourages Working Teams to hold Recovery Plan implementation workshops to provide a common understanding of the plan to all interested parties.
2) Provide guidance and interpretation on implementation and recommendations contained within the Recovery Plan.
3) Recommend Recovery Plan revisions based on lessons learned from implementation.
4) Coordinate landscape analyses among management agencies and private landowners. The landscape analyses are recommended to identify areas needing management intervention to protect and develop owl habitat. Coordinate occupancy and habitat monitoring among management agencies and private landowners.

5) Promote communication among local interests and help to resolve conflicting interpretations of the Recovery Plan if they arise.
6) Track plan implementation and report success, problems, and progress to the FWS and Recovery Team periodically.

D. Continuing Duties of the Recovery Team

The FWS intends that the Recovery Team be continued throughout implementation of the Recovery Plan. Once the Recovery Plan is finalized, the Recovery Team should meet annually to review plan implementation, confer with Working Teams, and report to FWS. If changes or adjustments to the Recovery Plan are warranted, the Recovery Team will forward recommendations for those changes to FWS for their consideration.

E. Centralized Mexican Spotted Owl Information Repository

The Recovery Team recommends development of a central repository for data related to Mexican spotted owl recovery. Historically, data have been retained in dispersed locations prohibiting meta-analyses to understand the status of the owl range-wide. Given that the owl inhabits lands under multiple jurisdictions, this central repository is critical to addressing pressing information needs about owl recovery. The primary purpose of such a facility would be to collate a spotted owl GIS database, occupancy monitoring data, habitat monitoring data, and other programs recommended in this Recovery Plan.

F. Research Needs

Despite the considerable interest in and research on the ecology of the Mexican spotted owl, much remains unknown, particularly in Mexico. Research is needed to develop long-term management strategies that assure predominant threats to the persistence of Mexican spotted owls will be alleviated. The primary focus of such research should be to elucidate factors that influence change in Mexican spotted owl distribution and abundance. Emphasis should be placed on identifying those factors that can be manipulated through social or natural resource management.

Communication and collaboration among scientists, land managers, and interested publics should play a key role in shaping future research. Managers need to understand the methods, problems, and uncertainties involved with gaining reliable knowledge from ecological research. Scientists, on the other hand, must rely on managers to identify appropriate questions and political and legal constraints, to implement experimental treatments, and to develop appropriate implementation of knowledge derived from research results in an adaptive management context. Too often scientists design and implement studies that do not directly address critical management issues. By working together, managers and scientists can bridge this gap and better focus research efforts by identifying relevant objectives and approaches. Involving and informing interested publics may facilitate implementation of important research activities without administrative or legal challenges.

Clearly, all research questions cannot be answered, given limited time and money. Similarly, we know that some population processes will vary among EMUs. It is therefore imperative that landscapes used for research study areas be considered for particular questions to maximize gain. For example, three studies of habitat requirements conducted within mixed-conifer forest in a single EMU will likely yield less information than studies in other habitat types or regions. Here, we recommend research on questions about Mexican spotted owls that still need answers. Clearly, a large number of research questions could be developed that address all aspects of Mexican spotted owl biology for which knowledge is lacking. Others have reviewed research agendas for conservation of spotted owls or other forest wildlife (DeStefano 2002, Noon and Franklin 2002). The topics we recommend here are similar. However, we pose what we believe are the most crucial questions that need to be addressed in terms of long-term resource management and recovery of Mexican spotted owls. Studies designed to answer these questions could be descriptive, experimental, or a combination of both. We do not repeat questions that will be answered through population and habitat monitoring.

1. Habitat and Demography

Recovering the Mexican spotted owl will require detailed knowledge of the habitat constituents (including food resources) required at various scales to maintain viable populations. Past research has scratched the surface of this topic and primarily concentrated on roosting and nesting microhabitat features and, to a lesser degree, on prey requirements. In particular, habitat requirements of spotted owls that dwell in canyon-type environments are poorly known. We also recognize that spotted owl nesting habitat in forested environments is not static over time and that many currently used nesting sites eventually will be lost due to various disturbance agents. We therefore recognize a need to hone management tools that can be used to develop recovery habitat. This will necessarily entail studies of long duration, given the temporal nature of forest development, for example, or the potential for climate change to alter thermal regimes and habitat conditions in arid canyonlands. Consequently, these studies should begin as soon as possible. Important questions that remain to be answered include:

1) Which habitat features directly influence reproduction and/or survival of Mexican spotted owls?
2) Which habitat features indirectly influence reproduction and/or survival of Mexican spotted owls by enhancing prey availability?
3) How should these features be arranged spatially on the landscape to optimize owl fitness and habitat quality?
4) How do stochastic environmental disturbances (particularly unplanned wildland fire) alter key habitat constituents and owl demography?
5) Which habitat features help buffer the influence of weather effects on reproduction and survival?
6) How do various planned management activities alter key habitat constituents (including prey) and owl demography? This question is particularly important relative to landscape-scale restoration projects currently in planning, because these projects have the potential to impact vast acreages in short time frames.
7) What is the probability that threshold nest/roost conditions recommended in the plan will become recovery habitat for roosting and/or nesting by Mexican spotted owls?

8) Which silvicultural prescriptions are best suited for creating and sustaining habitats used by Mexican spotted owls for various activities like roosting, nesting, foraging, and dispersal?
9) Which types of planned burning regimes and methods will promote development of the owl's roosting, nesting, and foraging habitat?
10) What proportion of Mexican spotted owl populations migrate seasonally, where are winter habitats located, what habitat features do owls use to select these areas, and how important are these areas for owl dispersal and survival?
11) How will climate change alter distribution, structure, and composition of owl habitat?
12) How will climate change influence owl and prey distribution and abundance?
13) If livestock grazing occurs within owl nesting, roosting, and foraging habitats, what livestock grazing strategies can be implemented to best maintain suitable habitat conditions for owl prey species and alleviate grazing impacts on the development of future owl nesting/roosting habitats (e.g., oak/cottonwood/willow/alder trees)?
14) What are the effects of various recreational activities (hiking, climbing, OHV use) on Mexican spotted owl behavior, habitat use and demography? How can managers mitigate potential effects in high-use areas?
15) If salvage logging is needed after a disturbance event (e.g., fire, insect/disease outbreak), how can it be implemented to maintain and protect existing habitat features or accelerate the development of future owl habitat?

The effects of different severities of wildland fire (Question 4 above) on Mexican spotted owls are still poorly understood. Stochastic disturbances and activities like wildland fire that may not be readily tested with experiments for lack of suitable control can be examined through development and analysis of simulation models and comparison with observational (retrospective) analyses. Planned management activities that should be studied for effects on owls, prey, and habitat include forest restoration, forest thinning prescriptions, and domestic livestock grazing. A number of Collaborative Forest Landscape Restoration Projects are pending implementation within the range of the owl. These projects offer an excellent opportunity to overlay research to understand effects of restoration prescriptions on owl populations and habitats.

2. Biological Interactions

Although recovery plans are mostly written for a single species, they must consider a wide array of interactions within biological communities and ecosystems. Community-level interactions that can affect Mexican spotted owl populations include parasitism, disease, predation, and competition. These factors are omnipresent in shaping population processes. However, the combined influence of these factors under particular environmental conditions can prove deleterious, resulting in significant and unrecoverable population decline. Important questions include:

1) Are any of these factors limiting Mexican spotted owl populations?
2) In particular, what are the effects of invasive pathogens like WNV?
3) What is the relative influence of other predators on common prey of the Mexican spotted owl?

4) What environmental conditions will lead to increased effects of community-level interactions?
5) What types of management actions are necessary to alleviate deleterious community-level interactions?
6) How might climate change alter these factors and/or their impacts on Mexican spotted owls?
7) How will planned habitat treatments influence different biological interactions that can limit Mexican spotted owl populations, and how do these effects vary across spatial and temporal scales?

3. Population Structure

For populations to persist through time, there must be adequate numbers of individuals present within and among subpopulations. The ultimate distribution and abundance of individuals is influenced by a wide array of factors. Some of these factors can be influenced by management. For example, restoration of riparian corridors between core populations (i.e., Other Riparian) may ensure stronger connectivity and mixing of genotypes. Other factors, like the distribution of canyons on the landscape, cannot be influenced, with the possible exception of removing dams. The questions posed below relate more to longer-term, larger-scale processes than the previous questions. However, these questions will need to be addressed in a long-term management plan. Specifically, questions about metapopulation function like dispersal and connectivity must be answered, along with questions about gene flow and fitness.

1) What are the relative numerical and genetic contributions of core and exterior populations?
2) Are subpopulations within and between EMUs connected?
3) What habitats and large-scale habitat configurations are required to maintain adequate survival rates during juvenile dispersal or adult migration?
4) What is the optimal arrangement of owl numbers and genetic mix that will lead to persistent populations at various time scales?
5) Which management activities help to ensure a well distributed set of functioning subpopulations? Which hinder this goal?
6) What are the potential impacts of climate change on connectivity of owl populations throughout their range?

4. Ecosystem Function

Implementation of recovery measures for the Mexican spotted owl will affect numerous ecosystem attributes directly and indirectly. Research is needed to determine the extent of these effects on biotic and abiotic components, and on ecosystem processes and function. Key questions are:

1) What are the effects of implementing this Recovery Plan on ecosystem structure and functions like soil erosion, water yield, and nutrient flow?
2) What are the effects of implementing this Recovery Plan on plant community structure, composition, and sustainability?
3) How has the implementation of this Recovery Plan affected long-term restoration of forested systems?

4) How are other focal wildlife species responding to conservation guidelines in this Recovery Plan?
5) How might this Recovery Plan be adjusted to mitigate potentially deleterious effects on other ecosystem attributes?
6) What are the potential implications of climate change to resilience of the ecosystems that support Mexican spotted owls, and how can we best balance increasing resilience in those systems with maintaining owl habitat?