A PROTOTYPE REGIONAL ASSESSMENT OF HABITATS FOR SPECIES OF CONSERVATION CONCERN IN THE GREAT BASIN ECOREGION AND NEVADA

Version 1.1, September 2003

Produced by USDA Forest Service, Pacific Northwest Research Station, in collaboration with:

**USDI Bureau of Land Management,
USGS Biological Resources Division, and
USDA Forest Service National Forest System**

**in Partial Fulfillment of
Interagency Agreement PNW-02-IA-11261967-046/BLM-DAI020006
between the Pacific Northwest Research Station
and the Bureau of Land Management**

Citation for this Document:

Wisdom, M. J., L. H. Suring, M. M. Rowland, R. J. Tausch, R. F. Miller, L. Schueck, C. Wolff Meinke, S. T. Knick, and B. C. Wales. 2003. A prototype regional assessment of habitats for species of conservation concern in the Great Basin Ecoregion and State of Nevada. Version 1.1, September 2003, unpublished report on file at USDA Forest Service, Pacific Northwest Research Station, 1401 Gekeler Lane, La Grande, OR 97850.

AUTHORS

Michael J. Wisdom, USDA Forest Service, Pacific Northwest Research Station, La Grande, OR
Lowell H. Suring, USDA Forest Service, Terrestrial Wildlife Ecology Unit, Boise, ID
Mary M. Rowland, USDA Forest Service, Pacific Northwest Research Station, La Grande, OR
Robin J. Tausch, USDA Forest Service, Rocky Mountain Research Station, Reno, NV
Richard F. Miller, Oregon State University, Squaw Butte Research Station, Burns, OR
Linda Schueck, USGS Biological Resources Division, Boise, ID
Cara Wolff Meinke, USGS Biological Resources Division, Boise, ID
Steven T. Knick, USGS Biological Resources Division, Boise, ID
Barbara C. Wales, USDA Forest Service, Pacific Northwest Research Station, La Grande, OR

ACKNOWLEDGMENTS

We thank Bob Abbey, Chris Jauhola, Mark Hilliard, Cal McCluskey, and Sherm Karl for leadership and guidance in the establishment and oversight of our work. We thank Karin Preston for spatial analyses and production of maps. Steve Monsen shared expert knowledge and key insights about vegetation ecology of the sagebrush ecosystem. The following species experts provided invaluable reviews of species-habitat associations: John Rotenberry for passerine birds, Bob Lehman for raptors, Eric Yensen for mammals, and Alan St. John for reptiles and amphibians. Matthias Leu provided a detailed and thoughtful review of all chapters that substantially improved the content. Jennifer Boyd edited and formatted the document. Joan Penzien and Dave Woodworth provided helpful literature. Dave Pickel provided information about watershed layers in Nevada and adjacent states. Funding and in-kind support were provided by the Washington Offices, USDI Bureau of Land Management and USDA Forest Service, by the USGS Biological Resources Division, Snake River Field Station, and by the USDA Forest Service Pacific Northwest Research Station and Rocky Mountain Research Station.

PREFACE

This document is a prototype, or working example, of the application of newly developed methods for regional assessment of habitats for sagebrush-associated species. The main purpose for using these methods in our prototype is to demonstrate the evaluation of some of the major threats to habitats for sagebrush-associated species in the Great Basin Ecoregion and state of Nevada. However, because our prototype is a working example, it does not address all regional threats to habitats within these spatial extents. Instead, our prototype provides a framework in which additional analyses can be conducted in the future to address the full spectrum of threats to sagebrush habitats and the associated species.

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KEY FINDINGS

- Sagebrush habitats have been substantially reduced in area and quality, owing to a variety of detrimental land uses and undesirable ecological processes. Our assessment focused on the Great Basin Ecoregion and state of Nevada, encompassing some of the largest areas of sagebrush habitats that remain today.

- Although substantial areas of sagebrush still exist in the Great Basin Ecoregion and Nevada, >40% of the current area of sagebrush (>4 million hectares [ha]) is at moderate or high risk of being displaced by cheatgrass over the next 30 years, based on model estimates developed for our assessment.

- Many non-sagebrush habitats also are susceptible to displacement by cheatgrass, particularly salt desert scrub, and >60% (>8 million ha) of the area currently occupied by these habitats are modeled as moderate to high risk.

- Substantial areas of sagebrush also are at moderate or high risk of displacement by pinyon-juniper woodlands over the next 30 years. In 3 ecological provinces where this risk was estimated, approximately 41% of existing sagebrush (>1.9 million ha) is estimated as moderate or high risk.

- Loss of native habitats to cheatgrass and pinyon-juniper would affect a variety of terrestrial vertebrates. Of the 40 species whose habitats we assessed, potential loss to cheatgrass, based on areas estimated at high risk, could eliminate as much as 66% of current habitats for some species, totaling >8 million ha.

- Greater sage-grouse may not always function well as an umbrella species for other sagebrush-associated species. Many sagebrush-associated species have different ranges, different habitat associations beyond sagebrush, or rely on habitats at greater risk to cheatgrass displacement than those identified for sage grouse.

- Retention of existing sagebrush and other native habitats in the Great Basin Ecoregion and Nevada requires both active and passive management designed to mitigate the risks posed by cheatgrass and pinyon-juniper. Such an approach is different and probably more effective, efficient, and less costly than attempts to restore native habitats already lost to cheatgrass and pinyon-juniper.

- Extensive field evaluations of the modeled estimates of risks that cheatgrass and pinyon-juniper will displace existing native habitats are needed as part of research support for our assessment and its management applications. Given the substantial areas of native habitats estimated to be at moderate or high risk, field validation is critical in understanding the scope and magnitude of habitat problems faced by land managers in the Great Basin Ecoregion and state of Nevada.

EXECUTIVE SUMMARY

Background and Purpose

We assessed habitats for 40 species of conservation concern (species with declining or rare habitats or populations, also called species of concern) in the Great Basin Ecoregion and state of Nevada. Our assessment was a prototype, or working example, that demonstrated the application of methods recently developed to evaluate sagebrush habitats at regional scales (areas >100,000 hectares [ha], and often >1 million ha) in the western United States.

Our prototype focused on assessment of sagebrush-associated species of concern because native habitats in the sagebrush ecosystem have been substantially reduced in area and quality. The ecosystem is now considered one of the most endangered in the United States. Consequently, the conservation of many species associated with sagebrush habitats, such as greater sage-grouse and pygmy rabbit, are of concern because of declining populations in relation to habitat loss and degradation.

Despite the accelerating loss and degradation of native habitats in the sagebrush ecosystem, the Great Basin Ecoregion (referred to as Great Basin) in Nevada, Utah, and California encompasses one of the largest remaining areas of sagebrush. Land cover types (referred to as cover types) of sagebrush occur on 8.8 million ha, or 30% of the Ecoregion. In Nevada, sagebrush cover types occupy 10.2 million ha, or 36% of the State. Consequently, management of these vast areas is likely to have strong bearing on the fate of many species associated with the sagebrush ecosystem in western North America. Accordingly, the main goals of our assessment were to (1) estimate habitat conditions and threats for species of concern, for effective conservation and restoration of these species' habitats; and (2) demonstrate the application of newly developed procedures for regional assessment of sagebrush habitats for species of concern.

Methods

We used the newly developed procedures for regional assessment to estimate and map the risks of future (next 30 yrs) loss of species' habitats from displacement by cheatgrass or by pinyon-juniper woodlands. Analyses of these threats were designed to provide spatially explicit estimates needed by managers to target each threat to species' habitats with the appropriate management prescriptions, and to estimate the area, time, and resources required to implement the prescriptions. Estimates of these habitat threats can be used for multi-species evaluations and management, described later.

To map species' habitats and associated threats, we used the recently completed 90-meter (m) x 90-m (0.81 ha) pixel map that composes the "sagestitch" layer (referred to here as the 90-m sagestitch map). The sagestitch layer is the only continuous coverage map of sagebrush cover types currently available for the United States, and is posted on SAGEMAP (http://sagemap.wr.usgs.gov).

We summarized threats to habitats from cheatgrass and pinyon-juniper for each of the 40 species, and for 5 groups of these species. Each species was placed in 1 of 5 groups: (1) sagebrush; (2) salt desert scrub; (3) shrubland; (4) sagebrush-woodland; and (5) generalist. The name of each group denotes the primary habitat associated with species in the group. For each

watershed and group, we mapped and estimated 2 habitat variables: (1) habitat abundance (low, moderate, or high); and (2) habitat risk (none to low; low to moderate; or moderate to high risk of habitat displacement by cheatgrass).

We also assessed the degree to which sage grouse may function as an "umbrella" species. We specifically evaluated how well the range, habitat associations, and threats to habitats for greater sage-grouse represented these same patterns for the other 39 species of concern. Detailed methods of our assessment are described in Chapters 3-8.

Results

Land Cover Types—Dominant cover types in the Great Basin include sagebrush (8.8 million ha), salt desert scrub (7.4 million ha), and pinyon-juniper (3.1 million ha). These cover types also dominate Nevada (sagebrush – 10.2 million ha; salt desert scrub – 6.2 million ha; and pinyon-juniper – 2.6 million ha).

All cover types of sagebrush were identified and modeled as being susceptible to future displacement by cheatgrass, as were many non-sagebrush cover types, including salt desert scrub, other shrublands, and native grassland. In the Great Basin, non-sagebrush cover types that were susceptible to cheatgrass, mostly salt desert scrub, composed the largest area estimated to be at high risk of cheatgrass displacement (7.5 million ha, or 51% of the area currently occupied by these cover types). These non-sagebrush cover types also had large areas at low risk to cheatgrass displacement (4.2 million ha, or 29% of the area occupied by these cover types). Approximately 3.0 million ha (20%) of these non-sagebrush cover types were identified as moderate risk.

By contrast, sagebrush cover types in the Great Basin had less area at high risk to displacement by cheatgrass (1.7 million ha, or 19% of current sagebrush), and substantial area at low risk (3.5 million ha, or 42% of current sagebrush). Approximately 3.1 ha (39%) of sagebrush cover types were estimated to be at moderate risk to displacement by cheatgrass.

We found similar results for Nevada. Non-sagebrush types that were susceptible to cheatgrass displacement, again mostly salt desert scrub, made up the largest area at high risk (6.2 million ha, or 50% of the area currently occupied by these cover types). Non-sagebrush cover types at moderate risk to cheatgrass encompassed 2.4 million ha, or 20% of the current area of these types. These susceptible, non-sagebrush cover types also had substantial area at low risk (3.8 million ha, or 31% of the area occupied by these cover types). Sagebrush cover types had less area at high risk to displacement by cheatgrass (1.5 million ha, or 15% of all existing sagebrush) and substantially more area at moderate (2.9 million ha, or 29% of existing sagebrush) or low (5.8 million ha, or 57% of existing sagebrush) risk.

For the 3 ecological provinces in the Great Basin where the risk of pinyon-juniper displacement of sagebrush was estimated (High Calcareous, Central High, and Bonneville Ecological Provinces), 1.7 million ha of the sagebrush cover types were at high risk (35% of the sagebrush area that was evaluated). Approximately 2.9 million ha of the sagebrush cover types were at low risk to pinyon-juniper (59% of the sagebrush area that was evaluated), while 0.3 million ha (6%) of sagebrush was estimated as moderate risk.

Habitats for Species of Concern—The 40 vertebrate species of conservation concern included 1 amphibian, 9 reptiles, 13 mammals, and 17 birds. Amount of current habitat for these species in the Great Basin varied from approximately 1 million ha for Wyoming ground squirrel

to almost 25 million ha for striped whipsnake. Amount of habitat in Nevada varied from 2.7 million ha for Wyoming ground squirrel to almost 26 million ha for striped whipsnake and night snake. For high-profile species such as greater sage-grouse and pygmy rabbit, amount of habitat was 5.4 and 8.5 million ha in the Great Basin, and 8.7 and 10.3 million ha in Nevada, respectively.

The 40 species were associated with a wide variety of habitats beyond sagebrush; 16 were associated with 50% or more of the 43 cover types that occur in the Great Basin. Among the 7 species that relied on ≥30 cover types, 4 were raptors (ferruginous hawk, Swainson's hawk, Northern harrier, and short-eared owl) and 3 were herptiles (Great Basin spadefoot, nightsnake, and striped whipsnake). Habitats for these 7 species included all 8 sagebrush cover types, as well as a broad array of other shrublands, agricultural lands, and pinyon-juniper woodlands. Overall, birds and herptiles were associated with more cover types ($\bar{x}$ = 22.5 and 22.0, respectively) than mammals ($\bar{x}$ = 17.8).

Species in the Great Basin with the highest percentage of their habitats at high risk to displacement by cheatgrass included Merriam's kangaroo rat (57%, 2.4 million ha), groundsnake (54%, 4.0 million ha), and long-nosed snake (53%, 6.4 million ha). Species with the highest percentage of their habitats at low risk to cheatgrass displacement included Brewer's blackbird (66%, 4.0 million ha), gray flycatcher (52%, 6.0 million ha), and Merriam's shrew (51%, 6.1 million ha).

In Nevada, the chisel-toothed kangaroo rat and Merriam's kangaroo rat had the highest percentage of habitats at high risk to cheatgrass displacement (45%, 5.1 million ha, and 45%, 3.3 million ha). Brewer's blackbird and gray flycatcher had the highest percentage of habitats in Nevada at low risk to cheatgrass (72%, 3.8 million ha, and 61%, 7.1 million ha).

For greater sage-grouse and pygmy rabbit, percentage of habitats at high risk to cheatgrass displacement was 19% (1.0 million ha) and 22% (1.9 million ha) in the Great Basin. In Nevada, percentage of habitats at high risk to cheatgrass was 14% for both species (1.2 million ha for sage grouse and 1.5 million ha for pygmy rabbit). Percentage of habitats at low risk to cheatgrass in the Great Basin was 60% (5.2 million ha) for greater sage- grouse and 51% (5.3 million ha) for pygmy rabbit. In Nevada, percentage of current habitats at low risk to cheatgrass was 60% (5.2 million ha) for greater sage-grouse, and 51% (5.3 million ha) for pygmy rabbit.

For the High Calcareous, Central High, and Bonneville Ecological Provinces in which the risk of sagebrush displacement by pinyon-juniper was estimated, Brewer's blackbird had the highest percentage of its sagebrush habitats at high risk (42%, 0.3 million ha). However, the majority of species had substantially more sagebrush habitats at high risk to pinyon-juniper, typically >1.0 million ha.

The groundsnake had the highest percentage of its sagebrush habitats at low risk to displacement by pinyon-juniper (86%, 0.5 ha). The majority of other species, however, had substantially more area at low risk, typically >2.0 million ha.

Habitats for Groups of Species—Of the 5 groups of species evaluated, the salt desert scrub group had the highest percentage (34%) of the 446 watersheds in Nevada with low habitat abundance (watersheds with habitat area <25%). The sagebrush group had the next-highest percentage (25%) of Nevada watersheds with low habitat abundance. By contrast, the generalist group had only 3 of the Nevada watersheds (1%) classified as low habitat abundance, and <3% of watersheds for the shrubland and sagebrush-woodland groups were low.

The generalist and shrubland groups had 90% or more of their Nevada watersheds classified as high habitat abundance (watersheds with habitat area >50%). The sagebrush-woodland group had 56% of its watersheds classified as high, while the salt desert scrub and sagebrush groups each had 39% of watersheds in the high class.

The salt desert scrub group of species had the highest percentage (47%) of Nevada watersheds with habitats dominated by moderate to high risk of displacement by cheatgrass. The salt-desert scrub group also had second-lowest percentage of watersheds (27%) with habitats dominated by no to low risk to cheatgrass.

This pattern also was evident for the shrubland group of species: 44% of Nevada watersheds were dominated by habitats at moderate to high risk and 26% were at no to low risk. The sagebrush group of species had 19% of the 446 watersheds in Nevada at moderate to high risk of cheatgrass displacement, 44% at low to moderate risk, and 36% at none to low risk.

We found similar patterns of habitat abundance among the groups and watersheds in the Great Basin. However, patterns of habitat risk among watersheds for the 5 groups of species were generally higher in the Great Basin than in Nevada. For example, the large majority of Great Basin watersheds for the shrubland and salt desert shrub groups were dominated by habitats at moderate to high risk of displacement by cheatgrass (63% and 71%, respectively). The percentage of Great Basin watersheds with habitats mostly at moderate to high risk for the other 3 groups also was substantially higher than Nevada watersheds (sagebrush-woodland group, 26%; sagebrush group, 32%; and generalist group, 43%).

Greater Sage-Grouse as an Umbrella Species—Within the Great Basin, overlap of the ranges for 39 species of concern with the current range of greater sage-grouse varied from 20% (groundsnake and Merriam's kangaroo rat) to 100% (Wyoming ground squirrel). For most species (n = 29), the percent overlap of their ranges with that of sage-grouse was about 46% (the percentage of the Great Basin occupied by sage-grouse), consistent with independence in the distribution of most species from the distribution of sage-grouse in the ecoregion. In comparing habitat associations of each species with sage-grouse, Wyoming ground squirrel had the greatest overlap with sage-grouse (70%). By contrast, chisel-toothed kangaroo rat had the least overlap, with only 1 (black sagebrush) of its 13 habitat cover types shared with sage-grouse. Mean overlap in cover types across all 39 species and sage-grouse was 32%.

Across the 39 species, the percentage of habitat found in the current range of sage-grouse averaged 48%, comparable to the mean overlap in range of 47%. Only 13 species (33%) had >50% of their habitat within the range of sage-grouse, including all members of the sagebrush and sagebrush-woodland groups. Again, Wyoming ground squirrel was best matched with sage-grouse, with 100% of its habitat in the Great Basin within the range of sage-grouse, in contrast to only 14% for groundsnake. For habitat at high risk of displacement by cheatgrass, the majority ($\bar{x}$ = 63%) was outside the range of sage-grouse; somewhat more habitat at moderate risk ($\bar{x}$ = 50%) was captured within the range of sage-grouse.

Using the criteria above to assess the efficacy of sage-grouse as an umbrella species, overlap with sage-grouse was best for the sagebrush group, and worst for the salt desert scrub group. Although some species, such as Wyoming ground squirrel, vesper sparrow, and other sagebrush obligates, may benefit from management directed toward habitats occupied by greater sage-grouse, many species, especially those associated with more arid salt desert scrub habitats, will not be accommodated by management based solely on habitats in the current range of sage-grouse.

Management Implications

1. The substantial area of salt desert scrub and sagebrush habitats at high risk to future displacement by cheatgrass presents a daunting management challenge. Understories of these stands are probably dominated by cheatgrass at the current time. Consequently, any fires occurring in these stands would facilitate further conversion to cheatgrass. Fire suppression, when feasible, would be a stop-gap, short-term mitigation. In the long term, the use of chemical or other treatments to reduce biomass of cheatgrass in understories of these stands, combined with reseeding of these understories with native grasses and forbs, is needed. These treatments may help prevent conversion of salt desert scrub and sagebrush habitats to cheatgrass. Once converted to cheatgrass, it may be difficult or impossible to restore these native shrublands. In the case of sagebrush habitats, management treatments to mitigate the high risk of cheatgrass displacement would require less area to be treated compared to salt desert scrub, owing to the smaller area of sagebrush at high risk.

2. The large area and high percentage of salt desert scrub and sagebrush habitats at moderate risk to cheatgrass also presents a management challenge, but one that poses a substantially higher chance of success than efforts to mitigate areas at high risk. Understories of these stands are likely to have cheatgrass present in varying amounts, in combination with native grasses and forbs. Such stands may be sensitive to inappropriate grazing by domestic and wild ungulates, which results in the reduction or elimination of native grasses and forbs, and thereby conveys competitive advantage to cheatgrass establishment and dominance. In such cases, stocking rates and grazing systems for domestic ungulates, as well as management regimes for wild ungulates, could be redesigned to allow native grasses to regain competitive advantage over cheatgrass. If cheatgrass takes over as the dominant understory in these stands, any subsequent fire will further enhance the spread and dominance of cheatgrass. In this case, fire is not the cause of the cheatgrass problem, but rather the resulting process that follows inappropriate grazing or other pervasive disturbances (e.g., road construction and use, energy development, mining, recreational activities, etc.). Consequently, careful management of pervasive disturbance agents in areas at moderate risk to cheatgrass displacement is an important factor in maintaining these areas as habitats for species of conservation concern.

3. Species with habitats most at risk from cheatgrass are those that depend on salt desert scrub cover types; these species and their habitats deserve a high degree of focus in conservation and management to prevent substantial losses of populations and habitats that are likely in the near future. Other species that deserve focus are in the shrubland group, which depend on a combination of salt desert scrub and sagebrush habitats. The sagebrush group of species also demands management attention, owing to the substantial area of their habitats at high risk to displacement by cheatgrass. However, the sagebrush group has a lower percentage of their habitats at high risk to cheatgrass displacement than does the salt desert scrub or shrubland groups of species.

4. Sagebrush habitats at low risk of displacement by cheatgrass are likely to be more resilient to disturbances of fire and grazing, and current management practices in relation to fire and grazing management may not increase this low risk. Such habitats are likely to be maintained in the future with current methods of managing vegetation. Moreover, frequent fire is an important component of mountain sagebrush habitats, and these habitats are mostly at low risk to cheatgrass. Consequently, extensive use of prescribed fire to maintain the health of low-risk stands in an important management consideration.

5. Sagebrush and salt desert scrub habitats at low risk of displacement by cheatgrass are likely to function as current and future "strongholds" for the associated species of concern. In that context, protection of these low-risk habitats from pervasive human disturbances, such as mining, energy, powerline, and road developments, is essential in maintaining these habitats as functional environments for many species of concern. Consequently, prevention and mitigation of these additional threats, beyond the risks posed by cheatgrass, will be important in maintaining persistence of these resilient habitats.

6. The substantial area of sagebrush habitats at high risk to displacement by pinyon-juniper woodlands deserves immediate management attention. Retention of existing sagebrush in these stands, with the use of prescribed fire or mechanical treatments to reduce density and biomass of pinyon-juniper, is likely to be more effective, efficient, and less costly than attempts to restore sagebrush habitats already lost to pinyon-juniper.

7. Sagebrush habitats at low risk to displacement by pinyon-juniper are likely to function as strongholds for sagebrush-associated species, in tandem with sagebrush habitats at low risk to displacement by cheatgrass. Protection of these low-risk habitats from pervasive human disturbance factors (e.g., energy, powerline, and road developments) is essential in maintaining these habitats as functional environments for many species of concern. Consequently, mitigation of these other threats, beyond the risks posed by pinyon-juniper, will be important in maintaining persistence of these resilient habitats.

8. Extensive field evaluations of our estimates of risk that cheatgrass and pinyon-juniper will displace existing native habitats are needed as part of research support for our assessment and its management application. Given the substantial areas of native habitats that are estimated to be at moderate or high risk, field validation is critical in understanding the scope and magnitude of habitat problems faced by land managers in the Great Basin Ecoregion and state of Nevada.

ARRANGEMENT OF MATERIAL BY CHAPTERS

This paper is arranged like chapters in a book. This arrangement is designed to enhance the readability and understanding of our work, by organizing subject matter in the most useful way possible. For example, vegetation ecologists may be interested in the amount, distribution, and threats to native cover types (Chapters 3 and 4). By contrast, biologists may want to focus on species of conservation concern and their habitats (Chapters 5 and 6). Alternatively,

managers typically are interested in habitat conditions and threats shared among many species, which are reflected in our assessment of species groups (Chapter 7). Finally, the use of sage grouse as an "umbrella species" (Chapter 8) is of interest to many disciplines, as are the cautionary points (Chapter 9) and conclusions (Chapter 10) drawn from our assessment.

Each chapter is self-contained to the degree possible. Chapters 3-8 compose the assessment chapters that contain background, justification, objectives, methods, and results, similar to "stand-alone" publications. Materials addressed in chapters before and after the assessment chapters (Chapters 1, 2, 9, and 10) provide context and detail in support of the overall assessment, as do the Appendices and Literature Cited. Formal metadata documentation for this assessment can be found on the SAGEMAP website (http://sagemap.wr.usgs.gov), as can the procedures document on which our methods are based (Wisdom et al. 2003).

In arranging these chapters, we followed the approximate order of analytical steps described by Wisdom et al. (2003) for regional assessment of habitats of species of concern in the sagebrush ecosystem. Each step is listed below, followed by the associated chapters that use each step for our assessment:

(1) Identify the ecoregion and associated spatial extents for regional assessment (Chapters 1, 2, 3);
(2) Identify species of conservation concern in the ecoregion (Chapter 5);
(3) Delineate species ranges (Chapter 5);
(4) Estimate habitat requirements of species (Chapter 6)
(5) Identify regional threats and effects of such threats on habitats (Chapters 4, 6);
(6) Estimate and map the risks of habitat loss or degradation posed by each threat (Chapters 4, 6);
(7) Calculate species-habitat effects from risks of all threats (Chapter 4);
(8) Form species groups to generalize results across species (Chapter 7);
(9) Summarize results for species and groups at desired spatial extents (Chapters 6, 7); and
(10) List major assumptions, limitations, and guidelines for management (Chapters 8, 9, 10).

Scientific names of the 40 species of conservation concern, which are the focus of our regional assessment in the Great Basin and Nevada are found in Table 5.1 of Chapter 5. A complete list of all species of conservation concern in the Great Basin and Nevada, the majority of which are local endemics not subject to regional assessment, is found in Appendix 3. Scientific names of all other plant and animal species mentioned in the text are given in Appendix 2.