CONSERVATION MANAGEMENT STRATEGY FOR MESQUITE AND ACACIA WOODLANDS IN CLARK COUNTY, NEVADA

Bureau of Land Management
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SUMMARY

Mesquite and acacia woodlands are of significant biological importance, providing habitat to many wildlife species in southern Nevada, including several species covered under the Clark County Multiple Species Habitat Conservation Plan (MSHCP). A number of covered plant species also co-occur with these woodlands. The extent and condition of woodlands, however, is severely impacted by the diverse activities of a growing human population. In response, the development of a Mesquite-Acacia Conservation Management Strategy (CMS) was mandated in the MSCHP, with the goal of bringing the best available scientific information to bear on the protection and management of these woodlands and their associated species in Clark County. This CMS

1) Assembles and reviews the literature on the ecology of mesquite, acacia and dependent species, and the spatial data on the distribution of these woodlands in southern Nevada;

2) Summarizes the condition of, human uses of, and threats to these woodlands and their associated species;

3) Determines the adequacy of current legislation and programs to protect and/or enhance mesquite and acacia woodlands;

4) Establishes Conservation Goals and Objectives, and prioritizes recommended Conservation Actions;

5) Ranks woodlands for conservation attention based on their biological value and the level of threat they face;

6) Identifies data gaps in our knowledge of the distribution, ecology, and potential responses to management of mesquite, acacia and associated species in southern Nevada; and

7) Recommends an Adaptive Management Strategy, including a monitoring program.

At least 14, 400 ha of mesquite and acacia woodlands are patchily distributed throughout southern Nevada. The majority (82%) occurs on lands managed by federal agencies, primarily the Bureau of Land Management, followed by the National Park Service, and the Fish and Wildlife Service. The remainder are privately owned or managed by state and county agencies. Woodlands range in size from less than 1 ha to over 1000 ha.

To date, more than 40 plant and animal species have been identified as being associated with or dependent on mesquite and/or acacia woodlands for foraging, breeding, resting, and

refuge. Of these, one of the most notable species is the Phainopepla (*Phainopepla nitens*), a bird that forages almost exclusively on the berries of desert mistletoe (*Phoradendron californicum)*; this mistletoe grows only on mesquites and acacias in Nevada. The Phainopepla has been used as a model species to inform this CMS because, of all the covered species, it is most closely tied to these woodlands, and its ecology in southern Nevada is comparatively well known.

Mesquite and acacia woodlands are also subjected to a variety of human activities, including mining, recreational activities, and grazing by livestock and wild horses and burros. Unauthorized activities that are known to occur in woodlands include grazing, dumping and woodcutting. Roads and utility rights-of-way often cross through woodlands. Wildfires frequently occur in woodlands, ignited from both natural and human sources.

There are many gaps in knowledge on the distribution and ecology of mesquite, acacia, and their associated species in southern Nevada. For example, it is likely that many acacia woodlands exist in the Muddy, McCullough, Highland and Ireteba mountains, but have yet to be groundtruthed and included in a geographical information system (GIS). The relationships between groundwater availability and acacia survival and regeneration are not well understood. The effects of certain human uses on woodlands and associated species have not been quantified. Techniques for mesquite and acacia restoration have not been rigorously established in an experimental framework. The response of Phainopeplas to fragmentation will need to be explored, including their movement patterns and metapopulation dynamics. These and other data gaps have been identified in the CMS, and prioritized for the purposes of allocating research and monitoring funding and staff.

The primary conservation and management issues facing mesquite and acacia woodlands fall into three categories: habitat loss and fragmentation, degradation of habitat quality, and lack of new tree recruitment. These woodlands and their associated species are especially threatened by urbanization, conversion to agriculture, fire, invasion by exotic plants, and water development and management. Human activities, depending on their frequency and intensity, also may contribute to these problems, as may grazing and trampling by wild horses and burros. Livestock grazing can also contribute to woodland habitat degradation, but most livestock grazing on public lands in Clark County has been discontinued.

In order for the CMS to satisfy the stated objectives of the MSCHP with regards to protecting covered species and their habitats, three Conservation Goals were developed:

1) To restore and maintain mesquite and acacia woodlands to the extent (area) they covered in year 2000 (inception of MSCHP), by protecting all woodlands on public land from habitat loss and acquiring (directly or with conservation partners and/or easements) as many woodlands as possible from private owners.
2) To restore and sustain mesquite and acacia woodlands in a healthy ecological condition (active recruitment of new plants, large trees with few stems, ability to support moderate mistletoe infection).
3) To maintain stable or increasing populations of mesquite- and acacia-dependent and associated species.

To measure progress towards these goals, and based on a literature review of the ecology of mesquite, acacia, and dependent species, the following Conservation Objectives were established:

1) The largest and most biologically significant (in terms of the criteria listed below) woodlands should be protected from habitat loss and degradation, and/or restored to conditions listed in Objectives 2-7 (*Goals 1, 2, and 3).*
2) Groundwater levels should be sustained at current or higher levels under all mesquite woodlands, and those acacia woodlands using groundwater (*Goals 1, 2, and 3).*
3) Woodlands should include multiple age classes and exhibit ongoing recruitment (20-35% seedlings/saplings in mesquite woodlands) (*Goals 2 and 3).*
4) The habitat quality of woodlands should be maintained or improved to meet the requirements of associated species, especially covered and other special status species (*Goal 3).*
5) The majority of woodlands should support actively growing, berry-producing mistletoe plants of all ages in at least 60 % of the trees (*Goal 3).*
6) At least 80% of woodlands should support Phainopeplas, and at least 50% of woodlands should support densities of at least 2 Phainopeplas/ha. Phainopepla nest success should average $\geq$ 50% across woodlands and years (higher in larger mesquite woodlands) (*Goal 3).*
7) Other species included in this CMS should be detected at the same (or greater) number of woodlands, and in the same (or greater) densities as at present (*Goal 3).*

The general types of conservation actions that are likely to have the most impact on mesquite and acacia woodlands and their dependent species were identified. Listed in order of their anticipated effectiveness and impact, and matched with Conservation Objectives, they are:

1) Protect all existing woodlands on public lands from further loss and fragmentation (including ensuring that woodlands are not lost in land disposals) (*Objective 1).*
2) Secure additional woodlands (via acquisition, conservation partners/easements) where possible (*Objective 1)*.
3) Do not authorize activities that would require additional groundwater resources. Ensure adequate groundwater availability under woodlands (including changing legislation regarding water use and encouraging water conservation) (*Objective 2)*.
4) Initiate restoration efforts in existing and former woodlands (*Objectives 1 and 3-7).*
5) Reduce deleterious human activity in woodlands (e.g. increase law enforcement, reduce access, limit OHV use, mining, and grazing) (*Objectives 3-7)*.
6) Reduce/control other threats (e.g. remove exotic plants, fence out burros, control populations of predatory animals) (*Objectives 3-7)*.
7) Address data gaps (e.g. inventory habitat patches and species distributions, monitor groundwater, determine recruitment habitat requirements, study host tree and mistletoe dynamics) (*all Objectives*).
8) Promote public appreciation of mesquite and acacia woodlands and associated species (*all Objectives*).

To identify those woodlands that had the most biological significance for the purposes of conserving associated species, a ranking system based on conservation biology theory and the habitat requirements of the associated species (particularly Phainopepla, the model species) was developed. Woodlands were grouped according to their score in the ranking system; Ranks 1 through 4 are considered priority woodlands, with 1 being the highest priority. After Rank 4, woodlands are not a priority for conservation, but nonetheless are likely to benefit from general conservation activities (e.g. protecting groundwater, public education) and should not be completely neglected. Based on *current* information, the thirteen priority woodlands in Clark County are (a * denotes a moderate-high level of risk: many and/or severe threats and a low-level of management protection):

Rank 1(Core): Muddy River*, Big Bend*

Rank 2: Piute, Hiko*, Overton*, Grapevine

Rank 3: North Las Vegas*, parts of Pahrump*, Arrow Canyon, SW Gold Butte*, Mormon Mesa E

Rank 4: Bunkerville*, Corn Creek, Nelson*

It should be noted that this ranking is based on the information currently available regarding the distribution of woodlands and the ecology of dependent species; as this knowledge increases, this ranking system and its results may change somewhat. This process is part of the adaptive management framework built into the CMS, which, via annual monitoring and well-planned research, will generate new information for future modifications to the CMS. A technical advisory group of experts in the field of mesquite and acacia ecology, ecophysiology, and restoration ecology, and the ecology of associated species, should be maintained to assist in the implementation of this CMS. The group should meet at least annually, starting in the spring of 2006, to determine and prioritize staffing and funding for implementing the studies and conservation actions recommended in this document, assisted by a county-sponsored workshop of management and scientific experts. As new knowledge is acquired, the group will reassess and redevelop conservation objectives and actions, and eventually (after five years) the CMS itself, thus improving the ability of Clark County and other MSHCP partners to protect and manage mesquite and acacia woodlands and their dependent species.

INTRODUCTION AND PURPOSE

This document is a Conservation Management Strategy (CMS) required by and in support of, the Clark County Multiple Species Habitat Conservation Plan (MSHCP; Recon 2000). Its intent is to review the literature pertinent to the ecology and management of mesquite and acacia woodlands; describe the distribution, management status and condition of mesquite and acacia woodlands in Clark County; and recommend and prioritize conservation actions for those woodlands. Because acacia and mesquite woodlands are embedded in other more extensive ecological communities and geographical areas in Clark County, other CMSs that are being developed or will be developed in the future should be consulted with this document. These other plans include the Muddy and Virgin River CMSs, the Meadow Valley Wash CMS, and the CMSs for the Piute-Eldorado, Gold Butte-Pakoon. Mormon Mesa, and Coyote Springs DWMAs.

Honey mesquite (*Prosopis glandulosa*), screwbean mesquite (*Prosopis pubescens*), catclaw acacia (*Acacia greggii*) and smoke tree (*Psorthamnus spinosa*) are woody shrubs or trees of the Fabaceae (Pea) family. In Nevada’s Mojave Desert, they are distributed as isolated patches of woodland associated with perennial groundwater, or where drainage patterns allow for greater soil moisture content than that typical of the Mojave Desert. The requirement of permanent, reliable water sources has placed these species in direct competition for scarce water supplies and land with a growing human population. The population of Clark County, within which Las Vegas is located, more than doubled between 1986 and 2004 (to 1.7 million people), and is projected to grow by another 75% (to 2.7 million people) by 2024 (U.S. Bureau of the Census, Washington, DC and Nevada State Demographer's Office, Reno, NV). Nye County, which contains some of southern Nevada's largest remaining complexes of mesquite woodlands, sustained a similar population increase for the same time period (U.S. Bureau of the Census, Washington, DC). Increasing regional population growth has resulted in greater demand for groundwater, and subsequent declines in water table level may threaten the continued survival of these trees in much of their range in southern Nevada. Urban and agricultural expansion has resulted in the destruction and fragmentation of many mesquite and acacia woodlands that occurred in the Las Vegas, Pahrump, and Moapa valleys. The concomitant increase in human use of these woodlands has resulted in their further degradation due to uncontrolled woodcutting, trampling, dumping, grazing, and increased frequency of wildfires. Although mesquites are invading some portions of the desert Southwest, converting grasslands to shrublands, this process does not appear to be occurring in the northeastern Mojave Desert. In Nevada, in the meantime, non-native, aggressively invasive tamarisk (*Tamarisk ramossisima*) is expanding into many riparian areas that formerly supported mesquite woodlands.

Mesquite and acacia woodlands have been, and still are, of significant cultural and biological importance in southern Nevada. The seeds of all three species were ground by indigenous people into a meal that was baked into cakes; honey from nectar produced by the plants was also an important staple (Jaeger 1941). The wood was used for structures, carving and fuel, and the leaves and seeds are important livestock and wildlife forage. Mesquites and acacias provide refuge and breeding sites for many animal taxa, including several of conservation concern, and as overstory plants and nitrogen fixers they create favorable conditions for many co-occurring plant species.

In a landscape dominated by desert scrub, these patches of woodland serve as important breeding, foraging, and resting places for many avian species. Mesquite and acacia woodlands offer protection from weather and predators, and provide refuges where birds may experience more favorable energy budgets. Desert woodlands comprise a small percentage of the total vegetation in the Southwest, but support greater densities of birds than surrounding desert habitats (Germano et al. 1983, Laudenslayer 1981, Szaro 1981). Woodland patches scattered throughout the desert may play an important role in the successful migration of birds attempting to cross large ecological barriers such as deserts (Berthold and Terrill 1991), as they provide important stopover sites (Kuenzi and Moore 1991, Moore et al. 1990, Rappole and Warner 1976). The degradation or loss of stopover habitat can severely reduce the chance of a successful migration (Terborgh 1992), because many neotropical migrant species cannot store enough fat to support them throughout an entire migration episode, and must stop periodically to rest and replenish energy reserves (Winker et al. 1992). Especially in drought years in the Mojave Desert, these woodland patches may provide the only green vegetation for miles, so they can be highly visible to migratory wildlife.

Desert woodlands add structural complexity to the landscape, providing nesting sites and food resources for breeding birds. Several species of desert breeding birds, including Phainopeplas

(*Phainopepla nitens*) and Vermilion Flycatchers (*Pyrocephalus rubinus)*, both covered species under Clark County's MSCHP[1]; and Lucy's Warblers *(Vermivora luciae*) and Verdins (*Auriparus flaviceps*) are strongly associated with mesquite and/or acacia woodlands (Anderson and Ohmart 1978, Meents et al. 1983; see Birds of North America Accounts and Appendix A). Among these species, Phainopeplas are the most dependent on these woodlands; their diet consists almost exclusively of the berries of desert mistletoe (*Phoradendron californiucum*), which in Nevada only grows on mesquites, acacias, and smoke trees. Several other avian species, including many MSCHP covered and evaluation species [e.g. Summer Tanagers (*Piranga rubra*), Arizona Bell's Vireos (*Vireo bellii*) and Yellow-billed Cuckoos (*Coccyzus americanus*)], although less dependent on mesquite or acacia woodlands, nevertheless use them during the breeding season (Appendix A).

Several insect, reptile, and mammal species, including MSHCP covered and evaluation species and/or Bureau of Land Management (BLM) sensitive species[2] are also associated with mesquite and acacia woodlands. In particular, several butterflies [e.g. Western Great Purple Hairstreak (*Atlides halesus*) and Western Palmer's Metalmark (*Apodemia palmeri*)] and bees (e.g. *Perdita ashmeadi simulans* and *Perdita dificilis*) are specialists on the nectar of mesquite or desert mistletoe and/or use these plants as larval host plants (Austin and Murphy, unpubl. MS; T. Griswold, pers. comm.). Ant abundance and species richness tend to be greater in mesquite-dominated sites than grassland sites (Bestelmeyer 2005); mesquite dunes also harbor more rare ant species than interdune areas (Bestelmeyer and Wiens 2001). Termites are more abundant in mesquite dunes (Whitford 1999). Also, rodent density and species richness are higher in mesquites than adjacent grassland in Mexico, and rodent communities exhibit less temporal and spatial variability in relative species abundances (Hernandez et al. 2005).

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[1]"Covered" species are those for which Clark County asked to be indemnified against any future "take" (as defined by the Endangered Species Act) during the development of the MSHCP.

[2]"Sensitive" species are designated by the BLM State Director, in cooperation with state wildlife agencies, and are afforded the same level of protection as is provided for candidate species under BLM Manual 6840.06 D. The designation of "sensitive species" includes species that could easily become endangered or extinct in a state. This policy states that the BLM will "carry out management consistent with the principles of multiple use for the conservation of candidate species and their habitats, and shall ensure that actions authorized, funded, or carried out do not contribute to the need to list any of these species as threatened or endangered." "Candidate" species are those under consideration for Threatened or Endangered status by the Fish and Wildlife Service.

The presence of mesquite and acacia woodlands may also affect the status of other plant species. In New Mexico, sites dominated by honey mesquite have greater spring aboveground net primary productivity than grasslands (Huenneke et al. 2002). Grassland species diversity is greatest beneath honey mesquites and on sites with light woody plant cover, which may in turn increase the availability of beneficial forages for herbivores (Ruthven 2001). In the Negev Desert, plant species diversity is higher under acacia canopies than in surrounding areas; interestingly, diversity is also higher under more water-stressed acacias and in woodlands with higher acacia mortality (Munzbergova and Ward 2002), perhaps because dead acacias are still able to provide important functions such as creating shade or windbreaks. Conservation measures adopted for mesquite woodlands in southern Nevada will serve to confer indirect protection for the Pahrump Valley Buckwheat *(Eriogonum bifurcatum*) and Parish's Phacelia (*Phacelia parishii*), two covered and BLM sensitive plant species that are closely associated with mesquite. Populations of these annuals in Clark and Nye counties, around Sandy and Pahrump, have been extirpated due to development of private lands (Krueger 1999). The protection of some acacia woodlands will benefit a covered and sensitive species, Las Vegas Bear Poppy (*Arctomecon californica),* and an evaluation species in the MSHCP, Las Vegas Valley Buckwheat (*Eriogonum corymbosum var. nilesii).*

In addition to the biological value of preserving mesquite and acacia woodlands, there are legal imperatives. The Federal Land Policy and Management Act of 1976 (FLPMA) requires that "the public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values; that ... will preserve and protect certain public lands in their natural condition; (and) that will provide food and habitat for fish and wildlife." Furthermore, it is the policy of the BLM "to manage habitat with emphasis on ecosystems to ensure self-sustaining populations and a natural abundance and diversity of wildlife, fish, and plant resources on the public lands" (BLM Manual 6500.06). The BLM's Las Vegas Resource Management Plan (LVRMP) specifically requires that mesquite and acacia woodlands be managed as wildlife habitat (see below). In addition, CMSs are required by the Section10(a)(1) incidental take permit issued by the U.S. Fish and Wildlife Service (FWS) to Clark County for the MSHCP. These strategies are intended to: 1) ensure the fulfillment of the conservation goals and objectives listed in the MSHCP for covered species, and 2) provide guidance to Clark County to prioritize actions that will result in the greatest benefit to covered species and prevent future species listings. Given the importance of mesquite and acacia habitat to many covered species and other taxa of concern, this CMS is an integral part of the MSHCP.

The purpose of this CMS is to use the best available scientific information and expertise to develop a strategy for protecting and managing acacia and mesquite woodlands on federal lands in southern Nevada. This strategy will provide guidance to efforts intended to promote the long-term survival of woodlands, which will in turn support important resources used by the diverse species that depend on these woodlands for survival. Specifically this CMS

1. Describes and portrays on map(s) the plan area, existing management and ownership, plant communities/vegetation association, and conditions of those habitats.
2. Summarizes the available information on MSHCP species and habitats that are covered under the management plan, and where possible, assesses their status and population trends, using the best available scientific information.
3. Describes threats to species and habitats.
4. Identifies data gaps and additional sites for data collection.
5. Assesses existing management objectives and actions to determine whether threats are being addressed adequately.
6. Lists conservation actions, public outreach programs, mitigation, monitoring, and research that can contribute to maintaining, improving, and ameliorating threats to mesquite-acacia woodlands.
7. Suggests prioritization for implementation of future conservation activities, including identification of specific projects, responsible parties, partners, and staffing and funding needs.
8. Describes a process for evaluating and updating priorities at regular intervals based on results of adaptive management and monitoring.

BACKGROUND, INVENTORY AND ASSESSMENT

A. Planning Area and Target Species

This strategy reviews the status and biological value of mesquite and acacia woodlands on federal lands in Clark County (Figure 1), focusing on woodlands that are the largest and/or

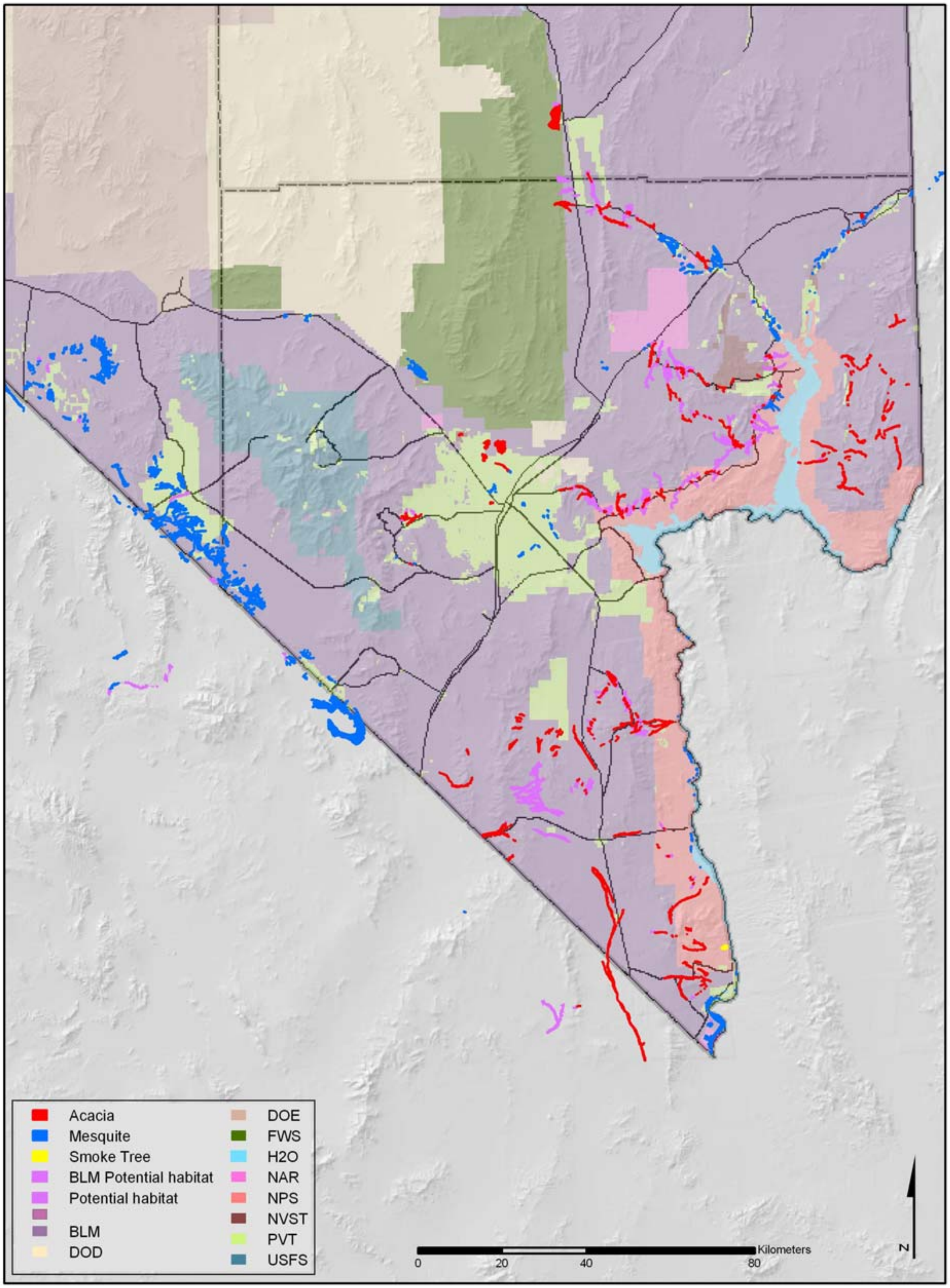

Figure 1. Distribution of mesquite and acacia woodlands in southern Nevada and neighboring portions of California and Arizona, with respect to land ownership and management.

most significant (in terms of actual or potential value to wildlife). Those woodlands are found in Pahranagat Wash and along the Muddy River, in the Newberry Mountains and Laughlin area, in Piute and Eldorado valleys, in the Highland and McCullough mountains, throughout Gold Butte, and in the Muddy Mountains. Smaller woodlands in Clark County were also considered, including those at Stump Springs, in Sandy Valley, near Corn Creek, at Cactus and Indian Springs, and in the Las Vegas Valley, and a small patch of smoke trees (*Psorothamnus spinosa*) found in the Lake Mead National Recreation Area (NRA). In addition to the main target species (mesquites and acacias), this CMS addresses the conservation of several plant and animal species in Clark County that depend on or are often associated with mesquites and acacia (see Appendix A).

This treatment does not explicitly discuss the status of or conservation actions for woodlands outside of Clark County (e.g. Pahrump, Mesquite Lake, Coyote Springs, Amargosa/Ash Meadows), although they were included in some analyses. The BLM's Draft Mesquite Habitat Management Plan of 1999 addresses many of those woodlands thoroughly.

B. Existing Information

1. Other Plans

a) Habitat Conservation Plans

The Clark County MSHCP has designated several levels of management for lands in the county. Many mesquite and acacia woodlands occur within the most protected of these levels, Intensively Managed Areas (IMAs) and Less Intensively Managed Areas (LIMAs; Figure 2), thus are likely to benefit from the directives for these management levels will affect these woodlands. Woodlands may also benefit from the MSHCP objectives for covered species, that is 1) to allow no net unmitigated loss or fragmentation of habitat within IMAs and LIMAs; and 2) to maintain stable or increasing population numbers.

The Lower Colorado River Multiple Species Conservation Plan (LCRMSCP) discusses conservation actions for species that are affected by water management practices on the river, including many mesquite-associated species. Conservation actions for mesquite woodlands along the Colorado River (e.g. in the Laughlin area) will need to be coordinated between the

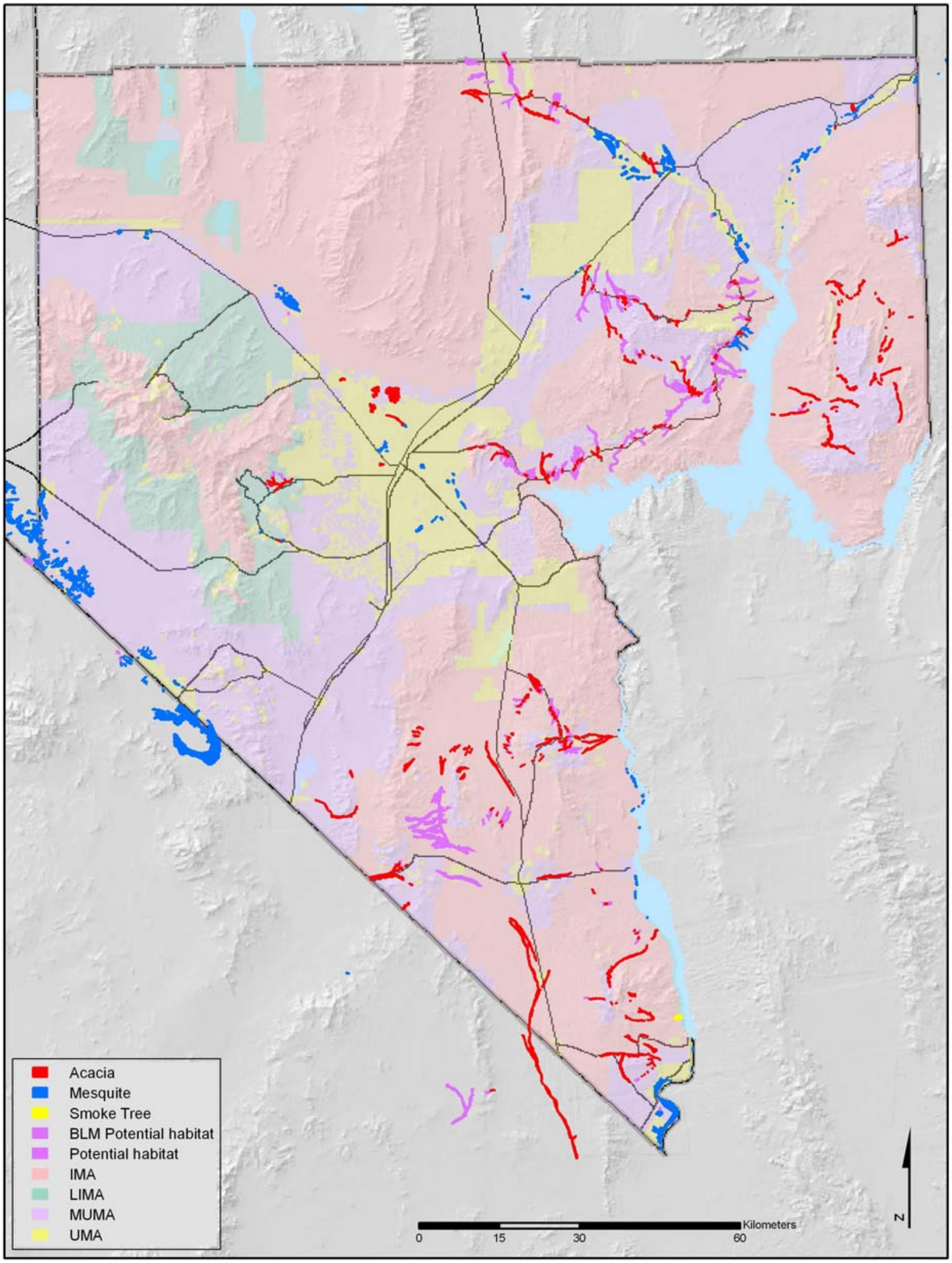

Figure 2. Distribution of mesquite and acacia woodlands in southern Nevada with respect to the management levels specified in the Clark County MSHCP.

conservation actions outlined in this CMS and the LCRMSCP. In addition, HCPs in development in Nye and Lincoln counties will be assisted by the information on mesquite and acacia woodlands in those counties that is presented in this document.

b) Federal Legislation and Management Plans

Several Federal agencies are guided by legislation and management plans that include directives that reference mesquite and acacia woodlands in the County. Pertinent to this strategy is the BLM's Draft Southern Nevada Mesquite Woodland Habitat Management Plan (HMP; Krueger 1999), much of which has been incorporated into the present document. Important also are the BLM's Las Vegas Resource Management Plan (LVRMP, 1998) and General Management Plan and Environment Impact Statement for Red Rock Canyon National Conservation Area (RRGMP, 2000); and the National Park Service's (NPS) Management Policies (2001) and the Lake Mead National Recreation Area (LMNRA) Resource Management Plan (1999). The Fish and Wildlife Service (FWS) is in the process of developing Comprehensive Conservation Plans for the Desert National Wildlife Refuge Complex in southern Nevada, which will likely include directives of relevance to mesquite and acacia woodlands. The Wilderness Act (1964) guides activities that might affect mesquite and acacia woodlands in designated Wilderness and Wilderness Study Areas. The development of management plans for Wilderness Areas was initiated in 2002; incorporation of the recommendations of this CMS in those plans will assist in the protection of mesquite and acacia woodlands.

Many hectares of mesquite and acacia occur on BLM land, so the LVRMP, which outlines major land use decisions and guides management actions for BLM lands within Clark and southern Nye counties, is one of the most influential plans. It includes several objectives and specific management directions that are relevant to BLM Special Status Species and mesquite-acacia woodlands in southern Nevada:

> Vegetation Management
>
> Objective VG-2: "Restore plant productivity on disturbed areas of the public lands."
>
> Areas of Critical Environmental Concern (ACECs)
>
> Objective AC-2: "Protect areas with significant cultural, natural, or geological values by establishing areas of critical environmental concern..." (many woodlands fall in ACECs)

Fish and Wildlife

Objective FW-3: “Support viable and diverse native wildlife populations by providing and maintaining sufficient quality and quantity of food, water, cover, and space to satisfy needs of wildlife species using habitats on public land.”

Management Directions

FW-3-a. “Manage mesquite and acacia woodlands for their value as wildlife habitat in the following areas: Amargosa Valley, Meadow Valley Wash, Moapa Valley, Pahrump Valley, Stewart Valley, Hiko Wash, Piute Wash, Crystal and Stump Springs, or any other areas identified as being of significant wildlife value.”

FW-3-b. “Allow harvesting of green or dead and down mesquite by permit only and in those areas identified in FW-3-a, where consistent with sustaining plant communities in a healthy and vigorous state and also consistent with sustaining viable wildlife populations.”

FW-3-g. “Protect important resting/nesting habitat, such as riparian areas and mesquite/acacia woodlands. Do not allow projects that may adversely impact the water table supporting these plant communities.”

FW-3-h. “Improve disturbed non-game bird habitat, including the water table supporting these habitats, by emphasizing maintenance and enhancement of natural biodiversity.”

Special Status Species

Objective SS-2. “...Manage habitats for non-listed special status species to support viable populations so that future listing would not be necessary.”

Management Direction

SS-2-a. “Enter into conservation agreements with the U.S. Fish and Wildlife Service and the State of Nevada that, if implemented, could reduce the necessity of future listings of the species in question. Conservation agreements may include, but not be limited to, the following: Blue Diamond cholla, Las Vegas bearpoppy, white-margined penstemon, and Phainopepla.”

Forestry Management

Objective FR-1: “Maintain woodland and conifer forest where possible for all-aged stands, with an understory vegetation forage value rating at moderate or better.”

Management Directions

FR-1-a. “Firewood cutting and gathering is limited to approved areas subject to restrictions developed for protection of Threatened, Endangered and sensitive species and other sensitive resources.”

FR-1-b. Allow harvest of dead and/or down wood or BLM-marked green mesquite ‘trees’ for mistletoe control only in approved areas.”

A few woodlands occur in BLM-managed Wilderness Areas, and two woodlands in the Desert Wildlife Range occur in a proposed Wilderness FWS Area. The most relevant section of the Wilderness Act is:

Sec. 4. (b): “…each agency…shall be responsible for preserving the wilderness character of the area and shall so administer such area for such other purposes for which it may have been established as also to preserve its wilderness character.”

Other sections of the Wilderness Act close Wilderness Areas to most commercial enterprises, roads and motorized uses, with exceptions for existing grazing and mining leases, and the roads, utility corridors and motorized activities that support them and permitted uses (i.e., management and research). Timber harvest is not allowed, although trees can be cut around valid mining claims. Wilderness Areas are open to recreation such as hiking, camping and hunting.

Woodlands occurring in the Lake Mead NRA are governed by two documents. The most relevant directives from these documents are:

NPS Management Policies (2001)

4.1 General Management Concepts

-"The Service cannot conduct or allow activities in parks that would impact park resources and values to a level that would constitute impairment."

-"Natural resources will be managed to preserve fundamental physical and biological processes, as well as individual species, features, and plant and animal communities."

4.1.5 Restoration of Natural Systems

"The Service will re- establish natural functions and processes in human- disturbed components of natural systems in parks unless otherwise directed by Congress."

Lake Mead NRA Resource Management Plan (1999), Park Strategic Plan

Goal 2. Restore 5% of targeted disturbed parklands, and contain 5% of priority targeted disturbances. (Strategic Plan I.a.1.)

Goal 8. Damage to natural and cultural resources from illegal activities is systematically monitored and investigated. High potential areas of plant and animal poaching are monitored for evidence of illegal activities. (Strategic Plan I.a.10).

c) Other Conservation Management Strategies

Several CMSs currently in preparation, including the Muddy and Virgin River CMSs, the Meadow Valley Wash CMS and CMSs for the Piute-Eldorado, Gold Butte-Pakoon. Mormon Mesa, and Coyote Springs DWMAs, are relevant to this strategy in that they may incorporate acacia-mesquite woodlands in their geographic treatment.

d) Other plans

Much relevant information on mesquite and acacia-associated species, and the threats to them and their habitat is contained in Nevada Department of Wildlife's (NDOW) Comprehensive Wildlife Conservation Strategy (CWCS, 2005). Also, some data and recommendations in the Nevada Bat Working Group's Nevada Bat Conservation Plan (Altenbach et al. 2002), Nevada Partners in Flight Plan (Neel 1999), and California Partners in Flight Desert Bird Conservation Plan (in development) apply to management of animal species included in this CMS. From a site-specific perspective, The Nature Conservancy's Integrated Science Plan for the Upper

Muddy River (2005) and the Meadow Valley Wash Final Report (2005) contain information pertinent to some of the county's most biologically significant mesquite woodlands.

2. Literature Review

a) Ecology of mesquite and acacia

Mesquite, acacia, and smoke tree taxonomy

All four species included in the CMS are members of the Fabaceae (Leguminosae), or pea family. Because they all are capable of hosting desert mistletoe, this document will sometimes use the shorthand expression "host plants" when referring to them collectively. The two mesquites belong to the genus *Prosopis,* which is an ancient genus that apparently split into several lineages (Burkart and Simpson 1977). In some of these lineages, recent isolation events appear to have led to speciation into very similar "sections" of species; related species may hybridize within these sections. Consequently, the taxonomy of *Prosopis* is complicated and can be confusing. The taxonomic status used in Table 1 is summarized from Burkart and Simpson (1977) and Hickman (1993). The only acacia that occurs in Nevada is *Acacia greggii*, or catclaw acacia, in reference to its curved thorns (Table 1). Smoke trees are the only arborescent *Psorothamnus* that occur in Nevada, and are restricted to very southern Clark County. Their taxonomy and ecology are not fully discussed here, due to their limited distribution in the county and the paucity of studies on this species.

Table 1. Taxonomy and characteristics of the three major woodland species covered in the CMS (sources: Jaeger 1941, Burkart and Simpson 1977, Kartesz 1987, Hickman 1993, plants.usda.gov http://medplant.nmsu.edu/acacia2.html).

Common Name	**Western Honey Mesquite**	**Screwbean Mesquite**	**Catclaw Acacia**
• Subfamily	Mimosoideae	Mimosoideae	Mimosoideae
• Genus	*Prosopis*	*Prosopis*	*Acacia*
• Species	*glandulosa*	*pubescens*	*greggii*
• Variety	*Torreyana*		*arizonica*

Common Name	**Western Honey Mesquite**	**Screwbean Mesquite**	**Catclaw Acacia**
• Habit	Winter deciduous woody shrub or tree generally 1 to 5 m tall, occasionally reaching heights up to 10 m; single or multi-stemmed with spines; dual root system consisting of lateral roots and large tap root. Bark is green to reddish-brown.	Winter deciduous, small, erect tree, occasionally to 8 m.; bark is grey and shreddy; spines are small, slender and paired.	Usually a winter deciduous rounded and much-branched shrub 1-3 m. tall, (occasionally tree-like to 9 m or a small tree with a broad crown); bark is gray to black; thorn is broad at the base and curved backward, < 5mm long.
• Leaves	Bipinnately compound, alternate, oblong, glabrous; primary leaflets generally 1 pair, opposite, 6-17 cm; secondary leaflets 7-17 pairs, opposite, 1-2.5 cm; length 7-9 times the width.	Leaflets 5-8 pairs per pinna, mostly < 10 mm long.	Twice-pinnate, gray-green pubescent leaflets, >1 pair.
• Flowers	Inflorescence a raceme, 6-10 cm, spike-like; flowers 5-numerous, radial, small, yellow, petals generally inconspicuous; invertebrate pollinated, esp by bees.	Inflorescence spicate, petals pale yellow; slightly sericeous; insect pollinated.	Creamy white or yellow flowers in bushy, 5 cm spikes; fragrant; insect pollinated.
• Fruit	Indehiscent pod; 10-20 cm; somewhat straight and flattened, narrowed between seeds; pulpy and green when young, becoming woody and light yellow; eaten by mammals.	Indehiscent pod; coiled and yellow-brown in color; 2-4 cm long.	Stiff and papery gray-brown legume-type fruits; 5- 14 cm long; curved or contorted, flattened, constricted between the seeds; split when mature.

Common Name	**Western Honey Mesquite**	**Screwbean Mesquite**	**Catclaw Acacia**
• Phenology	In southern Nevada, leaf-out begins early April to early May; flowers shortly thereafter; leaf-drop from November to January.	In southern Nevada, begins to leaf out in late April; flowers shortly thereafter; leaf-drop from November to January.	In southern Nevada, begins to leaf out in late April; flowers shortly thereafter; leaf-drop from November to January.
• Propagation	Varying success when transplanted or direct seeded; usually requires intensive irrigation. Seeds must be chemically or physically scarified before planting.		Varying success when transplanted. Seedlings can be nursery grown in tall containers to accommodate the deep root systems. In California, seed collected in the field exhibited good germination without any special treatment in fall or spring.

Distribution of mesquite and acacia

Honey mesquite occurs in Texas, northern Mexico, and southern New Mexico, Arizona, Nevada, and California (Simpson and Solbrig 1977). Western populations of honey mesquite (*P. glandulosa var. torreyana*) are separated from eastern populations *(P. glandulosa var. glandulosa*) by the Pecos River, and can be distinguished by the smaller leaves and longer fruits of the western variety (Hilu et al. 1982). Screwbean mesquite, easily identifiable by the shape of its corkscrew-like pods, is found from Texas west, and from Mexico north to Nevada and southern California (Jaeger 1941). Catclaw acacia is found in the southern portions of California, Nevada, and Utah, and in Arizona, New Mexico, and Texas. Smoke tree has the most limited distribution of the four species, especially in Nevada, typically occurring in frostless areas of the southern Mojave and Colorado deserts of California, Arizona, and extreme southern Nevada (Jaeger 1941). Southern Nevada contains a portion of the northernmost range extent of all four species. Because the species, to some degree, have overlapping ecological requirements, they frequently co-occur.

Both mesquite and acacia have lateral roots that absorb nutrients and shallow soil moisture and permit these plants to survive in areas with moderate precipitation where groundwater is less available. Mesquites also have large taproots that can grow to great depths (50-60 ft in honey mesquites; Jaeger 1965) to reach groundwater, enabling them to exist in arid environments where precipitation and soil moisture are low. Catclaw acacias may also have a taproot; most acacias, especially unnodulated ones in arid environments (such as catclaw acacia), are phreatophytes with taproots (Wickens 1998). (Also, a USDA Forest Service paper refers to catclaw acacia's deep roots.) In light of the likelihood and conservation implications of reduced groundwater in this region, it seems prudent at this point to assume that catclaw acacia is able to utilize groundwater to some extent. We recommend that this hypothesis be researched.

In the semi-arid portions of the range of mesquites and acacias, such as Texas, New Mexico, and Arizona, precipitation is greater and occurs more frequently than in the arid climates of southern California and Nevada. Mesquites and acacias occurring in semi-arid regions can rely on their lateral root system for water uptake, and thus are uncoupled from the requirement of a permanent groundwater source. In contrast, the arid climate of southern Nevada has served to restrict these species to localized areas with shallow groundwater, or greater soil moisture content than available in most parts of the Mojave Desert. Honey mesquite woodlands in southern Nevada typically occur in areas with deep soils along washes, riparian areas, and the edges of playas (dry lake beds) where their well-developed taproots can easily penetrate into subsurface waters. The requirements of screwbean mesquite are more restrictive, so this species is found mainly in locations where surface water is present, such as the edges of springs or streams. In Clark County, mesquite is primarily found in Sandy Valley, at Stump Spring, at Corn Creek, and in Meadow Valley Wash, while woodland remnants remain in the Las Vegas Valley, and along perennially flowing rivers (a large tract exists on Federal and private land along the Muddy River). In the Las Vegas Valley, remnant mesquites may use the perched water table, i.e. surface runoff still trapped 3-6 m below the surface by impervious layers (A. Newton, pers. comm.).

While restricted to riparian areas, acacias and smoke trees tolerate the driest conditions, preferring sandy or gravel washes (Jaeger 1941). Acacias are often found on the upper slopes of bajadas, where moisture is more available than on middle or lower bajadas. In Clark County, they are found east of the Spring Mountains, and are common in the Muddy Mountains, in the Pahrahagat/Muddy River area, in Gold Butte, and south of Las Vegas (in the Newberry, McCullough and Highland mountains, and in Eldorado and Piute valleys). Smoke trees are found only in low areas, and in Nevada are restricted to a single small stand along the Colorado River in extreme southern Clark County. They also occur in Piute Wash just south of the California-Nevada state line.

Factors affecting host plant survival, growth and regeneration

The primary natural factor influencing leguminous tree survival appears to be water supply (although see discussion re: desert mistletoe below). Honey mesquite mortality increases with increasing distance from the water table (Stromberg et al. 1992). Although mesquite roots have been excavated at depths as great as 60 m (Phillips 1963), this is the exception rather than the rule. In general, it becomes increasingly difficult for mesquite to survive once the water table falls below 15 m (Judd et al. 1971). In Nevada, it is unclear to what extent catclaw acacia depends on the water table, but if it is not rooted in the water table, it takes up surface runoff via its lateral roots, and so can be negatively impacted by drought. In the Negev Desert of Israel, many populations of native acacias have been observed to suffer severe mortality due to water stress (Munabergova and Ward 2002). Furthermore, diebacks of another related leguminous species, foothills palo verde (*Cercidium microphyllum)*, have occurred during severe deficits in annual rainfall; apparently severe drought interacts with natural senescence, such that trees with increased circumference (especially those on steep slopes) are less likely to survive (Bowers and Turner 2003).

Leguminous desert trees may be able to buffer the effects of water stress to some degree. For example, honey mesquite possesses several drought tolerance mechanisms, including use of different levels of soil water and enhanced physiology in seasons following drought (Reynolds et al. 1999). However, the effects of water stress may be exacerbated by interactions with other stressors. For instance, the invasive tamarisk is even more drought tolerant than honey mesquite, thus is assuming greater abundance compared to native species on floodplains in southern Nevada as these areas become more desiccated. This invasion is facilitated by the ability of tamarisk to reproduce rapidly, leading to high-density stands and concomitant high leaf area

(Cleverly et al. 1997). Tamarisk is also more tolerant of saline soil conditions, which are common along hydrologically altered streams, than is mesquite (Glenn and Nagler 2004). Furthermore, honey mesquite's tolerance of defoliation depends on abiotic stress or resource limitation, which makes regeneration more likely in periods of low herbivore density (Weltzin et al. 1998) or fire or woodcutting activity.

One of the major effects of water stress is to slow the growth rate of acacia and mesquite, and to alter the growth form of mesquite. In the Las Vegas Valley, acacias in the wash grow faster and taller than those on the terrace above the wash, where they have reduced access to water (Lei 1999). Honey mesquites in water-stressed environments are shorter, occurring as shrubs when especially stressed (Holland 1987; Judd et al. 1971; Minckley and Clark 1984; Stromberg et al. 1992, 1993). Reductions in tree height, canopy volume and stem diameter can be caused by limitations on soil water induced by intraspecific competition when tree density is high (Ansley et al. 1998, 2002). Interspecific competition with understory shrubs can also reduce annual trunk growth in honey mesquites, and can lead to the mesquites' demise (Barnes and Archer 1999). One study found that water-stressed honey mesquites produce more basal branches, and so have greater crown area with minimal investment (Martinez and Lopez-Portillo 2003), but Stromberg et al. (1992, 1993) determined that canopy size decreases with increasing distance to the water table, despite increased sprouting.

Water-stressed woodlands may be a more common scenario in Nevada under climate change scenarios, accentuated by the higher water demands of a larger human population. A potential mitigating factor is that CO_2 enrichment (another effect of global warming) seems to have a positive effect on the recruitment of drought-tolerant woody legumes, including honey mesquite, by reducing soil water depletion by grasses (Polley et al. 2002, 2003). Biomass of honey mesquite seedlings under CO_2 enrichment is also higher (Bassirirad et al. 1997); however, the growth form of these new, water-stressed, recruits remains to be seen.

Fire can have multiple effects on mesquite and acacia woodlands. In one study, fire treatment reduced the percent canopy cover and density of honey mesquite and twisted acacia, and eventually led to their decline (Ruthven et al. 2003). In another, fire killed small (< 3 cm diameter) mesquite and acacia shrubs, and large trees with woodrat nests at their bases (Owens et al. 2002). Mesquites and acacias may be able to regenerate following fire, usually by producing multiple basal sprouts. Although honey mesquite may resprout more readily following dormant season (versus growing season) fires, this response is dependent on fuel amounts (Drewa 2003, Kupfer and Miller 2005). Also, fire's effects on mesquite and acacia may depend on interactions with other factors. For example, while grazing is generally considered to have a negative impact on mesquite regeneration, trees in grazed areas were less damaged by fire than trees in ungrazed areas and consequently retained more leaf-bearing branches and produced fewer root sprouts after fire (Kupfer and Miller 2005).

In addition to the effects water stress and fire, damage to the stem as a result of woodcutting, chaining, fire, freezing temperatures, herbivory, or trampling promotes resprouting and can transform tall single-stemmed mesquite trees into shorter, multi-stemmed thickets (Fisher 1977, Heitschmidt et al. 1988). In southern Nevada, relatively undisturbed mesquite woodlands that occur in areas with a shallow, permanent groundwater source contain single-stemmed trees that reach heights as great as 10 m and have stems approaching 1 m in diameter (Krueger 1998), whereas trees in disturbed areas have many thin stems. Acacias also increase the number and length of current annual growth branches in response to defoliation by herbivores (Cooper et al. 2003).

Such changes in woodland structure may alter its effectiveness as wildlife habitat. Phainopeplas in Nevada prefer to nest in tall trees with heavy mistletoe infection and fewer stems, in which they have higher breeding success (Krueger 1998, Crampton 2004). They also prefer and have higher nest success in trees surrounded by many other infected trees (Crampton 2004). Also, Ladderback Woodpeckers, Lucy's Warblers and Ash-throated Flycatchers can only nest in tree trunks sufficiently large to hold nest cavities, and many other breeding bird species prefer woodlands with older, taller trees (Appendix A). The occurrence of old, undisturbed trees increases the availability of suitable nesting sites, therefore increases the chances of successful nesting attempts for these species.

Little is known about mesquite and acacia recruitment. Brown and Archer (1999) suggested that because honey mesquite recruitment in their study was neither dependent on rainfall nor negatively impacted by grass competition, it was likely limited by seed dispersal rates and patterns. Several species of wildlife consume honey mesquite seeds (Kneuper et al. 2003), including coyotes and roadrunners (Crampton, pers. obs.), but their effectiveness as seed dispersers is unknown. Cattle readily consume and disperse honey mesquite seeds, but sheep and goats may only reduce number of viable seeds (Kneuper et al. 2003).

Comparison of mesquite and acacia woodlands in the northeastern Mojave Desert

Nevada's mesquites and acacias are similar in that they are all small-leafed, woody legumes that host desert mistletoe, although acacias seem more susceptible (see below). They are all insect-pollinated and, to some degree, rely on animals (mammals) for seed dispersal. They seem to respond to many disturbances in a similar fashion, in that they are capable of buffering water stress and of resprouting, although the latter process does not lead to a major change in growth form in acacias. Because they are all restricted to riparian areas, they face many common threats. However, mesquite woodlands, due to their closer association with surface water, typically are more threatened by water-related issues.

In terms of plant and woodland structure, mesquite and acacias can differ greatly. Tree-like mesquites can grow in dense thickets, although they sometimes are spaced in the savanna-like pattern that is typically exhibited by shrub-like acacias. In a landscape level survey in the northeastern Mojave Desert (southeastern California, southern Nevada, northwestern Arizona), mesquites and acacias varied in most of the variables analyzed, including mean tree height, mean woodland isolation, and several measures of mistletoe abundance (mean berry abundance, mean volume of mistletoe, and mean proportion of infected trees; see Crampton 2004). In mesquite habitat, on average there were larger volumes of mistletoe, but fewer berries and infected hosts. On average, trees in mesquite woodlands were taller and patches were less isolated. There were no significant differences in tree density or canopy cover.

Restoration/cultivation of mesquite and acacia

According to available literature, many attempts at cultivating mesquite from either transplants or seeds have not fared well. Poor survival of mesquite transplants was experienced in an attempt to introduce them in Oregon (Sharrow 2001). In a cultivation experiment, Grantz et al. (1998) found that honey mesquite transplants did better in narrow augered holes (versus wide holes), and when surrounded by plastic cones (versus wire cages), but even in these conditions, plants required intensive irrigation. They concluded that the costs of irrigation might favor direct seeding over transplating mesquite. It should be noted, however, that biotic conditions on site hampered restoration by seeding in Mexico (Foroughbakhch et al. 2000).

A few unpublished attempts at transplanting mesquites in southern Nevada have had some success. A large-scale restoration project at Point of Rocks Spring in Ash Meadows (Nye County, Nevada) has been successful; after five years, 85% of the hundreds of mesquite trees that were planted have survived and reached heights of over 3 m (S. Goodchild, FWS, pers. obs.). At the outset of this project, the existing tamarisk was cleared and the ground was prepared for mesquite saplings. Hundreds of mesquite saplings were planted in protective tubes and drip-irrigated for the next few years. At both Point of Rocks and Cactus Spring, young mesquite saplings planted and irrigated in this fashion have survived for several years. The Las Vegas Springs Preserve took a different approach by transplanting mature trees. First they gradually dug deep trenches around the trees in their original location, then heavily irrigated trees after transplantation. This method was very successful, including natural colonization of trees with mistletoes, albeit very costly. A decisive factor in mesquite recolonization appears to be the availability of water, either via irrigation or high water tables.

<u>b) Ecology of desert mistletoe</u>

Factors affecting desert mistletoe colonization, survival, abundance and berry production

Desert mistletoe is one of 200 species in the genus, *Phoradendron*, which is part of the large mistletoe family, Viscacaeae (in reference to the sticky substance, viscin, contained in the berries of this family). Many of the 1300 mistletoe species worldwide are considered to be keystone species because of their mutualistic relationships with many insects, birds, and mammals (Norton and Reid 1997; Watson 2001, 2002). For example, wildlife is more abundant in conifer stands infested with other North American mistletoes, dwarf mistletoes (*Arceuthobium* spp.; see Bennetts et al. 1996).

Desert mistletoe is very important to several wildlife species included in this Conservation Management Strategy. First, in the Mojave Desert, Phainopeplas only occupy woodlands with abundant desert mistletoe and their density in occupied woodlands is positively correlated with mistletoe density (Crampton 2004). Phainopeplas are more abundant in large infected woodlands than in small woodlands or uninfected woodlands (Crampton 2004). This relationship is mutualistic, as Phainopeplas are the primary disperser of desert mistletoe seeds. Other birds that depend at least partly on desert mistletoe berries include Mountain Bluebirds, Sage Thrashers, Northern Mockingbirds, Gambel's Quail, and House Finches. Abert's Towhees, Loggerhead Shrikes, Crissal Thrashers and Black-throated Sparrows nest in desert mistletoe.

Mesquite and acacia woodlands in southern Nevada vary greatly in the degree and extent of mistletoe infection (Krueger 1998, Crampton 2004). Most mesquite west of the Spring Mountains and much acacia northeast of Las Vegas (Moapa, Bitter Springs) have little to no infection, whereas many woodlands south of Las Vegas are heavily infected. Causes of low levels of infection are not known, but may include a lack of mistletoe dispersal to those woodlands, unsuitable climate (too cold or dry), and/or a paucity of good host trees (e.g. the trees are resistant to infection, or too stressed).

While landscape studies of mistletoe infection are lacking, some insight into differences in infection among woodlands may be gained from studies of differences in infection among host trees (although unfortunately, most of these were not on desert mistletoe). Likely factors influencing recruitment, survival, and growth include light, water (precipitation and ground water), temperature, and characteristics of the host tree.

All mistletoes depend on their host for water and nutrients, which they acquire via the water potential gradient between their hosts and them; this gradient is maintained by high mistletoe transpiration rates and resistance in the hydraulic pathway, especially at the mistletoe haustorium (i.e. site of infection within the branch). As with their host plants, all mistletoe life stages are affected by water availability. Aerial shoot formation (one of the first stages of mistletoe colonization) of big leaf mistletoe (*Phoradendron macrophyllum*) on willow (*Salix* spp.) cuttings in the greenhouse was influenced by local moisture availability (Lichter and Berry 1991). In Australia, during periods of high rainfall, there is greater mistletoe establishment (Reid and Stafford Smith 2000). Similarly, establishment of juniper mistletoe (*Phoradendron juniperinum*) in Utah peaked during several years of high summer precipitation, and when host trees were 3 m high (Dawson et al. 1990). Mistletoes are more likely to occur on juniper hosts that maintain access to water during droughts (Gregg 1991), and less likely to occur on water stressed acacia hosts, including those in areas of high soil salinity (Miller et al. 2003). Drought in the growing season may cause mortality of *P. juniperinum* (Dawson et al. 1990) and two Australian mistletoes, which also experience reduction in canopy cover (Reid and Lange 1988). Not only do desert mistletoes experience lower mortality on less water-stressed acacias in the Las Vegas Valley, they are also more abundant and produce more fruit (Lei 1999).

Two major factors influencing the probability and degree of infection are host tree age and size. Larger bramble acacia (*Acacia victoriae*) in Australia (Reid and Stafford Smith 2000) and umbrella thorn (*Acacia tortilis*) in Yemen (Donohue 1995) are more likely to be infected and to support more mistletoes than small trees. In the Mojave Desert, the probability of *A. greggii* infection increased with tree age and size (Lei 1999, 2000).

The aerial shoots of mistletoe usually live no more than 10-20 years, but the haustoria (i.e. root-like portion attaching the mistletoe to the branch) can live as long as the host. Mistletoes have relatively high light requirements for optimum growth, which may be why more heavily infested trees are generally found in open areas (Boyce 1961), or when tree density is low (Donohue 1995).

There are also interspecific and intraspecific differences in host susceptibility to infection in general and to different strains of desert mistletoe. Honey mesquite in Texas is more susceptible to infection than two other mesquite species; also, honey mesquites at some sites are genetically more susceptible than those at other sites (May 1971). One strain of desert mistletoe primarily affects acacia, while another colonizes velvet mesquite (*Prosopis velutina*); these strains are also partly reproductively isolated by different flowering times (Overton 1997). This may explain why uninfected mesquite trees can be found surrounded by highly infected acacias in southern Nevada (Crampton, pers. obs.).

In infected woodlands, mean mistletoe berry abundance not surprisingly is positively correlated with mean mistletoe volume and proportion of infected trees. It is also positively correlated, but not quite significantly, with host density (Crampton 2004).

Effects of desert mistletoe on host plants

The extent to which parasitic plants are detrimental to the health and longevity of infested hosts has been a source of conflicting debate for many years. There is abundant literature on the physiological and ecological interactions between mistletoes and their hosts, but less on the physiological and ecological effects of mistletoes on their hosts.

The degree to which mistletoes cause harm to their hosts is partially dependent upon the ability of the former to photosynthesize. Holoparasites, such as dwarf mistletoe, contain very little chlorophyll and do not photosynthesize at a sufficient rate to produce enough food for survival; they depend on the host for nearly all of their sugar, water, and nutrients. Dwarf mistletoe can deform or kill trees of any age (Boyce 1961). In contrast, many members of the genus *Phoradendron*, including desert mistletoe, are hemiparasites, and contain enough chlorophyll to photosynthesize and produce their own food. Hemiparasites depend on their hosts for water and nutrients, but do not drain their host plants of sugars. Hemiparasites are seldom the primary cause of death to their hosts, but can cause deformations that decrease their economic worth and can reduce their value as wildlife habitat. The most common damage is death of the branch distal to the infection (Boyce 1961), although this is less likely as distal branch size increases (Reid and Stafford Smith 2000).

Mistletoes generally have higher transpiration rates, and lower leaf water potentials and CO_2 assimilation rates, than their hosts. These differences translate into lower water use efficiency in mistletoes, meaning that mistletoes transpire more water per unit of CO_2 assimilated than their hosts. In other words, mistletoes can place substantial demands on the water reserves of hosts. Mistletoes, however, tend to tightly regulate these physiological processes with the concurrent responses of the host (Whittington and Sinclair 1988, Davidson et al. 1989). This tight regulation may help avoid undue load on a host under conditions of high transpirational demand (Whittington and Sinclair 1988), and ensure the long-term survival of both host and parasite.

Results of studies of the correlation between water stress and mistletoe infection, and the long-term ramifications, are mixed. On the one hand, in the Las Vegas Valley, the more infested the acacia, the more water stressed it is (Lei 1999). On the other hand, an Australian acacia exhibited slight increased stress as mistletoe volume increased, as shown by lower midday leaf potential, but there was no difference in predawn leaf potential or water use efficiency (Miller et al. 2003). Infested junipers in Utah had higher midday water potentials than uninfested trees, i.e. were not negatively affected by the infection (Gregg 1991). It is not clear which comes first, the water stress or the mistletoe; already-stressed trees may simply be more prone to infection, although Miller et al. (2003) found that water-stressed trees were less suitable hosts for mistletoes.

The water demands of mistletoes on hosts may depend on environmental conditions. Mistletoes in a tropical mangrove system had a greater physiological effect on their hosts under more favorable soil water conditions (lower substrate salinities), because the mistletoe is exploiting a less critical habitat (Orozco et al. 1990). This leads to excessive water consumption by mistletoe that may deplete host water resources. Under conditions of higher substrate salinities, infection was either low or absent, most likely due to the critically low leaf water potential the mistletoe would need to develop to maintain xylem sap flow from a host under extreme water stress.

In arid and semi-arid climates mistletoes generally exhibit relatively more conservative water use efficiencies, and tend to transpire at rates closer to those of their hosts if nitrogen is more abundantly available (Schulze and Ehleringer 1984). Under these conditions, mistletoes can reduce the amount of water drawn from the host, which can be important for host survival in arid climates. This is most likely why we see a prevalence of mistletoe infections on nitrogen-fixing plant species at lower elevations in the Mojave Desert.

Judd et al. (1971) discussed the possible factors contributing to the widespread death of mesquite trees at Casa Grande National Monument in Arizona. Photographs documented heavy mistletoe infection in trees as far back as 1878. Tree ring analysis of three mesquite tree cross-sections determined tree ages of 110, 111, and 137 years. All trees in the area died between 1931 and 1949. Death was attributed to the precipitous decline of the water table (from 42' in 1931 to 102' in 1949) and aggravated by heavy mistletoe infection, with tree age and insect infection listed as secondary factors. Nonetheless, infection by desert mistletoe did not significantly affect the odds of survival of foothills palo verde (*Cercidium microphyllum*) in Arizona (Bowers and Turner 2001).

The presence of mistletoe in a stand may improve recruitment of new trees. In Arizona, more than twice the number of junipers sprout in mistletoe-rich patches than mistletoe-free ones, because the mistletoe fruit attracts frugivorous birds, which eat and disperse juniper berries as well as mistletoe berries (Van Ommeren and Whitham 2002).

Propagation of desert mistletoe by humans

It is apparently possible to infect mesquites and acacias with desert mistletoe by hand. In one study, May (1971) infected five seven-year old mesquites in an experimental garden with 20 seeds from each of three mistletoe plants from each of three locations (180 seeds/tree); seeds were covered with sleeves of fiberglass insect screening. Swelling of branches (from haustoria formation) occurred at 77-96% of infection sites. Up to 20% of axial shoots developed leaves, and up to 44% of endophytic shoots developed buds. Significantly greater mistletoe development occurred near the tops of branches than at the bases.

In a study on wild trees, Overton (1997) had some success infecting host trees with desert mistletoe, but not nearly as great as May (1971). Within 36 hours of collecting berries, he removed seeds from the exocarp and immediately placed them on the 1-3 year old growth of the branch (1-2 cm diameter at proximal end). Overton planted 20 seeds/branch on three branches on10 host/species, including velvet mesquite and catclaw acacia. He also compared infection rates on acacias from sites with high and low intensity infection. In an initial experiment, only 0.033 (20/600) of the seeds survived on mesquite after 15 months. In the second experiment, a cross-infection between different strains of mistletoe, 0.04 of “mesquite” mistletoe seeds reinfected mesquite, and 0.04 of them transferred to acacia. Reinfection of “acacia” mistletoe seeds on acacia was much higher (0.135 seeds).

Crampton and Turner (unpubl. data) used the methods of May (1971) and Overton (1997) to try infecting previously infected and uninfected acacias in the Las Vegas and Moapa Valleys with “acacia” mistletoe. Responses were reduced compared to the above studies: of 300 seeds at each of six sites in 2002 and 150 seeds at each of four sites in 2003, only one aerial shoot was produced. It was not clear if the poor success was due to the dry weather of 2002 and the late planting date of 2003, or to innate resistance of the specific trees selected.

Combined, the results of the above mesquite restoration and mistletoe propagation studies suggest that restoration of woodlands that provide habitat for many CMS species is likely to be labor and resource intensive; effort should be put into developing more promising techniques. Thus, while restoration may be a necessary tool in some situations encountered in this CMS, the strategy should in general focus on protecting existing habitat instead.

c) Phainopepla ecology

Among species included in this CMS, Phainopeplas are one of the most highly associated with mesquite and acacia woodlands, and, with the exception of some of the insect species, the most dependent on desert mistletoe. For several reasons, Phainopeplas are a useful model species for this CMS, and have been recommended as such by the CMS Technical Advisory Group. First, they are the only covered species exhibiting such high habitat specificity. Second, compared to many other species using these woodlands, their ecology is relatively well known, including two intensive studies conducted in Clark County (Krueger 1998, Crampton 2004). Third, while they are somewhat resilient to disturbance (e.g. they still occur in the Las Vegas Valley despite extensive fragmentation), they may also be area sensitive (Crampton 2004), thus can be used to inform decisions regarding conservation of patches of various sizes and isolation. However, given Phainopeplas' relatively large size and vagility, this approach comes with caveats for smaller, less mobile species that may require, for local persistence, habitat patches that are located closer together. Here, some background on Phainopepla ecology is provided that is used later to help prioritize woodlands and conservation actions.

Phainopeplas are frugivorous (fruit-eating) songbirds found only in the southwestern United States and Mexico (American Ornithologists' Union 1983). The name is derived from the Greek words meaning "shining robe", which describes the glossy black plumage of males (Terres 1995). Phainopeplas are the only member of the Ptilogonatidae (Silky Flycatcher) family in the United States. Their range extends from the Mexican Plateau north into Arizona, California, extreme western Texas, and the southern regions of Nevada and New Mexico (Walsberg 1977).

Within this range, Phainopeplas overwinter and breed in the Mojave, Colorado and Sonoran deserts, arriving each year in September and departing in May-June. During this time, their spatial distribution virtually mirrors the distribution of desert mistletoe. Mesquite and acacia woodlands that contain little to no mistletoe are rarely, if ever, occupied by Phainopeplas (Krueger 1998, Crampton 2004), whereas in woodlands where mistletoe is plentiful, Phainopeplas can be abundant. In other words, a habitat patch for Phainopeplas is not simply an acacia or mesquite woodland, but rather a woodland (or that portion of it) that has abundant mistletoe. In Nevada, mistletoe berries and Phainopeplas are generally most abundant in woodlands south of Las Vegas, followed in abundance by woodlands in the Las Vegas Valley, and along the Muddy and Virgin rivers.

Although mistletoe abundance is the only factor that appears to predict patterns of woodland occupancy and breeding success by Phainopeplas across multiple spatial and temporal scales (Crampton 2004, also Anderson and Ohmart 1978, Walsberg 1978, Chu 1999), other factors influence Phainopepla distribution and abundance to a lesser degree. Within woodland patches that contain abundant mistletoe, Phainopeplas prefer tall host trees (Krueger 1998), and areas where the tree density and canopy cover is high, likely because these factors affect the probability of nest predation. At the landscape scale, Phainopeplas prefer non-isolated, large, mistletoe-infected woodlands, in which breeding success is higher. They also prefer patches at lower elevation (Crampton 2004). These habitat and landscape attributes are shared by a number of other bird species included in this CMS (Appendix A), further support for the use of Phainopeplas as a model species.

Because of the close link between Phainopeplas and desert mistletoe, the birds can be particularly susceptible to changes in the quantity or quality of their habitat, hence their designation as a covered species in the MSHCP. Phainopeplas also are considered a Nevada sensitive species by the BLM, are listed as a priority species by Nevada Partners in Flight (PIF) plan, and are a focal species in the California PIF Desert Bird Conservation Plan.

d) Conservation biology theory: metapopulations and reserve design

A key element of this CMS is the application of appropriate conservation planning tools. Given the patchy nature of mesquite-acacia habitat, two main concepts -- metapopulation dynamics and reserve design -- are employed.

In the metapopulation framework, one assumes that larger regional populations have been divided into smaller subpopulations linked to some degree by dispersal. Even if a local subpopulation goes extinct, if conditions are right, its patch can be recolonized by dispersal before the other subpopulations go extinct (Wiens 1993). Thus the likelihood of regional persistence is greater than that of a population that is not spatially subdivided (Hanski 1991). However, several assumptions must be met for metapopulation persistence (Hanksi et al. 1995, 1996): 1) demography and population interactions are spatially structured, 2) there is no "mainland" population, 3) dynamics of subpopulations are asynchronous to the extent that simultaneous extinction of all of them is unlikely, and 4) recolonization is not prevented by excessive patch isolation. Clearly, many of these assumptions are species-dependent (e.g. how individuals perceive the matrix, the distances at which isolation occurs).

The current paradigm in reserve design for fragmented habitats holds that reserve systems must embrace disturbances, dynamics, and processes of natural systems, i.e. a non-equilibrium perspective. From this paradigm, it follows that 1) a reserve cannot be conserved in isolation from its surroundings, 2) reserves will not maintain themselves in stable and balanced configurations, and 3) reserves incur natural and human disturbances (Pickett et al. 1992). These considerations suggest that large reserves of high quality habitat are typically best; ideally they should be connected to other reserves on a regional scale (Meffe and Carroll 1994). Even with a high degree of connectedness, a system of small reserves is unlikely to 1) assure population persistence, 2) accommodate taxa with large territory/home range requirements and 3) retain evolutionary integrity. Also, reserves ideally should be spatially heterogeneous (easier to achieve in a large reserve) to provide patches within them that reduce the chances that individual disturbance events destroy all of the reserve (Meffe and Carroll 1994). A benefit of this "intra-reserve patchiness" is that the metapopulation dynamics of species that operate on smaller spatial scales can be accommodated within one reserve unit, while those of species that operate on larger spatial scales can function across reserves. Finally, the area/perimeter ratio should in general be maximized, so that there is relatively less edge and more core habitat. However, this quality of reserves is likely not important in this CMS, as many mesquite and acacia woodlands naturally contain substantial amounts of edge (e.g. washes).

3. Spatial Data

a) Data acquisition

Spatial data depicting mesquite, acacia, and smoke tree distribution, and in some case, habitat structure and condition have been generated by several different agencies and individuals over the last ten years. New data were collected on known, but unmapped, woodlands by the University of Nevada Reno (UNR) and the BLM in 2003-2005. The following is a description of the different data sets acquired and used in the CMS:

1. Original Bureau of Land Management (BLM)/Nevada Department of Wildlife (NDOW) data: The majority of woodlands were digitized from aerial photos by Krueger (and some were groundtruthed) in the mid-1990s. Krueger collected information on tree density, size, and sometimes, mistletoe infection. Data collected in aerial surveys by NDOW (primarily of Pahranagat, the Muddy River, Piute and Eldorado valleys, and North Las Vegas) and was added to the BLM layer and used for the previous draft Mesquite HMP. Much of the NDOW data was at a coarse scale and with the exception of the Lower Muddy River, was redigitized at a finer scale by the UNR in 2005. The Muddy River woodlands cannot be redigitized without groundtruthing, since the presence of many other deciduous tree species in the area precludes identification of host trees. Meanwhile, this portion of the layer should be used with appropriate caution.

2. National Park Service (NPS) data: These data consisted of small areas of 1) honey mesquite on the east side of Overton Wildlife Management Area (WMA) and 2) smoke trees in the south end of the park. The latter has been buffered to protect the location of the trees and thus is an overrepresentation of the area of the patch.

3. Bureau of Reclamation (BOR) data: BOR surveyed and classified vegetation type and structure along the Colorado and Virgin Rivers in 1997, including honey mesquite and mixed honey mesquite/tamarisk and screwbean mesquite/tamarisk stands. In 2005, the UNR extracted these stand types in Nevada for use in the CMS. BOR has collected new data on vegetation along the Virgin and Colorado rivers that will be available in early 2006; these data should be incorporated into this CMS.

4. New BLM data: In 2004, the BLM surveyed unmapped areas that had a high potential to support acacia woodlands (Pahranagat area, Muddy, Highland, McCullough and Newberry Mountains, Gold Butte, and Nelson area). Some of these areas were suggested by Crampton based on her 2000-2003 Phainopepla surveys. Others were identified by using topographic maps to locate washes likely to support acacia; larger, named washes that had four-wheel drive access generally were surveyed (Liang, pers. comm.). In each case, GPS was used to survey as much of the mesquite or acacia vegetation as possible by car or on foot, then this vegetation was digitized from digital orthophotoquad maps (DOQQs) in the lab. Digitized polygons encompassed the surveyed area, and usually any vegetation beyond the observed area, if it appeared similar to the observed vegetation on the DOQQ. The attribute table usually indicated which portion of the polygon was actually seen, and contains observations on tree height, density, infection and associated species. The vegetation that was not actually surveyed requires groundtruthing, and is considered "potential habitat" for this CMS (see below). The protocol used in mapping is described in Appendix B.

   In 2005, the BLM mapped acacia woodlands in Gold Butte and the Lucy Gray Mountains, using a protocol similar to the above, but with a few modifications (included in Appendix B). Also, criteria for determining which woodlands to map, and how to map them, were refined (Appendix C). First, a woodland had to be least 0.4 ha and contain trees that were not further than 50 m apart (a new woodland began if the trees were more than 50 m apart). The 0.4 ha rule was modified if the stand was particularly dense with either trees or mistletoe. Second, if the entire extent of the woodland was not actually surveyed, the distance that acacia continued to be visible ("distance visible") beyond the last GPS record (point or line) was recorded. In the lab, a buffer was created around the GPS record using this distance. The buffered polygon was then modified according to directions included in field notes to represent the shape and area of the woodland on DOQQs, Vegetation was not digitized beyond the recorded distance visible. This method increases confidence in the data by not overestimating habitat, but does not indicate potential habitat.

5. Las Vegas Valley EIS data: Mesquite and acacia woodlands in the Las Vegas Valley were digitized as part of an Environmental Impact Statement. Although this layer may depict some woodlands not included in other layers, it is of unknown quality, so it has been used in this CMS. Its major utility is that the map layer indicates general areas where acacia occurs that can be groundtruthed.

6. UNR data: During surveys in 2000-2003, Crampton recorded many areas where mesquite and acacia occurred that were not yet mapped. Based on this information, personnel at the UNR digitized many putative woodlands from DOQQs taken in the 1990s. Like the BLM 2004 data, this data set includes polygons in which the vegetation was digitized beyond the extent of vegetation that was physically seen; these polygons have been considered potential habitat and require groundtruthing (this has been noted in the attribute table).

In summary, the consolidated layer used for the CMS was compiled from data of different ages, accuracy, level of detail in the attribute table, and resolution. In terms of the latter, there is a lack of consistency with regards to which woodland patches should be included in single polygons versus multiple polygons; in some cases, each small group of trees was digitized as an individual polygon, whereas in others an entire wash of many kilometers was digitized as one polygon. Some of these issues can be dealt with in the lab (e.g. merging polygons, attributing tree density), but others must be addressed in the field (e.g. groundtruthing, attributing habitat condition including mistletoe infection). Also, some may be resolved by the use of multispectral imagery to identify mesquite, tamarisk and acacia, a UNR project in the pilot stage. The algorithms for distinguishing mesquite and acacia from tamarisk in these images may be developed in early 2006, although it may not be possible to separate mesquite from acacia.

<u>b) Data review and consolidation</u>

The woodland polygons shown in Figure 1 as “mesquite,” “acacia,” or “smoke tree” are those for which there is a high level of confidence that the polygons represent woodlands dominated by those species. These polygons are contained in the main “habitat_merged05” shapefile. Those woodlands for which there was doubt that they contained these species (“low confidence” polygons) are shown as “potential habitat.” To create potential habitat shapefiles, low confidence polygons were copied into new shapefiles, and deleted from the polygon from the main mesquite-acacia shapefile. This process affected about 200 polygons. The majority were polygons from the 2004 BLM data set that included vegetation beyond that actually observed or described; these polygons are in a shapefile called “2004_erase”, and represented as “BLM potential habitat.” This file was created by first including polygons in the 2004 data for which there were no attributes recorded, assuming that this lack indicated that the woodland represented by the polygon had not actually been visited. Then the remaining polygons were examined for evidence that they had been digitized too far beyond the last GPS record, using a typical estimate of visible distance based on the BLM’s 2005 field work. Polygons were truncated at this distance, removing the undocumented part of the polygon to the 2004_erase file, and retaining the rest in the original file. Similarly, data digitized by the UNR was compared to field notes and GPS points, and a potential habitat file was created for all unsubstantiated polygons. To this file, any records from the original BLM data for which the species was listed as “unknown” were added. Finally Craig Stevenson of NDOW used his field notes to construct a map of approximate distribution of acacia woodlands in the McCullough, Highland, Lucy Gray, Iretreba, and south Muddy mountains. Until these woodlands (see list in Appendix D) are groundtruthed and GPSd, they should be considered potential habitat.

Once the data sets had been reviewed, it became clear that many areas had duplicate coverages that needed to be eliminated from one or more data sets. Before this process began, a new copy of each data set was made that became the “edited” data set. If data overlap occurred with the original BLM/NDOW layer, then where possible, the data of the BLM/NDOW set was kept, and data was deleted from the other set. An exception to this rule occurred when data in the other set was more accurate or complete (e.g. BOR data for the Laughlin area distinguished mesquite from tamarisk better). If data overlap occurred between other data sets, then data in the set that was most accurate and complete for that area and of the resolution most consistent with that of the original BLM data were retained. Notes of each decision were kept.

Because much acacia habitat (~800 ha) in North Las Vegas was destroyed after it was mapped in the original BLM layer, the new CMS layer should reflect this loss. However, none of the DOQQs were recent enough to show this change. To estimate habitat loss, the most recent street layer from Clark County's website (GIZMO, May 2005) was superimposed over the original BLM/NDOW layer. Then (portions of) polygons that were covered by streets were copied to a "lost habitat" shape file, and deleted from the "edited" copy of the original layer, as it was assumed that those woodlands had been destroyed.

The next step before merging all data sets into one layer was to standardize the attribute tables. The original BLM data attribute table served as the model, with several new fields: data source, date data collected, land status, and metapatch and region designations (see below). Two comment fields, one for habitat condition, and one for data quality and resolution, were also added. Next, all the edited data sets were merged into habitat_merged05.shp; this new data set forms the map of known and potential mesquite-acacia woodlands in southern Nevada, southeastern California, and northwestern Arizona shown in Figure 1. The main limitations of this layer, denoted by the words "known" and "potential," is that some habitat is likely missing from areas not yet surveyed (see above and Appendix D). Other limitations are noted above. In the future, all spatial data collected on mesquite and acacia woodlands should include the attributes described in Appendix E.

C. Data Gaps

1. Data Gaps Requiring Research and Monitoring

The success of this Conservation Management Strategy depends on an ability to protect mesquite and acacia woodlands that have sufficient ecological integrity to collectively sustain themselves and the species that depend on them for the next 100 years. At this juncture, planning is hampered by a lack of knowledge in several areas. These gaps are described below and summarized in Table 2.

First, there a lack of recruitment of new mesquite trees in some mesquite woodlands (Krueger 1999), yet the causes of this failure to recruit are unknown and may include both natural factors, such as edaphic conditions, lack of seed production and dispersal, and herbivory; and anthropogenic factors, such as groundwater loss, grazing, and OHV use. Also, recruitment has not been quantified in woodlands not covered by the draft Mesquite HMA, so must be surveyed in other woodlands. Furthermore, mistletoe colonization and extinction dynamics, and their causes, are poorly understood. An understanding of why some woodlands are uninfected and

Table 2. Gaps in our knowledge of mesquite and acacia woodlands and associated species.

Data Gap	**Action**
• Extent of lack of mesquite and acacia recruitment.	• Survey plots in all woodlands.
• Cause of lack of mesquite and acacia recruitment (poor seed dispersal, germination, survival?).	• Correlative and/or manipulative research in several woodlands with different natural and anthropogenic conditions.
• Factors that affect mistletoe abundance, colonization and extinction; temporal and spatial scale of metapopulation dynamics.	• Correlative and/or manipulative research in several woodlands with different natural and anthropogenic conditions.
• Relationship between groundwater levels, and acacia and mistletoe establishment and survival.	• Survey condition of woodlands and correlate with data from existing wells (e.g. USGS); drill new wells, if none exist.
• Factors that promote successful restoration of mesquite and acacia.	• Conduct restoration efforts in experimental fashion, e.g. treatments with different planting densities, irrigation regimes.
• Determination of actual effects of possible threats to woodlands and associated species.	• Correlative and/or manipulative research in several woodlands on 1) seed production, recruitment, survival and growth form of trees, and 2) distribution, survivorship and reproductive success of associated species in the presence and absence of threat.
• Distribution and abundance of associated species.	• Survey plots in woodlands (see Monitoring).
• Determination of woodland requirements for Phainopepla and other associated species, in terms of area, distance between woodlands, habitat structure, and food resources.	• Correlative and/or manipulative research of those factors in multiple woodlands. Determination of animal movement patterns among woodlands (distance, frequency).
• Existence and nature of metapopulation dynamics of associated species.	• Examination of animal movement patterns among woodlands (distance, frequency) and of gene flow among patches.
• Existence and causes of area sensitivity (Are some organisms (including mistletoe) less likely to colonize, or have lower reproductive success, in small woodlands?)	• Correlative and/or manipulative research in woodlands of different sizes examining potential causes, e.g. microclimatic conditions, predator activity, resources, etc.
• Effect of drought on trees and mistletoe.	• Long-term monitoring; population modeling?

	modeling?
• Population viability of Phainopepals and other focal species.	• Conduct Population Viability Analyses.

others infected, but apparently undergoing a decline in mistletoe abundance should be developed. Experiments to determine what factors positively influence the success of restoration and cultivation projects should be conducted. A implementation goal should be to determine if there are correlations between groundwater levels, and tree (especially acacia) and mistletoe recruitment, survival and growth; existing groundwater monitoring wells should be used where possible, and additional wells drilled as needed. For example, the USGS provides data from existing wells at:

http://waterdata.usgs.gov/nv/nwis/gwsi?county_cd=32003&format=station_list&sort_key=station_nm&group_key=NONE&sitefile_output_format=html_table&column_name=agency_cd&column_name=site_no&column_name=station_nm&column_name=lat_va&column_name=long_va&column_name=coord_datum_cd&column_name=state_cd&column_name=county_cd&column_name=alt_va&column_name=alt_datum_cd&column_name=huc_cd&list_of_search_criteria=county_cd

Although the above data set is not complete, the BLM state hydrologist is working to secure funding for its improvement.

Second, the specific habitat requirements of most of the species that depend on or use these woodlands are not known. This is even true of many avian species, which are relatively well studied compared to mammals, reptiles, and invertebrates. A main objective should be to determine how different species determine what is a suitable habitat patch (e.g. in terms of habitat structure and patch size and isolation). This process could begin as a simple inventory of animal abundance in habitat patches that differ in key resource characteristics, but will have greater utility if habitat characteristics are also measured and correlated with abundance. Also, it is important to determine which species are distributed as metapopulations in this area, and study the dynamics of those metapopulations.

It is essential to better understand what configuration of trees hosting mistletoe constitutes a habitat patch for Phainopeplas – that is, how large a woodland has to be for Phainopeplas to see it as a habitat patch, and how much matrix habitat can intervene between woodlands before

Phainopeplas see them as separate patches. In highly fragmented habitat, Phainopeplas appear to use multiple woodlands regularly, if the woodlands are separated by short (approximately 200 – 300 m) distances (Crampton, unpubl. data). It is necessary to investigate if Phainopeplas in these patches function as a metapopulation and, if so, at what spatial scale. Also, the causes of area sensitivity -- that is, why Phainopeplas occur at lower density and have lower breeding success in small infected woodlands than large ones -- should be determined. Likely, a major factor is greater nest predation in small patches (Crampton 2004), so establishing the identity of the species that prey on Phainopepla nests would contribute substantially to management of this species. The effectiveness of the CMS would be increased by population viability analyses for Phainopeplas and several other focal covered species.

Third, several factors are thought to negatively impact mesquite and acacia dependent species, such as OHV use and woodcutting, but the nature and magnitude of effects of these factors needs to be quantified. Some effects may be direct (e.g. disturbance or trampling by OHVs) or indirect (e.g. loss of nesting habitat due to stress-induced changes in tree structure). The predators of woodland species of conservation concern that might be increasing due to anthropogenic changes on the landscape (e.g. Common Ravens, feral cats, also sometimes called subsidized species) should be identified, and potential control measures for these predators evaluated.

2. Data Gaps Requiring Surveying and GPS/GIS Work

Three main gaps exist in our GIS coverage. First, surveying and mapping of acacia woodlands in the areas identified in Appendix D must be completed. Second, the data in the "potential habitat" files should be groundtruthed. Third, the structure and condition of all woodlands in the spatial data set should be assessed; the degree of mistletoe infection, and human use patterns would also be surveyed and added (see Appendix E). All woodlands should be resurveyed every five to ten years since their condition (including mistletoe abundance) is likely to change; also, frequent assessments will help document metapopulation dynamics of mistletoe across the landscape. These goals may be achieved in part with multispectral imagery as it is developed, but nonetheless will require some field work. The other main project should be to standardize the resolution of the digitizing in the current spatial data layer.

D. Existing Environment

1. Distribution and Land Management Status of Woodlands

Both mesquite and acacia exhibit a widely spaced and patchy distribution throughout southern Nevada, extending through Clark County and into adjacent southern Nye and Lincoln counties (Figure 1). The natural patchiness (primarily due to hydrological patterns) of their distribution has been exacerbated by anthropogenic factors (e.g. conversion to agriculture and houses), such that many present day woodlands are smaller and more isolated than historical woodlands.

The total woodland area mapped to date (using only high quality spatial data), including some mixed mesquite/tamarisk woodlands and a few woodlands in California and Arizona, is 17 661 ha (43 641 acres). Table 3 shows woodland area by host species and also shows the area occupied primarily by tamarisk adjacent to mesquite stands. The area of potential woodlands may exceed 2500 ha, most of which is likely to be acacia rather than mesquite.

Table 3. Woodland area in southern Nevada, northwestern Arizona, and southeastern California by dominant species. The area of smoke trees is overrepresented to protect their location.

Species Group	**Woodland Area (ha)**	**Woodland Area (acres)**
Acacia	5784	14 292
Acacia/Mesquite	919	2272
Mesquite	9984	24 669
Mesquite/Tamarisk	885	2188
Smoke Tree	88*	219

Of the approximately 14, 400 ha of woodlands in southern Nevada, 82% occur on federal lands, primarily land managed by the BLM, followed by the NPS and the Fish and Wildlife Service (FWS; Table 4). Of the remainder, approximately 120 ha occur on public land managed by state agencies (Nevada State Parks and Overton Wildlife Management Area), 280 ha occur on either the Fort Mojave Indian Reservation or Moapa Tribal Land, and 2950 ha occur on private lands. Some of the woodlands Areas of Critical Concern (ACECs), which may confer them higher levels of management protection. No mesquite woodlands overlap with Wilderness or Wilderness Study Areas, although Corn Creek and Coyote Springs are located in a proposed FWS Wilderness in the Desert Wildlife Range. Several acacia woodlands occur at least partly in Wilderness Areas (Arrow Canyon, Lime Canyon, South McCullough, Sunrise ISA, and Spirit

Mountain). Also, as noted, several woodlands occur in IMAs or LIMAs, and are to be managed for their value as wildlife habitat. The management status of individual woodlands is discussed below.

Table 4. Approximate area of mesquite and acacia woodlands in southern Nevada and bordering states by land owner/manager.

Land Owner/Manager	**Area (ha)**	**Area (acres)**
Bureau of Land Management	9110	22510
Fish and Wildlife Service	1380	3410
Native American Reservation	280	690
National Park Service	965	2385
Nevada State Parks	100	250
NDOW (Overton WMA)	20	49
Private	2950	7300
Arizona	55	138
California	3165	7823

In Clark County, there are four major “regions” that support large areas of woodland (i.e. the sum of the area all the woodlands that occur in each region is over 1000 ha; Table 5, Figure 3). A region is defined as a collection of woodlands that are separated by less than 5 km; the distance to the next nearest region is usually at least 10 km (with the exception of the Eldorado/Piute/Newberry regions, which are separated by at least 7 km and by mountain ranges or rivers). These regions are the groups that result from running the woodlands through a statistical clustering program, based on their location. They are: Newberry (Newberry Mountains and Laughlin area), Eldorado (Eldorado Valley), Pahranagat (Pahranagat Wash and Upper Muddy River) and Gold Butte. Piute (Piute Valley), which is partly in California, is also a major region. The Muddy Mountains (Lower Muddy River, Bitter Springs/Buffington Pockets) have 800 ha of mapped habitat, and several hundred ha of potential habitat, so should be considered an important region. There are also large amounts of woodland in two regions in Nye County, one of which (Pahrump) is shared with Clark County. Collectively, these eight regions encompass the five major woodlands identified in the earlier mesquite HMP and also the minor Sandy Valley woodland. Seven regions in Clark County have less than 1000 ha of total woodland area.

Table 5. Mesquite and acacia woodland area in southern Nevada, western Arizona and southeastern California by region and land manager.

Region	**County or State**	**Area (ha)**	**Area (acres)**	**Land Manager***
Newberry	Clark	1700	4201	BLM, NPS, PVT, NAR
Eldorado	Clark	1200	2965	BLM, NPS, PVT
Pahranagat	Clark	1200	2965	BLM, PVT, FWS, NAR
Gold Butte	Clark	1000	2471	BLM, NPS
Muddy Mountains	Clark	807	1994	BLM, NPS, NVST
Las Vegas Valley	Clark	623	1539	PVT, COUNTY
Corn Creek	Clark	397	981	FWS
Nipton	Clark	220	544	BLM
Lucy Gray Mountains	Clark	126	311	BLM
Indian Springs	Clark	76	188	PVT, BLM
Red Rocks	Clark	55	136	BLM, PVT
Virgin River	Clark/AZ	266	657	PVT, BLM, NPS
Piute	Clark/CA	1100	2718	BLM, PVT
Pahrump	Nye/Clark	3900	9637	PVT, BLM
Amargosa Flat	Nye	1500	3707	BLM, PVT, FWS
Coyote Spring	Lincoln	901	2226	FWS
Mesquite Lake	CA/ Clark	3000	7413	BLM, PVT
Tecopa	CA	73	180	PVT, BLM
Piute Spring	CA	2.4	6	BLM, CAST
Ivanpah	CA	1.8	4	NPS
Willow Beach	AZ	3.3	8	NPS

*BLM=Bureau of Land Management, NPS=National Park Service, PVT=Private, NAR=North American Indian Reservation, FWS=Fish and Wildlife Service, NVST=State of Nevada, County=Clark County, CAST=State of California.

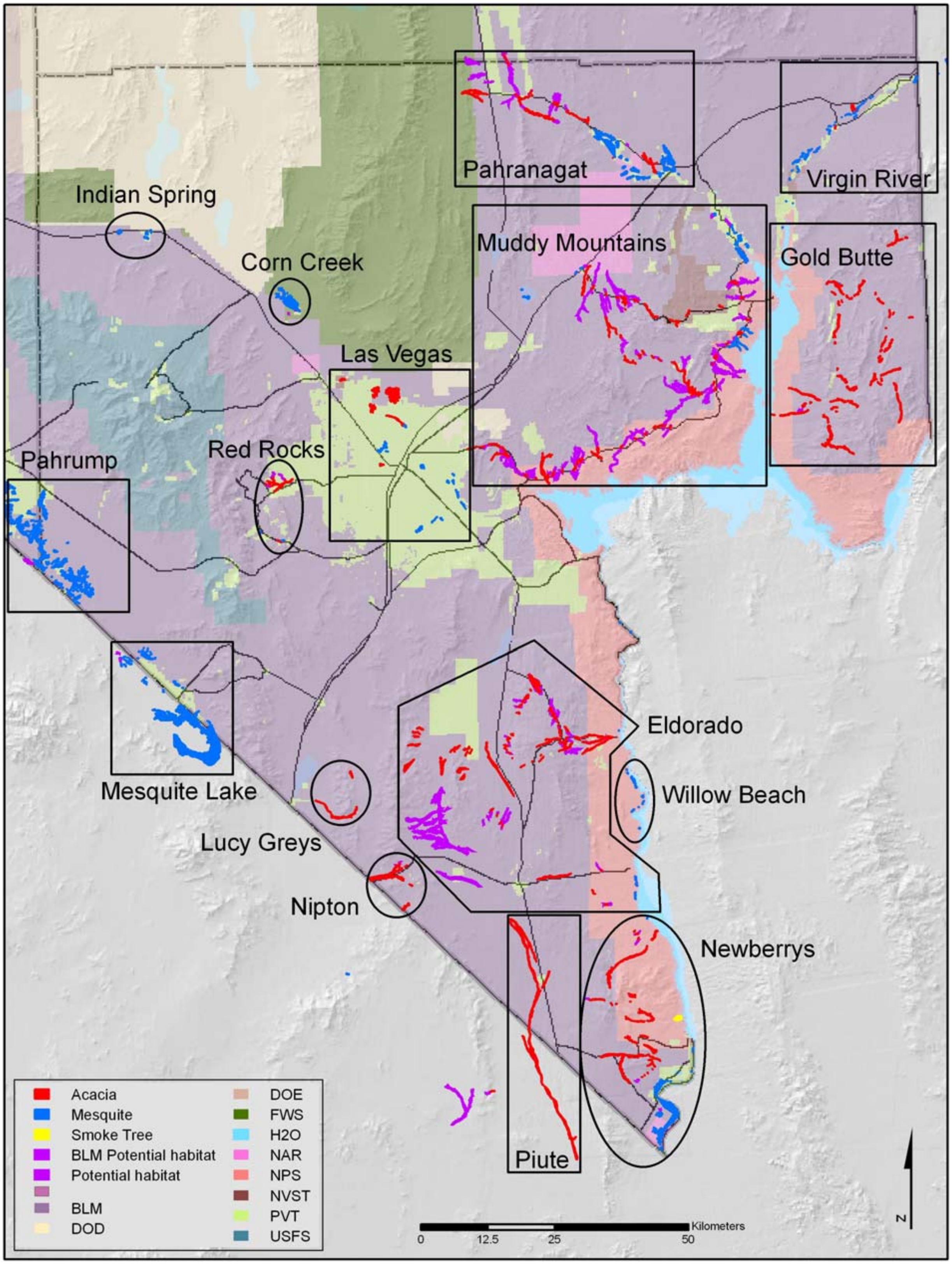

Figure 3. Major regions of mesquite and acacia woodlands in Clark County.

For analysis of woodland conditions and assignment of conservation actions, each region was divided into smaller groups of woodland patches called "woodland metapatches," defined as a collection of woodland patches separated by less than two km, and not separated by any major barrier (e.g. major river or mountain range). The woodland metapatch concept was used because it is not practicable or desirable from a conservation perspective to manage for individual woodland patches, some of which are tiny (< 0.01 ha) and only separated by a few meters. The operational definition (i.e. < 2 km between patches, no barriers) emerges from an attempt to group woodland patches within the distance that Phainopeplas might occasionally fly across matrix landscape areas, but beyond the distance they regularly travel during the breeding season (≥ 200 m, several times daily; Crampton and Liang, unpubl. data). The metapatch definition resulted in some metapatches being comprised of one continuous woodland patch (e.g. Coyote Springs), and others comprised of many small, but directly adjacent, woodland patches (e.g. Carson Slough). These differences in woodland metapatch continuity are reflected in Figure 1.

These 101 woodland metapatches range in area from 0.33 ha (along the Virgin River in Arizona) to 3662 ha (Pahrump/Stump Springs; Table 6). Approximately 85 woodland metapatches occur mostly in Clark County, with the largest being the Muddy River (967 ha) in the Pahranagat region, which is mostly on private lands. The largest metapatch entirely on federal land in Clark County is Gold Butte SW (503 ha), followed by Piute Wash (which at 1098 ha is larger in total extent, but about half of the wash runs through California).

Table 6. Areas of mesquite and acacia metapatches in southern Nevada, northwestern Arizona, and southeastern California.

MetaPatch	Area (ha)	Area (acres)
Pahrump	3661.5	9047.5
Mesquite Lake	2788.9	6891.3
Piute	1097.9	2713.0
Muddy River	920.5	2274.5
Coyote Spring	901.2	2226.9
Big Bend	736.0	1818.5
Amargosa Flat	702.5	1735.8
Gold Butte SW	503.5	1244.1
Hiko	433.2	1070.3
Corn Creek	397.3	981.7
North Las Vegas	388.4	959.8
Carson Slough	338.9	837.3
Nelson	298.0	736.3
Gold Butte E	266.1	657.6
SR 165	237.1	585.8
Empire	213.7	528.1
Stewart Valley	213.7	527.9
Nipton	204.4	505.0
Gold Butte NW	186.3	460.4
Franklin Wash	182.6	451.1
Muddy Mtns S	172.7	426.8
Amargosa Flat NW	161.3	398.5
Las Vegas Bay	146.9	363.0
Overton	143.7	355.1
Grapevine	141.9	350.7
Eldorado	139.4	344.5
Arrow Canyon	125.2	309.4
Bunkerville	125.0	308.8
Sandy N	116.7	288.3
Lucy Gray Mtns	114.3	282.4
Highland E	107.6	265.9
Arrow Canyon W	105.3	260.3
Smoke Tree	88.5	218.6
Highland	86.5	213.8
Rogers Spring	86.1	212.8
Mcullough S	86.1	212.7
Highland S	79.5	196.5
Mormon Mesa E	75.2	185.8
Virgin Mtns	74.7	184.7
McCullough N	74.5	184.1
Cottonwood	57.6	142.3
N Las Vegas Airport	56.1	138.5
Las Vegas Wash	51.7	127.7
Sunrise	47.1	116.4
Resting Spring	46.8	115.6
Indian Springs	42.0	103.7
Calico Basin	41.6	102.7
California Wash	41.1	101.6
Hwy 40	41.1	101.4
NW of Last Chance Spring	35.6	88.0
Craig	35.2	87.0
Cactus Spring	34.0	84.0
Bole Spring	33.5	82.7
Wetlands Park	33.2	82.1
Hidden Valley	31.6	78.0
AZ SR91 E	31.3	77.4
Sunset Park	31.1	76.9
West End	31.1	76.7
Sandy CA SE	29.5	73.0
Opal Mtn	27.3	67.5
China Ranch	26.7	65.9
Roman	22.7	56.1
AZ SR91 W	21.7	53.5
Lake Mojave N	19.3	47.8
Valley of Fire	16.9	41.8
Nipton S	15.6	38.5
Dry Lake	14.1	34.9
Keyhole	13.8	34.2
Overton N	13.0	32.1
Las Vegas Springs Preserve	12.4	30.6
Mesquite	12.0	29.8
Lucy Gray Mtns N	11.7	29.0
Sandy W	11.7	28.9
Blue Diamond	11.5	28.5
Pahranagat N	11.4	28.1
Stevens Springs	8.0	19.9
Empire N	7.9	19.5
Nellis Wash	7.8	19.2
Floyd Lamb	6.5	16.0
Sandy CA SW	5.6	13.7
Echo NW	4.9	12.1
St. Thomas N	4.9	12.1
Gold Butte NE	4.8	11.8
Calville	4.7	11.7
Nellis Wash N	4.3	10.6
Fire Canyon	4.0	9.8
St. Thomas	3.3	8.1
Cottonwood E	3.2	7.8
Piute Spring	2.4	5.9
Slaughterhouse Spring	1.8	4.5
Bonnie Springs	1.8	4.4
Willow Beach	1.7	4.1
Willow Beach S	1.7	4.1
Mt Davis	1.6	3.9
Laughlin N	1.1	2.8
Moapa	1.0	2.4
Lake Mojave S	0.7	1.7
E of Amargosa Flat	0.7	1.6
Laughlin	0.6	1.5
Overton WMA N	0.5	1.3
Black Ridge SW	0.5	1.2
AZ SR91 S	0.3	0.8

2. General Habitat Conditions

a) Historical/reference conditions

Distribution and extent of woodlands

Historically, before agricultural and urban development and encroachment by tamarisk, the distribution of mesquite and acacia woodlands in southern Nevada was much greater. The Las Vegas Valley was a 3 mi x 12 mi expanse of mesquite and acacia woodlands when the first European settlers colonized it (Paher 1971). The Virgin, Muddy, and Colorado rivers are believed to have supported much more extensive and denser stands of mesquite as well.

Woodland condition

There are few data on what constitutes a "healthy" mesquite or acacia woodland, and this definition may be somewhat site specific (e.g. a healthy stand may have a more open canopy in one area than another); however, mixed age structure, single stemmed trees, and evidence of recruitment may serve as reasonable criteria. Krueger (1999) considered the mesquite woodland in Stewart Valley to be one of the most pristine mesquite woodlands remaining in southern Nevada. Trees at Stewart Valley are significantly larger and have fewer stems than trees at other major woodland sites, and reach heights of 8-10 m, with stems approaching 1 m in diameter (Krueger 1998). Tree age at this site may exceed 100 years; recruitment is occurring there, with an age class distribution of 25% seedlings and 10% saplings.

b) Current conditions

General information in this section has been gathered from the literature. Data for specific sites were collected by Krueger (1998, 1999) and included in the draft Mesquite HMP. However, information of this level of specificity is not available for all woodlands included in the CMS.

Climate

In southern Nevada climate at lower elevations, where most woodlands occur, is arid, with characteristically high summer temperatures and low precipitation. Temperatures can range from a maximum of 48^0C (118^0F) in summer to a minimum of -5^0C (23^0F) in winter. Average annual precipitation is 10-15 cm (4-6 in), with the majority commonly supplied by infrequent, individual storms. Overall, probability of freezing temperatures is higher, and growing season is shorter, for sites west of the Spring Mountains than for sites east of the Spring Mountains, reflecting differences in elevation. In far southern Clark County (Piute and Newberry regions) temperatures are typically at least 3°C warmer than in the Las Vegas area.

From 2001-2004, southern Nevada was affected by a severe drought. The Southern Nevada Water Authority (http://www.snwa.com/html/drought_index.html) continues to claim drought conditions (based on water levels in Lake Mead and water use patterns), although most indices cited by the U. S. Drought Monitor (http://drought.unl.edu/dm/) suggest that recent increased rain events have mitigated drought conditions to some extent. During the drought, no changes were noticed in mesquite and acacia plants, but mistletoe production and survival may have been affected. In 2002, the most severe drought year, mistletoe berry abundance was lower than in 2003, a year of normal rain (Crampton 2004). Precipitation in 2003 and 2004, however, may not have completely offset the effects of the dry period, since in many woodlands, the number, size and berry production of mistletoe plants appeared to be lower in 2004 than in previous years (Crampton, pers. obs.).

Groundwater hydrology

In southern Nevada, mesquites, and perhaps some acacias, behave as obligate phreatophytes; that is, their existence depends upon the availability of a relatively shallow and permanent groundwater source. In some areas, however, acacia may be less tied to groundwater, and more dependent on surface flows. Groundwater levels, drainage patterns, and the soil's water-holding capacity all contribute to determining the distribution of mesquite and acacia in the northeastern Mojave Desert.

In general, groundwater levels in southern Nevada appear to be dropping. Water levels recorded for eight wells in the Amargosa Desert between 1952 and 1957 show a relatively constant level, whereas water levels recorded between 1957 and 1962 show declines (Walker and Eakin 1963). Declines ranged from 0.1 to 6.1 feet over a 5-year period, with an average yearly decline of 0.7 feet. In the Lower Moapa Valley, the trend has been very slow local decline of groundwater levels (Rush 1964). Water levels of wells drilled in Pahrump Valley generally have been declining since the first wells were constructed in 1913 (Harrill 1982). During the years 1962-1975, water levels declined between 1 and 4 1/2 feet per year, with the greatest declines occurring along the lower edge of the Pahrump and Manse alluvial fans, and lesser rates of water-level decline occurring lower in the valley bottom.

Most wells drilled in Pahrump Valley from 1913 to 1962 were used for irrigation of cotton and alfalfa. Pumpage reached a maximum high in 1968, then began to decrease after land was taken out of agricultural production and subdivided for real estate development. If these lands are fully developed, it is expected that pumpage will return to about the same level as in 1968. Harrill (1982) estimated that, as of 1975, pumping had created an overdraft of approximately 11,000 acre-feet per year on the groundwater supply in Pahrump Valley. An analysis of data on static water levels obtained from the Nevada State Water Engineer's office in Las Vegas for 651 wells drilled within a 1-mile radius of a mesquite woodland in the Pahrump area detected a significant downward trend in static water level for wells drilled between the years 1953 and 1996 (see Krueger 1998).

Geology and soils

Many mesquite woodlands in southern Nevada are located at lower elevations in valley bottoms where deep alluvial and playa lake deposits from Quaternary rock cover basin floors. The alluvial fans consist of gravel and rubble near the highlands and grade downward into fine sand and silt in the valley bottoms. The playa deposits consist of sand, silt, and clay strata, with a few lenses of fine gravel (Longwell et al. 1965, Cornwell 1972). Other mesquite woodlands occur along rivers or at springs. Mesquites also grow on sand dunes, which are prominent features in some areas, in particular Amargosa Flat, Stump Spring, Corn Creek, and Sandy Valley. Thus soils beneath mesquite woodlands are typically sand, loam, or clay, depending on the area. For example, soils at Moapa and Amargosa Flat that support mesquite are generally sandy, whereas soils at Pahrump and Stewart Valley are of a higher clay content (Table 7, Krueger 1999). In contrast, acacias grow in soils that tend to be sandy or gravelly, such as those found in washes (e.g. Roman Wash) and alluvial fans (e.g. North Las Vegas). Sometimes acacias co-occur with gypsiferous soils (e.g. near Blue Diamond).

Table 7. Soil texture profiles determined from samples taken at 1.5-m intervals during drilling of observation water wells at four mesquite woodland sites in southern Nevada.

	Site			
Depth (m)	Moapa	Stewart Valley	Pahrump	Stump Springs
0 - 1.5	Sand	SandyLoam	SiltyClay	Loam
1.5 - 3.0	Sand	Clay	Clay	Loam
3.0 - 4.5	SandyClayLoam	Clay	Clay	-----
4.5 - 6.0	Sand	Clay	Clay	ClayLoam
6.0 - 7.5	Sand	Clay	Clay	ClayLoam
7.5 - 9.0	LoamySand	Clay	Clay	ClayLoam
9.0 - 10.5	LoamySand	Clay	-----	ClayLoam
10.5 - 12.0	SandyClay	-----	Clay	-----
12.0 - 13.5	SiltyClay	ClayLoam	Clay	SiltyClayLoam
13.5 - 15.0	Clay	-----	Clay	-----

3. Associated Plants and Animals

This section lists the animals and plants that have been observed during studies in mesquite and acacia woodlands, supplemented by the accounts of several southern Nevada land managers and wildlife biologists. These lists are not intended to suggest that all species occur in all woodlands, but rather they indicate that the species that are common to many woodlands. Differences in woodland structure, soils, groundwater depth, surface water flow, microclimate, topography, elevation and amount of disturbance influence species composition in each woodland. Also, woodlands in extreme southern Nevada are influenced by the proximity of the Sonoran desert and its incumbent species.

a) Plants

In general, vegetation in and around mesquite woodlands is mostly comprised of phreatophytes, plants that obtain their water supply from permanent water sources at or near the soil surface. These species include shadscale (*Atriplex confertifolia*), quailbush (*Atriplex lentiformis*), four-wing saltbush (*Atriplex canescens*), cattle spinach (*Atriplex polycarpa*), Pepper grass (*Lepidium fremontii*), snakeweed (*Gutierrezia sarothrae*), arrowweed (*Pluchea sericea*), Prince's plume (*Stanleya pinnata*), goldenweed (*Haplopappus acradenius* var. *erimophilous*), saltgrass (*Distichlis spicata*), wolfberry (*Lycium* spp.), wild ryegrass (*Elymus cinereus*), and six-weeks fescue (*Vulpia octiflora*), seepweed (*Suaeda torreyana*), creosote bush (*Larrea tridentata*) rabbitbrush (*Chrysothamnus* spp.), Mormon tea (*Ephedra nevadensis*), Alkali sacaton

(*Sporobolus airoides*), and several species of buckwheat (*Eriogonum* spp.). In riparian woodlands, Freemont cottonwoods (*Populus fremontii*), willows (*Salix* spp.) and ash (*Fraxinus* spp.) can be found. Tamarisk (*Tamarix ramosissima*) has invaded several woodlands, particularly along the major rivers, but also in Pahrump and Ash Meadows. Russian thistle (*Salsola paulsenii*), Mediterranean split grass (*Schizmus barbatus*), and red brome (*Bromus rubens*) have also invaded some woodlands.

Some of these plants, such as red brome, snakeweed, wolfberry and creosote bush also occur in acacia woodlands. They are joined by Mojave yucca (*Yucca schidigera*), desert willow (*Chelopsis linearis*), cheese bush (*Hymenoclea salsola*), turpentine bush (*Thamnosma montana*), indigo bush (*Psorothamnus freemontii*), desert oak (*Quercus dumosa*), desert almond (*Prunus fasiculata*), pygmy cedar (*Peucephyllum schotii),* white ratany (*Krameria grayi*), spiny menedora *(Menodora spinescens*), paper-bag bush (*Salazaria mexicana*), chollas (*Opuntia* spp.), and barrel cactus (*Ferocactus acanthodes*), which is an MSHCP Watch List species.

Several covered or sensitive plant species are often found near acacia and/or mesquite woodlands and are expected to benefit under the management recommendations in the CMS (Appendix A). The Pahrump Valley buckwheat (*Eriogonum bifurcatum*) is a low, spreading annual with a very narrow endemic range of only three valleys along the Nevada-California border: Stewart Valley (Nye Co., NV), Pahrump Valley (Nye Co., NV, and Inyo Co., CA), and Mesquite Valley (Clark Co., NV, and Inyo and San Bernardino counties, CA). This species occurs in heavy clay soil, saline flats, and rolling hills around dry lake playas. Major plant associates are mesquite, shadscale, and seepweed. A status report documenting all known information on the taxon was completed in 1988, but the episodic nature of flowering events precluded a comprehensive survey until 1998 when intensive surveys were initiated. An analysis of occurrences by land ownership shows that significant extirpations are occurring in Sandy Valley where most of the land is private, while most of the populations in Pahrump and Stewart valleys are on public land (Krueger 1999).

Parish's phacelia (*Phacelia parishii*), another covered and BLM sensitive annual plant species, occurs adjacent to dry lake beds. It is more widely distributed than the Pahrump Valley buckwheat, occurring in 21 known sites on about 5,000 acres in California, Arizona, and

Nevada, although its populations are thought to be declining (Morefield 2001). Like the buckwheat, this plant is highly ephemeral and numbers can range from a few to millions depending upon favorable precipitation. Parish's phacelia was found in Stewart Valley on the edges of playas in fine-textured alkaline soils.

A third covered species, Las Vegas Bear Poppy (*Arctomecon californica*), is found in gypsiferous soils on slopes and ridges in the Las Vegas Valley, east through the southern Muddy Mountains towards Overton, and into Gold Butte (Morefield 2001). It occurs in, or adjacent to, at least two woodlands: North Las Vegas (acacia) and Las Vegas Springs Preserve (mesquite with some acacia). Its distribution is restricted to the eastern Mojave and it is thought to be declining in number.

The Las Vegas Buckwheat, an apparently rapidly declining BLM sensitive species found in Nevada only in Clark Count, co-occurs with catclaw acacia on gypsum soils (Morefield 2001). A large population occurs in and near the acacia woodland in North Las Vegas, and was surveyed in 2005. It has also been found in the Muddy Mountains and Gold Butte.

b) Animals

Mesquite and acacia woodlands occupy less than 1% of the land area in Clark, southern Nye and southern Lincoln counties, yet these woodlands support a disproportionately greater number of wildlife species than the surrounding desert scrub. Appendix A lists those species addressed in this CMS, with their status, habitat requirements, population trends and threats (if known). This list is a combination of covered Species, BLM sensitive species, and NDOW species of concern that use acacia and mesquite woodlands, and other species know to be closely associated with acacia and mesquite, regardless of legal status.

Wildlife in Nevada is under the managing authority of NDOW. There are currently no known wildlife species dependent on mesquite or acacia woodlands that are federally listed as threatened or endangered. However, southwestern willow flycatcher (*Empidonax traillii extimus*), an endangered species, may use woodlands as stopover sites during migration, and occasionally may use mesquite woodlands adjacent to riparian habitat (e.g. cottonwood, willow, ash, tamarisk) during the breeding season. Other threatened species that may occur in habitats adjacent to mesquite and acacia woodlands include desert tortoise (*Gopherus agassizii*) and bald eagle (*Haliaeetus leucocephalus*). Peregrine falcon (*Falco peregrinus*), which was delisted in 1999, may also use mesquite and acacia woodlands adjacent to appropriate habitat for hunting. Other than the southwestern willow flycatcher, these species are not addressed in this CMS, as their association with mesquite and acacia woodlands is very weak.

At least 65 species of birds have been observed using mesquite woodlands as migratory stopover sites, breeding sites, and wintering areas. Of these, at least 30 species of birds have been found breeding in southern Nevada mesquite and acacia woodlands (see Krueger 1999). Those species closely associated with mesquite and acacia woodlands and/or with legal status are also listed in Appendix A. Of these, Phainopeplas are the best studied in the area. Phainopeplas reach the greatest densities in the Pahranagat, Las Vegas, Piute, and Newberry regions, in woodlands where mistletoe berry abundance is high. They also have more breeding success in these woodlands, especially the larger (> 500 ha) ones, although breeding success is more variable in some woodlands than others (Crampton 2004). Breeding success and densities are consistently high only in the Warm Springs Ranch woodland of the Pahranagat region.

Birds on the BLM sensitive species or NDOW species of concern lists that have been observed in mesquite woodlands in high numbers during migration include Golden eagle (*Aquila chrysaetos)*, Swainson's hawk (*Buteo swainsoni*), Yellow warbler (*Dendroica petechia*), Yellow-breasted chat (*Icteria virens*), MacGillivray's warbler (*Opororis tolmiei*), Gray vireo (*Vireo vicinior*), Orange-crowned warbler (*Vermivora celata*) and Wilson's warbler (*Wilsonia pusilla*). Mourning dove (*Zenaida asiatica*) and Gambel's quail (*Callipepla gambelii*) are common game species found in mesquite stands.

Small mammals that occur in the eastern Mojave Desert include approximately 12 species of bats and over 20 species of rodents. In addition to the bats listed in Appendix A, the BLM sensitive and/or NDOW state protected Allen's big-eared bat (*Idionycteris phyllotis, or Plecotus p.)*, Small-footed myotis (*Myotis ciliolabrum*), Long-eared myotis (*Myotis evotis*), Fringed myotis (*Myotis thysanodes*), Cave myotis (*Myotis velifer*), Long-legged myotis (*Myotis volans*), Yuma myotis (*Myotis yumanensis*), Big free-tailed bat (*Nyctinomops macroti* or *Tadarida m., T. molossa)*, Spotted bat (*Euderma maculatum*) are found. Common lagomorphs include black-tailed jackrabbit (*Lepus californicus*) and desert cottontail (*Sylvilagus auduboni*). Carnivores include coyote (*Canis latrans*), badger (*Taxidea taxus*), and kit fox (*Vulpes macrotis*). Mountain lion (*Felis concolor*) is rare, but is known to inhabit rugged mountain ranges in the area. Large herbivores include desert bighorn sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*).

Many reptiles occur in southern Nevada such as western whiptail lizard (*Cnemidophorus tigris*), side-blotched lizard (*Uta stansburiana*), and zebra-tailed lizard (*Callisaurus draconoides*). Common snakes include gopher snake (*Pituophis melanoleucus*), Mojave rattlesnake (*Crotalus scutulatus*) and red coachwhip (*Masticophis flagellum*).

The status and trends of most mesquite- or acacia-dependent species are generally poorly known. For most species, there is no information at all. For others (e.g. most avian species) general status information is available at regional or national scales. Densities in woodlands in Clark County have been determined over short time frames for some species (e.g. Phainopeplas), but these may not provide accurate long-term information.

4. General Human Uses

This section outlines in a general fashion the common human uses of and activities in or adjacent to mesquite and acacia woodlands in southern Nevada. The uses of and activities in specific woodland metapatches are discussed in a subsequent section.

<u>a) Mining</u>

On BLM-managed lands, solid and fluid mineral leasing is an authorized public use within the conditions defined in the LVRMP. Management direction as defined in the LVRMP is to allow for solid mineral leasing outside of disposal and administrative areas, riparian and natural springs areas, and Areas of Critical Environmental Concern or ACECs (LVRMP MN-1-b). Material sites (gravel pits) may be allowed in ACECs if they are located half a mile from Federal Aid Highways. Free use permits for materials may be issued to governmental entities within half a mile of federal and state highways and county roads. Fluid mineral leasing is allowed outside of disposal and administrative areas, and ACECs. Fluid leasing, subject to no surface occupancy, may be allowed in areas with important cultural, geological, and riparian resources, special status plant and animal habitat, administrative sites, special recreation areas, and ACECs (MN-1-g in the LVRMP). Holders of mine leases that predate the Wilderness Act are allowed exercise the rights granted by those leases in Wilderness Areas.

Active mines and claims exist in several acacia woodlands, especially in the Nelson, Empire, and Cottonwood Cove areas. Because acacia co-occurs with gypsum, there is the potential for gypsum mining, although no mines are currently known to occur in acacia woodlands.

b) Livestock

Commercial livestock ranching has existed in southern Nevada since the 1880s. However, many allotments were closed to future grazing according to specific directions identified in the LVRMP, and some "open" allotments are in the process of being closed and are not grazed. The allotments that remain open and intersect with mesquite or acacia woodlands include Flat Top Mesa, Jean Lake, Muddy River and Wheeler Wash. Clark County is in the process of acquiring the lease to the Jean Lake allotment. Open allotments under the Las Vegas BLM's direction are to be managed using the "selective management" approach. The Mesquite Community allotment, managed by Arizona BLM, is open and contains a small mesquite woodland. Grazing that existed prior to Wilderness Area designation is allowed to continue where it was occurring. Some illegal grazing has been reported in the Highland Mountains and Gold Butte.

c) Feral horses and burros

Several mesquite and acacia woodlands overlap Herd Management Areas (HMAs), including the Amargosa, Ash Meadows, Eldorado, Gold Butte, Johnnie, Muddy Mountains, and Wheeler Peak HMAs. Of these, the first three have an Appropriate Management Limit set at 0 burros or horses. Burros also frequent Rogers and Blue Point springs in the Muddy Mountains region and many springs in the Red Rocks region, including Red Springs in Calico Basin, the largest patch.

d) Rights-of-way

Existing or future utility rights-of-way pass through several mesquite and acacia woodlands in the Amargosa, Mesquite Lake, Indian Springs, Pahranagat, Muddy Mountains, Pahrump, Piute and Eldorado regions. All future applicants for utility rights-of-way will be encouraged to construct utility lines and pipelines within one of the designated corridors. ACECs are mandated rights-of way avoidance areas, except in designated corridors. Access and utility corridors may be used in Wilderness Areas if determined necessary.

e) Woodcutting

Some mesquite and acacia woodlands, especially adjacent to urban areas, have been exposed to moderate to high levels of woodcutting. Woodcutting is not allowed on NPS land, or in Wilderness Areas, and is only allowed by permit on BLM land, as long as it is consistent with managing healthy woodland communities. Signs have been posted to this effect at many woodlands on BLM lands; however, ongoing illegal logging (cutting of whole trees) and limbing (cutting of branches) has been documented in the Indian Springs, Muddy River, Muddy Mountains (Overton), and Pahrump regions. The patch of smoke trees in Lake Mead NRA also experiences illegal cutting (A. Newton, National Park Service, pers. comm.).

f) Historical/anthropological resources

Portions of several woodlands intersect with culturally significant areas. The Stump Springs woodland includes the site of a prehistoric camp and a section of the Old Spanish Trail and is eligible for nomination to the National Register of Historic Places (see Myhrer et al. 1990). Many areas in the Newberry region are also culturally significant, especially Grapevine Canyon and Hiko Springs where petroglyphs occur, and Nelson, home to historic mines. Petroglyphs also occur in Calico Basin. Other woodlands occurring in areas of historical and cultural significance are largely managed by non-federal entities (e.g. Nevada State Parks, Clark County Parks, Las Vegas Valley Water District).

g) Recreational resources

Recreational activities within mesquite and acacia woodlands include hiking, biking, horseback riding, wildlife viewing, camping, hunting, trapping, recreational target shooting, and OHV use. Walking, horseback riding, and dirt biking in the woodlands adjacent to the urban areas continue to increase as these areas expand. Wildlife viewing is popular in Grapevine Canyon, in Overton WMA, and at Corn Creek. Hunting is common in woodlands because of the abundance of gamebirds, such as Gambel's quail and mourning dove.

OHV use is popular, especially in acacia woodlands that occur in washes, such as Hiko, Piute, and Gold Butte washes. OHV use includes both causal and permitted use, such as speed and non-speed events, within the restrictions of the LVRMP. Although the LVRMP limited OHV use in areas of some ACECs to designated roads, the designation process is not currently complete in Gold Butte, Mormon Mesa, and Coyote Springs. Without the enforcement authority of the designation process, casual OHV use continues to lead to the proliferation of trails. Once trails are designated in these areas, trail proliferation will only be minimized if there is adequate law enforcement, sign maintenance and trail restoration. Recreational OHV use is not permitted in Wilderness Areas; OHV use for commercial purposes is limited.

5. General Conservation Issues and Threats

The three main problems facing mesquite and acacia woodlands are habitat loss and fragmentation, degradation of habitat quality, and lack of mesquite and perhaps acacia recruitment. These issues may all lead to the listing of species under the Endangered Species Act (ESA), as “present or threatened destruction, modification or curtailment of species’ habitat or range” is one of five listing factors. Also, habitat fragmentation and degradation may lead indirectly to increases in predation or disease, another reason for listing species.

Habitat loss and fragmentation have been primarily caused by urban and agricultural development, followed by tamarisk encroachment and fire, and, at smaller scales, mining, gravel pits, and rights-of-way. Some of these threats may interact; for example, invasion by tamarisk, *Bromus* and *Schizmus* may increase fire intensity or frequency. Fire suppression activities also can change plant community dynamics, increase fuel loads, and lead to greater fire intensity or extent should a fire escape control. The potential of damage to utility lines by wildfires may induce right-of-way holders to clear vegetation from the right-of-way, resulting in loss of mesquite and acacia habitat, and degrading habitat quality.

Changes in groundwater levels also may lead to habitat loss, and almost certainly leads to degradation in habitat quality, as water-stressed trees may be shorter, have more but thinner trunks and support less mistletoe. If climate change leads to more frequent or severe drought, it may also cause habitat loss and degradation of habitat quality, particularly in acacia woodlands.

Habitat quality is degraded by any stressor that affects host plant growth form or mistletoe production. Other possible culprits are heavy grazing by horses, burros, cattle and wildlife, woodcutting, low-intensity fire, which can all cause trees to become smaller and multi-stemmed, and reduce mistletoe abundance. Soil compaction, due to heavy use by livestock, burros, horses, vehicles and pedestrians, can also influence tree and mistletoe growth via reduced water uptake.

Most of these issues similarly affect both mesquite and acacia woodlands. However, mesquite woodlands, due to their closer association with surface water, typically are more threatened by tamarisk invasion, woodcutting, conversion to agriculture, and water management than are acacia woodlands, which likely are more threatened by OHV use.

Although mesquite and acacia are renewable resources, in arid climates their germination and seedling establishment require a specific set of environmental factors, which results in infrequent and episodic recruitment, and many of the above stressors may exacerbate naturally low host tree recruitment. Seeds may fail to establish due to soil compaction by vehicles, large mammals, and heavy foot traffic; these same agents might crush young saplings. Competition from native and non-native plants may also hamper establishment. The net effect of herbivory by wildlife, cattle, burros and horses on woodlands is more complex; these animals may kill young saplings and mistletoe, and stress older trees by grazing, but may also be important seed dispersers assisting in germination. Finally, reduced groundwater levels or increased drought may limit recruitment in many woodlands.

In Table 8, these potential threats are summarized, with an indication of whether they are likely to lead to habitat loss and fragmentation, degradation of habitat quality, or lack of recruitment (see also Figure 4). They are ranked by the projected severity of their impacts, should that threat occur in a given woodland. This ranking is based on the typical areal extent of woodland that is affected (few or many hectares); the intensity (e.g. does it kill trees or affect their structure), frequency, and duration of the impacts of the disturbance; and the reversibility of the impacts (e.g. regenerates naturally, requires intense restoration, not reversible). Note that the degree of impact of many of these threats are somewhat speculative, and should be investigated more rigorously (these cases are indicated with a *).

Table 8. Potential threats to mesquite and acacia woodlands with presumed impact, ranked by severity of impact should they occur (see text). The numbers in the Impact column refer to whether the threat is likely to cause habitat loss and fragmentation (1), degradation of habitat quality (2), or lack of recruitment (3).

Threat	Impact	Severity
Urbanization	1, 2, 3	Severe
Water development/management	1, 2, 3	Severe
Exotic plants (direct threat from tamarisk, indirect from brome)	1, 2, 3	High
Fire	1, 2, 3	High
Conversion to agriculture	1	High
Livestock (browsing/trampling by cattle, burros, horses)*	2, 3	Moderate
Woodcutting*	2	Moderate
Construction/proliferation of roads and rights-of-way (including casual OHV)	1, 3	Moderate
Use and maintenance of roads and rights-of-way (including OHV)*	2, 3	Moderate
Construction of mines, gravel pits etc.	1, 3	Moderate
Use and maintenance of mines, gravel pits etc.*	2, 3	Moderate
Other recreation (e.g., camping, hiking, hunting)*	2, 3	Low

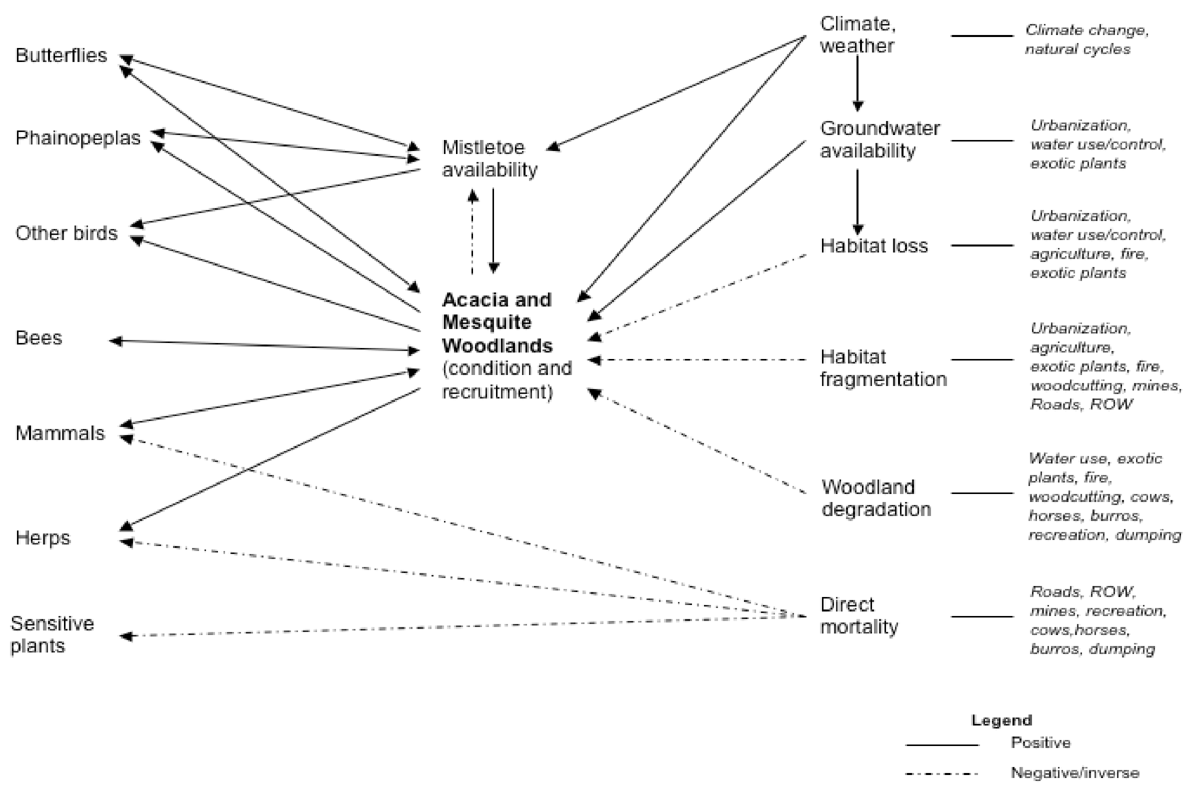

Figure 4. Conceptual model relating natural and anthropogenic factors that affect the extent and condition of mesquite and acacia woodlands in southern Nevada.

In addition to affecting habitat size and habitat quality, many of the above threats directly impact woodland-associated species, and could lead to species' listing under ESA listing factor #5 (other natural or manmade factors affecting the species' continued existence). Plants, bird nests, and small/slow-moving animals may be disturbed or destroyed by fire, vehicles (during and after construction of roads, rights-of-way, and mines), horses, burros, cattle, trash dumping, or pedestrians. These agents may also raise stress levels, which could lead to increased incidence of disease (ESA listing factor #3), or interrupt important behaviors (such as foraging or breeding) of many species. Air pollution can stress many plants. Many woodland-associated animal species are not adapted to use tamarisk (e.g. for foraging or nesting), should it replace mesquite. Also, fragmentation of woodlands by roads, and the presence of nearby urban developments both may increase the risk of predation to many wildlife species from human commensals such as feral cats, dogs, Common Ravens, and Brown-headed Cowbirds; they also increase commercial collection activities. Additionally, many species already exist in small, highly isolated populations with low genetic diversity, and so are more susceptible to extinction from stochastic events; anthropogenic fragmentation increases this risk. Appendix A summarizes the threats faced by individual species.

6. Major Woodland Regions and Metapatches in Clark County: Status and Threats

In this section, we briefly describe the regions in Clark County in terms of the land management and condition of their major (largest and/or most biologically significant) woodland metapatches. Woodlands outside Clark County are not discussed.

<u>a) Pahranagat</u>

Major metapatches: Muddy River (920 ha), Arrow Canyon (125 ha).

Land management: Private, BLM (some ACEC, WA), Tribal.

Human uses: Roads, rights-of-way, grazing (private land), camping, casual OHV, hunting, illegal woodcutting.

Threats: Urbanization, conversion to agriculture, water diversion, fire, exotics, and all above human uses.

This region comprises some of the most significant remaining mesquite and acacia woodlands in southern Nevada, in terms of area, biological diversity, and wildlife use, especially in the Warm Springs area. Land management in the Muddy River metapatch, the largest mesquite-dominated metapatch in Clark County, is a combination of private (529 ha), BLM (327 ha), and Moapa Tribal Enterprises (MTE; (Figure 5). This metapatch contains the largest (~700 ha) remaining patch (Warm Springs) of continuous mesquite in the county. A large number of animal species have been recorded in this patch, including several covered species such as Yellow-billed Cuckoo, Vermillion Flycatcher, Phainopepla, and Blue Grosbeak, some of which have a limited distribution in Nevada. This fauna likely reflects the wide variety of riparian tree (including cottonwoods and willows) and other plant species, diverse habitat structure, and presence of flowing surface water in this patch. Mistletoe is also abundant. Breeding success of Phainopeplas is higher and more consistent in this patch than in other patches in southern Nevada (Crampton 2004). This patch, which is largely privately owned, should be a cornerstone of any conservation strategy for fragmentation-sensitive, mesquite-dependent species, and major efforts should be made to attempt to acquire or otherwise ensure the protection of this patch. Substantial conservation attention should also be directed to the BLM-owned portions (~ 80 ha) of this patch. Cattle and horse grazing is often heavy in the private portions of this patch; hunting occurs rarely. Tamarisk has invaded the riparian sections of this patch. Fire may be promoted by the presence of Washington palms on private land. Another major potential threat is local and upstream water diversion. Southern Nevada Water Authority (SNWA) has applied to withdraw water from the Muddy River, and is investigating the feasibility of pumping groundwater from Coyote Springs Valley, in both cases for use in Las Vegas. Concerns have been expressed that upstream water development for this project and others will impact the availability of ground and surface water in the Muddy River system.

The remaining portions of this metapatch consist of smaller woodland patches dotted along the Muddy River, Meadow Valley Wash (mostly mesquite in both cases) and SR 168 (mostly acacia). Land ownership along the Muddy River is mostly private or MTE, except for a patch on the south side of the Muddy River near California Wash that is owned by the BLM. The BLM manages most of the land along SR 168 and in Meadow Valley Wash. Of these woodlands, Meadow Valley Wash is best known, as it was the site of intensive work by Krueger (1998,

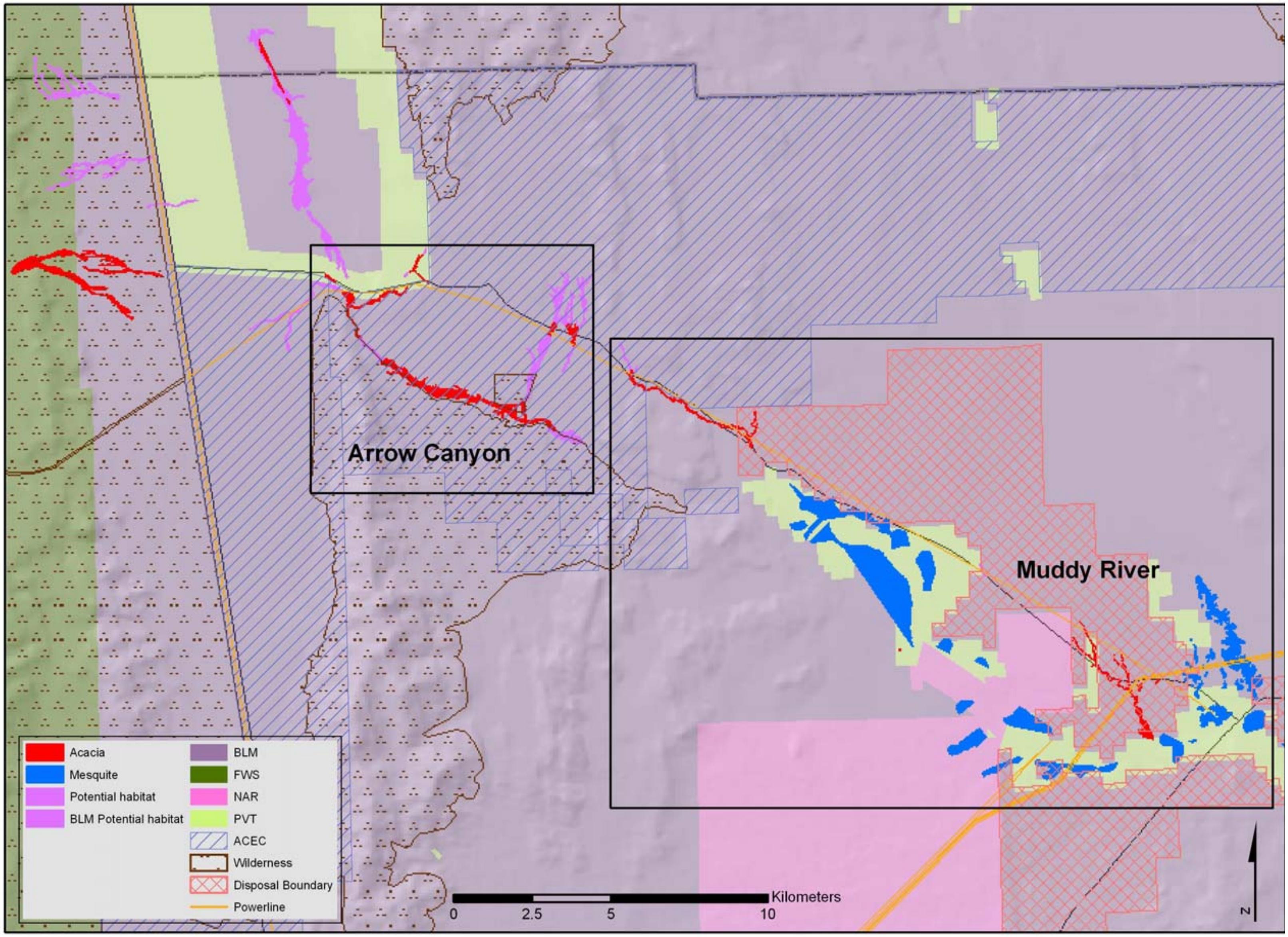

Figure 5. Major mesquite and acacia woodland metapatches, and land ownership and management, in the Pahranagat region**.**

1999) in the mid to late 1990s, and by Crampton (2004) in 2001-2003. Much of this woodland burned in the early 1990s. Of the remaining 49 ha, approximately one-half is comprised of short shrubby plants that are apparently stressed; the causes of the stress are unknown, but could include lack of water, former grazing or poor soils. The other half supports a relatively open grove of large, mature trees that are 100+ years old. In the mid-1990s, tree recruitment appeared to be low, with no evidence of seedlings and very few saplings. Approximately half of the trees were infested with mistletoe, with less than 10% heavily infested (Krueger 1998). Although mistletoe production was very high in this patch in 1996-1997 (Krueger 1998), it was very low from 2001-2003 (Crampton 2004), and much of the mistletoe appears to be dying. Phainopeplas did not breed there in 2001-2003, although 12-16 pairs had bred there in the mid 1990s. Approximately 35 acres of mesquite woodland in Meadow Valley Wash occur within the Moapa/Glendale land disposal area designated in the LVRMP. Heavy unauthorized woodcutting occurs in this patch, along with casual recreational use, especially camping and OHV. Tamarisk has invaded the more riparian patches. The risk of fire is increased by camping and the presence of utility lines, the corridors beneath which may be cleared to minimize this risk. Two major potential threats to all of these patches are urbanization and water extraction. A new urban development planned at the I-15 Moapa interchange may impact woodlands both directly through habitat loss, and indirectly via ground and surface water usage (see above paragraph).

The other large metapatch, Arrow Canyon, is an acacia-lined wash south of and paralleling SR 168, beginning a few km east of the junction with US 93. If the potential habitat digitized by the BLM and UNR for this area is corroborated by groundtruthing, then this metapatch and the Muddy River metapatch will be connected, forming one very large metapatch. The Arrow Canyon metapatch is on BLM land, mostly in the Mormon Mesa ACEC, and partly in the Arrow Canyon Wilderness. The acacia in this area is distributed in narrow bands on either side of the wash and mostly bears little mistletoe; Phainopeplas are uncommon there. The main threat to this metapatch is the above-mention plans for water development in Coyote Springs Valley; occasional casual OHV use is a mild threat.

b) Muddy Mountains

Major metapatches: Overton (144 ha), Roger's Spring (86 ha).
Other metapatches: Las Vegas Bay (147 ha), Muddy Mountain South (173 ha), California Wash (41 ha), Hwy 40 (41 ha), Sunrise (47 ha).
Land management: BLM (some ACEC, WA, Recreation Management Area), Private, NDOW, Tribal.
Human uses: Roads, grazing, casual OHV, hunting, bird watching, illegal woodcutting.
Threats: Urbanization, conversion to agriculture, water management, fire, exotics, wild horses, burros, roads, grazing, OHV, illegal woodcutting.

With the exception of woodlands at Roger's and Blue Point springs, in the Dry Lake west of I-15 at US 93, and in Overton/Logandale, the woodlands in this region are dominated by acacia (Figure 6). They occur mostly on BLM land, but also on NPS and State of Nevada (NDOW and State Parks) land. Most of the woodlands in this area were only recently mapped and are less familiar to the authors of this document. There is also a large amount of potential habitat between the Sunrise and Las Vegas Bay metapatches, Muddy Mountain South and Roger's Spring metapatches, and California Wash and Highway 40 metapatches. If the presence of this habitat is corroborated, then each of these pairs of metapatches will be united in larger, single metapatches, for a total of three metapatches, and this region will contain the greatest total woodland area in southern Nevada.

Most of the acacia woodlands in these metapatches follow washes draining out of the Muddy Mountains. Those on the northwestern side (California Wash and Highway 40) are sparse and largely uninfected by mistletoe; Phainopeplas are rare except in Valley of Fire State Park (Crampton 2004 and pers. obs.). The woodlands are mostly managed by the BLM, although a few hectares cross Moapa Tribal Enterprises land. Main human uses in this area are camping, hiking, bird watching, and casual OHV use; likely only the latter poses a threat. Another potential threat is fire; the sale of fireworks near California Wash may increase this risk. Some of these woodlands are divided by highways or major roads.

The southern acacia washes of Muddy Mountain South, Las Vegas Bay, and Sunrise are sometimes moderately infected with mistletoe, sometimes uninfected. Tree density tends to be

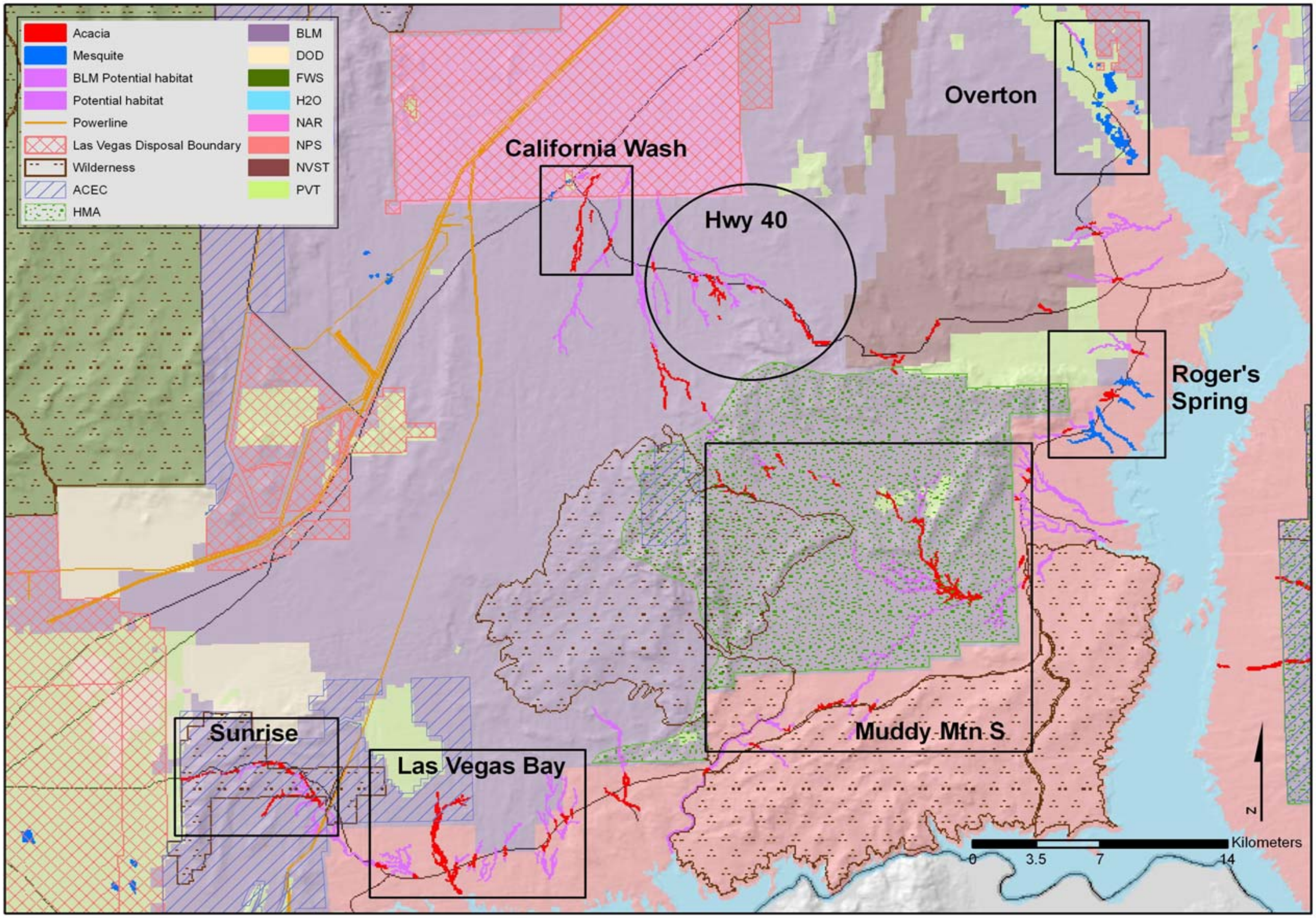

Figure 6. Major mesquite and acacia woodland metapatches, and land ownership and management, in the Muddy Mountains region.

low. Phainopeplas occasionally occur in these washes (Crampton, unpubl. data). Las Vegas bear poppy occurs in some woodland patches. The woodlands in these metapatches all occur on BLM or NPS land. All of the Sunrise metapatch falls in the Rainbow Garden ACEC, and most of it is in the Sunrise ISA. A few hectares of the Las Vegas Bay metapatch lie in the Rainbow Garden ACEC. The main human use is casual and organized recreation. Much of this region overlaps with the Muddy Mountain Special Recreation Management Area (SRMA), approximately one-third of which is managed for semi-primitive motorized recreation; the remainder is managed for non-motorized recreation. Some woodlands in this region occur in the Sunrise Mountain SRMA, which is closed to speed events; other events are regulated. Other woodlands occur in the Hidden Valley area, which is closed to OHV use. Also, the North Shore Road cuts through some washes. It is possible that water management might affect these woodlands, particularly those around Bitter Springs. There is also a community gravel pit in Government Wash in the Las Vegas Bay region, where some acacia occurs.

Both mesquite species and acacia occur near the springs in the Roger’s Spring metapatch, which is managed by NPS. Tree density is high along the streams emanating from the springs, but mistletoe infection is low, except on the acacias in the large wash between Roger’s and Blue Point springs. A pair or two of Phainopeplas may breed in this wash; they are otherwise uncommon in this metapatch. This area gets heavy burro use and human recreation, and may be affected by water development. Tamarisk had invaded here, but was eradicated by NPS.

The most significant metapatch in this area (more in terms of wildlife and size) is Overton. The woodlands are typically mixed honey mesquite/tamarisk/screwbean mesquite. Many (123 ha) occur on private land, but a small (20 ha) woodland of high wildlife value, Overton WMA, is managed by Nevada Department of Wildlife. This woodland contains tall, dense trees with moderate mistletoe infection, but the presence of surface water and other riparian trees attracts many birds, including the occasional Blue Grosbeak and moderate densities of breeding Phainopeplas. Frequented by primarily waterfowl hunters, this woodland (and others in the area) is also popular with bird watchers. Major threats to woodlands in this metapatch are urbanization, development and use of infrastructure, water development, recreation (including casual OHV), tamarisk encroachment, conversion to agriculture and fire.

c) Gold Butte

Major metapatch: Gold Butte SW (503 ha).

Other metapatches: Gold Butte NW (186 ha), Gold Butte E (266 ha), Virgin Mountains (75 ha).

Land management: BLM (ACEC, WA), NPS.

Human uses: Roads, rights-of-way, illegal grazing, casual OHV.

Threats: Fire, exotics, water development?, and the above human uses.

These metapatches were only recently mapped, and are not well known by the authors of this CMS. All are dominated by acacia and occur on BLM land, except for a few (40 ha) hectares of Gold Butte SW woodlands that are located on NPS land (Figure 7). Major portions of each metapatch, if not all (Gold Butte E), fall in the Gold Butte A, Gold Butte B and/or Virgin Mountains ACECs, and the Gold Butte HMA, which allows for a herd of 98 burros. Some parts of Gold Butte NW are in the Lime Canyon Wilderness. The acacia and mistletoe are typically sparse to moderate, although none of the acacia in the Virgin Mountains metapatch is infected. Phainopeplas are usually scarce, but in some places, such as Catclaw Wash, the acacia is more dense and infected and Phainopeplas are common. Roads and OHV use are main threats in this area; the backcountry byway bisects some major woodlands in Gold Butte NW. The Virgin Mountains metapatch overlaps open grazing allotments and illegal grazing occurs throughout Gold Butte. The fires of 2005 only affected a few hectares of acacia woodland, but changes in the fire regime due to invasion by weeds may put these woodlands at greater future risk. Should water development occur, it could affect the springs in the area (e.g., those springs close to the Virgin River).

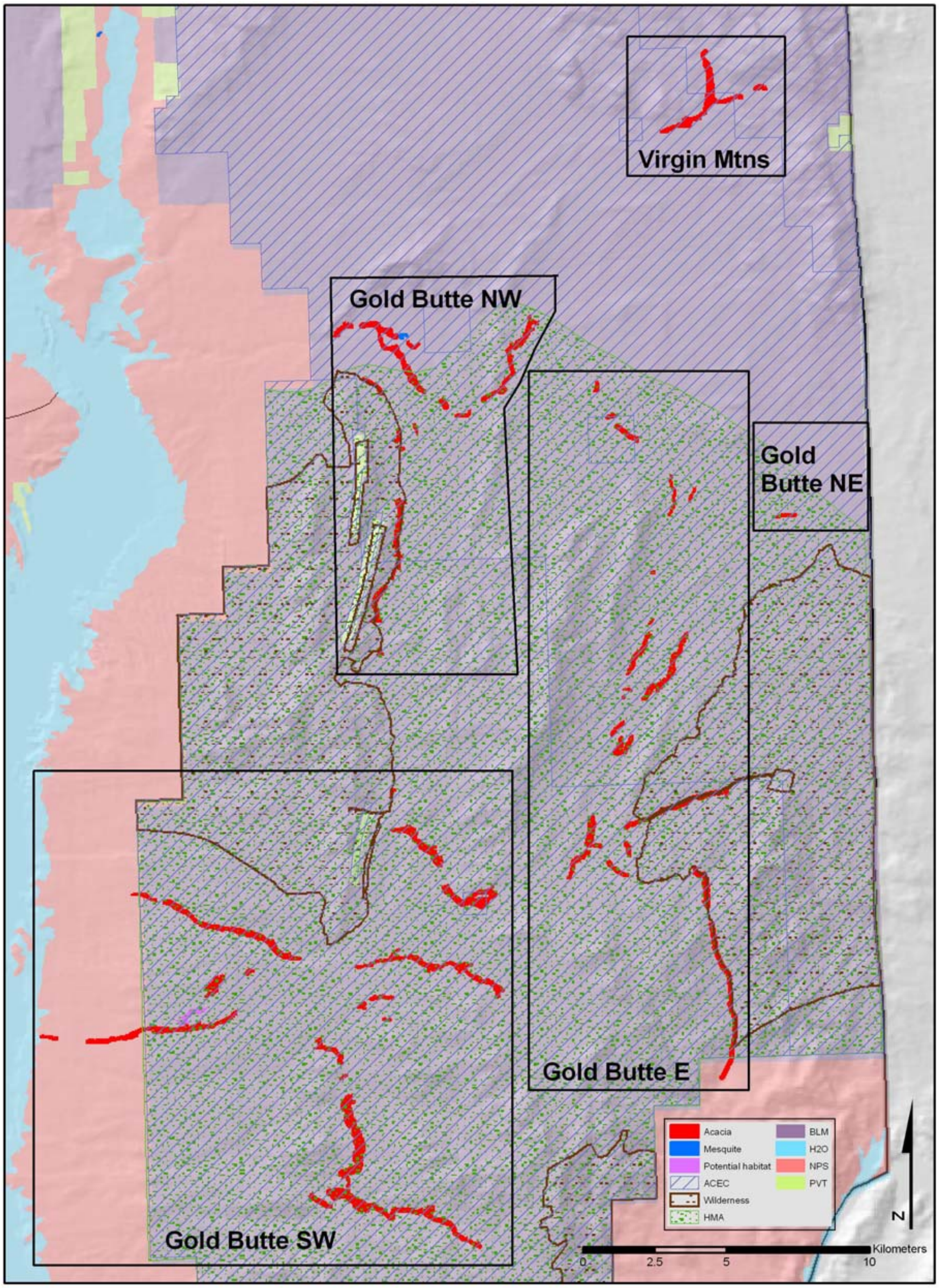

Figure 7. Major mesquite and acacia woodland metapatches, and land ownership and management, in the Gold Butte region

d) Virgin River

Major metapatches: Mormon Mesa E (75 ha) and Bunkerville (125 ha).

Land management: BLM, Private, NPS.

Human uses: Grazing, casual OHV, hiking.

Threats: Urbanization, conversion to agriculture, fire, exotics, water management, grazing, casual OHV use.

Mormon Mesa E and Bunkerville are both highly fragmented metapatches along the Virgin River (Figure 8). Woodlands in both metapatches are mostly BLM-owned (Mormon Mesa E: 64 ha, Bunkerville 119 ha), with a small amount of woodlands being privately owned (2 and 6 ha respectively. Also, 8 ha of woodlands in Mormon Mesa E are managed by the State of Nevada. Most of the woodlands that make up these metapatches are mesquite or mesquite/tamarisk dominated, but woodlands at higher elevations are usually dominated by acacia. Mistletoe infection ranges from sparse to heavy. Phainopeplas are in low to moderate numbers.

A major issue for these woodlands is water development and management. Some woodlands may have been heavily impacted by the floods of 2004-2005. Tamarisk invasion is also severe. Bunkerville woodlands are threatened by urbanization, grazing, and recreation activities, whereas Mormon Mesa E is more remote, and likely less threatened. Some cultivation of crops along the Virgin River also occurs in the Bunkerville area. This area will be covered in the Virgin River CMS, so conservation objectives and actions for woodlands in these metapatches should be consistent in the two strategies.

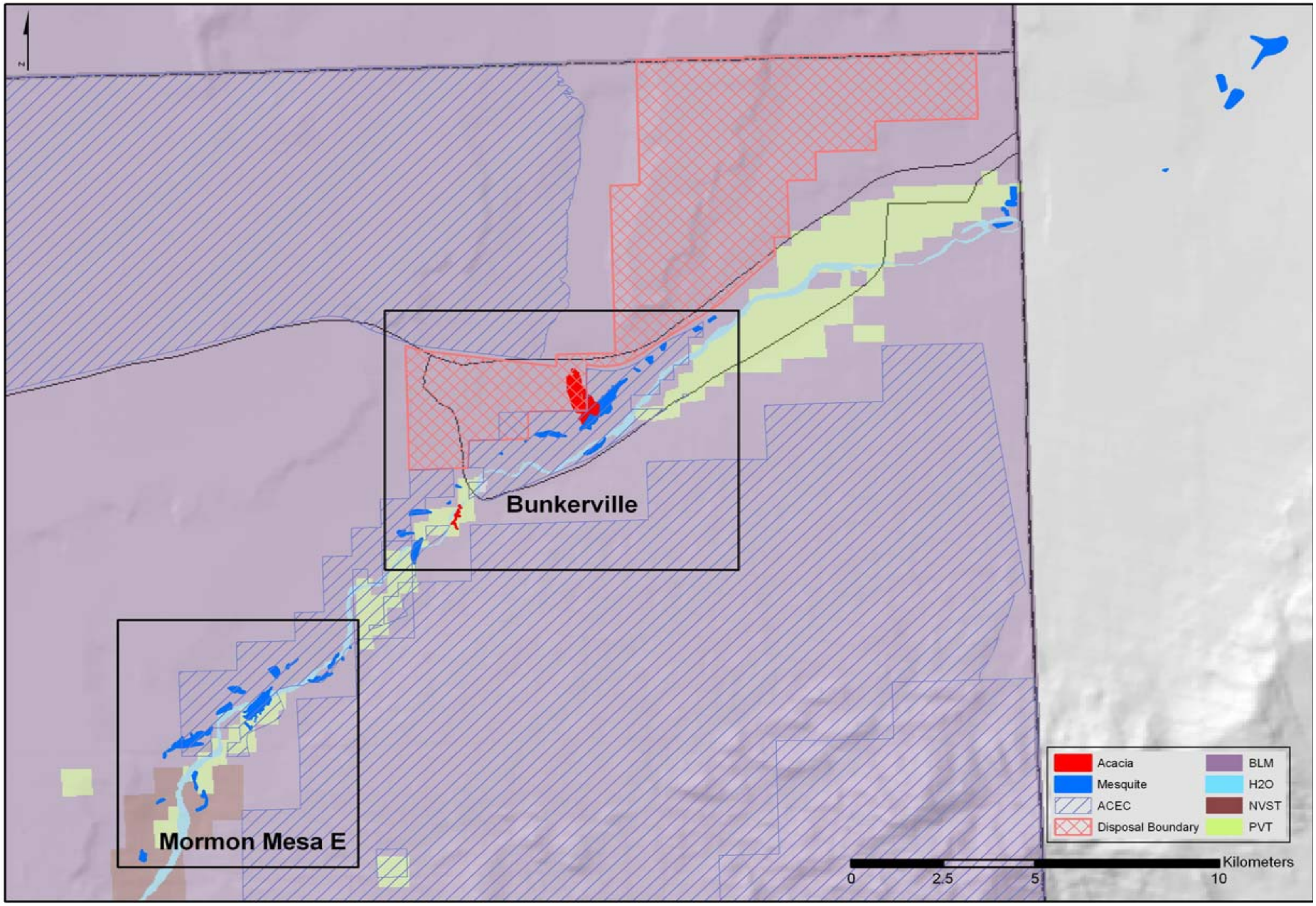

Figure 8. Major mesquite and acacia woodland metapatches, and land ownership and management, in the Virgin River region.

e) Las Vegas Valley

Major metapatches: North Las Vegas (388 ha), Las Vegas Wash (52 ha).

Land management: BLM, Private, Clark County, State of Nevada.

Human uses: Roads, rights-of-way, casual OHV, hiking, birdwatching.

Threats: Urbanization, fire, exotics, water development, roads, rights-of-way, casual OHV use.

Although there are two major metapatches in the Las Vegas Valley, only one occurs on federal land: the North Las Vegas metapatch, most of which was slated for land disposal by the BLM's LVRMP (Figure 9). Originally approximately 1200 ha in area, more than 800 ha of this metapatch have already been converted into urban uses since the mid-1990s, shown in yellow in Figure 9. Much of the remainder (the parcels east and west of the Aliante community) was sold at auction in November 2005; it is expected that development will not commence on this project for at least one year. However, because both the Las Vegas bear poppy and Las Vegas buckwheat occur in and near portions of this metapatch, approximately 120 ha of land east of Clayton Street and south of Grand Teton Drive have been set aside as a Conservation Transfer Area (CTA). Some of the CTA, which may eventually expand to the northwest towards Corn Creek to encompass over 1000 ha of land, overlaps acacia woodland. The acacia in the CTA mostly does not appear to provide good Phainopepla habitat, as it is short, sparse, and lightly infected with mistletoe, whereas much of the acacia in the disposal boundary is tall, dense, and heavily infected. Phainopeplas in the latter area are quite numerous and have moderate breeding success. Previously, heavy recreational use (OHV and paintball), camping, and some illegal woodcutting threatened the woodlands in this area, but these activities have lessened or ceased since urban development began in 2001. As urban boundaries encroach, the CTA may see an increase in foot traffic, and domestic and feral animals, and perhaps even some OHV use. Other threats include water management activities in the wash. A major powerline runs along the north end of the area.

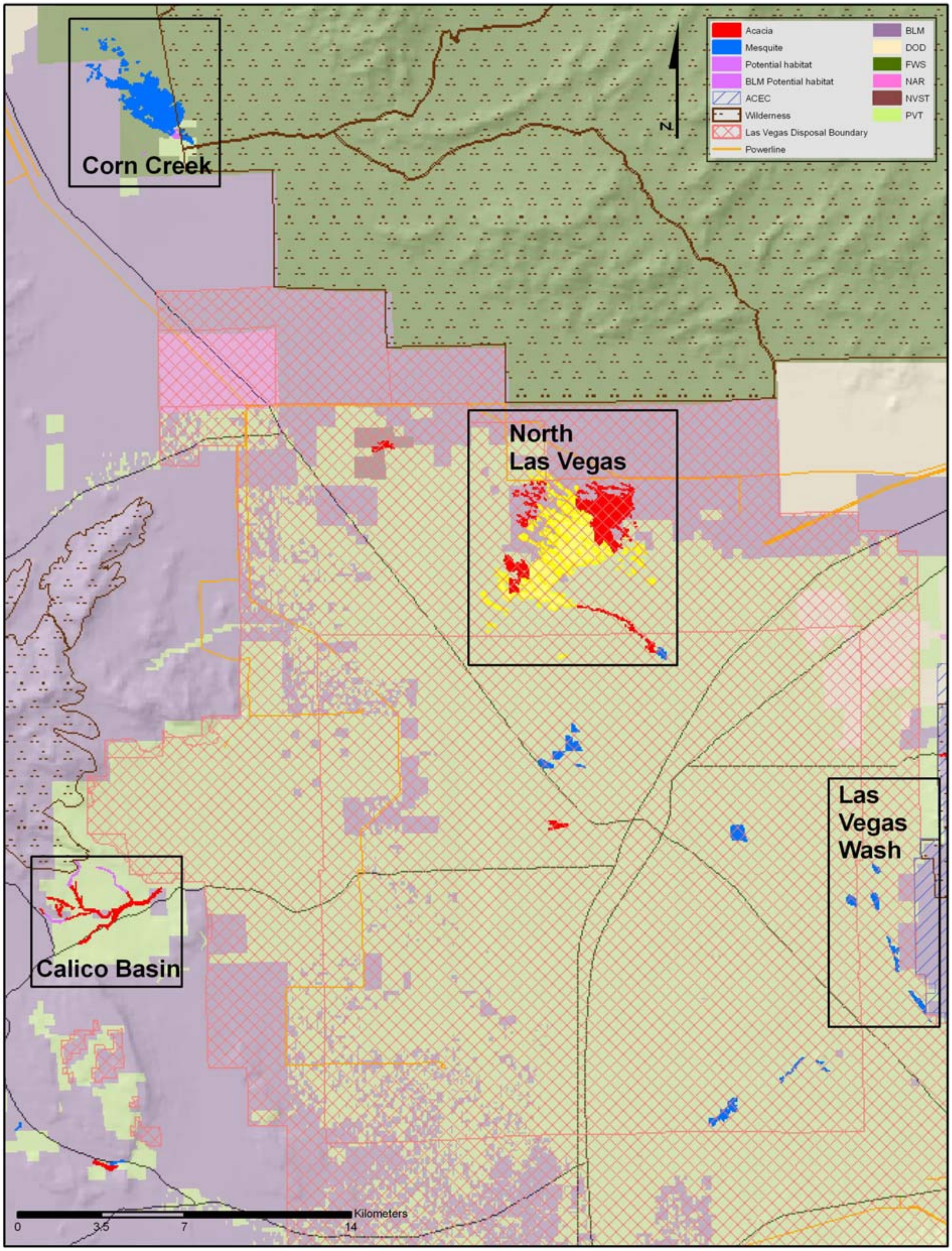

Figure 9. Major mesquite and acacia woodland metapatches, and land ownership and management, in the Las Vegas and Corn Creek regions.

The Las Vegas Wash metapatch consists of several small woodland patches dominated by mesquite and/or tamarisk, including the Wetlands Park. These woodlands do not support much mistletoe, and Phainopeplas are not common. They are frequented by birdwatchers, however. Major threats are urbanization, fire, invasion by exotics, and water development.

f) Eldorado

Major metapatches: Nelson (298 ha), SR 165 (237 ha).

Other metapatches: Eldorado (139 ha), Highland E (108 ha), Highland (87 ha), Highland S (80 ha), McCullough N (75 ha), McCullough S (86 ha), Nipton (204 ha).

Land management: BLM (some ACEC, WA, SRMA), Private, NPS.

Human uses: Roads, rights-of-way, legal and illegal grazing, casual and organized (including speed events) OHV, hiking, mining.

Threats: Urbanization, fire, exotics, and all the above human uses except hiking.

This region encompasses several metapatches west of US 95 in Eldorado Valley and the Highland and McCullough Mountains, and east of US 95 in the area near Nelson (Figure 10). The largest metapatches, Nelson and SR 165, may become one large metapatch (of > 800 ha) if the presence of potential habitat between them is corroborated. A large amount of potential habitat also exists in the Wee Thump area (up to 1200 ha). Furthermore, NDOW has indicated that there are more woodlands in washes on both sides of the McCullough and Highland mountains, and on the east side of the Ireteba Mountains that should be mapped.

All of the woodlands in the Eldorado region are dominated by acacia, although a few mesquites occurs at some springs. In most cases, tree density and mistletoe infection are low, but in a few woodlands (e.g. Techaticup Wash, Highland and Highland E), mistletoe is moderately abundant. Phainopeplas occur in small numbers in many woodland patches, and breed in some. This area is mostly managed by BLM, although Techaticup Wash runs into the Lake Mead NRA, and a few woodlands occur on private land. Many hectares of woodlands in the Highland and McCullough mountains are in the Piute-Eldorado ACEC and in the Boulder City Conservation Easement. Some of the SR 165 metapatch also falls in the latter. Most of the McCullough Mountain woodlands are within the boundaries of the Wilderness Area.

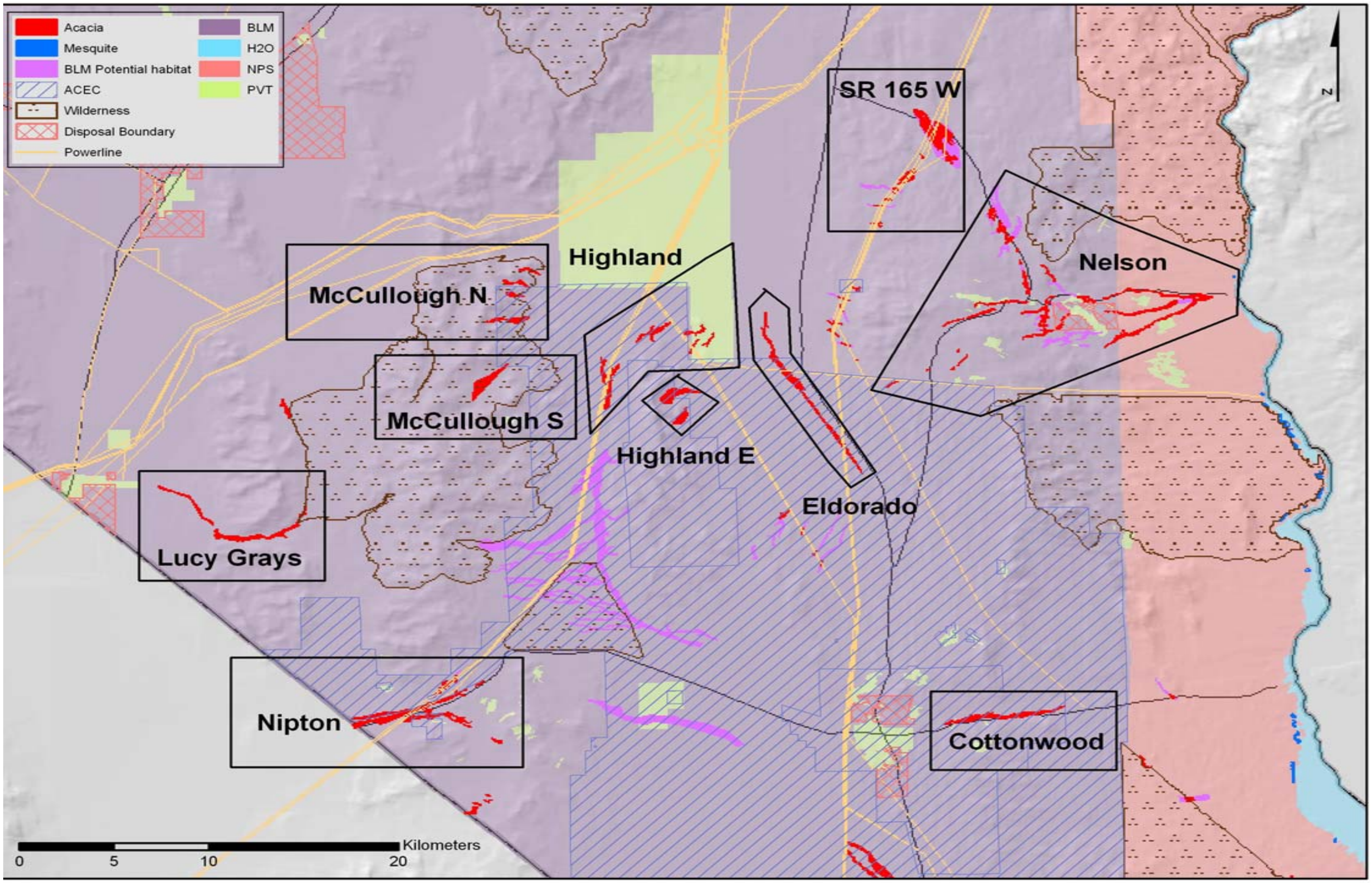

Figure 10. Major acacia woodland metapatches, and land ownership and management, in the Eldorado, Nipton, and Lucy Gray Mountains regions.

Much of the west side of this area is remote and does not experience much human activity, other than that associated with the right-of-way corridors, which will lead to ongoing disturbance of these woodlands from utility companies and OHV users. The Nipton metapatch falls in the open Jean Lake grazing allotment (currently the sale of this permit to the county is being negotiated); cattle stray from this allotment, therefore illegal grazing occurs west of the Highland range. Near Nelson, where the landownership is BLM (142 ha), NPS (138 ha) and private (18 ha), there is more human activity including mining and recreation (OHV, hiking, caving). Most of the woodlands in the region fall within the Nelson Hills/Eldorado Special Recreation Management Area, in which competitive OHV events (including a maximum of nine speed events yearly) are permitted on existing courses, with some restrictions designed to protect desert tortoises. The main threats in this region are OHV use, mining, fire, urbanization and grazing.

<u>g) Piute</u>

Major (only) metapatch: Piute (1098 ha).
Land management: BLM (ACEC), California.
Human uses: Roads, rights-of-way, casual OHV.
Threats: Urbanization, fire, exotics, and the above human uses.

One extensive metapatch, Piute Wash, comprises this region (Figure 11). The wash runs north-south on BLM land for more than 40 km, approximately half of which is in California. Acacias in this wash are usually tall and occur thickly along the edges of the braided wash channels, which are often quite wide. Many trees are heavily infected with mistletoe and used to produce abundant berries; recently, however, mistletoe in some portions of the wash appears to have died off and the remainder is producing fewer berries (Crampton, unpubl. data). Desert tortoises and other reptiles are common in this wash. Phainopeplas are abundant to very abundant, and have poor to good breeding success (both abundance and breeding success depend on the section of the wash and the year; Crampton 2004). This metapatch is highly significant in terms of spatial extent, flora and fauna, especially the occurrence of Sonoran species, including smoke trees, which occur in the southern part of the wash. In the past, this area was grazed by cattle. Presently, the wash is intersected by several powerlines and roadways, including US 95, which passes over the wash on a low bridge. The roads and the wash are used by OHVs, including the

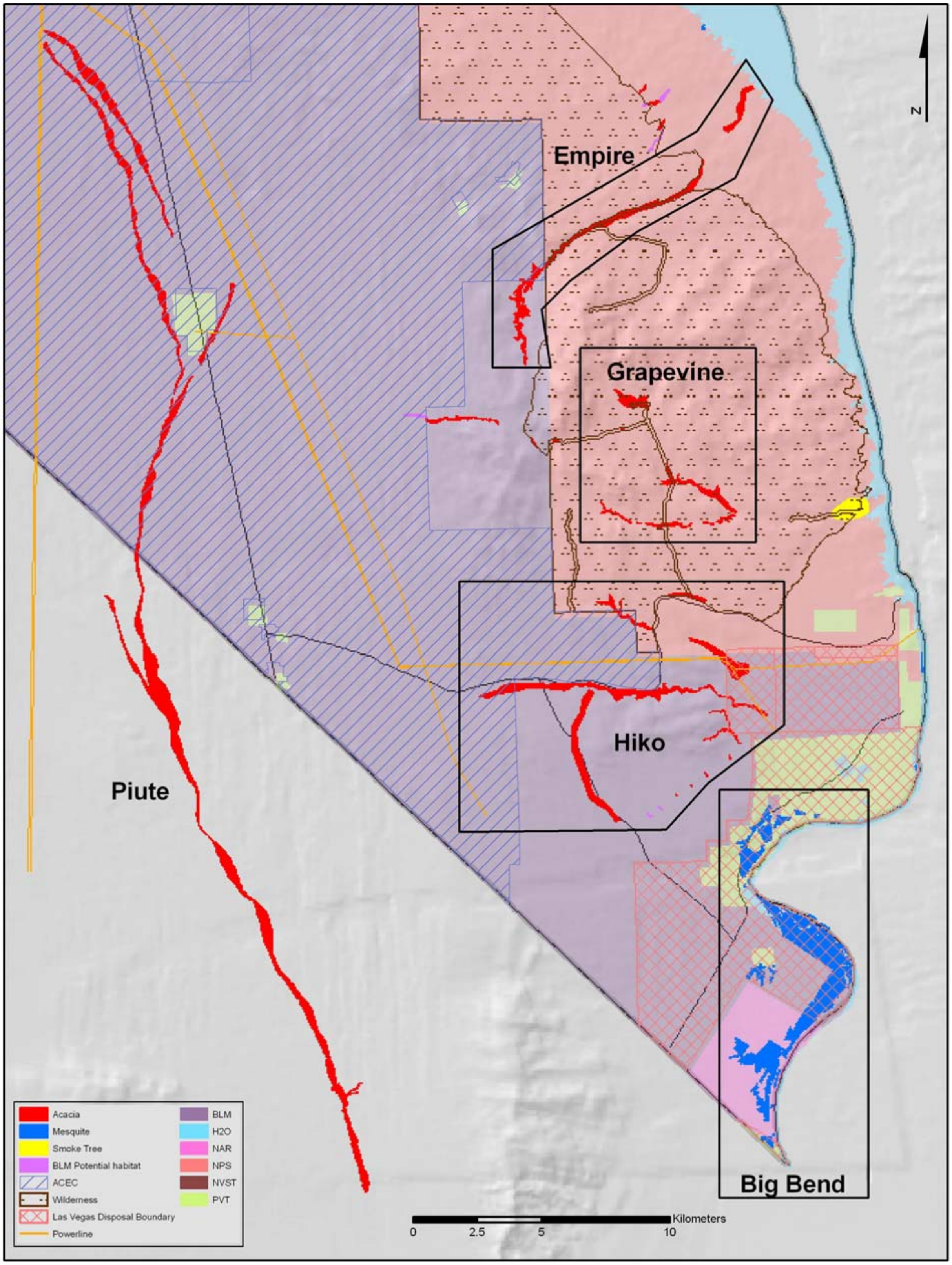

Figure 11. Major mesquite and acacia woodland metapatches, and land ownership and land management, in the Piute and Newberry regions.

sections that have been fenced off. Main threats are utility development and maintenance, OHV use, fire, and expansion of the small urban developments nearby. Ravens, which commonly use the power lines for perching, may prey on bird nests and reptiles.

h) Newberry

Major metapatches: Big Bend (736 ha), Hiko (433 ha), Grapevine (142 ha).

Other metapatches: Empire (214 ha).

Land management: BLM (some ACEC, WA, some SRMA), NPS, Private, State of Nevada.

Human uses: Roads, rights-of-way, casual and permitted (including speed events) OHV, mining, hiking, camping, bird watching.

Threats: Urbanization, water management, conversion to agriculture, fire, exotics, roads, rights-of-way, mining, heavy OHV use.

This region includes some of the most significant metapatches in southern Nevada: the mixed mesquite/tamarisk woodlands in the Laughlin/Fort Mojave area (Big Bend metapatch) and some of the acacia-lined washes in the Newberry Mountains (Figure 11). The largest metapatch, Big Bend, is a collection of mesquite or mesquite/tamarisk (both honey and screwbean mesquite) woodland patches along, or just inland from, the Colorado River. Some of these patches occur on BLM land (416 ha), while others are in Big Bend State Park (68 ha), or the Fort Mojave Indian Reservation (205 ha) or private (43 ha) lands. Many woodlands fall under the auspices of Lower Colorado River MSCP, so conservation efforts for this metapatch should be coordinated with this plan. These patches support a high diversity of migrant and breeding birds, including abundant breeding Phainopeplas, Lucy’s Warblers, and Abert’s Towhees. Bell’s Vireos have been detected here (Crampton, pers. obs.). The vegetation in these patches is tall and dense, and in many places supports abundant mistletoe. Just south of Big Bend State Park, cottonwoods and other riparian overstory trees grow close to the river. This woodland is very popular with campers who often stay for weeks, despite the lack of facilities; their activities may increase the risk of fire. Woodcutting has been observed here, but only of tamarisk and dead mesquite. This area is at risk of urbanization, occurring within a disposal boundary. Further south, the Fort Mojave land is a checkerboard of alfalfa fields and mesquite/tamarisk woodlands; it is not known whether the tribe plans to expand their agricultural activities. Recently, a casino was built on this land; future related developments may lead to the clearing of mesquite. In these woodlands, Crampton (2004) observed the highest densities of Phainopeplas of her extensive survey. Water management projects on the Colorado River may pose an additional threat to this metapatch.

Three acacia metapatches --Hiko, Grapevine and Empire -- are significant in area, biological diversity, and sensitive species. The Hiko metapatch consists of 355 ha of BLM land, mostly in Hiko Wash, and 79 ha of NPS land along the southern edge of the Lake Mead NRA. The acacia in Hiko Wash is sparse and uninfected at the western end, which is in the Piute-Eldorado ACEC, but becomes dense and highly infected in the eastern end near Hiko Springs. This woodland attracts high numbers of birds because of the presence of springs and large cottonwoods at the eastern end. Some of the greatest numbers of mistletoe berries and Phainopeplas of Crampton's (2004) surveys were observed in this woodland in the early 2000's, but recently numbers of both seem to have dropped (Crampton, pers. obs.). Hunters and campers use the area near the springs, which is also home to petroglyphs, so gets some recreational viewing activity. The far east end of this metapatch, beyond the spring, is included in LVRMP land disposal. There are many threats to BLM portions of this metapatch, including heavy and frequent OHV use, such as sanctioned speed events, in the western end of the wash; the Laughlin Special Recreation Management Area overlaps Hiko Wash and the washes to the south and east, allowing for limited OHV events when the LVRMP was approved. The wash was divided in two by an active Nevada Department of Transportation gravel pit, which is used as a staging area by causal and permitted OHV activities. Other main threats include tamarisk invasion (some is growing near the spring despite eradication efforts). Water development for nearby Laughlin may negatively affect the spring. The NPS-owned portions of this metapatch are at lower risk from these threats.

The Grapevine metapatch includes the woodlands in Grapevine and Sacatone washes in the Lake Mead NRA. The acacia is generally sparse these washes, but occasionally occurs in more dense, well-infected patches that support breeding Phainopeplas. These washes have above-ground water much of the year, thus support tree species other than mesquite and acacia (e.g. willow and cottonwood) and high biological diversity, including several lizard species (like Chuckwalla, a covered species) and some rare plants. Petroglyphs were left in Grapevine Canyon. The main threats in these woodlands are fire and foot traffic from hikers and birdwatchers.

The Empire metapatch is made up of the acacia woodland running along two interconnected washes. In the upper, southern, Roman Wash, which is managed by BLM, the acacia is more dense and is more infected with mistletoe than in the lower Empire Wash, managed by NPS. Where the wash meets the river, tamarisk occurs. Breeding Phainopeplas are abundant (and have poor-moderate breeding success) in the upper end, but are scarce in the lower end. Chuckwallas, horned lizards, and leopard lizards have all been observed. These washes are somewhat remote, but nonetheless are occasionally used for OHV recreation and hunting; a road runs down the middle of the washes. Many mine claims have been staked throughout this woodland; a large, mine is active in southern Roman Wash.

<u>i) Corn Creek</u>

Major (only) metapatch: Corn Creek (397 ha).
Land management: FWS.
Human uses: Horseback riding, hiking, bird watching.
Threats: Water management, fire, exotics, heavy foot traffic.

The Corn Creek region consists of a single metapatch at Corn Creek in the Desert Wildlife Range, managed by FWS (Figure 12). Most of the woodlands in this area are scrubby dune honey mesquite with little mistletoe, but close to the springs at Corn Creek, they attain a tree-like growth form. The presence of water and riparian and fruit trees in this area greatly increases its value for wildlife. Phainopeplas are uncommon except near the springs, where they are common but not abundant, and which is one of the few places they occur into the summer. Past activities have included farming and ranching. Recreation, especially bird watching, is the main current human activity in this area. The main threat to this woodland is groundwater loss, although heavy foot traffic may cause soil compaction near the headquarters.

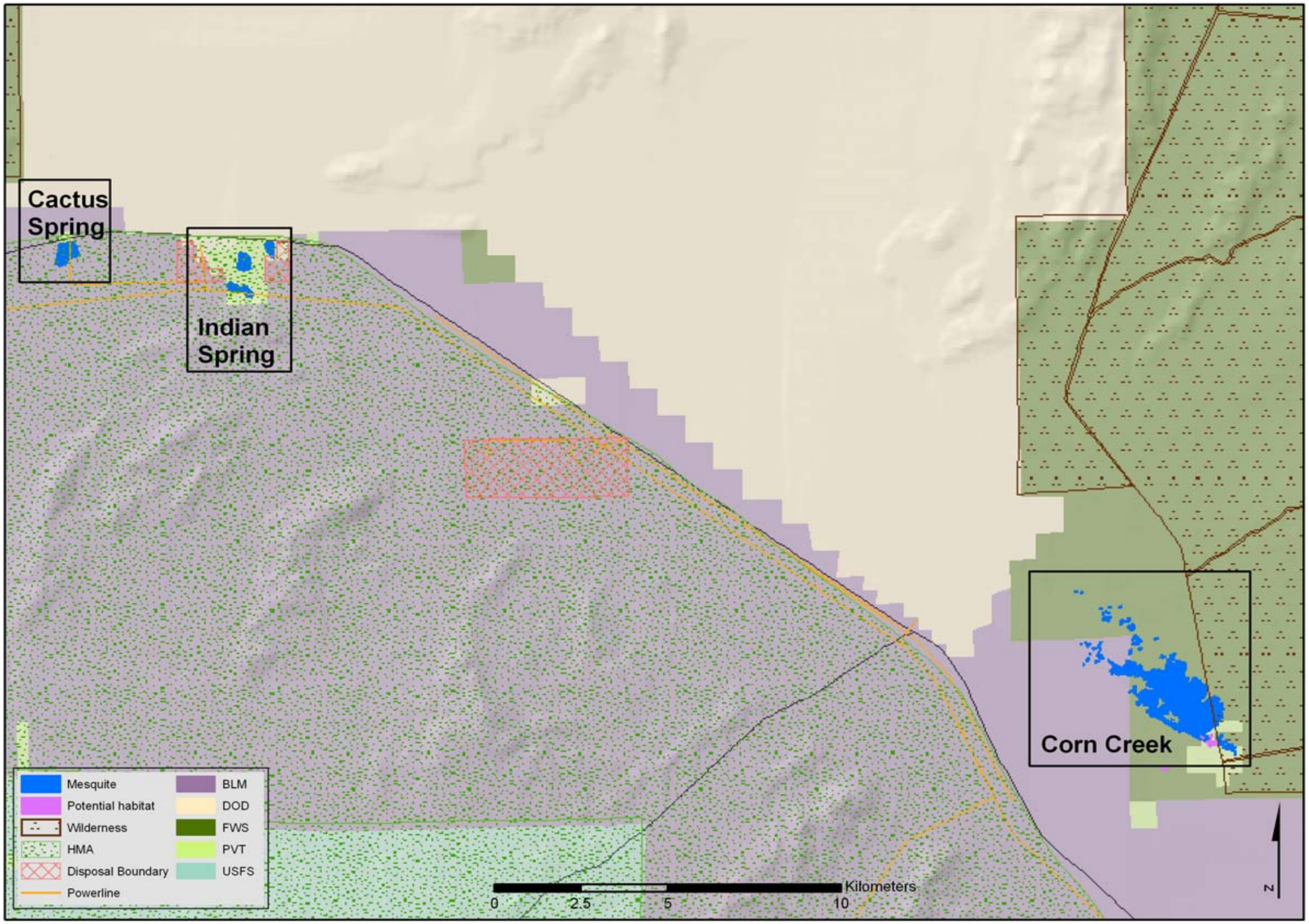

Figure 12. Major mesquite and acacia woodland metapatches, and land ownership and management, in the Corn Creek and Indian Spring regions.

j) Pahrump

Major metapatches: Pahrump (3661 ha) and Stewart Valley (528 ha).

Land management: BLM (some ACEC), private.

Human uses: Roads, rights-of-way, casual OHV use, camping, hiking, illegal woodcutting, dumping.

Threats: Water management, fire, exotics, roads, rights-of-way, OHV use, illegal woodcutting, dumping.

Most of the Pahrump metaptach occurs in Nye County (Figure 13), and will not be dealt with here (it is well-described in the draft mesquite HMP), other than to comment that most of the mesquite on BLM land (with the exception of the southeastern woodlands) does not support much mistletoe or many Phainopeplas despite the age and stature of the trees. However, the southern portion of this metapatch, known as Stump Spring, is in Clark County, off the Tecopa road. It is distinct from the rest of the region in topography, hydrology, soils and mesquite growth form. The Stump Spring area supports approximately 775 ha of mesquite, of which 135 ha occur on private land. Many of these woodland patches are comprised of shrubby dune mesquite; however, larger shrubs and trees grow along the deeply eroded wash. Recruitment is poor, with about 8% saplings, and no evidence of recent seedling establishment. Mistletoe infection at Stump Spring is low, with about 15% of trees showing light infection. Phainopeplas are uncommon. This area contains several widely spaced, remnant patches of cottonwood (*Populus fremontii* Wats.) and willow (*Salix goodingii* Ball), all of which are dead, dying, or in a state of severe stress, perhaps due to heavy groundwater use in the middle part of the last century in Pahrump area. Surface water once occurred at this site, and was documented in the diary of southwestern explorer John C. Fremont (Fremont 1845) who forged the southern Nevada portion of the Old Spanish Trail; a portion of the area has been designated an ACEC of cultural significance (Myhrer et al. 1990). Human activity in the area includes grazing (past) and recreation including camping. Trapping is a popular activity at Stump Spring. Main threats are groundwater loss, disturbance from recreation, increased risk of wildfire from campers, illegal woodcutting, and encroachment by tamarisk.

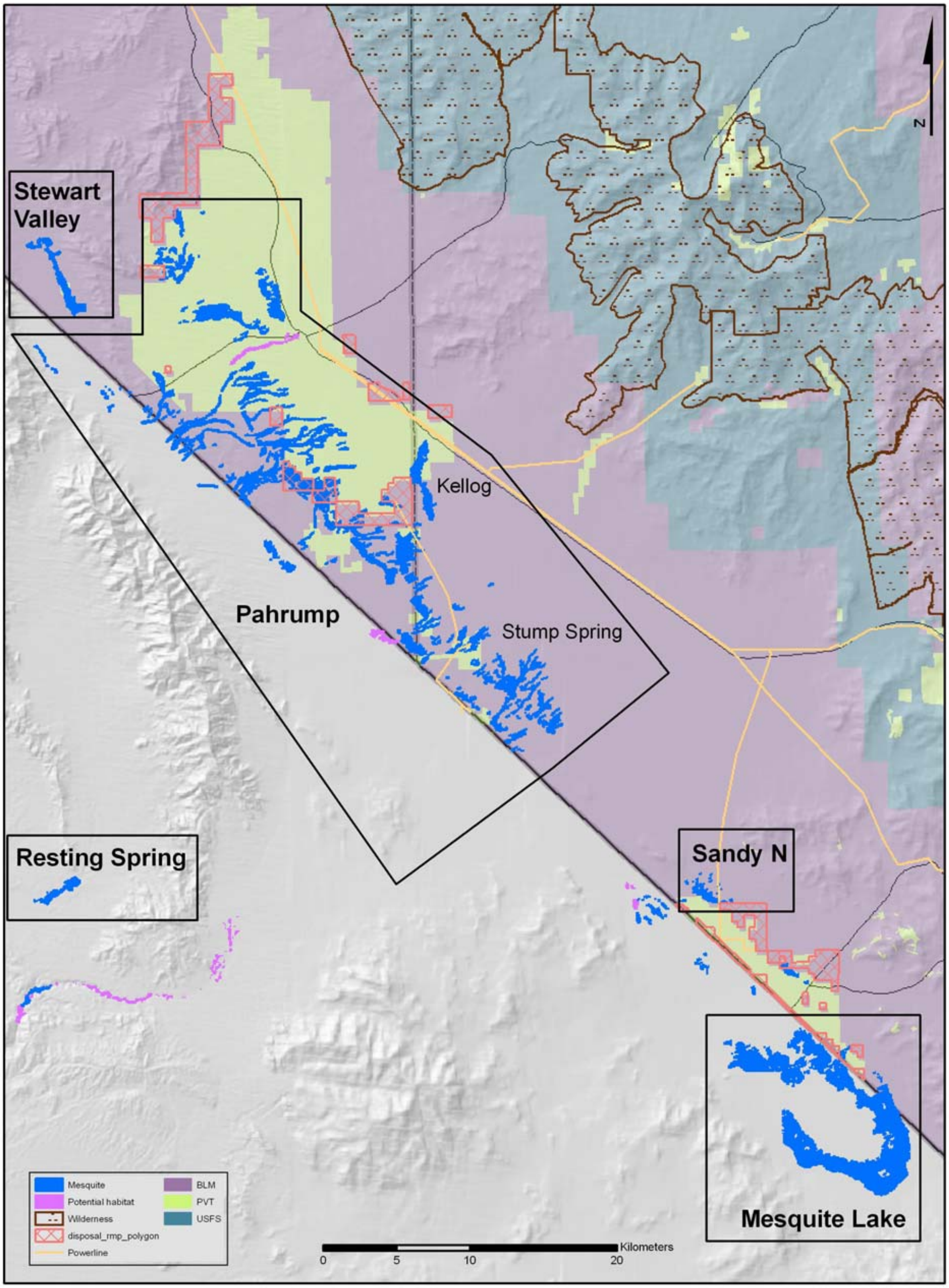

Figure 13. Major mesquite woodland metapatches, and land ownership and management, in the Pahrump, Tecopa, and Mesquite Lake regions.

Another biologically significant part of this metapatch occurs in Clark County, east of Haffenranch Rd and south of Kellog Rd ("Kellog"; Figure 13). The mesquite in the Kellog woodlands is tall, dense, and well-infected. Phainopeplas are abundant and have moderate or high breeding success. Human use of this woodland is heavy, including casual OHV use (which has led to trail proliferation), illegal woodcutting and dumping; all are threats. Water development threatens these woodlands.

k) Mesquite Lake

Major metapatches: Mesquite Lake (2789 ha) and Sandy Valley North (167 ha).

Land management: BLM, private.

Human uses: Roads, rights-of-way, casual OHV, grazing, hiking, water development.

Threats: Water management, fire, exotics, roads, rights-of-way, OHV, grazing.

Most of this large metapatch ringing the dry Mesquite Lake is found in California (Figure 13), and will not be discussed here, save to note that most of it does not support much mistletoe or many Phainopeplas (except around the water wells). However, some of the woodland patches occur near the town of Sandy, NV, on private and BLM land. The Sandy North metapatch is comprised of short, dense mesquite growing on sand dunes. Age class distribution is unknown; mistletoe infection is low. Phainopeplas occur in low-moderate densities near town. The rare Pahrump Valley buckwheat has been found here, on land identified in the LVRMP for disposal. Other than urbanization, other threats include groundwater loss (the dry lake is the site of numerous water wells) and recreation. The proximity of town and the power line that cuts through a few of the patches both increase the risk of fire. A fire in 2005 burned several hectares of mesquite.

l) Small regions (Lucy Gray Mountains, Indian Springs, Red Rocks)

Major metapatches: Lucy Grays (114 ha), Cactus Spring (34 ha), Indian Spring (42 ha), Calico Basin (42 ha).

Land management: BLM, private.

Human uses: Roads, rights-of-way, casual OHV use, illegal grazing, (heavy) hiking, camping, hunting, mining, depending on the region.

Threats: Urbanization, water management, fire, exotics, and the above human uses, depending on the region.

Managed by the BLM, the Lucy Gray metapatch (Figure 10) was only recently mapped and is not yet well studied. This metapatch is an acacia woodland of low-moderate tree density, but fairly heavy mistletoe infection. According to NDOW, many more woodlands occur in this area, some with Phainopeplas. The remoteness of this area likely buffers the woodlands from many threats, although mining and likely OHV use occur.

The major metapatches in the Indian Springs Region are Cactus and Indian Springs (Figure 12). All of the mesquite at Indian Springs occurs on private land and is highly fragmented. Mesquite at Cactus Springs occurs on both private and BLM land, and receives heavy human use from camping and recreational shooting. A powerline bisects the woodland. This woodland contains a spring with surface water, but the spring and riparian area are severely degraded from human use. Protective fencing installed in 2001 has decreased impacts from vehicles, and restoration efforts for the spring have yielded some results. The BLM also planted mesquite saplings on now-closed roads, with some surviving. The original mesquites are mostly tall and mature, but an estimate of age class structure is lacking. In the past, mistletoe infection was heavy, but most mistletoe now appears to be dead, due to unknown causes (Crampton 2004). Phainopeplas occur in low-moderate densities in the fall, but do not breed here.

Most of the mesquite and acacia in the Red Rocks region occurs in small patches and is not infected (Figure 9). The exception is the washes of the Calico Basin area, which support some mistletoe and breeding Phainopeplas. The riparian nature of this area also attracts many wildlife and burros. Some of this area is on private land and the remainder is managed by the BLM. Recent restoration efforts for other sensitive plant species appear to have displaced Phainopeplas, at least temporarily (Crampton, pers. obs.). The main threat in this area is urbanization, disturbance from recreation and perhaps water management.

CONSERVATION OBJECTIVES AND ACTIONS

A. Legal Framework

Conservation Management Strategies are required by Clark County's Section 10(a)(1) incidental take permit, and are intended to provide a prioritized array of proposed conservation actions that ensure the conservation of species and habitats and prevent future species listings. The following proposed conservation goals, objectives and actions thus are aimed at protecting mesquite and acacia woodlands, and those species, especially covered species, which depend on them. Furthermore, the CMS can and should build on the objectives and management directions of the various plans described in section B1 above that are relevant to mesquite and acacia woodlands in southern Nevada and to covered and other special status species. The conservation objectives and actions for mesquite and acacia woodlands described in this section draw on the literature, data and legal directives discussed in the previous two sections.

B. Desired Future Condition and General Conservation Goals

An ideal Desired Future Condition would be to restore all extant and restorable mesquite and acacia woodlands to their historic (pre-European settlement) extent and condition in Clark County (as described in Section D2a)), thereby maintaining and enhancing the biodiversity of these woodlands and minimizing the chances of future species listings. Such restoration would increase the amount of woodland habitat for dependent species and the connectivity between woodlands; both attributes increase the likelihood of species' persistence. However, given that many of these woodlands have been destroyed or greatly disturbed, and others are in private ownership, a more realistic goal, which likely will also prevent species listing, is to sustain and restore as many woodlands as possible at least to the extent they were distributed, and the condition they were in, at the inception of the MSHCP. The General Conservation Goals of this CMS thus are to:

1) Restore and maintain mesquite and acacia woodlands to the extent (area) they covered in year 2000 (inception of MSCHP), by protecting all woodlands on public land from habitat loss, and by acquiring (directly or with conservation partners/easements) as many woodlands as possible from private owners.
2) Restore and sustain pristine condition of mesquite and acacia woodlands.
3) Sustain or restore viable populations of mesquite and acacia dependent or associated species at their year 2000 levels or higher.

The third goal reflects the fact that the underlying purpose in developing the Mesquite-Acacia CMS is, at a minimum, to prevent the listing of mesquite- and acacia-associated species, especially covered species, by protecting their habitats. In fact, one of the primary objectives of the MSCHP goes further by stating that there should be no net decrease in species abundances, as stated in the third goal. Yet this goal cannot be met without addressing the first two goals. Either all woodlands existing in 2000, including those on private lands, must be protected or restored, and their quality sustained, or the area and/or quality of remaining woodlands must be enhanced to compensate for a loss of woodlands, allowing the same numbers of individual plants and animals to exist with the same probabilities of persistence. At this point, it is not clear whether the latter option (enhancement) is feasible. Thus, the conservation objectives and actions discussed below emphasize protecting the current woodlands, including private ones.

C. General Conservation Objectives

In accordance with the General Conservation Goals, and based on data collected by Krueger (1998) and Crampton (2004), the following preliminary objectives were developed for mesquite and acacia woodlands. It should be noted that data gaps need to be filled before some objectives (e.g. Objectives 4 and 7) can be quantified; addressing these gaps is a high priority action, listed in a subsequent section.

1) The largest and most biologically significant (in terms of the criteria listed below) woodlands should be protected from habitat loss and degradation, and/or restored to the conditions listed in Objectives 2-7 (*Goals 1, 2, and 3)*.
2) Surface and groundwater levels should be sustained at current or higher levels near and under all mesquite woodlands, and any acacia woodlands relying on groundwater (*Goals 1, 2, and 3)*.
3) Woodlands should include multiple age classes and exhibit ongoing recruitment (20-35% seedlings/saplings in mesquite woodlands) (*Goals 2 and 3)*.
4) The habitat quality of woodlands should be maintained or improved to meet the requirements of CMS species, especially covered and other special status species (see below and Appendix A; note that this objective requires the maintenance of a range of tree densities and heights across woodlands, although the majority of woodlands should have tall, dense trees) (*Goal 3)*.
5) In the majority of woodlands, > 60 % of trees should be mistletoe-infected. Mistletoe plants of all ages should exist, and produce new stems and berries (*Goal 3)*.

6) Phainopeplas should occur in $\geq$ 80% of woodlands, at densities $\geq$ 2 Phainopeplas/ha in $\geq$ 50% of woodlands. Phainopepla nest success should average $\geq$ 50% across sites and years (higher in large mesquite woodlands) (*Goal 3).*

7) Other species included in this CMS should continue to be detected at the same (or higher) number of woodlands and in the same (or higher) densities as at present (*Goal 3).*

D. General Conservation Actions

The following are the general types of conservation actions that are likely to have the most impact on mesquite-acacia woodlands and their dependent species. They are listed in order of their anticipated expectedness, and matched with the General Conservation Objectives discussed above. In general, actions aimed at protecting or increasing the area of mistletoe-infected woodlands, including securing the groundwater under those woodlands dependent on a high water table, and preventing fire and tamarisk invasion, are of the highest priority. Actions that address threats that affect only small portions of woodlands, or act to degrade habitat quality rather than reduce woodland area are of lesser importance.

1) Protect all existing woodlands on public lands from further loss and fragmentation (including ensuring that woodlands are not lost in land disposals) (*Objective 1).*
2) Secure additional woodlands (via acquisition, conservation partners/easements) where possible (*Objective 1).*
3) Ensure adequate groundwater flow under woodlands (e.g. introduce legislation limiting water use, encourage water conservation) (*Objective 2).*
4) Initiate restoration efforts in existing and former woodlands (*Objectives 1 and 3-7).*
5) Reduce deleterious human activity in woodlands (e.g. increase law enforcement, reduce access, limit OHV use, mining and grazing) (*Objectives 3-7).*
6) Reduce/control non-human threats (e.g. remove exotic plants, fence out burros, control populations of non-native or subsidized predators, such as feral cats or Brown-headed Cowbirds) (*Objectives 3-7).*
7) Address data gaps (e.g. inventory habitat patches and species distributions, monitor groundwater, determine recruitment habitat requirements, study host tree and mistletoe dynamics) (*Objectives 1-7*).
8) Promote public appreciation of mesquite and acacia woodlands, and associated species (*Objectives 1-7*).

In the following tables, conservation actions and studies that will benefit many, if not all woodlands, are listed in further detail, and prioritized. Priority ranking is 1 (highest) to 4, and is assigned relevant to all actions and studies, not just to those in the same table. The ranking is based largely on the above philosophy (that actions that protect or increase woodland area are of highest priority), tempered slightly by the perceived efficacy of the action (e.g.) those involving public education and cooperation are ranked slightly lower). The actions are divided into Tables 8a - 8f, addressing Lands and Realty, Groundwater, Human Activities, Non-human Threats, Public Awareness, and Research and Monitoring, respectively. The ownership of affected woodlands is listed, along with any applicable existing policy that supports, even partially, the action. If the MSHCP lists such a policy, then that policy is referenced with the format AGENCY(##) as in the MSCHP, rather than referencing the policy as listed in the plans of specific agencies. However, if the policy is not listed in the MSCHP, but is listed in the LVRMP, it is referenced in the table below in the LVRMP format of XX-#-x. As in the MSHCP, BLM activities that require an amendment to the LVRMP are italicized. By coupling these recommended actions these policies, the actions that simply require enforcement of existing directives and regulations are distinguished from those that require the formulation of new policy or a new land management designation.

Table 8a. Conservation actions regarding lands and realty.

Conservation Action	Priority	Wood-lands affected	Agency	Existing Policies
• Retain all public lands that contain mesquite and acacia woodlands and Special Status Plants in federal or state ownership.	1	All public	All	RP-1-e
• Ensure that all discretionary land disposals as described in the RMP are consistent with the objectives of this CMS, and do not result in the net loss of mesquite and acacia woodlands or habitat for Special Status Plants and covered species.	1	BLM	BLM	BLM(111), NDOW(21)
• Acquire (directly, with conservation partners, or through conservation easements) mesquite and acacia woodlands, especially those that meet the majority of criteria of biologically valuable metapatches.	1	Some private	All	BLM(99), AQ-1-a

Conservation Action	Priority	Wood-lands affected	Agency	Existing Policies
• Accord public land in high priority metapatches (see below) special status (e.g. ACEC, Wilderness). The management recommendations for this special status are described in Appendix F.	2	High priority public	All	*BLM(222)*
• Do not authorize mineral sales in woodlands.	2	BLM	BLM	BLM(89)
• Amend the RMP to withdraw woodlands from mineral entry.	2	BLM	BLM	
• In woodlands where mining is allowed, mitigate impacts to trees during the mining plan approval process.	2	BLM	BLM	
• During notice-level activities, work with the proponent to minimize impacts to mesquite.	2	BLM	BLM	
• Where possible, designate woodlands as rights-of-way avoidance areas. Otherwise, restrict all construction to existing designated corridors.	3	All public	All	BLM(301)
• Mitigate impacts within right-of-way corridors during construction and maintenance to minimize destruction or disturbance to woodlands (e.g. avoidance, restoration, minimizing clearance of vegetation within rights-of-way, selective pole/tower placement to avoid host trees, and other measures as appropriate).	3	All	All	
• Discourage the construction of new roads and require restoration of temporary or closed roads.	3	All public	All	USFWS(24), USFWS(40), BLM(303), NPS(50),

Table 8b. Conservation actions to address groundwater issues. These issues affect all mesquite woodlands that do not border rivers, and perhaps some acacia woodlands.

Conservation Action	Priority	Agency	Existing Policy
• Investigate the feasibility of obtaining a guaranteed minimum groundwater level sufficient to maintain existing woodlands. Work with the State Water Engineer to develop standards for acceptable aquifer drawdown levels.	1	All, County	
• File for appropriative water rights in accordance with state water laws for water sources that are not federally reserved	1	All, County	BLM(120)
• Do not allow any projects on public land that impact the water table; protect water sources	1	All	NPS(39), FW-3-g
• Institute (stricter) penalties and increased policing for watering violations.	2		
• Through the NEPA process, analyze federal actions that may impact groundwater within the hydrographic basin of woodlands.	2	All	
• Develop and promote more water conservation incentives for public and private landowners.	3	County with SNWA	
• Develop a public educational program to enhance understanding of the importance of groundwater conservation.	4	County	

Table 8c. Conservation actions to deal with potentially deleterious human activities.

Conservation Action	Priority	Wood-lands affected	Agency	Existing Policies
Law Enforcement				
• Increase law enforcement presence in woodlands to discourage illegal activities.	2	All public	All	BLM(98)*, NPS(32), NPS(36), USFWS(28), NDOW(19)
• Include mesquite and acacia woodlands, especially those near urban centers and Priority metapatches, as high priority areas in patrol plans.	2	All public	All	
• Expedite resolution of trespass violations and illegal occupancy within woodlands.	3	All public	All	
• Establish a toll-free phone number for the public to report violations and other relevant information.	4	All public	Coun ty	
Woodcutting				
• Prohibit or require permits for the harvest of any mesquite or acacia wood; issue only for those circumstances that are consistent with promoting the health of woodlands (e.g. fuel load reduction).	2	All BLM	BLM	BLM(91), NPS(29), USFWS(14), USFWS(15)
• Post and maintain No Woodcutting signs around perimeter of mesquite (and acacia) woodlands.	3	All BLM	BLM	
Recreation				
• Prohibit off-road driving. Close as many OHV roads and trails as possible, and change OHV designations from existing roads and trails to designated roads and trails in woodlands. Roads that are designated closed should be restored.	2	All public	All	BLM(71), *BLM(221),* NDOW(15)
• Document, with the use of GPS, existing roads and trails in all woodlands by the end of FY06 to establish a baseline for existing roads and trails to be closed or designated.	2	All public	All	
• Do not permit open fires in the vicinity of woodlands.	2	All public	All	

Conservation Action	Priority	Wood-lands affected	Agency	Existing Policies
• Do not permit OHV speed events or high intensity OHV use in high priority metapatches.	2	All public	All	BLM(102), BLM(118), NPS(42)
• Ensure that recreational activities, particularly OHV speed events, are routed away from areas of active plant recruitment.	3	All public	All	USFWS(19), NDOW(16)
• Ensure that recreational activities, particularly OHV speed events, do not harm populations of mammals and reptiles.	3	All public	All	USFWS(19), USFWS(25)
• Ensure that recreational activities permitted during the avian breeding season do not have a negative impact on breeding success.	3	All public	All	USFWS(19)
• Do not allow OHV speed events within 1/4 mile of woodlands during the breeding season (February through August).	3	All public	All	BLM(102)
• Designate camping areas within woodlands to concentrate activity in previously disturbed sites and away from trees. Provide facilities for waste disposal.	3	All public	All	NDOW(16)
• Control vehicular access into mesquite (and acacia secondarily) woodlands via fencing and/or road closures.	3	All public	All	
Dumping				
• Post and maintain "No Dumping" signs around perimeters of woodlands.	3			
• Organize periodic clean-ups through volunteer programs.	4			

Table 8d. Conservation actions to deal with non-human threats.

Conservation Action	Priority	Wood-lands affected	Agency	Existing Policies
Livestock, horses and burros				
• If the overall effect of livestock grazing is negative, even at light grazing intensity (see Research and Monitoring), remove woodlands from grazing allotments.	3	All public	BLM	BLM(125), BLM(103)*, USFWS(22)
• Minimize horse and burro activity in woodlands during the avian breeding season. Ideally, manage all HMAs and areas of LMNRA containing woodlands for zero horses and burros, especially during the avian breeding season.	3	All public	BLM, NPS	BLM(59)*, NPS(24), USFWS(22)
• After determining if, and which, species (horses, burros, cattle, rodents, lagomorphs) negatively impact seedling recruitment or tree structure (see Research and Monitoring), protect seedlings and saplings as appropriate (individual cages, exclosure plots, population control).	3	All public	All	
Invasive Exotic Plants				
• Eradicate and/or control invading tamarisk in woodlands, where possible given the requirement of breeding birds.	1	All public	All	USFWS(37), BLM(141)*, BLM(142)*, NPS(46), NPS(49)
• Eradicate patches of Russian knapweed and star thistle that have established in woodlands to reduce the risk of wildfire.	1	All public	All	
Pest Animals				
• Reduce populations of ravens, cowbirds, and feral cats near woodlands.	3	All public	All	BLM(109)*, NPS(48)
• Reduce the number of artificial perches for ravens near woodlands.	3	All public	All	

Conservation Action	Priority	Wood-lands affected	Agency	Existing Policies
Wildfire				
• Implement the BLM Fire Management Plan that designates mesquite woodland areas as a Zone A fire suppression zone. Include acacia woodlands. Implement NPS Fire Management Plan.	1	All public	BLM, NPS	NPS(26)
• Devise a naming or numbering system for roads, mark roads, and produce maps (based on GPS work of Table 8a) to be distributed to local and area fire stations, search and rescue, and sheriff's departments to assist in quick response to fire outbreaks.	2	All public	All	
• Reduce fuel loads in woodlands by removing slash build-up caused by previous woodcutting and illegal dumping of fire-prone materials.	3	All public	All	
• Create firebreaks within the private/public land interface, and work with County public works to reduce vegetation along roadsides that run along private/public land boundaries.	2	All public	All	
Restoration				
• Plant seeds or seedlings to re-establish desirable age classes, increase density or restore woodlands, while ensuring genetic integrity of the mesquite or acacia community. Protect as necessary from vehicles, livestock, horses, burros and wildlife.	2	All public	All	USFWS(38), BLM(142)*, BLM(141)*, NPS(43), NPS(46)

Table 8e. Public awareness actions to enhance conservation of woodlands. These actions should benefit all woodlands

Conservation Action	Priority	Agency	Existing Policy
• Work through the Clark County Multiple Species Habitat Conservation Plan to increase public awareness of the ecological significance of woodlands in the Mojave Desert.	2	County	
• Construct interpretive signs where appropriate to educate the public on the importance of mesquite and acacia woodlands and mistletoe in southern Nevada.	3	All, County	
• Develop a web page under the Nevada BLM, NPS, NDOW and/or MSHCP web site describing woodland conservation efforts in Nevada, including maps of the areas, lists and images of associated flora and fauna, and links to other sites associated with mesquite and acacia research and conservation.	4	All, County	
• Develop a brochure or video on wildlife use of mesquite and acacia woodlands in the Mojave Desert.	4	County	
• Develop and circulate a check-list for avian and other species that occur in southern Nevada woodlands.	4	NDOW	
• Develop a slide show for presentations to civic groups that will educate the public on the importance of mesquite and acacia woodlands in the Mojave Desert, and their use by wildlife species.	4	County	

Table 8f. Research and monitoring studies to improve conservation of mesquite and acacia woodlands. The conservation of most or all woodlands will benefit from these studies. Clark County should take responsibility for seeing that these studies are contracted out to appropriate parties and conducted satisfactorily.

Research or Monitoring Study	Priority
Groundwater	
• Monitor groundwater levels every three months using existing observation wells. Use USGS data if other wells do not exist.	1
• Determine the relationship between groundwater and catclaw acacias.	2
Woodland distribution	
• Complete surveying and mapping of woodlands by end FY06 (including groundtruth and redigitizing problem areas and potential habitat noted above). As soon as possible information about habitat structure and condition (including mistletoe infection) and human use patterns. Resample mistletoe infection levels at least every 10 years.	2
Tree and mistletoe recruitment and survival	
• Investigate impacts of drought, groundwater loss, OHV use (through soil compaction) and grazing on tree and mistletoe survival, in an AM framework.	1
• In an AM framework, determine the cause(s) of low tree recruitment in some woodlands (e.g. Stump Springs, Meadow Valley Wash). Consider the influence of pollinators, cattle, horses, burros, rodents, lagomorphs, OHV, soil compaction, fire, climate and ground water on seed production, seed consumption, seed dispersal, and seedling and sapling survival. Investigate potential multiple roles and interactions. Also investigate the impact of different intensity/timing of herbivory, OHV use etc.	1
• Monitor woodlands (especially high priority metapatches) for host tree germination events and sapling survival.	2
• Improve techniques for tree and mistletoe restoration/cultivation in an AM framework.	2
• At a landscape level, investigate the dynamics of mistletoe colonization and extinction of woodlands (time scale, causes-why are some patches infected, others not).	3
Wildlife	
• Establish a list of indicator and priority taxa for research and monitoring.	1

Research or Monitoring Study	Priority
• Coordinate with appropriate agencies or entities to establish a Phainopepla breeding density (annual) and success (biannual) monitoring program at Priority 1 metapatches and (at least) breeding sites used by Crampton (2004).	1
• Regularly (at least annually) inventory as many taxa as possible in woodlands, especially high priority metapatches (focus on indicator taxa if necessary). If possible, determine general habitat requirements. Attempt coordination with ongoing bird monitoring by the GBBO.	1
• Monitor wildlife populations at any sites home to management or development activities, before and after these activities are initiated. Improve communication between groups responsible for management/development and for monitoring.	2
• Determine how Phainopeplas (and other indicator taxa) perceive patches (area, isolation), and establish if they exist as a metapopulation(s) within or adjacent to southern Nevada (i.e. assess population genetic structure and migratory connectivity)	2
• Conduct long-term studies to collect data required for a population viability analysis of Phainopeplas and other select taxa.	2
• Determine causes (e.g. predation, food) of area sensitivity in Phainopeplas (and other taxa as applicable).	2
• Determine the identity of nest predators of Phainopeplas, and if possible, other avian species identified in the CMS.	3
• Determine the effects of different intensity and timing of OHV, livestock, horse, and burro use on wildlife and sensitive plants.	4

CONSERVATION STRATEGY

A. Identification of Priority Woodland Metapatches

To reach the overarching goal of the CMS (of maintaining or restoring woodlands to 2000 condition and extent) given limited resources, protection, acquisition, and restoration activities must focus on a suite of priority woodland metapatches. These metapatches should individually represent biologically high quality woodlands, and collectively exhibit a wide range of woodland attributes that allow for the dynamics of disturbance. After ranking woodland metapatches based on their biological quality, this document will identify threats to those metapatches, and will prioritize appropriate conservation actions for those specific metapatches and for woodlands in general.

The criteria used for prioritizing metapatches ideally would be drawn from conservation theory and the habitat requirements of mesquite and acacia associated species. However, several problems arose in the development of a single ranking scheme based on these criteria. First, few data exist on specific habitat requirements for many of these species. When information on habitat use is available (such as for most birds), it is typically vague (for example, “prefers dense forests”), with no quantitative data. Nonetheless, some general patterns emerge, which leads to the second problem: each species differs from other species in its habitat requirements. Most, but not all, birds considered in this CMS prefer lower elevation, riparian woodlands. Of these, approximately half occur in dense, tall vegetation, while the remainder uses more open, shorter vegetation. Some birds and mammals, and many reptiles prefer sparse woodlands. Because the preferences of many species overlap with those of Phainopeplas (the species for which there is the most quantitative data), the requirements of Phainopeplas strongly guide the prioritization criteria. Even then, however, there is a third problem: data such as tree height, age distribution, and recruitment is lacking for many woodlands.

In recognition of these issues, several alternative prioritization schemes were developed. These schemes differ in the criteria included, and the weights given to each criterion (Appendix G). These criteria and weights should be viewed as a working hypothesis to be evaluated further as more data are gathered on the requirements of the species that use mesquite and acacia woodlands. For now, criteria that are integral to reserve design theory, or affect a large number of species were given greater weights. For the “Phainopepla” ranking scheme, the weights reflect the amount of variance each criterion explains in multiple regressions evaluating the determinants of Phainopepla occupancy and density (Crampton 2004). The different ranking schemes incorporate combinations of the following criteria:

1) Large area (in accordance with the principles of reserve design and to accommodate area-sensitive species like Phainopeplas).
2) Contiguous woodland metapatch (in accordance with the principles of reserve design; also a sign of reduced disturbance).
3) Proximity to other woodland metapatches (in accordance with the principles of reserve design).
4) Multiple age classes of dominant native vegetation, and ongoing tree and mistletoe recruitment and growth (to provide for a range of species and to ensure tree replacement; NB-insufficient data exist to use this criteria at this time).

5) Large trees with few trunks (rather than multi-stemmed, stressed trees; these large trees favor several breeding bird species; NB-insufficient data exist to use this criteria at this time).
6) Moderate-high tree density (favored by several breeding bird species and increases Phainopepla nest success; also small insect species may perceive each individual tree as a patch, so a more dense patch is more contiguous).
7) Near permanent water (favored by most bird species, including covered species).
8) Abundant mistletoe (for Phainopeplas, other birds, and butterfly specialists).
9) Potential to support a large number of CMS species (as predicted by REGAP models)
10) Presence of special status plant species.

Additionally priority metapatches collectively should:

1) Encompass the range of woodland characteristics (e.g. tree ages and densities, elevation, latitude/longitude, distance to riparian, species composition, level of infection) that have been historically observed, and that are believe to be required by the diversity of woodland-dependent species.
2) Be at appropriate distances from other metapatches to buffer the impact of major ecological disturbances, yet accommodate behaviors of dependent species. On this note, some attention should be given to the protection of smaller patches that may serve as stepping stone links to larger patches.

Interestingly, the rankings generated by these schemes largely produce the same results, with metapatches clustering in relatively obvious groupings; Table 9 shows the metapatches in the top four groups (the top half (52) of the metapatches are presented in Appendix G). The following biological rankings are based on the comprehensive score and grand sum of all the ranking scores. Muddy River and Big Bend (both largely privately owned) are among the top five metapatches in each scheme, leading to scores much higher than the rest of the metapatches; therefore, they have been given Rank 1, or “core” status. A principal recommendation of this CMS is that the acquisition of these patches be a high priority. These rankings also come with the caveat that the prioritization process was conducted with incomplete information on the condition of many woodlands, and the requirements of woodland-dependent species, and should be updated as new information is obtained. For example, data on mistletoe abundance, tree density or the presence of CMS species were not available for the metapatches marked with an asterisk in Appendix G. Also, although many conservation actions will be targeted to metapatches in the top four categories, other metapatches should not be ignored.

Table 9. Ranking of metapatches based on their biological value as determined by the criteria listed on p. 94-95 and in Appendix G. See Appendix H for the assessment of the level of threat to each metapatch. The "Concern" Rating is a combination of the threat level and the land ownership/level of management for that metapatch. Metapatches on private land, or not in ACECs or WAs, or in UMAs have higher worry levels. The Combined Rating is the sum of the Biological Ranking (4 points for Rank 1, 1 point for Rank 4) and the Concern Ratings (High=3, Low=1), with values from 2-7.

Name	Region	Dominant Sp.	Area (ha)	Comprehen-sive Score	Sum of Scores	Biological Ranking	Land Management	"Special" Management	Clark Co status	Threat Level	Concern Rating	Combined Rating
Muddy River	Pahranagat	M, A	921	126	370	1	BLM, PVT	None	UMA, MUMA	High	High	7
Big Bend	Newberry	M	736	118	365	1	PVT, BLM, NVST, NAR	None	UMA, MUMA	High	High	7
Piute	Piute	A	1098	108	318	2	BLM	ACEC	IMA	Low	Low	4
Hiko	Newberry	A		110	317	2	BLM	ACEC (few ha)	IMA, MUMA	Medium	High	6
Overton	Muddy Mtn	M	144	103	315	2	NPS, PVT, NDOW	None	UMA, MUMA, IMA	High	High	6
Grapevine	Newberry	A	142	104	312	2	NPS	WA	IMA	Low	Low	4

Name	Region	Dominant Sp.	Area (ha)	Comprehen-sive Score	Sum of Scores	Biological Ranking	Land Management	"Special" Management	Clark Co status	Threat Level	Concern Rating	Combined Rating
Mesquite Lake (CA)	Mesquite Lake	M	2799	111	299	2-3	BLM (CA)		N/A	Medium	Medium	5.5
Stewart Valley (Nye)	Pahrump	M	214	100	306	3	BLM, PVT		N/A	Medium	Medium	4
Resting Spring (CA)	Tecopa	M	47	97	299	3	PVT		N/A	Low	Medium	4
North Las Vegas	Las Vegas	A	388	102	299	3	BLM, PVT	None	UMA, MUMA	Medium	High	5
Coyote Spring (Lincoln)	Coyote Spring	A, M	900	98	283	3	FWS	Propos ed WA	N/A	Low	Low	3
Pahrump (Nye)	Pahrump	M	3662	102	283	3	BLM, PVT	ACEC (few ha)	MUMA	High	High	5
Arrow Canyon	Pahranagat	A	125	93	275	3-4	BLM	ACE (half)	IMA	Low	Low	2.5

Name	Region	Dominant Sp.	Area (ha)	Comprehen-sive Score	Sum of Scores	Biological Ranking	Land Management	"Special" Management	Clark Co status	Threat Level	Concern Rating	Combined Rating
Franklin Wash (CA)	Amargosa	M	183	93	269	3-4	BLM		N/A	Low	Low	2.5
Gold Butte SW	Gold Butte	A	504	92	269	3-4	BLM, NPS	ACEC	IMA	Medium	Medium	3.5
Mormon Mesa E	Virgin River	M	75	88	270	3-4	BLM, NPS, PVT	ACEC (many ha)	IMA	Low	Low	3.5
Amargosa Flat (Nye)	Amargosa	M	703	93	256	4	BLM	ACEC (half)	N/A	Medium	Medium	3
Bunkerville	Virgin River	M, A	125	90	256	4	BLM, NPS, PVT	ACEC (many ha)	IMA, MUMA	Medium	Medium	3
Corn Creek	Corn Creek	M	397	92	252	4	FWS	None	IMA	Low	Low	2
Nelson	Eldorado	A	298	93	250	4	BLM, NPS, PVT	None	UMA, MUMA, IMA	Medium	Medium	3

B. Specific Conservation Objectives and Actions for Priority Metapatches

In this section, recommended conservation objectives and actions for the priority metapatches in Clark County are presented and prioritized. With the exception of Piute and Grapevine, which are reasonably well protected, the Biological Rankings and Combined Ratings for these metapatches largely produce the same list; thus in this section, metapatches are listed in order of their biological ranking. These specific conservation objectives are intended to supplement (or further clarify), not replace, the general conservation objectives listed above. In some cases, conservation objectives have been quantified with data from earlier studies. In the remaining cases, monitoring and inventory studies should be conducted in at least two years of non-drought conditions to determine suitable targets. As with the General Conservation Actions, the actions recommended below have been matched with any existing management policies not already described above. The threats addressed (if applicable) are also listed in each metapatch's table of conservation actions (Ur=urbanization, Ag=conversion to agriculture, Gw=groundwater loss, Wm=water management/flood control, Ex=invasion by exotics, Wc=woodcutting, In=infrastructure (construction or maintenance of roads, rights-of-way, mines etc.), Gr=grazing, Rec=recreation).

1. Muddy River

This metapatch is mostly privately held. Those woodlands on BLM land have no special status, and thus are protected solely by the provisions of the RMP. Some of the Meadow Valley Wash woodlands are subject to land disposal, but this disposal was not mandated by Congress and is at the BLM's discretion. It is recommended that these woodlands be withdrawn from the disposal boundary. This metapatch is faced with all categories of threat, at their highest levels (Appendix I). The combination of high biological value, high level of threat, and low level of management protection indicate that this metapatch should be a top concern for conservation actions (see Table 10).

<u>Main conservation objectives:</u>

1) Protect or increase the current extent of the acacia and mesquite woodlands.
2) Maintain groundwater at a static level not to exceed 30 ft in depth at the Moapa well.
3) Maintain or improve habitat quality (depending on woodland patch).

- Ensure mixed tree age class distribution, including sufficient recruitment to at least replace senescent trees.
- At Warm Springs Ranch, manage woodlands to support current or greater mistletoe production (2000 berries/tree on average, and at least 50% of trees infected), and current or greater Phainopepla breeding density (1 breeding pair/ha) and nest success ($\geq$ 65%); maintain or increase mesquite and acacia density (see Crampton 2004).
- At Meadow Valley Wash, manage woodlands to improve mistletoe production, and Phainopepla breeding density and nest success, to approximately 1997 levels, and maintain (see Krueger 1998; as per BLM(20)).
- At Meadow Valley Wash, manage to achieve an average of <3 primary stems per mesquite tree (as per BLM(20)).

4) Prevent damage to trees and woodlands from fire, woodcutting, recreation, construction and maintenance of roads and rights-of-way. If damage occurs, restore woodlands.
5) Coordinate conservation actions with those of the Muddy River CMS, which should include conservation of this woodland metapatch as a high priority.

Table 10. Main conservation actions for the Muddy River metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Acquire as many woodland acres as possible on private lands, especially Warm Springs Ranch and other parcels with large woodland patches	1	Ur, Ag	1
• Follow other Groundwater Actions listed in Table 8b	2, 3	Gw	3
• Determine instream flow requirements to support woodlands in conditions described in General Conservation Objectives, and acquire water rights on Meadow Valley Wash as per BLM(121)	2, 3	Gw	2
• Monitor Moapa well regularly as per BLM(35)	2, 3	Gw	4
• Withdraw all BLM woodlands from land disposal	1	Ur	5
• Designate all BLM woodlands as an ACEC (with the restrictions described in Appendix F)	1, 3, 4	All except Ex, Gw	6
• Control tamarisk and restore mesquite as per BLM(141)	1, 3	Ex	7
• Arrest woodcutting at Meadow Valley Wash by increasing law enforcement and/or fencing.	3, 4	Fire, Wc	8

Conservation Action	Objectives Met	Threats Addressed	Priority
• Ensure that construction and maintenance of roads and rights-of-way do not negatively impact mesquite woodlands	3, 4	In	8
• Close and rehabilitate dirt roads through the middle of Meadow Valley Wash woodlands. Create a buffer of 50 m between roads around the woodlands and the woodlands	3, 4	In	9
• Maintain or restore mesquite woodlands on BLM land acquired from Nevada Power on the Muddy River in the conditions described under General Conservation Objectives.	1, 3		10
• Change Las Vegas RMP to disallow camping in BLM woodlands in this metapatch and enforce	3, 4	Fire	11
• Determine cause of mistletoe dieback since 1997	3		12
• Groundtruth potential habitat between Muddy River and Arrow Canyon metapatches	1		13

2. Big Bend

This metapatch occurs on private, Fort Mojave Indian Reservation, Nevada State Parks, and BLM lands. The woodlands on BLM land have no special status, thus are protected solely by the provisions of the LVRMP. All threats, except grazing and woodcutting, affect these woodlands. The combination of high biological value, high level of threat and low level of management protection indicate that this metapatch should be a top concern for conservation actions (see Table 11).

Main conservation objectives:

1) Protect or increase the current extent of the mesquite woodlands.
2) Maintain groundwater at current or higher levels; ensure suitable water management.
3) Maintain or improve habitat quality.
    - Ensure mixed tree age class distribution, including sufficient recruitment to at least replace senescent trees.
    - Prevent further encroachment by tamarisk. If possible, remove tamarisk and replant with mesquite, especially at Big Bend State Park.

- On BLM land just south of Big Bend State Park (near the power house) manage woodlands to sustain current mistletoe production (3000 berries/tree ± 500 berries on average, and at least 80% ± 15% of trees infected,), and current Phainopepla breeding density (at 0.5-1 breeding pair/ha) and nest success (at 50% ± 15%) (Crampton 2004).

4) Prevent damage to trees and woodlands from fire, woodcutting, recreation, and construction and maintenance of roads and rights-of-way. If damage occurs, restore woodlands.

5) Coordinate conservation actions with those of the Lower Colorado River MSCP.

Table 11. Main conservation actions for the Big Bend metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Control tamarisk and restore mesquite	1, 3	Ex	1
• Ensure that water management/flood control projects do not negatively impact mesquite woodlands	1, 2, 3	Wm	2
• Follow other Groundwater Actions listed in Table 8b	2, 3	Gw	3
• Prohibit campfires on public lands near mesquite woodlands	4	Fire	4
• Engage in a dialog with Nevada State Parks regarding conservation of mesquite woodlands on their land (minimizing infrastructure development, controlling tamarisk), as per BLM(99)	1, 3	In, Rec, Ex	5
• Engage in a dialogue with the Colorado River Indian Tribe regarding conservation of mesquite woodlands on their land controlling tamarisk, preserving current woodlands, restoring alfalfa fields to mesquite.	1, 3	Ur, Ag, Ex	6
• Develop, maintain and patrol limited camping infrastructure to minimize encroachment on woodlands on BLM land at the Big Bend	1, 3	Fire, Wc, Rec	7
• Ensure that construction and maintenance of roads and rights-of-way do not negatively impact mesquite woodlands.	1, 4	In	8
• Designate BLM lands as an ACEC as per Appendix F		All except Ex, Gw	9

3. Piute Wash

All of this metapatch occurs in the BLM's Piute-Eldorado ACEC. Enforcement of the management directives for this ACEC will assist in the conservation of the acacia woodlands and the associated species. This woodland is subject to few threats; thus, although it received a high biological ranking, it can generally be considered a moderate priority for conservation actions (see Table 12), as long as it retains current management protection, and key private woodlands in the above metapatches are acquired. High priority exceptions are controlling exotics to reduce the risk of fire and determining and remedying the causes of the mistletoe dieback. If private woodlands are not acquired, then means of substantially enhancing the quality of this woodland could be investigated (although none are immediately apparent).

<u>Main conservation objectives:</u>

1) Protect the current extent of the acacia woodland, including the California portion if possible.
2) Maintain or improve habitat quality.
    - Ensure mixed tree age class distribution, including sufficient acacia recruitment to at least replace senescent trees.
    - Manage woodlands to restore mistletoe production (to average 5000 berries/tree, and 75% of trees infected), and Phainopepla breeding density (to 1.2 pairs/ha) and nest success (to 50%) (Crampton 2004) and maintain within 15% variance.
3) Prevent damage to trees and woodlands from fire, recreation, and construction and maintenance of roads and rights-of-way. If damage occurs, restore woodlands.

Table 12. Main conservation actions for the Piute Wash metapatch

Conservation Action	Objectives Met	Threats Addressed	Priority
• As specified in the LRMP, retain lands in Federal ownership	1	Ur	1
• Control *Schizmus* and *Bromus*	3	Ex, Fire	2
• Enforce ACEC provisions regarding roads (as per BLM(71), rights-of-way, OHV and livestock. Hire additional law enforcement and reclamation personnel, and increase signage as necessary to comply	2, 3	In, Rec, Gr, Fire	3
• Determine and mitigate the cause of the	2		4

mistletoe dieback

4. Hiko

All of this metapatch occurs on BLM land, with a few hectares at the west end lying in the Piute-Eldorado ACEC. This woodland is subject to several threats, which coupled with a low level of management protection, cause concern. It should be a high priority for conservation actions (see Table 13); it is one of the few metapatches that could be increased in size through restoration.

Main conservation objectives:

1) Protect and increase the current extent of the acacia woodland.
2) Maintain or improve habitat quality.
   - Ensure mixed tree age class distribution, including sufficient acacia recruitment to at least replace senescent trees.
   - Manage woodlands to restore mistletoe production (on average, 5000 ± 500 berries/tree, 75% ± 15% of trees infected) and Phainopepla breeding density (5 ± 2 Phainopeplas/ha) (Crampton 2004) and maintain.
3) Prevent damage to trees and woodlands from fire, recreation, and construction and maintenance of roads and rights-of-way. If damage occurs, restore woodlands.

Table 13. Main conservation actions for the Hiko metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain lands in Federal ownership and designate acacia woodlands as an ACEC as per Appendix F	1, 3	All except Ex, Gw	1
• Consult with NDOT to close and reclaim the borrow pit	1	In	2
• Limit OHV use to designated roads and trails, and prohibit OHV speed and high intensity or frequency events	2, 3	In, Rec	3
• Investigate and maintain source of water that feeds spring	2	Wm	4
• Control tamarisk, *Schizmus*, and *Bromus*	2, 3	Ex, Fire	5
• Prohibit camping at Hiko Springs	3	Fire, Rec	6
• Plant acacias east of Hiko Spring as per BLM(135)	1	Restor.	7

5. Overton

Many woodlands in this metapatch are on private land, and are threatened by a variety of activities. The remainder is managed by NPS and NDOW, and face few threats other than recreation and tamarisk invasion. This metapatch is a high priority for conservation activities (see Table 14).

Main conservation objectives:

1) Protect or increase the current extent of the mesquite woodlands.
2) Maintain groundwater at current or higher levels; ensure suitable water management.
3) Maintain or improve habitat quality.
   - Ensure mixed tree age class distribution, including sufficient acacia recruitment to at least replace senescent trees.
   - Prevent further tamarisk encroachment. If possible, remove tamarisk and replant with honey mesquite, especially at Overton WMA.
   - At Overton WMA, manage woodlands to sustain current mistletoe production (on average, 1500 ± 500 berries/tree, 80% ± 10% of trees infected), and current or greater Phainopepla breeding densities (at 0.5-1 pairs/ha) and nest success (50% ±10%) (Crampton 2004).
4) Prevent damage to trees and woodlands from fire, woodcutting, recreation, and construction and maintenance of roads and rights-of-way. If damage occurs, restore woodlands.
5) Coordinate conservation actions with NDOW.

Table 14. Main conservation actions for the Overton metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Ensure that water management/flood control projects do not negatively impact mesquite woodlands	1, 2, 3	Wm	1
• Follow other Groundwater Actions listed in Table 8b	2, 3	Gw	2
• Control tamarisk and restore mesquite	1, 3	Ex	3
• Engage in a dialog with NDOW regarding conservation of mesquite woodlands on their land (minimizing infrastructure development, controlling tamarisk) as per BLM(99)	1, 3	In, Rec, Ex	4

Conservation Action	Objectives Met	Threats Addressed	Priority
• Acquire woodlands on private lands, especially parcels with large woodland patches and those that provide connectivity	1	Ur, Ag	5
• Monitor and prevent illegal cutting of mesquite on NPS lands	1, 3	Wc	6
• Ensure that construction and maintenance of roads and rights-of-way do not negatively impact mesquite woodlands.	1, 4	In	7

6. Grapevine

The NPS management of this metapatch affords it high protection. Enforcement of park policies will adequately address most threats. Like Piute Wash, this metapatch can generally be considered a moderate priority for conservation actions (see Table 15) as long as it retains current management protection, and key private woodlands in the above metapatches are acquired. If private woodlands are not acquired, then comparatively expensive and logistically challenging options to increase the area and quality of this metapatch as mitigation for lost woodlands could be investigated.

<u>Main conservation objectives:</u>

1) Protect and increase the current extent of the acacia woodlands.
2) Maintain or improve habitat quality.
    - Ensure mixed tree age class distribution, including sufficient acacia recruitment to at least replace senescent trees.
    - Ensure that Park actions do not disrupt surface water flow as per NPS(39).
3) Prevent damage to trees and woodlands from fire, recreation, and construction and maintenance of roads. If damage occurs, restore woodlands.

Table 15. Main conservation actions for the Grapevine metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain lands in NPS ownership	1, 3	Ur	1
• Control tamarisk, *Schizmus* and *Bromus* as necessary	2, 3	Ex, Fire	2

Conservation Action	Objectives Met	Threats Addressed	Priority
• Ensure that maintenance of Christmas Tree Pass road and parking areas do not further encroach on woodlands	2, 3	In	3
• Post signs at trailheads into woodlands discussing acacia woodland ecology	1	Lack of Education	4

7. North Las Vegas

This metapatch is almost entirely managed by the BLM, except for a few hectares on private land. Most of the BLM land was Congressionally designated for disposal and has been sold; however, it is recommended that any remaining BLM lands be withdrawn from disposal. The other woodlands in this metapatch are subject to numerous threats and currently receive little protection, indicating that they are fairly high priority for conservation actions (see Table 16). Their biological value will decrease if woodlands in the disposal area are lost and this metapatch becomes more fragmented.

<u>Main conservation objectives:</u>

1) Protect and increase the current extent of the acacia woodland.
2) Maintain or improve habitat quality.
    - Ensure mixed tree age class distribution, including sufficient acacia recruitment to at least replace senescent trees.
    - Plant acacias in the stringers on the north and east parts (e.g. Conservation Transfer Area) of the metapatch to increase woodland area and density
    - In Conservation Transfer Area, attempt to manage woodlands to support Phainopepla breeding densities of at least 0.7 birds/ha, and mistletoe production of 70 % $\pm$ 10% of trees infected with average 1000 $\pm$ 200 berries/tree.
    - Prevent damage to trees and woodlands from fire, recreation, and construction and maintenance of roads and rights-of-way.

Table 16. Main conservation actions for the North Las Vegas metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain lands in Federal ownership by withdrawing them from the disposal boundary and/or acquiring them through conservation partners/easements	1	Ur	1
• If used by acacias, maintain ground or perched water table	2	Wm	2
• Extend the boundaries of the Preservation Area closer to the wash east of Commerce Street and south of Elkhorn Farm Road, and north of Grand Teton Road	1	Ur	3
• Designate acacia woodlands on BLM lands as an ACEC as per Appendix F	1, 2, 3	All except Ex, Gw	4
• Control *Schizmus* and *Bromus*	2, 3	Ex, Fire	5
• Ensure that construction and maintenance of roads and rights-of-way do not negatively impact woodlands.	2, 3	In	6
• Limit OHV use to designated roads and trails and prohibit OHV speed events	2, 3	In, Rec	7
• Plant acacias in the Conservation Transfer Area	1, 2		8

8. Pahrump-Stump Springs and southeast Pahrump

As noted, most of this metapatch lies outside Clark County, but two portions of it in Clark County warrant mention here: Stump Spring and a 200 ha woodland patch in southeast Pahrump east of Hafenranch Road and south of Kellog Road (hereafter called Kellog), both on BLM land. At the center of the former is the Stump Spring ACEC, the management provisions of which are largely sufficient to protect the woodlands except for being open to grazing. The rest of the woodlands in these two areas receive no special protection, which coupled with a variety threats, increases the level of concern, especially for Kellog, on the edge of Pahrump. Thus these areas are a high priority for conservation actions (see Table 17), which should be coordinated with Nye County and the city of Pahrump.

<u>Main conservation objectives:</u>

1) Protect or increase the current extent of the mesquite woodlands.
2) Maintain groundwater at current or higher levels; at Stump Springs this is 35 ft.
3) Maintain or improve habitat quality.
   - Improve mesquite tree age class distribution along the Stump Springs main wash to include at least 20% seedlings and saplings, and improve tree growth structure to ≤ 5 stems per tree.
   - At Kellog, manage woodlands to sustain current mistletoe production (90% ± 5% of trees infected, with an average of 2000 ± 100 berries per tree), and current Phainopepla breeding density (1 ± 0.2 pairs/ha) and success (50% ± 10%) (Crampton 2004)
4) Prevent damage to trees and woodlands from grazing, fire, woodcutting, recreation, and construction and maintenance of roads and rights-of-way. If damage occurs, restore woodlands.
5) Coordinate conservation actions with Pahrump and Nye County.

Table 17. Main conservation actions for the Pahrump metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain all BLM woodlands in Federal management and designate as an ACEC with the restrictions described in Appendix F	1, 4	Ur, Ag	1
• Follow other Groundwater Actions listed in Table 8b	2, 3	Gw	2
• Monitor well at Stump Springs as per BLM(35)	2	Gw	3
• Install suitable flood control structures along Stump Spring Wash to control erosion	2, 3	Wm	4
• Engage in a dialog with Pahrump and Nye Co. regarding conservation of mesquite woodlands on their land (e.g. minimizing housing and infrastructure development, protecting groundwater)	1-5	All	5
• Close roads through woodlands; designate roads on the edges woodlands with a 50 m buffer	4	Rec	6
• Monitor and prevent illegal cutting of mesquite	1, 3	Wc	7
• Control tamarisk and other weeds, and restore mesquite	3	Ex	8

• Ensure that construction and maintenance of roads and rights-of-way do not negatively impact mesquite woodlands.	1, 4	In	9
• Monitor and prevent illegal dumping in woodlands	3		10

9. Arrow Canyon

Arrow Canyon is BLM-managed, and much of it occurs in the Mormon Mesa Desert Tortoise ACEC; a small portion of the remainder lies in the Arrow Canyon Wilderness Area. Thus, this woodland is reasonably well protected from many threats and is of lower priority for conservation actions (see Table 18). It is a candidate metapatch for mitigation of loss of other habitat, if means to increase tree density and mistletoe abundance can be found.

Main conservation objectives:

1) Protect and increase the current extent of the acacia woodland.
2) Determine if acacia depends on groundwater levels; if so, maintain or improve.
3) Maintain or improve habitat quality.
   - Determine causes of low level of mistletoe infection and low tree density; encourage infection and tree recruitment if feasible.
4) Prevent damage to trees and woodlands from grazing, fire, recreation, and construction and maintenance of roads. If damage occurs, restore woodlands.

Table 18. Main conservation actions for the Arrow Canyon metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain lands in Federal ownership and incorporate all acacia woodlands not in the Wilderness Area into the ACEC	1, 4	All except Ex, Gw	1
• Determine if these woodlands use groundwater table; if so maintain table at current or higher levels	2	Gw	2
• Close road through wash, designate or close other roads	2, 3	In	3
• Limit OHV use to designated roads and trails and prohibit OHV speed events	2, 3	In, Rec	4
• Control *Schizmus* and *Bromus*	2, 3	Ex, Fire	5

10. Gold Butte SW

Most this metapatch lies in the BLM's Gold Butte B ACEC, with small portions in the Gold Butte Townsite ACEC or on NPS land. The existence of illegal grazing and the possibility of geothermal prospecting among other threats make this metapatch of moderate priority for conservation actions (see Table 19). Again, it is a candidate metapatch for mitigation of loss of other habitat, if means to increase tree density and mistletoe abundance can be found.

Main conservation objectives:

1) Protect and increase the current extent of the acacia woodland.
2) Maintain or improve habitat quality.
3) Prevent damage to trees and woodlands from grazing, fire, recreation, and construction and maintenance of roads and geothermal plants. If damage occurs, restore woodlands.

Table 19. Main conservation actions for the Gold Butte SW metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain lands in Federal ownership and incorporate all acacia woodlands currently in ACECs into the Gold Butte B ACEC. Upgrade protections for woodlands in this ACEC to those described in Appendix F	1. 3	All except Ex, Gw	1
• Determine if these woodlands use groundwater table; if so, maintain table at current or higher levels	2	Gw	2
• Designate or close roads.	2, 3	In	3
• Limit OHV use to designated roads and trails, and prohibit OHV speed events	2, 3	In, Rec	4
• Control *Schizmus* and *Bromus*	2, 3	Ex, Fire	5

11. Mormon Mesa E

Approximately three-quarters of this metapatch are in the Virgin River ACEC; the rest is on NPS and private lands. It is not well known, but currently appears to face few threats and thus is of low priority for management actions (see Table 20), although this situation could change as the towns along the Virgin River grow. This metapatch may provide opportunities for increases in woodland size and quality if flood control is properly managed, tamarisk is controlled and restoration is feasible.

Main conservation objectives:

1) Protect or increase the current extent of the mesquite woodlands.
2) Maintain groundwater at current or higher levels; ensure suitable water management.
3) Maintain or improve habitat quality.
4) Prevent damage to trees and woodlands from fire, woodcutting, recreation, and construction and maintenance of roads and rights-of-way. If damage occurs, restore woodlands.

Table 20. Main conservation actions for the Mormon Mesa E metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain all Federal woodlands in Federal ownership; upgrade protections of ACEC to levels described in Appendix F	1, 3	Ur, Ag	1
• Ensure that water management/flood control projects do not negatively impact mesquite woodlands	1, 2, 3	Wm	2
• Follow other Groundwater Actions listed in Table 8b	2, 3	Gw	3
• Control tamarisk and restore mesquite	1, 3	Ex	4
• Acquire woodlands on private lands, especially parcels with large woodland patches and those that provide connectivity	1	Ur, Ag	5

12. Bunkerville

Most of this metapatch is in the Virgin River ACEC; the rest is on BLM land with no special protection, and on NPS and private lands. It is not well known, but currently appears to face a moderate level of threat from its proximity to Bunkerville and Mesquite, and is a moderate priority for conservation actions (see Table 21). Some of the BLM land is within the disposal boundary, but it is discretionary and it is recommended that it be withdrawn as per BLM(111). This metapatch may provide opportunities for increases in woodland size and quality if flood control is properly managed, tamarisk is controlled, and restoration is implemented in a cost-effective fashion.

<u>Main conservation objectives:</u>

1) Protect or increase the current extent of the mesquite and acacia woodlands.
2) Maintain groundwater at current or higher levels; ensure suitable water management.
3) Maintain or improve habitat quality.
4) Prevent damage to trees and woodlands from fire, woodcutting, recreation, and construction and maintenance of roads and rights-of-way. If damage occurs, restore woodlands.

Table 21. Main conservation actions for the Bunkerville metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain all Federal woodlands in Federal ownership, including withdrawing lands from disposal boundaries; upgrade protections of ACEC to levels described in Appendix F	1, 4	Ur, Ag	1
• Ensure that water management/flood control projects do not negatively impact mesquite woodlands	1, 2, 3	Wm	2
• Control tamarisk and restore mesquite	1, 3	Ex	3
• Follow other Groundwater Actions listed in Table 8b	2, 3	Gw	4
• Acquire woodlands on private lands, especially parcels with large woodland patches and those that provide connectivity	1	Ur, Ag	5

13. Nelson

This metapatch is a mix of BLM, private, and NPS-managed woodlands. None of the public lands have special management protections. Combined with the presence of a variety of threats, this metapatch is of moderate concern for conservation actions (see Table 22). It may provide opportunities for increased extent or quality of habitat if acacia densities and mistletoe infection can be increased.

<u>Main conservation objectives:</u>

1) Protect the current extent of the acacia woodlands; increase where possible by connecting woodlands.
2) Determine if acacia depends on groundwater levels; if so, maintain or improve.

3) Maintain or improve habitat quality:
   - Ensure mixed tree age class distribution, including sufficient acacia recruitment to at least replace senescent trees.
   - Increase acacia density in Techaticup Wash to densities similar to those in the wash north of Roger's Spring.
   - Determine the causes of low level of mistletoe infection in lower Techaticup Wash; encourage infection if feasible.
4) Prevent damage to trees and woodlands from grazing, fire, recreation, and construction and maintenance of roads, rights-of-way and mines. If damage occurs, restore woodlands.

Table 22. Main conservation actions for the Nelson metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain lands in Federal ownership and incorporate all BLM woodlands into an ACEC with the restrictions described in Appendix F	1, 4	All except Ex, Gw	1
• Determine if these woodlands use groundwater table; if so maintain table at current or higher levels	2	Gw	2
• Close road through wash, designate or close other roads.	2, 3	In	3
• Limit OHV use to designated roads and trails and prohibit OHV speed events	2, 3	In, Rec	4
• Control *Schizmus* and *Bromus*	2, 3	Ex, Fire	5
• Close the woodlands to new mines; limit impacts of existing mines.	3	In	6

14. Corn Creek

This metapatch is on the FWS Desert Wildlife Range and receives a high level of protection. It is faced with few threats, and is of low priority for conservation actions (see Table 23).

<u>Main conservation objectives:</u>

1) Protect the current extent of the mesquite woodlands.
2) Determine groundwater levels and maintain at current or better levels.
3) Maintain or improve habitat quality:

- Ensure mixed tree age class distribution, including sufficient mesquite recruitment to replace senescent trees.
- Increase mesquite density in areas near buildings and springs.
- Manage to achieve an average of <5 primary stems per tree in areas near buildings and springs.

4) Prevent damage to trees and woodlands from recreation, and construction and maintenance of roads and facilities. If damage occurs, restore woodlands.

Table 23. Main conservation actions for the Corn Creek metapatch.

Conservation Action	Objectives Met	Threats Addressed	Priority
• Retain lands in Federal ownership; manage with the restrictions described in Appendix F	1, 4	All except Ex, Gw	1
• Maintain water table at current or higher levels	2, 4	Gw	2
• Ensure that recreation and associated development do not negatively impact woodlands	3, 4	Rec, In	3

C. Global Prioritization of Conservation Actions and Timeline for their Implementation

The county-wide prioritization of conservation actions across high priority metapatches (e.g. should Action 2 of Metapatch 1 be implemented before or after Action 1 of Metapatch 2) should not be fixed in the CMS; rather, managers should be given flexibility to take advantage of conservation opportunities, and be encouraged to respond to urgent situations. County-wide prioritization should be guided by two principles: a) the Biological and Concern Ranking of the Metapatch, so that resources are directed first to the highest ranked patches, and b) the following general hierarchy of conservation actions, reflected by the rankings in General Conservation Actions: 1) acquisition/withdrawal from disposal for highly ranked metapatches, 2) large-scale and sustaining management (maintaining groundwater and current level of protection; decreasing threats like fire and tamarisk that affect large portions of woodlands), 3) small-scale and enhancement management (minimizing threats like wood-cutting and grazing, elevating the management status of a woodland), and 4) restoration. Most research studies may be viewed as medium to high priority. Actions requiring no inputs in terms of money or personnel should be implemented without hesitation, regardless of priority or metapatch ranking.

For example, the top two conservation actions listed for the Muddy River metapatch are higher priorities than the top action for the Priority 2 metapatches, but the top-priority action of the latter should probably be implemented before the third- and fourth- priority action of the Muddy River metapatch. The lowest priority Muddy River actions should probably be implemented after more high or medium priority actions from Priority 2 and 3 metapatches have been implemented, unless unique opportunities arise.

In this CMS, the Muddy River metapatch must be singled out for conservation attention (the Big Bend metapatch also warrants special attention, but it is largely in the purview of the Lower Colorado River MSCP). Although generally it may be possible (albeit difficult) to enhance a metapatch to mitigate for the loss of another metapatch, the unique ecological associations of the Muddy River appear to be irreplaceable. Mitigation for the habitat of an individual species that occupies the Muddy River may be possible in another metapatch, but not mitigation for the whole community. The only potential candidate riparian mesquite woodlands are equally imperiled; the better-protected acacia woodlands in washes of far southern Nevada simply are not surrogates. Several covered species are found only in this type of riparian association, or, like the Yellow-billed Cuckoo, occur only at the Warm Springs Ranch; also this woodland patch is the only one surveyed in which Phainopeplas have consistently positive nest success. Moreover, loss of mesquite and other trees along the Muddy River will likely affect fluvial processes to the extent that they further threaten the federally endangered Moapa Dace. It is difficult to see how a central goal of this CMS (and the MSCHP) -- that of maintaining populations of covered species in the county -- can be met without acquiring the key private parcels along this river, protecting all public land (including those in the disposal boundary), and sustaining the groundwater in this area.

In general, very high priority actions include securing in public ownership or private conservation easements the Warm Springs Ranch and other large woodland patches in the Muddy River metapatch, followed by entering into conservation agreements with various entities in the Big Bend metapatch, and acquiring large woodland patches in the Overton metapatch. The next, or simultaneous, actions should be maintaining the public ownership and condition (i.e. preventing the spread of tamarisk, fires and roads etc) of the Muddy River, Big Bend, Overton, Hiko, Piute, Grapevine, and North Las Vegas metapatches, in approximately that order. Note that maintaining the condition of these metapatches requires sustaining the groundwater table (except for some of the acacia metapatches).

It is impossible to set a definitive timeline for these conservation actions without knowledge of agency and county budgets and staff availability, and other agency priorities. A top priority of the next mesquite and acacia Technical Advisory Group (TAG) meeting (which should be held in March 2006) should be to discuss each agency's available funds and staff, to decide which and how many of the top priority actions can be implemented in 2006, and to determine how much money and personnel should be assigned to (or solicited for) actions in 2007.

That being said, a vague timeline for some actions can be established. The time-consuming process of acquiring (or withdraw from land disposal) high priority and at-risk woodlands should begin immediately, before they are developed and/or land prices further increase, as should attempts to secure guarantees for the ground water table that supports these woodlands. In general, most of the General Conservation Actions ranked 1 or 2 should be initiated, if not completed, by the end of 2007. Monitoring should begin immediately with available funds, and high priority research and monitoring studies should be funded for the next biennium through the County.

D. Adaptive Management and Performance Measures

Management of mesquite and acacia woodlands must be done adaptively; that is, by conducting conservation actions, research studies, and monitoring in a manner that maximizes the opportunities for gaining new knowledge of the system and for evaluating hypotheses about the effect of different stressors on ecological relationships. Conservation actions recommended in this CMS should be implemented such that a scientific assessment can be made as to their efficacy, and management adapted accordingly. This process has several steps: 1) specification of a conceptual model of the system, 2) postulation of an hypothesis regarding the effect of the action an explicitly defined variable (or "performance measure"), 3) collection of baseline data before the action is initiated, 4) replication of the action at several sites, to be contrasted with control sites subject to the same stressor but where no action is initiated, and/or 5) evaluation of the hypothesis and conservation action in light of the results of the study (Figure 14). As this process enhances understanding of the system, conservation objectives and even the conceptual model can be modified appropriately.

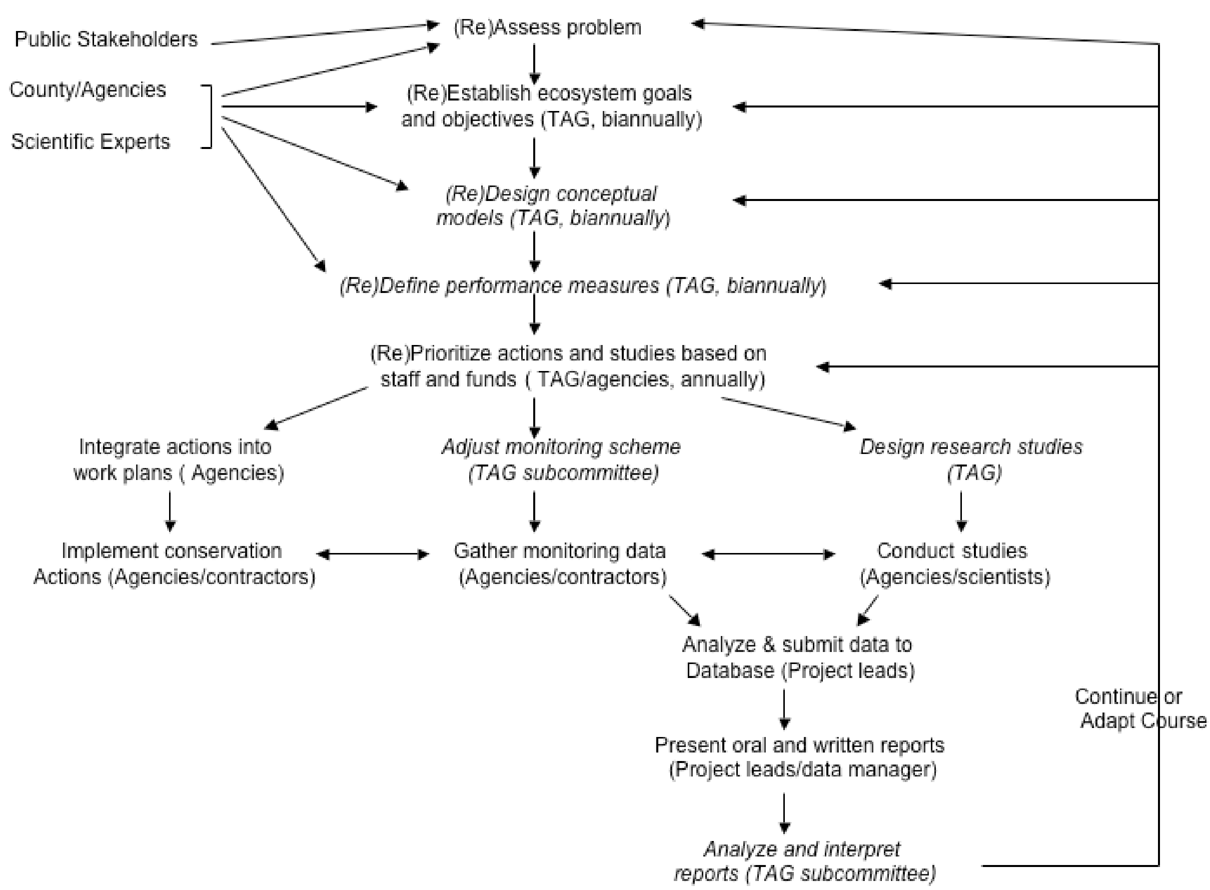

Figure 14. Recommended adaptive management framework for developing and refining performance measures, determining conservation, monitoring and research actions, and incorporating new information into the CMS. The group responsible for each stage is listed in parentheses. All stages below "Prioritize actions and studies…" should be conducted annually. Elements in italics are those that require additional input from scientific experts.

The development of a conceptual model and identification of the most important performance measures require the collective knowledge of a team of scientific and management experts, because those tasks involve the determination of key linkages between the system's ecological attributes, and of the variables (performance measures) to measure given the stressors on the system. At a minimum, performance measures must be identified for management planning, management implementation, programmatic adaptive management and monitoring, and can be drawn from any part of the conceptual model (drivers, linkages, outcomes; Murphy 2005). Also, appropriate means to evaluate those measures must be specified. It is highly recommended that Clark County assemble a team, which will include members of the current TAG, and conduct a workshop to accomplish these tasks by June 2006.

Although program constraints may limit the number of performance measures, and the intensity and frequency at which they can be monitored, the use of multiple measures enhances opportunities to learn about the system and efficiently target conservation actions (Murphy 2005). Potential performance indicators for this CMS include:

1) Remotely sensed data (DOQQs or multi-spectral images) to evaluate changes in the extent of mesquite and acacia woodlands. These data should be collected and analyzed every five years.
2) Direct measures of physical processes in and near woodlands (e.g., water table depth, floodplain features, soil composition). These data should be collected and analyzed every 3-5 years (depending on the variable and on logistic constraints).
3) Direct measures of woodland composition and structure (e.g., mesquite and acacia recruitment, tree density, tree diameter, tree height, mistletoe abundance, and tree species presence/absence). These data should be collected and analyzed every 3-5 years (depending on the variable and on logistic constraints).
4) Indices of the abundance and productivity of key biotic indicators. These species should represent a variety of taxa of concern in this CMS and any other species determined to be good indicators (shrubs, forbs and grasses, bees and butterflies, and vertebrates). These data should be collected and analyzed every 1-5 years, depending on the type of data (presence/absence vs. productivity) and taxon in question.

Monitoring of these performance measures should occur regularly at the Priority 1 – Priority 4 woodlands, such that each time a given variable is measured, it is sampled at each priority woodland, which will serve as “sentinel” sites. The remaining woodlands should be surveyed on a rotating basis, such that they are visited every other or every third interval. For example, assume there are 10 priority and 30 non-priority woodlands, and presence/absence of a bird species is to be monitored every year. In the first year, all 10 priority woodlands and the first 10 non-priority woodlands (randomly selected) should be sampled; in the second year, all 10 priority woodlands and the next 10 randomly selected non-priority woodlands should be surveyed, and so on. Care should be taken that all sampling for each performance measure occur at the same time of year each year, and at the most suitable time for that measure. More specific timing and frequency of sampling for different indicators and performance measures should be decided during the workshop recommended above, based on reference to the conceptual model, project goals, historical data and power analyses of the sample size necessary to detect trends (Murphy 2005).

This scheme maximizes the ability to detect changes in the performance measures, given limits on funds and personnel. The variation in monitoring frequencies for different measures accommodates longer response times of some elements of the system, and budgetary and time constraints, while allowing for some more immediate feedback from biotic indicators into the adaptive management process. Workshop participants should be asked to predict expected values or trends of the performance measures given a certain management action (i.e. formulate a directional hypothesis) and to establish a value of the performance indicator that would trigger a management response.

The TAG should coordinate and determine responsibilities for monitoring, meeting as early as spring 2006 to establish baseline monitoring programs based on the recommendations of the CMS. Most responsibilities will naturally assign themselves; e.g. to the appropriate land manager for monitoring of the structure and composition of woodlands, or to NDOW for wildlife inventories. A key requirement is that the TAG develop and the agencies follow a consistent monitoring protocol for each performance measure so that data are comparable across woodlands and jurisdictions. Data, including spatial data, should be reviewed and entered, and a preliminary analysis conducted by each agency. All data should be transferred and stored as per the MSHCP's requirements. One agency should be nominated to perform synthetic analyses for performance measures with data from multiple agencies.

IMPLEMENTATION PLAN

The general process for implementing the CMS, including adaptive management, is described in Figure 13. As noted above, the ideal first step to this process is convening a workshop by June 2006 to review the conceptual model and determine performance measures. This workshop will determine the actions and monitoring studies for the next two years, and will help the County identify important themes for the next biennium's Call for Proposals. Meanwhile, the TAG should meet in March 2006 to identify preliminary performance measures, conservation actions, and research and monitoring studies to be conducted during the spring and summer of 2006.

Thereafter, the TAG should meet at least annually, probably in the winter. At this meeting, the TAG can review the recommendations of its technical subcommittee, which should be formed in March 2006. This subcommittee will analyze and interpret the results of research and monitoring, if necessary with the assistance of outside scientific expertise. Leaders of research and monitoring teams should give brief oral presentations of results and conclusions to the subcommittee, with presentation materials sent to TAG member two weeks before the meeting. This process will enable the subcommittee to make modifications to monitoring schemes, and to recommend to the larger TAG any changes in goals, conceptual models, and performance measures, or the priority of conservation actions. With input from agencies and the subcommittee, the TAG can reassess site rankings as new information becomes available on the sites themselves and on the most important biological criteria.

In summary, different parts of the CMS will be reviewed and updated with varying frequency. Annually, adjustments can be made to the targets, frequency and intensity of monitoring schemes; as well as to the nature and priority of research studies and conservation actions. At least biannually, ecosystem goals and objectives, conceptual models and performance measures should be reviewed and updated. The rest of the CMS should be updated every 5-10 years, with the spatial data, description of the existing environment, status of associated species and reassessment of the basic problem should be brought up to date every five years, and the introduction and literature review updated every ten years.

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APPENDIX A. CHARACTERISTICS AND STATUS OF SPECIES INCLUDED IN THE CMS

A.1. BIRDS

Species	Latin Name	Status	Distribution (special)	Elevation (m)	Season	Mesquite (M) or acacia (A)	Strength of association	Use	Use mistletoe	Riparian?	Stand structure	Canopy cover	Stand age	Territory size	Patch size	Population trend (BBS 1966-2004)	Threats	Comment
Abert's towhee	*Pipilo aberti*		N edge	≤1370	Year	M	M-H	nest in	nest	Y	dense, diverse	high	older	1.5 - 2 ha	large	local decl, no data for range	1, 1f, 2	endemic to desert SW
Arizona Bell's vireo	*Vireo bellii arizonae*	Covered		<1300	Summer	M (A)	M	nest in		Y	dense (shrubs)		younger		NK	decl in US range	1, 2	dense shrub layer v. imp; not clear if needs large or small patches; high or low canopy cover
Ash-throated flycatcher	*Myiarchus cinerascens*	NV PIF		0-2400	Summer	M, A	M-H	nest in		S	open, or edge		older	1-36 ha		stable in NV, Mojave	1	need woodpeckers to make cavities in large trees
Bendire's thrasher	*Taxostoma bendirei*	Eval.		<1800	Year	M, A	M-H	nest in	occas nest	S	open					decl in US range	1, 1f, 1g	need low dense cover in lateral branches
Black-tailed gnatcatcher	*Polioptila melanura*		N edge	<1000	Year	M, A	H	forage in, nest in	nest	N	dense?			1 ha		nearly sig. decl in US range	1a, 1i	like overhanging cover for nest
Black-throated sparrow	*Amphispiza bilineata*			<1500	Year	M, A	M	nest in	nest in	S	semi-open	some tall trees		0.84 - 2.6 ha		sig decl in US range	1a, 1c	doesn't use urban landscaping
Blue Grosbeak	*Passerina caerulea*	Covered	NW edge	low	Summer	M	L	general assoc?		Y	edge or open	low		NK		stable in western US	1b, 2?	high ground cover, low shrub density, low canopy. Near clearings.
Crissal thrasher	*Taxostoma crissale*	BLM	N edge	< ~1800	Year	M, A	H	nest in	occas nest	S	dense (edge of)			3.8-6.9 ha		Not known, poss decl in western US	1a, 1b, 1c	like low veg; nest in center of densest shrubs/thickets, sometimes on overhanging branch
Greater roadrunner	*Geococcyx californianus*		N edge	NK	Year	M	M	nest in		S	open, edge			7-8 km diam	smaller?	Not known, apparently stable	1a, 4, 5, 6	nest in thickets in otherwise open areas; like high diversity of spp and size next to nest
Ladder-backed woodpecker	*Picoides scalaris*		N edge	0 - 2300	Year	M (A)	M	nest in		S						decl in US, including West	1f?	
LeConte's thrasher	*Taxostoma lecontei*	Eval., BLM	N edge	low	Year	M, A	M	nests in		N	v open	none		7.34 ha		stable in western US	1a, 1c, 1e, 1f, 5	like LOW shrubs, leaf litter; nests need low dense cover in lateral branches
Loggerhead shrike	*Lanius ludovicianus*	NDOW, BLM, NV PIF		900 - 2800	Year	M, A	L	nest in	nest in	N	open			4.6-25		sig decl in western US	1c, 5	high cover at nest
Long-eared owl	*Asio otus*	BLM		<3000	Year	M	M	roost in, nest in?		S	dense next to open		older	n/a		stable or decl	1a	use mesquite groves (smaller woodlands)
Lucy's warbler	*Vermivora luciae*	BLM, NV PIF	N edge	<1200 (1700)	Summer	M, A	H	nest in		Y	dense	high	older	~ 0.2 ha	larger	stable across range, local decl.	1d, 1g	v. close tied to mesq, tho use tam.
Phainopepla*	*Phainopepla nitens*	Covered	N edge	<1200	Winter/ Spring	M, A	H	nest in, food	nest in, eat	S	dense		older		larger	decl in Mojave, western US	1a, 1c, 1d, 1g, 1j	
Sage thrasher	*Oreoscoptes montanus*	NDOW, NV PIF		<3660	Winter (Year)	A?	L	food	eats	S	semi-open		older	0.5-1.7 ha	large	decl in US range	1	one source says breeds in Clark Co, other doesn't.
Scott's oriole	*Icterus parisorum*	Watch, NV PIF	NW edge	higher	Summer	M, A	L	nest in	eat?	N?				NK		stable in western US	1	
Southwestern Willow Flycatcher	*Empidonax traillii extimus*	End., NDOW		low	Summer	(M)	L	donÕt		Y	dense		younger	<1.5 ha		decl in western US	1a, 1d, 1f, 1i	wooded desert streams, dense shrubs
Summer Tanager	*Piranga rubra*	Covered	N edge	low	summer	M, A	M	nest?		Y		v. high		9 - 11 ha		incr in western US	1c	
Verdin	*Auriparus flaviceps*		N edge	low	Year	M, A	H	forage in, nest in,		S	dense?			0 - 8 ha		decl in US range	1a, 1c, 1e	nest in low foliage cover
Vermilion flycatcher	*Pyrocephalus rubinus*	Covered	N edge	<3000	Year	M	H	nest in		Y	open, semi-open	not high	older			stable in US range	1a, 1c, 1d, 2?	
Western bluebird	*Sialia mexicana*	NV PIF		900 - 2700	Winter	M, A	M	food	eats	S	open, edge	low				sig decl in western US	1a, 1f, 1g, 3	exotic animals compete for nest cavities
Western screech owl	*Otus kennicotti*	Watch		<1300	Year	M	M	nests in??		Y	semi-open?	low	older	nests 400 m apart		NK (stable or decl)	1a, 1c, 6	cavity nester-needs big trees
Yellow-billed cuckoo	*Coccyzus americanus*	Covered, NDOW	uncerta in in NV	0 - 2400	Summer	M	L-M	nest in	nest in?	Y	dense next to edge	10-80%	older	0-4 ha (20?)	>30 ha	decl in western US	1a, 1c, 1d, 1i, 2, 5, 7	need high humidity; dense understory of mesq 3-4 m tall, tall overstory; next to open areas

Abbrevations: Eval. = Evaluation, NV PIF = Nevada Partners in Flight, L=Low, M=Moderate, H=High, NK=Not known, decl. = declining

Key to Threats: 1. Habitat Loss and Degradation, due to: a. urbanization, b. suburban development, c. agriculture, d. water management, e. recreation, e.g. OHV, f. grazing, g. woodcutting, h. yucca harvest, i. exotic plants, j. fire; 2. Brood parasitism; 3. Competition from exotic animals; 4. Poaching; 5. Pesticides; 6. Traffic mortality; 7. Tower collisions.

Source: Birds of North America Species Accounts, Southwestern REGAP, Clark County MSCHP Database

A.2. REPTILES AND AMPHIBIANS

Species	Latin Name	Status	Distribution (special)	Elevation (m)	Mesquite (M) or acacia (A)	Strength of Association	Riparian?	Stand structure	Topography	Soils	Population trend	Threats	Comment
Banded gecko*	*Coleonyx variegatus*	Covered	desert southwest		M, A	M	S			rocks	NK	1, 2, 4, 8	
Banded Gila monster*	*Heloderma suspectum*	Eval., NDOW, BLM	eastern Mojave, northern Sonora	30 - 1500	M, A	L	?		hills, bajadas	rocky	NK	2, 3, 5, 6	
California king snake	*Lampropeltis getulus californiae*	Covered	desert southwest		M	L	S						generalist
Common zebra-tailed lizard*	*Callisaurus draconoides draconoides*	Watch											
Desert iguana*	*Dipsosaurus dorsalis*	Covered	Amargosa, Colorado and Virgin R	<1000	M	L	N		flood-plains, washes, bajadas	sand, firm ground	NK	1 , 3, 4, 5	mostly creosote associate
Desert night lizard*	*Xantusia vigilils*	Eval.	Colorado and Mojave	<2855	M, A	M	N				NK	5, 8	needs cover, esp. downed logs
Great Basin collared lizard*	*Crotaphytus insularis bicinctores*	Covered	Great Basin, Mojave	<2300	M, A	M	N	open	slopes, washes	rocky	NK	4, 5	
Large-spotted leopard lizard	*Gambeila wislizenii wislizenii*	Covered		0-2100	M, A			open		rocky, sand, clay			
Sidewinder*	*Crotalus cerastes*	Covered	northern edge	<1370	M, A	M	N	open, semi-open	valleys, washes, dunes	rocky, sand	NK	1, 3, 4, 5, 9	
Southern desert horned lizard*	*Phrynosoma platyrhinos calidiarum*	Eval., BLM	desert southwest	<2000	M, A	L	N		flats, dunes, washes	sandy	NK	2, 3, 4, 5	
Western chuckwalla*	*Sauromalus obesus*	Covered, BLM	desert southwest	<1800	M, A	M	N		slopes	well-drained	local decl	5	
Western red-tailed skink*	*Eumeces gilberti rubricaudatus*	Covered, BLM	Spring, Sheep, Newberry Mtns	mon-tane		L	Y			rocky	NK	2, 3, 4, 5, 7, 8	

Abbreviations: NK= Not known, L=Low, M=Moderate, H=High, Y=Yes, S=Somewhat, N=No

Key to Threats: 1. Urban development, 2. Mining, 3. Recreation, including OHV, 4. Roadkill, 5. Commerical collection, 6. Predation by feral animals, 7. Fire suppression, 8. Wood collection, 9. Rural development

Source: Southwestern REGAP, Clark County MSCHP Database

A.3. MAMMALS

Species	Latin Name	Status	Distribution (special)	Elevation (m)	Mesquite (M) or acacia (A)	Strength of association	Riparian?	Stand structure	Canopy cover	Stand age	Home range	Topography	Soils	Population trend	Threats	Comment
Desert pocket mouse	*Chaetodipus pencillatus sobrinus*	Eval.	N edge	NK	M, A	M	S	open	some	older		NOT rocky hills	sand (deep)	NK	1, 6	uses tamarisk
Kit fox	*Vulpes macrotus*	Eval.	W N Am	20 - 2000		L		open			5-12.3 sq km		sand, clay		1, 2, 3, 4	
Bushy-tailed woodrat	*Neotoma cinerea lucida*	Eval.	W N Am	0 - 3600								hills, rocky outcrop				
Nuttall's cottontail	*Sylvilagus nuttallii*	Eval.	Inter mtn W	1200 - 3500				open, semi-open				hills				
Pale Towsend's big-eared bat	*Corynorhinus townsendii pallescens*	Eval., NDOW, BLM	W N Am	0 - 3160	M	L-M						cliffs, caves, mines				needs caves or mines
California leaf-nosed bat	*Macrotus californicus*	Watch, BLM	N edge	1220	A	L-M	Y					cliffs, hills			5	needs caves or mines
Pallid bat	*Antrozous pallidus*	NDOW, BLM	W N Am	0 - 2400			Y					rocky outcrop				don't need caves or mines

Abbreviations: NK= Not known, L=Low, M=Moderate, H=High, Y=Yes, S=Somewhat, N=No

Key to Threats: 1. Urban development, 2. Recreation, 3. Roadkill, 4. Hunting, 5. Disturbance to roosts, 6. Small population

Source: Mammalian Species Accounts, Southwestern REGAP, Clark County MSCHP Database

A.4. INSECTS

Species	Latin Name	Distribution (special)	Season	Mesquite (M) or acacia (A)	Strength of association	Use?	Use mistletoe	Threats
Butterflies:								
Western great purple hairstreak	*Atlides halesus*	N edge	Feb-Dec	M, A	H	host plant, nectar	host plant, nectar	development, woodcutting
Leda hairstreak	*Ministrymon leda*	N edge	Apr-Oct	M	H	host plant, nectar		
Dammer's fatal metalmark	*Calephelis nemesis*	Moapa	June-Oct	*in Baccharis*	L			clearing of vegetation
Western Palmer's Metalmark	*Apodemia palmeri*	NE edge	Apr-Oct	M	H	host plant, nectar		
Bees:								
	Perdita ashmeadi simulans Timb				H	Pollen specialist		
	Perdita difficilis Timberlake				H	Pollen specialist		
	Perdita exclamans Cockerell				H	Pollen specialist		
	Peridita innotata Timberlake				H	Pollen specialist		
	Perdita luciae decora Timberlake				H	Pollen specialist		
	Perdita pallidipes Timberlake				H	Pollen specialist		
	Perdita prosopidis Timberlake				H	Pollen specialist		
	Perdita punctosignata flava Timberlake				H	Pollen specialist		
	Perdita punctosignata sulphurea Timberlake				H	Pollen specialist		
	Perdita sonorensis Cockerell				H	Pollen specialist		
	Perdita stathamae eluta Timberlake				H	Pollen specialist		
	Perdita triangulifera Timberlake				H	Pollen specialist		
	Colletes algarobiae Cockerell				H	Pollen specialist		
	Hylaeus sejunctus Snelling				H	Pollen specialist		
	Megachile newberryae Cockerell				H	Pollen specialist		
	Megachile odontostoma (Cockerell)				H	Pollen specialist		
	Ashmeadiella prospidis(Cockerell)				H	Pollen specialist		
Other bees						generalist		

Abbreviations: L=Low, M=Moderate, H=High

Sources: Murphy and Austin, unpubl. MS; T. Griswold, pers. comm.

A.5. PLANTS

Species	Latin Name	Status	Distribution (special)	Elevation (m)	Mesquite (M) or acacia (A)	Strength of association	Riparian?	Canopy cover	Topography	Soils	Population trend	Threats
Desert mistletoe	*Phoradendron californicum*		N edge		M, A	H	S					1, 3, 5, 9, 10
Las Vegas Bear Poppy*	*Arctomecon californica*	Covered	eastern Mojave	<1110	M, A	L	N	sparse	slopes, ridges	gyp-siferous	declining	1, 2, 3, 4, 6, 8
Barrel cactus	*Ferocactus acanthoides* var. *Lecontei*	Watch	desert southwest, Mexico	<600	A	L			slopes	gravel, sand		7
Pahrump Valley wild buckwheat*	*Eriogonum bifurcatum*	Covered, BLM	Mojave	<850	M	M	S	sparse	lowlands, playas	saline clay or silt	Not known	1, 4, 6, 10
Parish phacelia*	*Phacelia parishii*	Covered, BLM	desert southwest	<1200	M	L	Y		lowlands, playas	silt, clay	declining	2
Las Vegas Buckwheat*	*Eriogonum corymbosum*	BLM	Clark Co.	579 - 1170	A	M	S		washes, low relief	gyp-siferous	rapid decline	1, 2, 3, 4, 6

Abbreviations: L=Low, M=Moderate, H=High

Key to Threats: 1. Urban Development, 2. Mining, 3. Water management, 4. OHV use and roads, 5. Fire, 6. Dumping, 7. Collection, 8. Pollinator decline, 9. Grazing, 10. Conversion to agriculture

source: Nevada Heritage Database http://heritage.nv.gov/atlas/atlas.html*

APPENDIX B. BLM GIS PROTOCOL FOR MAPPING ACACIA AND MESQUITE WOODLANDS

Tracy Liang and Jodie Lucas: June 30 – December 24, 2004
Refinements (in blue) from Ann Ollila and Brian Walker: June – July 2005

The collection methods used to map acacia and mesquite were refined early in the project to improve efficiency and practicality. The project began without any set standards on what should or should not be mapped, as well as, what attributes at each location needed to be recorded. With this in mind, we developed the criteria (see below) for the project after spending some time in the field, looking at areas already mapped, and reviewing the goal of the project, which was to find mesquite and acacia woodlands that might provide habitat to MSHCP covered species, such as the Phainopepla.

We started this project by visiting areas previously mapped by Cali Crampton/Lisa Smith, Cris Tomlinson and Jeri Krueger. This helped us to get an idea of what to look for. We noticed that many of the areas previously mapped existed in association with some type of hydrological feature, and covered large areas that varied in the shape, size and fragmentation of woodlands. The density of mistletoe infection and host trees also varied. With this information and the use of topographic maps, we were able to develop a consistent method for deciding where to map.

Before going out to the field, we looked at a topographic map, starting with the southern areas within Clark County and gradually working north. Within each general area, we would look more closely at the landscape level of the topographic map to see where washes and other water features occurred.

We began by looking at DOQQs and marking areas that looked like possible mesquite/acacia habitat. We then drove to those areas and took points and lines along the way when habitat was encountered. Our predictions of habitat from the DOQQs were fairly accurate and we covered most of the drivable roads or washes while looking for those points. We were unable to visit all possible sites, since some roads were severely eroded due to weather.

Once we decided on a general area to visit we would drive out to the location using as many jeep trails as possible to get there. Driving the back roads was the most effective method to ground truth many of the washes we planned to look at. The jeep trails usually crossed over or paralleled a wash which allowed us to map multiple washes during one trip. If they crossed a wash, we would map a point where they crossed, then we would walk a few hundred meters down the wash to see if it continued. When we foudn a wash or hillside without acacia or mesquite we would document where that was on the topographic map to maintain an organized search. We also revisited most of areas that were mapped previously to verify the boundaries of mapped data.

Criteria were established in order to know what to map and what not to map. An acacia or mesquite stand needed to cover at least 1 acre to be mapped and documented regardless of tree density and amount of mistletoe infection. This was necessary to avoid mapping a very small stand or a single tree. If the stand was less than an acre it was not GPSed, but is was noted on the topographic maps as an area visited. If the stand did meet the criteria we would GPS a point or line in that location. If an area was inaccessible to drive through or too large to map by foot we would map a point somewhere within the stand. In most cases, we would map a point where a road crossed a wash containing acacia. A line was used when we could drive alongside or through a wash containing acacia or mesquite.

In 2006, Cali provided more specific criteria for identifying GPS-worthy stands based on phainopepela habitat requirements (see Appendix B). We GPSd stands that were at least 0.4 Ha and the trees were not further than 50 meters apart. This 0.4 Ha rule could be modified if the stand was particularly dense with either trees or mistletoe. We would attribute the stand with a slightly modified data dictionary (see below).

When a point or line was mapped we would also include a list of attributes for each site. These were recorded in the data dictionary found in the GPS unit. The following is the structure for the data dictionary:
(If marked with a *, refer to the glossary for additional procedural information)

<u>*Comment:</u>

<u>*Species:</u>

Honey Mesquite
Tamarisk
Acacia
Desert Willow
Screw bean Mesquite
Dune Mesquite
Other

<u>Acres:</u> (measured by area) (not in data dictionary-computer generated for digitized polygons)

<u>*Estimated Density:</u> (Tree Density)

Scattered
Low
Medium
High

<u>*Estimated Height:</u> (Tree Height)

<2m
2-4m
>4m

<u>*Mistletoe Infection:</u> (Mistletoe Infestatn)

Yes	Changed to:	Scattered
No		Low
		Medium
		High

<u>Associated Vegetation:</u> (Assoc_vegetation)

Mixed	Changed to:	Creosote/Bursage
Cholla		Blackbrush
Creosote		Mojave Mixed Scrub
Joshua tree		Pinon/Juniper
Yucca		Salt Desert

Cottonwood

Wildlife Observed:

Birds
Lizards
Mammal
Desert Tortoise
Many types

Added:
*Distance_Vis (m): write in

Date collected: date_collected

Collected By: (collected_by)
Jodi
Tracy
Other

*** Glossary ***

- The **comment** field was used to record any supplemental information for the sections listed and for further descriptions of the site location.
- The **species** selected represented the most dominant tree species of the area being mapped.
- The **density** selected was recorded as a representative density of the area being mapped. Scattered density was selected if the distribution of the trees contained large amounts of space between them. Low density was selected if the trees were in closer proximity but still separated. Medium density was selected if the trees were clumped together in various spots within the stand. High density was selected if the trees were consistently close together.
- **Estimated height** was recorded as a representative height from the area being mapped. We found that the most common height found in the Acacia stands was 2-4 meters.
- The density of **Mistletoe infection** in a stand was included in the comment section. Density gradients for the mistletoe infection were ranked similar to the tree densities.
- Distance Visible is the distance we felt we could accurately see the stand attributes including mistletoe infection.

The final step in the mapping process involved digitizing the points and lines collected in the field to create a GIS coverage. This was done by using the DOQQ's of a GPSed site and digitizing a polygon to represent the geographic extent of the Mesquite or Acacia community. This proved to be a very efficient method of mapping for very large areas. *What should be noted, however, is that the attributes for each polygon do not represent the entire area within its boundaries.* The attributes of each polygon only represent the area that was seen when mapping the point or line prior to digitizing. For each polygon we have manually entered a list of attributes.

We took our points and lines and created a buffer using the distance visible listed in the attribute table. We then modified the polygon created by the buffer to represent what we had recorded in the field notes. For example in our notes we recorded that acacia was only present on the north side of the road displaced 20 meters over in a wash. We edited the buffer polygon using the DOQQs and field notes to more accurately represent observed habitat. By recording distance visible, a confidence level is built into the digitized polygons. This method voids over estimating habitat.

APPENDIX C. RECOMMENDED CRITERIA FOR MAPPING MESQUITE AND ACACIA WOODLANDS

These criteria are intended to help field technicians determine and prioritize which mesquites and acacias to digitally map, and how to map them. They arose out of logistical concerns: was it worth the effort to map single trees, small woodlands, or highly scattered trees. These criteria are also an attempt to define when groups of trees constitute single or multiple woodlands. The criteria primarily have been developed from habitat requirements of Phainopeplas as reported in Kruger (1998), Chu and Walsberg 1999, and Crampton (2004). As habitat requirements of other species become available, they should be incorporated.

1. **Patch size**: At least 0.4 ha (av. Phainopepla territory size); contingent also on tree density and infection (map smaller patches if trees are dense or infected, larger patches if trees are scattered and uninfected).
2. **Tree density**: No greater than 50 m apart on average; if trees are more scattered than this, then don't map. Also contingent on infection (if very infected, could tolerate slightly lower density.
3. **Distance between patches**: If the distance between 2 groups of trees is > 200 m, then they are separate patches; otherwise are the same patch (we have observed Phainopeplas flying at least 200 m between stringers regularly; some territories comprise >1 stringer).

APPENDIX D. ADDITIONAL SURVEY NEEDS FOR MESQUITE AND ACACIA WOODLANDS IN CLARK COUNTY

The following are areas of Clark County that need further on-the-ground surveying and digitizing to a) improve the quality (e.g., accuracy, resolution amount of attributed information) of the current coverage, b) incorporate known stands in the coverage, or c) determine if they contain acacia and mesquite. These areas have been suggested by Cali Crampton, the BLM Interns of 2004 and 2005, TAG members, and/or Craig Stevenson of NDOW (see attached maps). Within sections they are organized geographically.

A. Areas currently in GIS coverage but that require more attention

1) to be groundtruthed as to the true extent of the habitat and possibly redigitized

- Areas denoted as Potential Habitat: Pahranagat/Moapa, Muddy Mountains, Nelson area, McCullough Mountains
- Overton/Logandale (coverage seems both incomplete and inaccurate and may not reflect mesquite vs. tamarisk; we redigitized some of it near the WMA, but it needs to be groundtruthed)
- Coyote Springs (southwest portion near SR 168; not sure to what extent these washes have acacia)
- El Dorado Valley (the northern part of the patch represented in the original BLM coverage does not seem to be accurate)
- Laughlin (Big Bend SP; need to separate mesquite vs. tamarisk; most of it is the latter, so the current coverage over-represents the amount of mesquite)
- Laughlin (BLM land just south of Big Bend SP along Colorado R; distinguish mesquite vs. tamarisk)

2) to be redigitized

- Moapa: (in areas of LDS Center, Warm Springs and Perkins Ranches (very coarsely digitized and does not reflect mesquite vs. other trees; also does not seem to include some smaller patches that appear to be acacia or mesquite-these need to be checked out). TNC may have better data).
- Coyote Springs (northwest portion near the recycling operation (the digitizing is very coarse, so the patch seems larger than it probably is)

B. Areas that have not been included in coverage (need to be surveyed, digitized, groundtruthed)

1) *Areas where acacia/mesquite has been seen but not surveyed or added to coverage (some shown in attached maps)*

- Gold Butte (Whitney Pockets to Quail Point)*
- Moapa: (washes off SR-168 west of Moapa to Warm Springs Rd)

- California Wash (west of I-15, and east of 1-15 north of Hwy 40)
- Valley of Fire SP (many washes have not been surveyed at all)
- Black Mountains
- Gale Hills
- Red Rock NCA (Mud Springs 1 and 2, springs at Oliver Ranch, and possibly others)
- Southern Bird Spring Range
- Southern Spring Mountains (west and south of Goodsprings)
- Nelson (Aztec Wash)
- Ireteba Mountains
- McCullough Mountains (west and northeast portions)
- Highland Range (especially southern half)
- Lucy Gray Mountains
- Laughlin (the area Christina mentioned)
- Laughlin (slope above (west of) the Needles Road, just south of SR 163
- Laughlin (mesquite along Colorado R between Big Bend SP and Fort Mojave)
- Fort Mojave (include habitat and distinguish mesquite vs. tamarisk)
- Ash Meadows (some habitat patches seem to not be in the coverage (e.g. Point of Rocks)

2. Areas where there is likely mesquite/acacia, based on topography

- Caladala Well

APPENDIX E. RECOMMENDED ATTRIBUTES TO RECORD DURING SURVEYS OF ACACIA AND MESQUITE WOODLANDS

These recommendations primarily have been developed from habitat requirements of Phainopeplas as reported in Kruger (1998) and Crampton (2004) and from information available in species accounts. As habitat requirements of other species are learned, they should be more fully incorporated. Because different species have different and often conflicting requirements (e.g. low vs. high tree density), the best approach is to describe/record each of the woodland's attributes rather than ranking the woodland's quality (unless it is ranked separately for different species of concern). The following attributes seem to be of the highest importance to measure/record, based on current information:

1. **Mistletoe berry abundance** (if possible, directly estimated; if not, indirectly estimated from the volume of mistletoe infection, the proportion of infected trees or the density of infected trees; Phainopeplas and many other bird species rely heavily on the berries)
2. **Tree height** (especially in acacia, but also in mesquite stands, Phainopeplas prefer tall trees for nesting and have better nest success; however, Crissal and LeConte's Thrashers prefer short trees)
3. **Tree diameter** (Lucy's Warblers, Ash-throated Flycatchers and Ladderbacked Woodpeckers need large old trees for nesting)
4. **Tree density** (Phainopeplas, Abert's Towhees and Lucy's Warblers prefer areas of high tree density, but Blue Grosbeaks and Yellow-billed Cuckoos like high density adjacent to more open areas, while Bendire's Thrashers and loggerhead shrikes like open habitat)
5. **Canopy cover** (of large mesquites or cottonwoods/willows) (Abert's Towhees, Lucy's Warblers and Summer Tanagers like high cover, but Vermillion Flycatchers and Western Screech Owls like low cover)
6. **Shrub layer cover** (Bell's Vireos and Yellow-billed Cuckoos need dense shrub cover, but Blue Grosbeaks like low shrub cover)
7. **Area of (infected) woodland** (Phainopeplas have more dense populations and have better nest success in large infected woodlands than small infected woodlands; Abert's Towhees, Lucy's Warblers and Yellow-billed Cuckoos also need large patches)
8. **Proximity to other woodlands** (there is some evidence that Phainopeplas are more likely to occupy woodlands that are close to large amounts of other mesquite/acacia woodlands)
9. **Soils** (e.g. favorable for bear poppy and barrel cactus)
10. **Distance to riparian** (many species require or often use riparian areas, but a few are found only in more arid habitat)
11. **Elevation**
12. **Urban landscaping** (Black-throated Sparrows and Crissal Thrashers will not use it).
13. **Type, intensity and frequency of disturbances**

APPENDIX F. RECOMMENDED CONSTRAINTS ON HUMAN ACTIVITIES IN AREAS OF ENVIRONMENTAL CONCERN DESIGNED TO PROTECT MESQUITE, ACACIA AND ASSOCIATED SPECIES

These recommendations are derived from the ecological and threats information described in the main body of the CMS, and further guided by the constraints specified for the Desert Tortoise ACECs, and the Ash Meadows and Amargosa Mesquite ACECs. Recommendations that are not followed by "preferred" should be viewed as the minimum constraints.

1. Lands

-Retain in Federal ownership.

-ROW avoidance (preferred); OR: ROW avoidance except in designated corridors (acceptable).

-Close to mineral material ROW (preferred).

-Acquire private land (if recommended in site-specific Conservation Actions).

2. Minerals

-Closed to locatable minerals.

-Closed to saleable minerals.

-Closed to solid leaseable minerals.

3. Fluid Minerals

-Closed to geothermal prospecting and leasing (preferred).

4. Range

-Closed to livestock grazing.

-Managed for zero horses and burros.

5. Roads

-Reclaim temporary roads.

6. ORV-OHV-Recreation

-Closed to OHV use Feb 1-June 15 and June 15-October 15 (highly preferred).

-Limit to designated roads and trails.

-Prohibit ORV speed events and speed testing, mountain bike races and 4-WD hill climbs.

-Permit commercial activities consistent with mesquite and acacia recruitment, and the survival and reproduction of dependent species (including mistletoe).

-Do not allow competitive OHV events (preferred); OR: Allow non-speed events subject to the following limitations (acceptable):

- permits required for events with more than 15 vehicles,
- maximum number of entrants, 100 vehicles, motorcycles or 4-wheel vehicles,
- no OHV events Feb 1-June 15 and June 15-October 15,
- limit to a maximum of 2 events per ACEC,
- maximum speed for permitted events is 25 mph.

-Close to camping, or allow camping only in designated campsites.

-Do not allow campfires within 50 m of woodlands (preferred); OR: Allow campfires only in designated fire structures and only when risk of forest fire is low (acceptable).

APPENDIX G. METAPATCH RANKING PROCESS

G.1. SCHEMES FOR RANKING METAPATCHES

The current lack of understanding regarding both the current condition ecology of mesquite and acacia woodlands, and associated species, has curtailed the ability to develop comprehensive ranking schemes for prioritizing metapatches for conservation purposes. Also, different species have different needs. Thus several schemes were developed to encompass as broad a range of species as possible, given the state of knowledge. It should be noted that various other attributes would have been included (e.g. tree height), had these data been available for most metapatches. As more information becomes available, these schemes should be revised. Separate schemes should be developed for "guilds" of associated species (e.g. open uplands, or dense riparian) as the habitat requirements of these species are better understood.

In these schemes, metapatch area and "contiguousness", distance between metapatches, and area of potential habitat (how much area would be added to the metapatch should the potential habitat be confirmed) were measured in GIS. Because data do not exist on the distribution of most of the species included in this CMS, we used GIS to estimate how many of the CMS vertebrate species were likely to occur in mesquite or acacia woodlands, based on their predicted distribution from the Southwestern REGAP model. The presence of Special Status plants was based on the expert knowledge of the Technical Advisory Group to the CMS, and should be updated in GIS. The remaining data were taken from the attribute tables of the mesquite-acacia GIS layer and from expert knowledge.

1. "COMPREHENSIVE" SCHEME (combines reserve design and species biology)

Criterion	**Weight**	**Excellent (4 pts)**	**Good (3 pts)**	**Fair (2 pts)**	**Poor (1 pt)**
Metapatch area	10	> 900 ha	300-900 ha	100-299 ha	<100 ha
Contiguous Mesquite or Acacia (# patches, patch size, distance between patches)	7	Unbroken	Little fragmen-tation	Moderate fragmen-tation	Highly fragmen -ted
Tree density (low-high)	5	High	Moderate	Low	Sparse
Distance to nearest metapatch	5	<3km	<5km	<10km	>10 km
Riparian	4		Yes	Spring	No
Mistletoe abundance (low-high; none=0)	3	High	Moderate	Low-moderate	Low
# CMS vertebrate species	1	22-29	14-21	5-13	0-4
# Special Status plants species	1	<3spp	3 spp	2 spp	1 sp
Area of adjacent potential habitat	1	>100 ha		<100 ha	

2. RESERVE DESIGN SCHEME

Criterion	**Weight**	**Excellent (4 pts)**	**Good (3 pts)**	**Fair (2 pts)**	**Poor (1 pt)**	**Small/ None (0 pts)**
Metapatch area	10	> 900 ha	300-900 ha	100-299 ha	<100 ha	
Contiguous Mesquite or Acacia (# patches, patch size, distance between patches)	7	Unbroken	Little fragmen-tation	Moderate fragmen-tation	Highly fragmen-ted	
Tree density (low-high)	5	High	Moderate	Low	Sparse	
Distance to nearest metapatch	5	<3km	<5km	<10km	>10 km	
Area of adjacent potential habitat	1	>100 ha		<100 ha		None known

3. ASSOCIATED SPECIES BIOLOGY SCHEME

Criterion	**Weight**	**Excellent (4 pts)**	**Good (3 pts)**	**Fair (2 pts)**	**Poor (1 pt)**	**None (0 pts)**
Tree density (low-high)*	6	High	Moderate	Low	Sparse	
Riparian	10	River/lake		Spring		None
Mistletoe abundance	4^	High	Moderate	Low-moderate	Low	None
# CMS vertebrate species	1	22-29	14-21	5-13	0-4	None
# Special Status plants species	1	<3spp	3 spp	2 spp	1 sp	None

*many species like dense woodlands, but some don't; hence middle range weighting
^1/3 species use

4. PHAINOPEPLA/MISTLETOE SCHEME (based on statistical results in Crampton 2004)

Criterion	**Weight**	**Excellent (4 pts)**	**Good (3 pts)**	**Fair (2 pts)**	**Poor (1 pt)**	**None (0 pts)**
Mistletoe abundance	10	High	Moderate	Low-moderate	Low	None
Mistletoe x metapatch area	7	> 2000 mistletoe* ha	500-2000 mistletoe* ha	150-499 mistletoe* ha	<150 mistletoe *ha	
% cover[&]	5	High	Moderate	Low	Sparse	
Isolation	3	<3km	<5km	<10km	>10 km	

[&] used tree density as surrogate

G.2. RESULTS OF RANKING SCHEMES FOR TOP 52 METAPATCHES

MetaPatch	Comprehensive SUM	Comprehensive rank	Phainopepla SUM	Phainopepla rank	Biological SUM	Biological rank	Reserve Design SUM	Reserve Design rank	Grand sum	Average rank
Muddy River	125.65	1	81.97	5	71.11	4	91.4	2	**370.12**	**3**
Big Bend	118.38	2	89.15	1	74.38	2	83.15	6	**365.06**	**2.75**
Piute	108.38	5	85.92	3	33.73	17	90.45	3	**318.48**	**7**
Hiko	110.50	4	74.18	8	47.07	9	85.5	5	**317.26**	**6.5**
Overton	103.31	7	67.85	12	73.74	3	70.5	20	**315.40**	**10.5**
Grapevine	104.33	6	67.36	13	69.74	7	71.25	19	**312.68**	**11.25**
Stewart Valley	100.28	10	87.15	2	40.78	13	78.15	12	**306.36**	**9.25**
Resting Spring*	97.00	12	67.00	15	76.00	1	66	24	**306.00**	**13**
Mesquite Lake	110.90	3	67.25	14	23.90	32	97.25	1	**299.30**	**12.5**
North Las Vegas	101.62	9	83.60	4	34.12	16	79.6	10	**298.94**	**9.75**
Coyote Spring	98.00	11	75.00	7	28.00	20	82	7	**283.00**	**11.25**
Pahrump	102.38	8	64.78	17	27.31	24	88.5	4	**282.97**	**13.25**
Arrow Canyon	92.66	15	75.18	6	34.63	15	73.45	17	**275.92**	**13.25**
Mormon Mesa E	88.29	20	55.20	26	70.04	6	56.7	43	**270.23**	**23.75**
Franklin Wash*	93.14	13	69.70	11	27.64	22	78.7	11	**269.18**	**14.25**
Gold Butte SW	91.69	18	71.85	10	29.86	18	75.15	13	**268.55**	**14.75**
Amargosa Flat	92.62	16	59.85	19	22.62	35	80.85	8	**255.94**	**19.5**
Bunkerville	90.10	19	42.75	37	61.10	8	61.75	31	**255.70**	**23.75**
Corn Creek	92.12	17	43.60	34	42.12	11	74.6	14	**252.44**	**19**
Las Vegas Wash	76.28	32	59.60	20	71.04	5	44	52	**250.92**	**27.25**
Nelson	93.02	14	57.00	22	19.44	43	80.8	9	**250.27**	**22**
Lucy Grays	82.50	27	64.18	18	27.47	23	66.5	23	**240.66**	**22.75**
Cactus Springs	85.00	24	45.00	31	45.00	10	65	25	**240.00**	**22.5**
Carson Slough	86.50	22	53.75	27	26.50	25	73.25	18	**240.00**	**23**
Empire	87.53	21	56.16	24	21.18	36	73.65	16	**238.53**	**24.25**
NW of Last Chance Spring	84.56	25	55.64	25	28.30	19	69.3	22	**237.81**	**22.75**
Highland	76.50	30	66.98	16	27.95	21	60.45	33	**231.89**	**25**

Gold Butte NW	76.32	31	72.20	9	25.24	27	57.95	41	**231.71**	**27**
SR 165 W	77.06	29	57.20	21	25.48	26	64	27	**223.75**	**25.75**
Highland E	83.14	26	45.45	30	23.14	33	70.45	21	**222.18**	**27.5**
Eldorado	86.00	23	43.00	35	19.00	44	74	15	**222.00**	**29.25**
Gold Butte E	76.27	33	56.53	23	23.93	31	61.9	30	**218.63**	**29.25**
Rogers Spring	77.84	28	40.59	41	39.56	14	58.4	39	**216.38**	**30.5**
Muddy Mtn S	73.12	35	51.60	28	20.12	42	60.1	34	**204.94**	**34.75**
Mcullough Range S	76.00	34	43.00	36	19.00	45	64	26	**202.00**	**35.25**
Hwy 40	72.08	36	49.57	29	20.59	40	59.45	36	**201.69**	**35.25**
Calico Basin	69.40	42	39.55	43	41.70	12	49.35	51	**200.00**	**37**
Highland S	72.05	37	39.11	45	24.12	28	62.35	28	**197.63**	**34.5**
Cottonwood	70.50	41	44.50	32	24.00	29	58.5	38	**197.50**	**35**
Nipton	71.46	39	44.00	33	16.48	49	60.85	32	**192.79**	**38.25**
Amargosa Flat NW	67.00	46	42.50	38	21.00	38	55.5	45	**186.00**	**41.75**
Las Vegas Bay	70.90	40	40.75	40	13.90	51	59.75	35	**185.30**	**41.5**
Craig*	72.00	38	30.00	50	21.00	37	62	29	**185.00**	**38.5**
Arrow Canyon W	69.00	43	36.00	47	19.00	46	59	37	**183.00**	**43.25**
N Las Vegas Airport*	68.00	45	31.50	49	24.00	30	57.5	42	**181.00**	**41.5**
California Wash	68.48	44	38.15	46	15.98	50	58.15	40	**180.76**	**45**
Sandy N	64.00	48	39.50	44	23.00	34	51.5	47	**178.00**	**43.25**
Sunrise	65.70	47	40.25	42	16.70	48	54.25	46	**176.90**	**45.75**
McCullough N	62.00	49	41.00	39	19.00	47	50	49	**172.00**	**46**
Virgin Mountains*	61.40	50	33.00	48	20.40	41	56	44	**170.80**	**45.75**
Indian Springs*	60.00	51	26.00	51	21.00	39	51	48	**158.00**	**47.25**
Smoke Tree*	56.00	52	13.00	52	3.00	52	50	50	**122.00**	**51.5**

Colors indicate natural groupings of scores. Where two colors are shown (one for the font, one for the highlighting), the natural groupings differ depending on whether the Grand Sum or Average Rank is used. In the ranking table in the CMS, these metapatches are given split rankings (e.g. rank 2-3).

APPENDIX H. EXISTING OR LIKELY THREATS TO THE 52 MOST BIOLOGICALLY IMPORTANT METAPATCHES.

MetaPatch	Risk of urbanization (1 low - 3 high)	Affected by loss of groundwater (1 yes, 0 no)*	Risk of conversion to ag (1 high, 0 low)	Exotics present (1 Bromus/Schizmus, 1.5 Some tamarisk, 2 Lots of tamarisk	Fire risk (1 low, 2 high)[&]	Woodcutting (1 yes, 0 no)	Horses, burros, or cattle present (1 yes, 0 no)	Construction of roads, ROW, mines (1 Likely, 0)[$]	Use of roads, ROW, mines, OHV (0 low - high/speed)	Other recreation (0 low, 1 heavy)	SUM	Comment
Muddy River	3	1	1	2	2	1	1	1	2	1	**15**	
Big Bend	3	1	1	2	2	0	0	1	2	1	**13**	
Mesquite Lake	1	1	0	1	1	0	1		1	0	**6**	
Hiko	1	1	0	1.5	2	0	0		2	1	**8.5**	
Piute	2	0	0	1	1	0	0	0	1	0	**5**	
Grapevine	1	?	0	1	1	0	0		0	1	**4**	
Overton	3	1	1	2	2	1	1		2	1	**14**	
Pahrump	3	1	1	2	2	1	1	1	2	1	**15**	
North Las Vegas	3	0	0	1	2	1	0	1	1	0	**9**	
Stewart Valley	1	1	0	1	2	1	1		1	0	**8**	
Coyote Spring	1	1	0	1	1	0	0		0	0	**4**	
Resting Spring	1	1	0	1	1	0			0	0	**4**	
Franklin Wash	1	1	0	1	1	0			1	0	**5**	
Nelson	3	0	0	1	2	0	0	1?	1	1	**8**	
Arrow Canyon	1	1	0	1	1	0	1?	1?	0	0?	**4**	
Amargosa Flat	1	1	0	1	2	0	1	1?	1	0	**7**	
Corn Creek	1	1	0	1	1	0	0		0	1	**5**	
Gold Butte SW	1	1	0	1	1		1	1	1	0	**7**	illegal grazing, poss. Geothermal
Bunkerville	3	1	1	2	1		1	1?	1		**10**	
Mormon Mesa E	1	1	0	2	1		1?	1?	0	0	**5**	
Empire	1	0	0	1	1	0	0		1	0	**4**	
Carson Slough	1	1	0	2	1		0		0	0	**5**	
Eldorado	1	0	0	1	2	0	0	1?	1	0	**5**	
Cactus Springs	1	1	0	1	2	1	0		0	1	**7**	
NW of Last Chance Spring	1	1	0	2	1	0	0		0	0	**5**	

Highland E	1	0	0	1	1	0	1	1?		0	0	**4**	illegal grazing
Lucy Grays	1	0	0	1	1					0	0	**3**	
Rogers Spring	1	1	0	1.5	1	0	1			0	1	**6.5**	
SR 165 W	1	1	0	1	2			1?		1	0	**6**	
Highland	1	1	0	1	1	0	1	1?		1	0	**6**	illegal grazing
Gold Butte NW	1	1	0	1	1		1		1	1	0	**7**	illegal grazing
Las Vegas Wash	3	1	0	2	1		0			1	1	**9**	
Gold Butte E	1	?	0	1	1		1		1	1	0	**6**	illegal grazing
Mcullough Range S	1	0	0	1	1		0			0	0	**3**	
Muddy Mtn S	1	1	0	1	1		1		1	1	0	**7**	
Hwy 40	1	?	0	1	1	0			1	1	0	**5**	
Highland S	1	0	0	1	2		0	1?		1	0	**5**	
Craig	3	1	0	1	1		0			0	0	**6**	
Nipton	1	0	0	1	2					1	0	**5**	
Las Vegas Bay	1	?	0	1	1			1?		0	0	**3**	
Cottonwood	1	?	0	1	1	0				1	0	**4**	
Arrow Canyon W	1	?	0	1	1	0	0			0	0	**3**	
California Wash	1	?	0	2	2	0		1?		1	0	**6**	
N Las Vegas Airport	3	?	0	1	1		0			0	0	**5**	
Calico Basin	2	1	0	1	2	0	1	1?		1	1	**9**	
Amargosa Flat NW	3	1	0	2	1	0				1	0	**8**	
Sunrise	3	?	0	1	1			1?		0	0	**5**	
Sandy N	2	0	0	1	2	1		1?		1	0	**7**	
McCullough N	1	0	0	1	1		0			0	0	**3**	
Virgin Mountains	1	0	0	1	1		0			1	0	**4**	
Indian Springs	2	1	0	1	2					1	0	**7**	
Smoke Tree	1	?	0	1	1	0				0	0	**3**	

*****Assumed all mesquite, and any acacias near springs or other water sources, affected by groundwater
& Assumed fire more likely near towns and major roads
$ Includes proliferation of roads by casual users