Conservation Management Strategy

Coyote Springs Desert Wildlife Management Area

Clark County, Nevada

February 2007

EXECUTIVE SUMMARY

The Mojave Desert population of desert tortoises has been declining since the 1970s and was declared threatened under the Federal Endangered Species Act (ESA) in 1990. Impacts of urban growth, agriculture, recreation, and other human activities—coupled with the rise of predators and disease—are thought to be the major causes of tortoise decline. Over the past 16 years, several attempts to define and implement specific Conservation Actions (CAs), strategies, and plans have been proposed to protect the tortoise and other species considered imperiled. Clark County and the U.S. Fish and Wildlife Service (USFWS) entered into the Multiple Species Habitat Conservation Plan (MSHCP) as a binding commitment to protect 78 species, including the tortoise, by providing a commitment to implement specific CAs. Subsequent to the MSHCP, a site-specific conservation management strategy (CMS) is required for each of four areas in Clark County known as Desert Wildlife Management Areas (DWMAs). The intent of the CMS is to guide management actions and to unite federal, state, and local agencies in coordinated, adaptive management for each DWMA.

This document is a CMS for the Coyote Springs DWMA, which encompasses the Desert National Wildlife Refuge, Coyote Springs Investment, and Coyote Springs area of critical environmental concern (ACEC), and is almost entirely preferred desert tortoise habitat of creosote-bursage vegetation on gentle plains and bajadas. Along its northern boundary, a large residential and resort development has the potential to impact conservation efforts. Construction of roads and utility rights-of-way (ROWs), as well as increased human activity, may introduce serious threats to the future viability of desert tortoise populations in the DWMA.

The purpose of this CMS is to consolidate and prioritize CAs and guide their implementation. This document consists of eight chapters:

- Chapter 1 reviews the background leading to the present situation, the need for and purpose of the CMS, and the process of its development. It also details steps that will be taken to involve and educate the public in conservation efforts.

- Chapter 2 describes the Coyote Springs planning area. It identifies gaps in the knowledge base needed to complete the CMS, reviews the existing environment and the current status of desert tortoise populations, and presents current land uses and future potential scenarios.

- Chapter 3 defines the purpose of the CMS and provides conservation objectives to achieve that purpose in the context of existing federal and state policies and mandates.

- Chapter 4 reviews a suite of previously proposed CAs. It assesses funding sources and staffing necessary to implement them, describes their potential effects, and ranks them based on cost–benefit ratios.

- Chapter 5 recommends, in order of priority, 12 new CAs that build on the existing base to evaluate the current status of recovery in the DWMA, address gaps in knowledge, and provide a long-term research, monitoring, and management plan. Specific projects, tasks, and performance measures for each action are included.

- Chapter 6 describes the implementation plan for the 12 new CAs and provides a timeline for CMS review and assessment.

- Chapter 7 lists references.

- Chapter 8 lists frequently used acronyms in the CMS.

The following is a summary of the 12 new CAs described in Chapter 5.

Priority CA 1—Identify where, how many, and to what extent CAs previously defined in the Clark County MSHCP have been implemented.

Priority CA 2—Determine whether current levels of law enforcement staffing are sufficient to identify and quickly remedy human behaviors that negatively impact conservation.

Priority CA 3—Provide managers with specific information on how and where outreach and education programs and materials are being used, whether they are effective, and how they need to be improved.

Priority CA 4—Immediately establish monitoring programs for species about which very little is known concerning their distribution and abundance.

Priority CA 5—Collect the results of existing research and monitoring efforts and investigate new methods of assessing threats to determine the extent and severity of human activities on sensitive species and habitats.

Priority CA 6—Develop a comprehensive, centralized database to track the status of conservation efforts.

Priority CA 7—Provide managers with reliable quantitative measures to more effectively evaluate conservation success using methods such as remote sensing and satellite imagery.

Priority CA 8—Develop a monitoring program to determine the effectiveness of each CA. Monitoring should consist of hypothesis-based studies that measure tortoise and habitat responses before and after implementation of recovery actions.

Priority CA 9—Establish a timeline for review and update of the CMS as the results of research and monitoring become available.

Priority CA 10—Pursue a research program to identify tortoise movement patterns.

Priority CA 11—Conduct long-term research studies on the biology and ecology of juvenile and hatchling tortoises and relate their survival rates to tortoise population viability and persistence.

Priority CA 12—Pursue research aimed at recognizing, diagnosing, and treating tortoise diseases and establishing clear standards to accurately determine the health status of the tortoise population.

The implementation plan of this CMS is meant to act as a guide for carrying out the CAs in consecutive steps. Changes to the CAs, to their priority ranking, and to the time frame for their implementation may occur as additional information is collected and analyzed and as funding and resources fluctuate. The adaptive management approach followed by this plan, and required by the MSHCP, links conservation strategies to the findings of research and monitoring activities over time. This CMS recommends continuous periodic review and revision of the CMS to produce the most effective plan over the long term.

CONTENTS

APPENDICES

FIGURES

TABLES

1. INTRODUCTION

1.1 Background

A desert tortoise (*Gopherus agassizii*). Photo courtesy of Eric Holt; JBR Environmental Consultants, Inc.

In 1990, the U.S. Fish and Wildlife Service (USFWS) listed the desert tortoise (*Gopherus agassizii*) as a threatened species under the *Endangered Species Act* (ESA) following declines in the Mojave population due to direct and indirect human-caused mortality coupled with the inadequacy of existing regulatory mechanisms to protect tortoises and their habitat (USFWS 1994a). In response, Clark County, Nevada, applied for an incidental take permit under Section 10(a)(1) of the ESA (see explanation in box below) and immediately developed their own specific short-term Habitat Conservation Plan (HCP) (RECON 1991). The HCP proposed the establishment of Tortoise Management Areas in exchange for development opportunities on non-Federal lands in a prescribed permit area within the city boundaries of Las Vegas, North Las Vegas, Henderson, and Boulder City. In 1991, the USFWS approved the permit application effective for three years during which time a long-term plan was developed to address the growth and economic needs of Clark County.

In 1994, the USFWS designated 6.4 million acres of desert tortoise critical habitat throughout its range in the Mojave Desert, including 846,000 acres of critical habitat in the eastern and northeastern Mojave Recovery Units (RUs) in Clark County, Nevada (USFWS 1994a). In 1994, the USFWS completed the Desert Tortoise Recovery Plan (DTRP), which recommended establishing reserves, known as Desert Wildlife Management Areas (DWMAs), to achieve tortoise recovery and delisting (USFWS 1994b). Once established, the DWMAs could then be analyzed to address threats and implement management actions (MAs) specific to each RU. This approach allows land management agencies within each state to consider the tortoise when developing their land use plans.

Incidental Take Permits

"Private landowners, corporations, state or local governments, or other non-Federal landowners who wish to conduct activities on their land that might incidentally harm (or "take") wildlife that is listed as endangered or threatened must first obtain an incidental take permit from the U.S. Fish and Wildlife Service."

"To obtain a permit, the applicant must develop a Habitat Conservation Plan (HCP), designed to offset any harmful effects the proposed activity might have on the species. The HCP process allows development to proceed while promoting listed species conservation" (USFWS 2005).

In 1995, the USFWS expanded Clark County's incidental take permit for a 30-year period on (1) non-Federal land in Clark County and (2) Nevada Department of Transportation (NDOT) rights-of-way (ROWs) in the other Nevada counties of Clark, Lincoln, Esmeralda, Mineral, and Nye counties. This expansion was based on the Clark County Desert Conservation Plan (DCP) (RECON 1994), which detailed measures to minimize, monitor, and mitigate the effects of the proposed take on the desert tortoise. To fund these measures, the DCP included a fee of $550 per acre of habitat disturbance to be levied on development projects. To receive this permit, the County was required to spend between $1.35 million and $1.65 million per year for the first 10 years and a minimum of $1.35 million per year for the rest of the 30-year period to minimize and mitigate the potential loss of desert tortoise habitat through a variety of conservation actions (CAs) outlined in the DCP (RECON 1994).

The Bureau of Land Management (BLM) is the primary Federal landowner in Nevada, managing nearly 48 million acres, or 67% of the State's total land area and 87% of the land designated as desert tortoise critical habitat (BLM 1998). BLM manages for sensitive species to prevent future listings according to 6,840 regulations. In 1998, the BLM Las Vegas field office developed the Las Vegas Resource Management Plan (LVRMP) designating four areas of critical environmental concern (ACECs) to help provide protection for desert tortoise. Public land uses, such as mining, grazing, and recreation, are restricted in these areas (BLM 1998). In addition to providing desert tortoise protection consistent with the USFWS recommendations, the LVRMP was developed in response to a determination during a regularly scheduled review of the Clark County Management Framework Plan (CCMFP) that deemed the CCMFP did not adequately address the rapidly changing public land-use demands in Clark County. The LVRMP also addressed public concern arising from the public land disposals and exchanges occurring by legislative action.

While the DCP and LVRMP mitigated for incidental take of the desert tortoise and protected desert tortoise habitat, a number of other sensitive habitats and species were left unprotected, as they were not Federally listed. Consequently, in order to maintain potentially critical ecological interactions among desert wildlife and prevent future listings, Clark County approved the Multiple Species Habitat Conservation Plan (MSHCP) (RECON 2000) in 2000. The MSHCP provided protection for 78 environmentally sensitive species in the Mojave Desert, including the desert tortoise, for 30 years and offered a number of specific CAs and policies from multiple Federal and State agencies. With information in the MSHCP, a cohesive management strategy for the Clark County desert ecosystem could be developed.

The MSHCP provided a foundation for the county-wide conservation but did not address specific management strategies for the four designated DWMAs: Mormon Mesa, Coyote Springs, Gold Butte, and Piute Eldorado. The Desert Tortoise Recovery Plan Assessment Committee (DTRPAC) reviewed the Desert Tortoise Recover Plan (DTRP) in light of new information and determined that each DWMA lacked a long-term, unified management approach for recovery of the desert tortoise and other sensitive desert species (Tracy et al. 2004). Consequently, four site-specific conservation plans (TNC 2003) reviewing existing threats, stresses, and biological communities in each DWMA were developed through consultation with The Nature Conservancy (TNC). Based on these plans, each DWMA-specific conservation management strategy (CMS) will guide management actions, thereby uniting Federal, State, and local agencies in coordinated, adaptive management.

1.2 Purpose

The purpose of this document is to provide a CMS for the Coyote Springs DWMA. It is the intent of this document to:

- Comply with terms and conditions set forth in Section 10(a)(1) of the Incidental Take Permit issued by the USFWS to Clark County and meet the goals of the Clark County MSHCP
- Provide a suite of prioritized CAs to enhance the conservation of species and habitats in the DWMA to prevent future species listings

- Provide guidance to facilitate the implementation of CAs in an orderly, organized, and public fashion.

1.3 Need

The population of Las Vegas has increased 122% and has been one of the fastest growing metropolitan areas in the United States since 1990 (U.S. Census 2003, NSDO 2004) (see Figure 1). As urban growth in Southern Nevada increases, a demand on public infrastructure and affordable housing escalates. However, the protection afforded to the desert tortoise under Section 9(2)(b) of the ESA, states that:

> "it is unlawful for any person subject to the jurisdiction of the United States to remove and reduce to possession any such species from areas under Federal jurisdiction; maliciously damage or destroy any such species on any such area; or remove cut, dig up, or damage or destroy any such species on any other area in knowing violation of any law or regulation of any State or in the course of any violation of a State criminal trespass law" (USFWS 2005a).

Development of Federal land is hindered by the ESA, and because nearly 90% of Clark County is Federal land and moreover, desert tortoise habitat, most of the county cannot be developed for residential development outside the disposal boundary. However, activities such as ROWs and mining can occur throughout the county. The ACECs are ROW avoidance areas and limited use areas for other activities such as mining. In accordance with the LVRMP, ROWs are sited within designated corridors whenever possible, but can be constructed outside corridors if necessary. Impacts of these are minimized project by project in accordance with the applicable biological opinion (BO). The incidental take permit issued by the USFWS resolves conflicts between land development and conservation of Covered Species by requiring an HCP to minimize and mitigate impacts on all Covered Species.

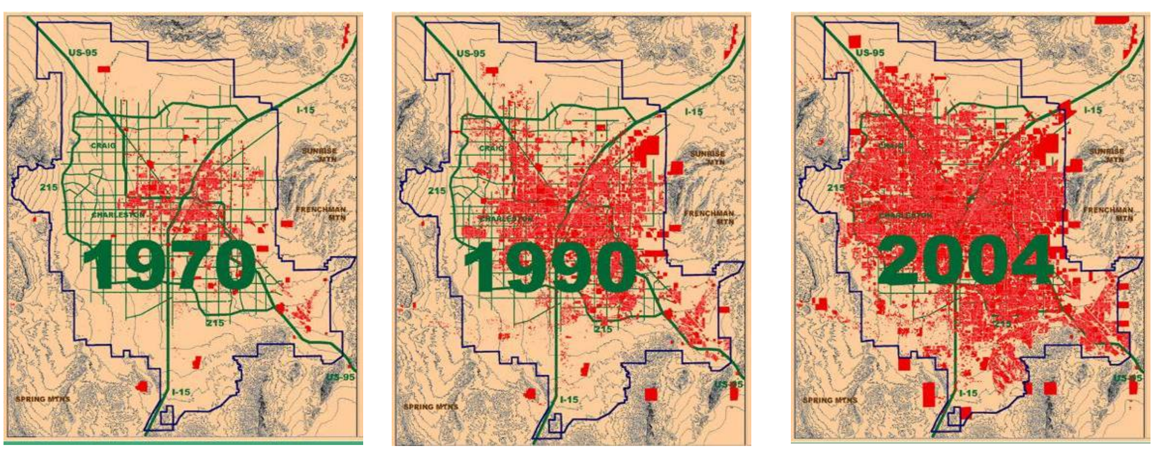

FIGURE 1. Urban growth in Las Vegas Valley from 1970 to 2004 is depicted in red. The blue line represents the Las Vegas Disposal Boundary (Source: Clark County Environmental Planning).

Under the HCP, the designation of four DWMAs partially mitigates for the impacts of land development on the desert tortoise on Federal lands in Clark County. However, setting aside a large land area for desert wildlife is not sufficient to prevent future species/population listings and to ensure delisting of the desert tortoise (USFWS 1994a). Active management for the benefit of the species through a unified conservation strategy, including a biologically based suite of recovery actions, is needed. The current approach in conservation biology is to adopt an ecosystem-scale approach to preserve components of biodiversity, ecological integrity, and biological interactions (Grumbine 1994). This document represents a CMS for the Coyote Springs DWMA with the intent to fulfill the requirements of the incidental take permit and in addition attempt to preserve both elements (species and communities) and ecological process at the landscape-level through a series of detailed actions.

1.4 Public Participation

Individual action, education, and public involvement are integral to the success of a long-term CMS, allowing people to voice their concerns about environmental issues affecting their communities. The goal of public involvement is to ensure early and continuous public notification about and participation in major actions regarding the development and implementation of the CMSs. To encourage the early and continuous involvement of citizens, jurisdictions, communities, and others with special interests in the planning process, a variety of public notification procedures are used, including a project website, a representative stakeholder mailing/contact list, electronic newsletters, media involvement, project questionnaires, and public scoping meetings. Each of these elements is described in further detail below.

1.4.1 Website

To communicate information regarding the CMS process to a wide audience, a website was established and maintained during the development of the CMSs. The website included information about the project, current participants, downloadable information documents, meeting schedules, past meeting notes, newsletters and interest items, and contact information. This website also included notices and other information to help keep the public informed about progress on the four CMSs.

1.4.2 Stakeholder Mailing List

A stakeholder mailing list identifying interested individuals was compiled from the existing electronic mailing list for the Clark County Desert Conservation Program and a list of landowners within the Coyote Springs DWMA. This list included local media, community and interest groups, environmental organizations, trustee agencies, and other affected agencies. An initial mailing informed stakeholders about project goals and timeline, and provided contact information.

1.4.3 Electronic Newsletters

Stakeholders were updated and informed through quarterly Desert Wash electronic newsletters (E-newsletters) (Appendix A). E-newsletters were sent via e-mail to those stakeholders who provided working e-mail addresses to the County or Contractor. During the duration of the project, three editions of the Desert Wash E-newsletter were published. These editions contain articles describing the ecology of the Mojave Desert and the DWMAs, information and updates on the development of CMSs, project timelines and updates, and information regarding times and locations of scoping meetings. The E-newsletters were available in portable document format (PDF) on the project website and in hardcopy (in limited numbers) from the Desert Conservation Program, Department of Air Quality and Environmental Management, on the first floor of the Clark County Government Center, 500 South Grand Central Parkway, Las Vegas.

1.4.4 Press Releases

An initial news release was distributed to provide information about the CMS project and the time and location of public meetings. Press releases were issued to news media in the region regarding major upcoming actions, when and where the action would be taken, and whom to contact for more information.

1.4.5 Public Scoping Meetings

Public scoping meetings provided the public an opportunity to voice suggestions, ideas, and concerns to be addressed in the final CMSs. Three public scoping meetings were held (in Las Vegas, Searchlight, and Moapa) and public input was solicited through distribution of a questionnaire.

Issues raised during the public scoping meetings were summarized in a scoping summary report (Appendix B). The scoping report reviewed public concerns and summarized decisions made as a result of the scoping process. This CMS will address key issues raised during scoping meetings.

Information included in the scoping summary report was generated from the limited feedback received through questionnaires distributed at the meetings. According to the 12 questionnaire respondents, the most common public uses of DWMAs are scenery and wildlife viewing, hiking and backpacking, camping, astronomy/night sky viewing, and Sunday drives. Participants identified development, habitat fragmentation, and off-highway vehicle (OHV) use as critical threats to be addressed in CMSs and expressed concern that conservation management will eliminate multiple use in the DWMA (e.g., exclude recreational or commercial activities).

While public comments had a better chance of influencing the final CMSs if they were received in a timely fashion (within 30 days of the public scoping meetings), comments were accepted throughout the planning process. Interested parties were asked to send their comments to:

Four CMS Projects
c/o The Shipley Group
1584 South 500 West, Suite 201
Woods Cross, UT 84010

Comments were also accepted via e-mail at: comments@shipleygroup.com

1.5 Document Structure

Chapter 2 provides background, inventory, and assessment of elements relevant to the CMS. The chapter also describes the planning area, reviews existing information, identifies gaps in information needed to complete the CMS, reviews the existing environment, and identifies human issues and opportunities associated with the planning effort. Chapter 3 identifies existing relevant management actions, goals, and objectives. It also provides a final set of conservation objectives and long-term goals for the Coyote Springs DWMA. Chapter 4 proposes a preliminary set of existing CAs advised by the MSHCP and TNC and describes the associated benefits and human impacts. In Chapter 5, a conservation strategy recommends a suite of priority CAs and identifies and describes specific projects, tasks, and performance measures for each action. Finally, Chapter 6 describes the implementation plan incorporating adaptive management and provides a timeline for CMS review and assessment.

2. BACKGROUND, INVENTORY, AND ASSESSMENT

Ecological integrity is defined as the total native diversity (genetic structure, species, populations and metapopulations, communities and ecosystems) and the ecological patterns and processes that maintain that diversity (Grumbine 1994). This CMS strives to maintain the ecological integrity of the system by electing a threatened species, the desert tortoise, for the management focus (Appendix E). This strategy assumes that protecting the desert tortoise will have multiple ecological benefits for coexisting populations, communities, or ecosystem components without the expense of monitoring hundreds of species (Brooks 2000). Yet management must ultimately balance the protection of ecological values while providing of resources for human use, making it a social issue as well as a scientific one (Grumbine 1994). The purpose of this Section is to summarize the existing environment as it relates to the ecological and social components of DWMA management.

Section 2.1 describes the planning area. Section 2.2 reviews gaps in knowledge that need to be addressed in an adaptive management process. Section 2.3 describes the existing environment, including land ownership and designation, human use, and resource management, including relevant management plans. Current species conditions are also described in this Section. Section 2.5 characterizes human issues and potential opportunities associated with the DWMA.

2.1 Planning Area

Located less than five miles north of metropolitan Las Vegas, the Coyote Springs DWMA is the largest DWMA in Clark County. The DWMA general planning area encompasses the Desert National Wildlife Refuge (DNWR), a large private parcel owned by Coyote Springs Investment (CSI), and Coyote Springs ACEC (Appendix C; Map A).

The DWMA planning area for the purposes of this CMS is the DWMA area proposed by the USFWS in the 1994 DTRP, but throughout this CMS, careful attention is given to the BLM Coyote Springs ACEC. Map B (Appendix C) depicts the general approximation of the 1994 proposed DWMA. DWMAs do not have technical legal boundaries–they are areas that were determined to be of greatest importance to the continued survival and recovery of the tortoise and are approximately bounded by geologic, geographic, or other types of barriers that would limit tortoise movement. Therefore, tortoise populations within each of these areas display a certain level of genetic distinctness. Tortoise conservation measures independently implemented by the USFWS at the DNWR effectively provide protection for tortoises in this area. The proposed development of a large residential and resort destination on the CSI property will likely require higher levels of CAs on adjacent habitat.

Spatial integrity and connectivity is an important element in the long-term viability of the desert tortoise and other ecologically sensitive species (USFWS 1994a). The Coyote Springs ACEC is very narrow, only four miles at its widest point, extending west from the Arrow Canyon wilderness area to the DNWR, and while its boundary encompasses only a narrow corridor between two mountain ranges, it effectively offers over 1.6 million acres of protection for the tortoise when its area is combined with the DNWR and Arrow Canyon Range (USFWS 1994b). Additionally, the Coyote Springs ACEC is adjacent to the Mormon Mesa ACEC and the Arrow Canyon wilderness, and movement between these two ACECs can occur. Map C (Appendix C) illustrates currently protected lands associated with the DWMA, including the DNWR, Mormon Mesa DWMA, and Arrow Canyon Wilderness.

Human infrastructure impacts in the ACEC are currently limited to roads, trails, and utility corridors (Appendix C; Map D). The ACEC is bisected by U.S. Highway 93 and intersected by several class 4 roads. ROWs within the ACEC may increase as the CSI property is developed, with associated power and water transmission lines installed.

2.2 Gaps in Information Needed to Complete Strategy

In order to design CAs benefiting the desert tortoise in an adaptive management framework, several gaps in the knowledge base need to be addressed. These gaps may limit our ability to identify, prioritize, implement, and monitor CAs in accordance with the Section 10(a)(1) incidental take permit issued to Clark County, Nevada, for desert tortoise takings. The following issues were identified as knowledge gaps that should be addressed immediately:

- Implementation status of existing management actions
- Enforcement status of existing management actions
- Spatially explicit distribution and density patterns for the desert tortoise quantitatively related to habitat type and disturbance
- Tortoise movements within and outside of the DWMA
- Cost-effective ways to restore corridors and maintain regional and local connectivity
- Alternative ecological indicator metrics to quantitatively assess and monitor tortoise populations, habitat conditions, and trends
- Type, aerial extent, frequency, predictability, and rate of change of threats and stressors, both natural and anthropogenic, and impacts on habitat condition and individual tortoises
- Impact of threats at the population and ecosystem level
- The effect of cumulative and synergistic threats and stressors on desert tortoise populations/metapopulations and habitat condition
- Techniques and analyses to isolate the effects of one threat, to treat multiple threats simultaneously, and to analyze the demographic impacts of threats on tortoise populations at multiple scales
- Underlying tortoise population structure and critical ecological processes
- Impacts from development by CSI, LLC and the potential for mitigation
- Juvenile tortoise ecology and biology
- The extent and severity of disease as a threat to tortoise populations.

If these gaps in knowledge are addressed, managers forced to make swift decisions will be able to review the strategy in light of future data collection and analysis. This information will guide management towards the most effective conservation plan for tortoise population recovery in Clark County, Nevada.

2.3 Existing Environment

2.3.1 Desert Tortoise Listing

The entire Mojave population of desert tortoises was listed as threatened under the ESA on April 2, 1990, following observations of declining numbers across much of their range since the 1970s (USFWS 1994a). The primary reasons for listing the desert tortoise include habitat loss and degradation, collection of tortoises as pets and other purposes, elevated predation levels, disease, and the inadequacy of existing regulatory mechanisms to protect tortoises and their habitat (USFWS 1994a).

2.3.2 Relevant Plans and Literature

A desert tortoise recovery team was assembled to draft a recovery plan to establish goals and objectives and to recommend specific management actions, per the ESA. The USFWS DTRP was finalized in June 1994, which resulted in a host of management implications for Federal, State, local, and private landowners in the Mojave Desert.

2.3.2.1 USFWS Desert Tortoise Recovery Plan

In 1994, the USFWS designated 6.4 million acres of critical habitat for the desert tortoise, including 1.2 million acres in Nevada (RECON 1994). The DTRP (USFWS 1994a) outlined a detailed strategy for the recovery and delisting of desert tortoise on this land and identified five criteria for the delisting of the tortoise:

- As determined by a scientifically credible monitoring plan, the population within a RU must exhibit a statistically significant upward trend or remain stationary for at least 25 years (one desert tortoise generation)
- To ensure long-term viability, enough habitat must be protected within a recovery unit or the habitat and desert tortoise populations must be managed intensively enough
- Provisions must be made for population management within each recovery unit so that discrete population growth rates (lambdas) are maintained at or above 1.0
- Regulatory mechanisms or land management commitments must be implemented that provide for long-term protection of desert tortoises and their habitat
- The population in the recovery unit is unlikely to need protection under the ESA in the foreseeable future.

The DTRP identified six broad RUs based on fine-scale patterns of desert tortoise genetics, morphology, ecology, and behavioral differences, which were further subdivided into fourteen DWMAs (USFWS 1994a). The Coyote Springs DWMA is in the Northeast Mojave RU, along with the Mormon Mesa and Gold Butte-Pakoon DWMAs in Nevada and the Beaver Dam Slope DWMA in Utah. In 2003, the DTRPAC prepared an assessment of the Recovery Plan based on more detailed genetic and biochemical evidence that was available for desert tortoise populations, based mainly on four studies (Tracy et al. 2004). The assessment identified that the concept of evolutionary significant units, which guided the 1994 delineation of RUs, was being replaced by distinct population segments (DPSs) (Pennock and Dimmick 1997) for directing threatened/endangered species recovery. The Desert Tortoise Recovery Plan Assessment (DTRPAC report) (Tracy et al. 2004) recommended that RUs as defined in the 1994 Recovery Plan be revised to reflect more current information on the distribution of DPSs, which would result in the reassignment of DWMAs to different DPS units. This recommendation, if acted upon, would not change current understanding that tortoises in the Coyote Springs, Mormon Mesa, and Beaver Dam Slope DWMAs are similarly related. However, the DTRPAC report suggests that additional genetic research studies are needed and may result in modification to the report's recommendations. The DTRPAC report also states that the existing DWMAs/critical habitat remain well-justified to sustain survival of the tortoise.

The Eastern and Northeastern RUs exhibit regional-scale conservation, whereas the CMS for each DWMA represents site-specific management. Throughout Clark County and adjacent counties in Nevada, Utah, Arizona, and California, specially designated lands provide opportunities for desert tortoise conservation (Map E). Protection of tortoise habitat over local and regional scales may offer the best opportunity for desert tortoise recovery and highlights the importance of coordinating management, monitoring, and research among various Federal, State, and local land management agencies.

The DTRP contains a number of management recommendations for the desert tortoise, including actions to establish and implement management plans for each RU, establish environmental education programs, and initiate research necessary to monitor and guide recovery efforts (USFWS 1994a). Currently in Nevada, ACEC boundaries have been identified, and some site-specific management actions have been identified and implemented. Grazing has been removed and allotments closed. Wild horses and burros are managed for a zero population size. The ACEC is designated and managed as a ROW avoidance area, prioritized high for restoration, route inventory has been completed, and BLM is in the process of designating routes. A resident law enforcement ranger patrols the DWMA weekly, stationed out of Logandale and Overton. The DWMA has been temporarily segregated (5 years) from mineral entry to allow the BLM to complete a mineral potential report and apply for permanent withdrawal. This CMS recommends a framework to further develop and implement additional management actions specific to the Coyote Springs DWMA.

Ecoregion-based Conservation in the Mojave Desert—In the past two decades, the framework of conservation biology has shifted from a narrow approach emphasizing high yields of a particular species to a more holistic ecosystem approach, emphasizing the preservation of biodiversity, or the variety of living organisms, habitats, and ecosystems, and the ecological processes that link them (Meffe and Carroll 1997). TNC advocates a multi-species ecosystem approach to conservation in the Mojave Desert. In "Ecoregion-based Conservation in the Mojave Desert" (TNC 2001), TNC recommended a regional conservation plan emphasizing the protection of high-quality habitat and critical ecosystems. The report advocated that protecting a suite of sites would collectively conserve the native species and community types representative of an ecoregion (TNC 2001). The report identified 367 natural areas and 600 conservation targets in seven ecological systems, including the four DWMAs in Clark County, to be included in a Mojave Desert "ecological portfolio." To address potential threats and ensure the long-term protection of the biodiversity within the ecoregion, TNC and its partners recommend implementing a complementary suite of strategies, including direct CA, community-based programs, and cross-jurisdictional public lands management strategies, for example, coordinating regional HCP implementation and engaging local colleges and universities to pursue basic and applied research into habitat and species ecological dynamics.

Site Conservation Plan for the Coyote Springs DWMA—Although the DTRP provided scientifically rigorous information, the management approach was too broad to be implemented in the DWMA. To provide a more unified direction for site-specific conservation strategies and budgeting reviews, information concerning local conditions, biotic and abiotic threats, and management concerns and challenges, TNC developed a site-specific plan for each of the Clark County DWMAs (TNC 2003). The plan identified conservation targets within each DWMA, described and ranked threats and sources of stress, and recommended a suite of CAs to be considered in the CMS. The site conservation plan for the Coyote Springs DWMA provided much of the background information necessary to develop a cohesive CMS. Whereas the site conservation plan created a good starting point for this CMS, this document was developed according to the goals and objectives established by the permitees and the USFWS to satisfy the incidental take permit.

2.3.3 Land Ownership and Resource Management

Clark County Land Use Designation—Clark County contains approximately 5.1 million acres of land with a variety of urban, rural, commercial, recreational, and conservation land uses. Nearly 90% of Clark County is Federal land, managed by six Federal agencies, while the remaining 10% includes State and local government, private land, and Indian reservations (Table 1).

Federal Land

Bureau of Land Management—As the primary landholder in the Clark County, the BLM is responsible for managing 2.9 million acres, including ROWs, mineral leases, and conservation efforts (BLM 1998). BLM-managed land associated with the Coyote Springs DWMA includes specially designated lands as well as adjacent land managed for multiple-use.

TABLE 1. Federal and State land ownership in Nevada.

Agency	Acres	Total Land Area (Percent)
Bureau of Land Management	2,900,000	57%
National Park Service	587,000	12%
U.S. Fish and Wildlife Service	493,000	9%
U.S. Fish and Wildlife Service/Air Force	327,000	6%
U.S. Forest Service	252,000	5%
Bureau of Reclamation	50,700	1%
Nellis Air Force Base	13,500	<1%
Total Federal	**4,623,200**	**90%**
State & Local Government, Private, Native American Lands	496,800	10%
Total	**5,120,000**	—

Source: CCCPD 2005.

Las Vegas Resource Management Plan—The LVRMP defined a 20-year management plan for 3.3 million acres of public land in Clark and Nye counties, replacing the CCMFP (1984) and the Esmeralda-Southern Nye, Area B Resource Management Plan (1986) (BLM 1998). The LVRMP designated 24 ACECs, of which four are being managed specifically for desert tortoise recovery. It also set regulations managing threatened and endangered species, wilderness management, land disposal actions, wildlife habitat, special status species, riparian areas, forestry and vegetative products, wild horses and burros, livestock grazing, air soil, water, fire, land acquisition priorities, hazardous materials management, ROWs, cultural resources, recreation, utility corridors, mineral extractions.

The LVRMP (BLM 1998), in accordance with desert tortoise recovery in the DWMA, eliminated grazing and speed-based OHV events and restricted ROW developments and mining operations. It also directed that ACECs be managed to meet minimum protection needs for desert tortoise, to enhance long-term persistence of desert tortoise populations, and to maximize benefits to other sensitive plants and animals within ACEC boundaries. Although the management actions set forth in the LVRMP have provided some protection for the desert tortoise and will continue to be valid under the CMS, a more site-specific approach is needed to focus on the issues and threats unique to each DWMA. For more detailed information, see the LVRMP, available on the Nevada BLM website (BLM 1998).

Areas of Critical Environmental Concern—Section 202(3)(c) of the Federal Land Policy and Management Act of 1976 (FLPMA) directed the BLM to give priority to the designation and protection of areas warranting special attention because of significant cultural, physical, or biological values associated with the areas (BLM 2001a). These specially designated areas are known as ACECs (areas of critical environmental concern) and are managed to minimize or eliminate competing or conflicting uses (BLM 1998). The designation of ACECs in Clark County protects unique cultural and archaeological values and areas of high-quality habitat for species of concern, including the desert tortoise. Following the designation of an ACEC, BLM is required to develop a site-specific ACEC management plan. Documents such as this CMS may provide guidance for the development of that plan.

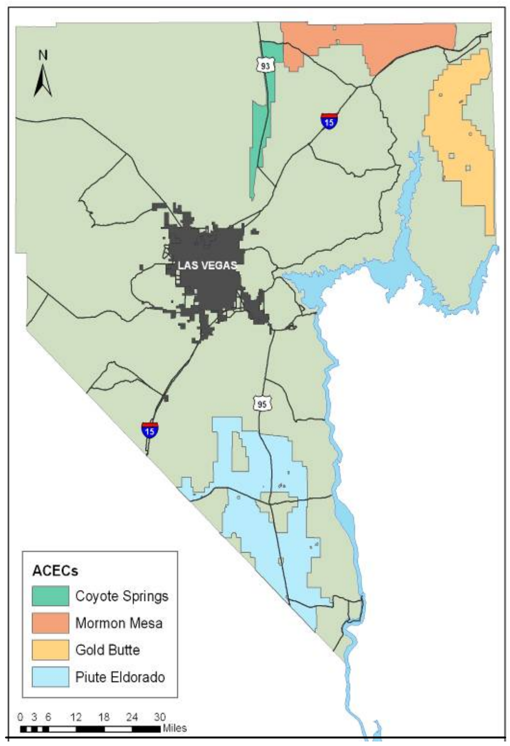

FIGURE 2. BLM ACECs in Clark County: Mormon Mesa, Coyote Springs, Gold Butte, and Piute Eldorado.

The BLM manages 87% of the 846,000 acres of designated critical tortoise habitat in the Nevada portion of the Northeastern Mojave RU. Because the BLM considers implementation of the DTRP objectives a high priority, it established four desert tortoise ACECs in Clark County (Figure 2): Piute Eldorado (329,440 acres), Coyote Springs (75,500 acres), Mormon Mesa (151,360 acres), and Gold Butte (186,909 acres). The four reserves fulfill USFWS desert tortoise conservation requirements to establish reserves in the Northeastern Mojave RU. Public land uses on the ACEC not compatible with desert tortoise conservation (e.g., grazing; organized, speed-based OHV events and unrestricted casual OHV use) were strictly curtailed or eliminated (BLM 1998). Additionally, in 2002, the Clark County Conservation of Public Land and Natural Resources Act of 2002(PL 107-282) withdrew these

ACECs from mineral entry for five years to allow the BLM to complete a mineral potential report and apply for a permanent withdrawal. In Clark County, the Coyote Springs ACEC is located within the Coyote Springs DWMA and the Mormon Mesa Critical Habitat Unit.

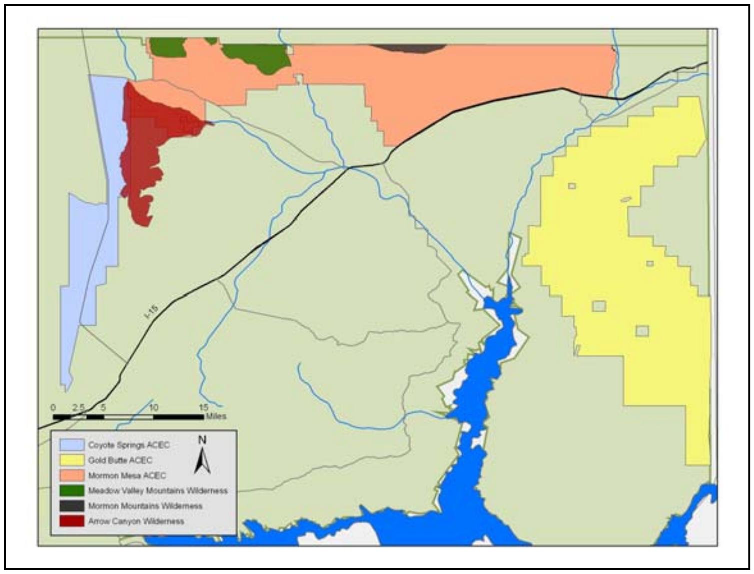

FIGURE 3. Wilderness areas associated with the Coyote Springs ACEC.

Wilderness—The Clark County Conservation of Public Land and Natural Resources Act of 2002 (PL 107-282) designated 18 wilderness areas (Wilderness.net 2005). The Arrow Canyon Wilderness (27,530 acres), managed by the BLM, is associated with the Coyote Springs ACEC (Figure 3). Arrow Canyon is adjacent to both the Mormon Mesa and Coyote Springs DWMAs between S.R. 168 and U.S. Highway 93. The wilderness area contains rolling bajadas, with cholla, yucca, and Joshua trees, as well as higher elevation pinyon-juniper and ponderosa pine habitats, and is prized for its high biodiversity, which includes a number of federally listed species, including the desert tortoise, as well as several reptile species of concern, and numerous birds of prey (Wilderness.net 2005).

In accordance with the Wilderness Act of 1964 and FLPMA, the BLM manages wilderness for the public's use and enjoyment by providing protection and preservation of these areas. Activities not compatible with the preservation of natural conditions are prohibited, including surface disturbance, construction of permanent or temporary structures, land disposal, and motorized equipment use (Wilderness.net 2005).

Special Designation Areas—The majority of BLM land in Nevada (57%) is managed for sustainable human use of public lands. These uses include grazing, mining (mineral materials, non-energy leasables, oil and gas leasing, and exploratory activity), geothermal production, ROWs, and recreation (BLM 1998). Within these multiple-use lands, special designations, including special recreation management area, disposal areas, and moderate density tortoise habitat, have been established that have use limitations identified in the LVRMP, biological opinions, or other management documents to protect resources and maintain compatibility of uses.

Land development in the Western U.S., and particularly in Nevada, has been restricted by the predominance of Federal land, much of which is owned by the BLM. FLPMA allows for the disposal of specified BLM lands nationwide (BLM 2001a), facilitated by the Federal Land Transfer Facilitation Act (FLTFA) of 2000 (FLTFA; PL 106-248), which authorized the use of funds for the acquisition of environmentally sensitive lands (BLM 2005a). In October 1998, Congress passed the Southern Nevada Public Land Management Act (SNPLMA; PL 105-263). SNPLMA enabled the BLM to auction off BLM-owned lands with much of the proceeds devoted to (1) acquisition of environmentally sensitive lands, (2) development of conservation efforts (such as the MSHCP), and (3) education (see LVRMP [BLM 1998] for specific locations) (BLM 2004a). Disposal lands are located outside of the DWMA. Disposal lands do contain wildlife habitat for listed and sensitive species, including the desert tortoise, banded Gila monster, phainopepla, and western burrowing owl (BLM 1998).

Statewide, Federal collections from BLM managed lands and minerals in 2004 totaled approximately $560 million, of which 95% was collected from sale of land and materials authorized by the SNPLMA (BLM 2005b). As of December 2004, 24 parcels of land totaling 3,738 acres have been sold in Nevada under the FLTFA, generating nearly $16.3 million (BLM 2005a).

U.S. Fish and Wildlife Service

Desert National Wildlife Refuge Complex—The complex consists of four refuges located in southern Nevada: the Ash Meadows National Wildlife Refuge in Nye County, the Pahranagat National Wildlife Refuge in Lincoln County, the DNWR, and Moapa Valley National Wildlife Refuge (MVNWR) in Clark County (USFWS 2005b). Only the DNWR is associated with the Coyote Springs DWMA, although the Pahranagat Wash, which represents the headwaters of the Muddy River, flows through the northeast corner of the DWMA, and conservation efforts along this section and in the Mormon Mesa DWMA may impact the MVNWR further downstream (Figure 4).

The DNWR, the largest national wildlife refuge in the lower 48 states, encompasses 1.5 million acres of the diverse Mojave Desert in southern Nevada (USFWS 2005b). The Refuge is located in the northeastern portion of the Mojave Desert in northwestern Clark County and southwestern Lincoln County. It is directly adjacent to the Coyote Springs DWMA east of U.S. Highway 93.

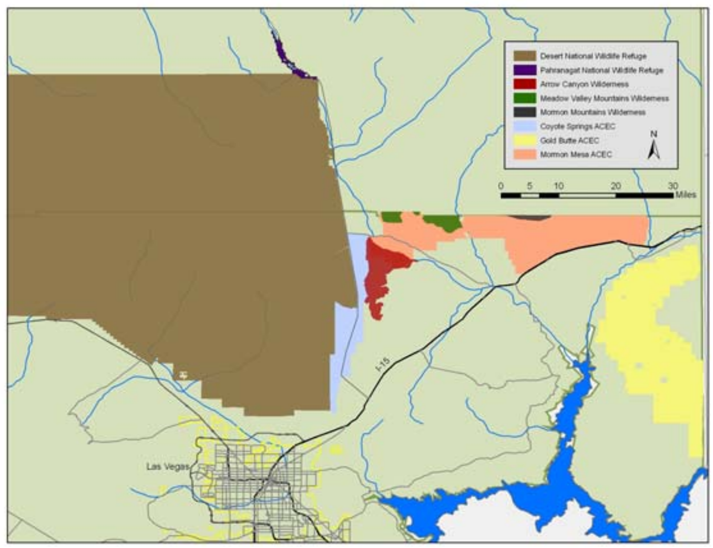

FIGURE 4. Map of the Desert National Wildlife Refuge Complex.

The refuge contains six major mountain ranges, the highest rising from 2,500-foot valleys to nearly 10,000 feet. The foremost objective of the refuge is protecting the desert bighorn sheep and its habitat, which protects numerous other wildlife species that share the range with bighorns. The refuge provides a range of recreational opportunities to enhance public appreciation, understanding, and enjoyment of refuge fish, wildlife, and habitats, and receives over 68,000 visitors a year (USFWS 2005a).

The MVNWR, established in 1979, is located on 106 acres in the Warm Springs area of the upper Moapa Valley in northeastern Clark County. It lies just south of S.R. 168 along the Muddy River, near the town of Moapa and the Moapa Indian Reservation. The refuge was created to secure habitat for the Moapa dace, an endangered species of fish endemic to the Muddy River system whose populations have declined due to habitat destruction and the introduction of nonnative fish species.

The refuge is critical to prevent extinction of the Moapa dace. MVNWR is currently closed to public access (USFWS 2005b). The USFWS is currently preparing a comprehensive conservation plan and environmental impact statement for the Desert Wildlife Refuge Complex (USFWS 2002).

Native American Land

Moapa River Reservation—The Moapa River Reservation (71,954 acres) in its current configuration was established in 1981. The current reservation population is 425, with tribal enrollment at 287 (EDA 1995). The reservation is less than two miles east of the Coyote Springs DWMA. Towns near the reservation include Glendale, Logandale, and Overton, which lie along the Muddy River as it flows southeast towards Lake Mead, twelve miles east of the DWMA.

The Moapa Band of Paiutes or "Nuwuvi" are part of the Southern Paiute Nation, whose traditional territory covered much of present southern Nevada, northern Arizona, and southern Utah. Agriculture is an important sector of tribal economy, and approximately 460 acres are currently under cultivation. The Tribe markets alfalfa, the major crop, in the Las Vegas area and also operates a tomato greenhouse. Some land is utilized for ephemeral ranching (EDA 1995). The 32 on-reservation homes are served by a tribal sewer and water system. Electricity is provided by the Nevada Power Company (EDA 1995). Plans are being made with a major development company for a five-phase project, including two golf courses, a residential community, RV park, and hotel/casino on the reservation near I-15 (EDA 1995).

Clark County-owned or Administered Lands—While the County does not own land within the planning area, it does administer all public services for the cities adjacent to the planning area, such as Mesquite, and for unincorporated towns such as Moapa, Bunkerville, and Glendale. In addition, as the permittee for the incidental take permit issued by the USFWS, Clark County is responsible for the development and implementation of HCPs to mitigate and minimize effects of incidental take on the desert tortoise, pursuant to Section 10 of the ESA.

Clark County Desert Conservation Plan—The Clark County DCP (RECON 1994) was developed as an HCP to minimize, monitor, and mitigate the impacts of any incidental take of desert tortoises for at least 30 years after approval of the incidental take permit on 525,000 acres of desert tortoise habitat subject to development. To ensure funding for desert tortoise recovery, Clark County implemented a $550/acre fee for habitat disturbance. The County agreed to pay $1.325 million per year during the first 10 years of the plan to fund conservation measures recommended in the DTRP (USFWS 1994a). A number of conservation measures were implemented to mitigate the taking impacts, including, but not limited to, a tortoise pick-up service and translocation program, a public information and education program, increased law enforcement efforts, tortoise inventory and monitoring, and tortoise fencing. For a complete listing of conservation measures, see the final DCP (RECON 1994).

The measures set forth in the DCP focused on the desert tortoise over a broad geographic area. The plan lacked two important features: (1) a suite of conservation measures ensuring the preservation of multiple species and preventing listing additional species by protecting habitats representative of the Mojave Desert ecosystem and (2) a management strategy for conservation in the four DWMAs.

Multiple Species Habitat Conservation Plan (MSHCP)—The Clark County MSHCP (RECON 2000) is a regional conservation plan promoting an ecosystem-based habitat preservation strategy to replace the DCP, which focused solely on the desert tortoise. Rather than a single-species approach, the intent of the MSHCP is to address the conservation needs of the entire range of biological resources within Clark County. The plan details proposed measures to minimize, mitigate, and monitor the effects of desert activities on 79 covered species.

The MSHCP outlines a strategy to address conservation issues in Clark County while permitting development pursuant to the USFWS incidental take permit (not exceeding 145,000 acres) for a 30-year period. The key purpose of the MSHCP is to achieve balance between long-term conservation and recovery of desert biodiversity and beneficial land uses to support a growing population.

Clark County's protection of the desert tortoise and other important species is ensured through a variety of mechanisms including the continuation of the $550/acre development fee on non-Federal land. The County has committed to spend $4.1 million biennially over the plan's 30-year term, primarily from the collection of this development fee, to manage public lands within the county that harbor ecosystems upon which these species depend.

Much of the plan is contingent upon the continued maintenance of intensively managed areas (IMAs) providing sufficient habitat quantity and quality to support viable sensitive desert specie populations covered by the plan. The plan's provisions include agreements between Federal and State land managers to continue managing IMAs consistent with MSHCP conservation strategies. IMAs include wilderness, wilderness study areas, State and National Parks, USFWS refuges, ACECs and DWMAs.

Coyote Springs Private Land Ownership—There are no private lands within the DWMA, although it is bordered on the north and south by privately owned parcels. The CSI property, adjacent to the northern border of the DWMA along S.R. 168, has the potential to substantially impact conservation efforts. The parcel, the largest privately held property in Southern Nevada, contains approximately 42,800 acres of undeveloped property within Lincoln and Clark counties, of which potentially 13,310 acres will be developed in Clark County (CSI 2005). The project site occupies most of the eastern portion of Coyote Springs Valley and is bordered by the Delamar Mountains to the north, the Meadow Valley Mountains to the east, S.R. 168 and the Arrow Canyon Range to the south, and U.S. Highway 93 to the west. The Pahranagat Wash, which feeds the Muddy River, also intersects CSI land before flowing into the Mormon Mesa DWMA and on to the Muddy River. Due to the proximity of the CSI parcel to the DWMA, activities on CSI lands may directly impact DWMA conservation efforts. Land along the southern border of the DWMA is also in private ownership but development is unlikely at this time.

2.3.4 Human Use and Condition

Clark County supports a thriving community, including urban and rural areas, industry such as agriculture and mining, and recreational use of open space.

Clark County—Nearly 96% of the population of Clark County lives in the Las Vegas Valley urban area (328,960 acres) (DCNR 2002). The Las Vegas Valley has the fastest growing urban population in the United States; the county's population surpassed 1.5 million people in 2003 (US Census 2003). Figure 5 illustrates the rapid increase in population since 1960 and projects future population growth to 2035.

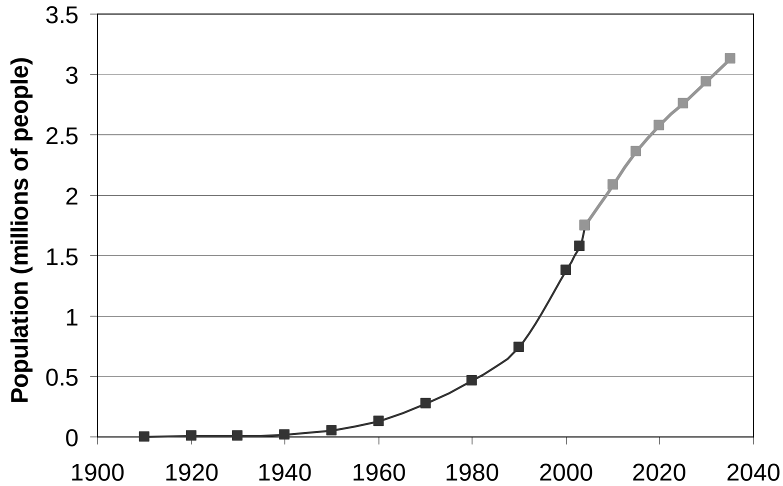

FIGURE 5. Population of Clark County from 1910 to 2005 (black) and projected population estimates to 2035 (gray) (Source: Nevada State Demographer [NSDO 2004b]).

The leisure and hospitality industry employs the highest percentage of the county's population; 13 of the 20 largest employers in 2004 were hotels and casinos (NDETR 2004). Natural resource industries (agriculture, forestry, fishing, and mining) employ comparatively few Clark County residents (0.05%). The proportion of Clark County's population employed by industry sector is illustrated in Figure 6.

Coyote Springs Desert Wildlife Management Area—Currently, residential areas associated with the DWMA are limited to the few landowners south of the DWMA and the small population on the Moapa River Reservation. However, development of the CSI property at the northern boundary may have profound impacts on conservation efforts within the DWMA.

Coyote Springs Investments—Coyote Springs Investment, LLC proposes to build a residential community, the focus of which will be a suite of golf courses and a Professional Golfer's Association village (Nicklaus.com 2004). The completed community will feature residential housing, business-oriented services, commercial uses, recreational amenities, and public-oriented components. Community development will be completed in phases, with the initial emphasis placed on developing a primary and second home community. CSI estimates a total of 49,600 units will be built over the next 40 years. In addition to golf course construction, Pardee Homes, the contracted builder, will begin grading 2,000 acres in the next year, with a projected estimate of 2,600 to 3,630 residential units built by 2007 (CSI 2005). The latter stages will transform the small community into a self-sufficient town complete with schools, medical facilities, police and fire protection, and grocery stores. The estimated economic value of the planned community after 25 years is over $25 billion dollars (CSI 2005).

CSI plans to begin development on the southern portion of the property, consisting of approximately 12,800 acres, of which 10,640 acres will be developed in accordance with the December 2002 Development Agreement between Clark County and CSI. CSI is working with Lincoln County representatives to establish a similar development agreement for the remaining 30,000 acres, which lie entirely within Lincoln County.

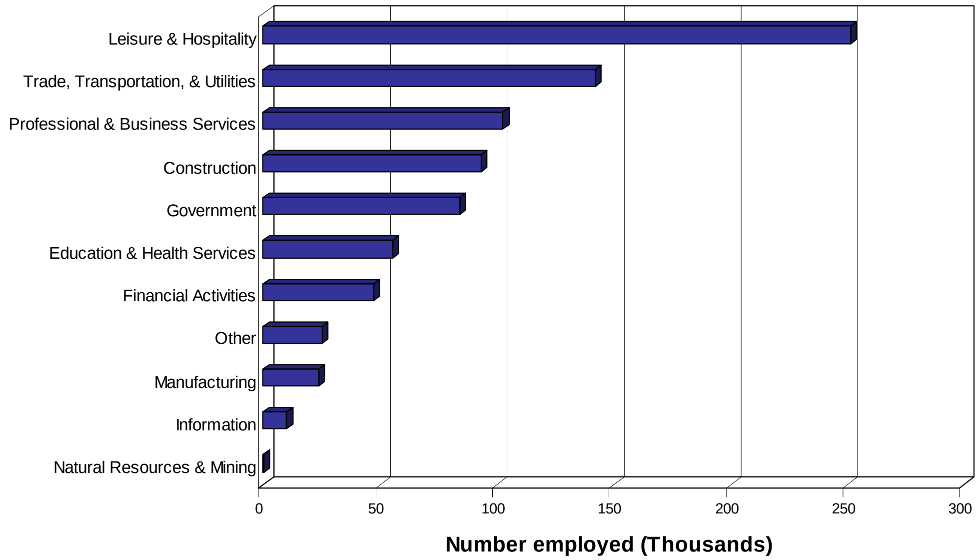

FIGURE 6. Percent of Clark County residents employed by sector (Source: NDETR 2004).

A community development of this magnitude will require a multitude of public services such as water, electric light and power, flood control, and sanitation and waste management. To this end, CSI has proposed the Coyote Springs Independent general improvement district within Clark County to ensure that necessary public services are provided without placing the burden on the County (CSI 2005). The Coyote Springs general improvement district will be responsible for providing Coyote Springs with the following services:

- electric light and power
- streets and alleys
- storm drainage and flood control
- sanitation services;
- water
- pest control
- street lights
- waste disposal
- recreation facilities
- weed abatement
- habitat conservation areas for the preservation of threatened or endangered species.

A large residential population, along with the services and amenities required by such a community, has the potential to disrupt DWMA conservation efforts if precautions are not taken. U.S. Highway 93 is one of two access roads to the community, and traffic levels through the DWMA may increase substantially following development. Residential proximity may increase public access of the DWMA, requiring additional enforcement to ensure regulations are upheld. New ROWs may be constructed through the DWMA to supply power to the community, and groundwater withdrawals may impact flow levels in the Muddy River (CSI 2005). Finally, residential communities also tend to attract opportunistic predators, such as coyotes and ravens, as well as increased density of domestic animals (Boarman 2002a). Altered predator regimes adjacent to the DMWA may negatively affect tortoise survival within DWMA boundaries.

Clark County Water Ownership and Use—Nevada Water Law is set forth in Nevada Revised Statutes (NRS), Chapters 533 and 534. Surface and groundwater in Nevada belong to the people of the State and entities within the State can apply for the right to use those waters. The State Engineer is the water rights administrator and is responsible for the appropriation, adjudication, distribution, and management of water in the State. Nevada Water Law is founded on the doctrine of prior appropriation, in other words, the first user of water acquired a priority right to the use and to the extent of its use. A water right is lost by forfeiture if the right is not used for five years. Water lost through abandonment or forfeiture reverts back to the public and is subject to future appropriation (NDWP 1992a).

Surface waters in the State of Nevada are fully appropriated with most priority rights established in the 1800s (TNC 2003). In addition, over half of the groundwater basins within the State are fully or partially appropriated (DCNR 2003). Clark County's water resources are managed by the Southern Nevada Water Authority (SNWA), a regional water board created in 1991; SNWA unified seven major districts to develop solutions to ensure adequate water supply in the future. The Colorado River provides nearly 90% of southern Nevada's water supply, with groundwater withdrawals providing the remainder (SNWA 2005a). A major challenge for Clark County in the next 10 years will be meeting the water needs of a growing desert community.

Most of the rural population in Clark County, such as residents in Moapa, primarily uses groundwater for their water supply (NDWP 1992b). While groundwater accounted for only 14% of Clark County's total water use in 2000, 75% of groundwater consumption is used for public supply (USGS 2002). Irrigation was the second highest user of groundwater, accounting for 8.4% of total use, while private domestic wells accounted for 7.4% of total use. Commercial and industrial uses each accounted for only 4% of groundwater use, and the least consumptive use was mining, accounting for less than 1% of groundwater consumption (USGS 2002). In the DWMA, springs are replenished primarily by groundwater and surface runoff.

Coyote Springs DWMA Water Ownership and Use—In the DWMA, springs are replenished primarily by groundwater and surface runoff. In the three groundwater basins that underlie the DWMA, there are 63 wells (Table 2). Most of these wells are for public supply or industrial use in Garnet Valley, which covers the southernmost portion of the DWMA. In the Coyote Springs and Hidden valleys, which encompass the majority of the DWMA, there are 17 wells, used for monitoring, testing, domestic supply, public supply, and livestock.

CSI Water Withdrawal Impact—The development of a large residential community adjacent to the DWMA may impact water availability in the DWMA, especially for perennial and intermittent streams. Groundwater withdrawals to supply Coyote Springs will limit groundwater availability for springs downstream from wells. The total groundwater withdrawals upon complete build-out for domestic, commercial, and irrigation use is estimated to be 23,700 acre-feet per year, which includes reclamation of half of domestic and commercial water withdrawals for irrigation (CSI 2005). Withdrawals will occur in phased increases, as community development proceeds, beginning with only 3,500 acre-feet per year by year 5. Initial withdrawals will be from on-site wells, with new wells developed in the first phase of development, as well as other regional well development (CSI 2005).

Table 2. Summary of the number of wells of each type, the well depth, and static water levels for all wells in three groundwater basins associated with the DWMA.

	Number of Wells			
Well Use	**Eldorado Valley**	**Colorado Valley**	**Piute Valley**	**Total**
Monitoring Well	6	8	3	17
Test Well	3	2	0	5
Domestic	0	0	1	1
Public Supply	2	19	1	22
Industrial	0	12	0	12
Commercial	0	1	0	1
Irrigation	0	0	0	0
Stock	1	0	0	1
Mining	0	0	0	0
Unused	0	0	0	0
Other	0	0	0	0
Dewater	0	4	0	4
Industrial Cooling	0	0	0	0
Total	12	46	5	63
Max Well Depth (feet)	1,783	2,480	430	—
Min Well Depth (feet)	353	50	70	—
Max Static Water Level (feet)	1,086	888	350	—
Min Static Water Level (feet)	320	0	46	—

Source: DCNR 2005.

The SNWA has applied to the BLM for issuance of ROWs to construct and operate the Clark, Lincoln, and White Pine Counties Groundwater Development Project (SNWA 2005b). The Groundwater Development Project is a system of regional water supply facilities, including groundwater production wells, water conveyance facilities, and power facilities, located on BLM-managed public lands. An environmental impact statement is being prepared to determine the environmental effects of a ROW issuance for construction and operation of the proposed facilities, with primary pipeline construction anticipated to begin in 2009.

The SNWA anticipates a total groundwater volume of 180,000 acre-feet per year from Coyote Spring, Delamar, Dry Lake, Tikaboo North, Cave, Spring, and Snake Valleys (SNWA 2005a, 2005b). The project is divided into eight segments, two of which are associated with the Coyote Springs DWMA. Segment 1 is the terminus of the project and will not have groundwater production. There will be a primary transmission pipeline (30 miles long by 78 inches in diameter buried 5 to 10 feet underground), a 15-mile long power transmission line, and permanent ROWs covering approximately 1,000 acres for conveyance and power facilities (SNWA 2005a, 2005b). Segment 2 is the Coyote Spring Valley Basin. In this segment, the SNWA has applications for up to 27,560 acre-feet per year of water rights, of which one-half will go to the Moapa Valley Water District. Water production activities have estimated 10 to 15 groundwater production wells in the valley and will continue well explorations on CSI lands (SNWA 2005). A pipeline and power transmission line, each about 40 miles long, will be accompanied by a right-of-way for water conveyance and power transmission covering approximately 1,500 acres (SNWA 2005).

Preliminary surveys of water resources in the area suggest sufficient water availability to meet these demands, but impacts of groundwater withdrawals on water availability for wildlife in the

DWMA is uncertain. Wildlife along the Pahranagat Wash and Muddy River, including the MVNWR, may be impacted by reduced water availability to feed springs, particularly the Moapa dace, an endangered fish species that occurs only on the refuge (USFWS 2005b). Groundwater pumping may also impact existing water rights and wells. These issues should be investigated prior to well pumping to ensure water quantity is adequate to supply all water rights holders as well as native wildlife.

2.3.5 Biotic and Abiotic Factors

Physiography—Adapted from Nevada Bureau of Mines and Geology Bulletin 62 (Longwell et al. 1965).

The Coyote Springs DWMA is shaped by two adjoining valleys, Coyote Springs Valley and Kane Springs Valley, creating a broad alluvial bottomland that lies between the Sheep Range, Arrow Canyon Range, and the Meadow Valley Mountains. The Sheep Range, which runs north to south, is located entirely within the DNWR and rises to a height of 8,912 feet at Hayford Peak. The Arrow Canyon Range is approximately 32 miles long in a north–south orientation, and its highest point is about 5,100 feet. To the south, this range merges with the Las Vegas Range, and to the north, the Arrow Canyon Range ridgeline slopes into the alluvial fill of the valley floor formed around Pahranagat Wash.

Climate—Summers are typified by hot days and mild nights with daily average temperatures hovering in the mid-90 degrees Fahrenheit. December through February, daily temperatures average in the mid-40 degrees Fahrenheit. Low temperatures dip below the freezing mark for approximately 12 days per year. Most precipitation falls from November to February and during the summer months of July and August. The region's driest periods are from April through June and the month of September. Summer rains are highly intense, localized, and short in duration. Total annual precipitation ranges from 2 to 13 inches, with a mean of 5 inches per year.

Soils—Adapted from Nevada Bureau of Mines and Geology Bulletin 62 (Longwell et al. 1965) and the Las Vegas Resource Management Plan (BLM 1998).

Fan piedmont remnants dominate the planning area. The soils in Coyote Springs are sandy to sandy loam, which have been formed largely in alluvial deposits, on alluvial fans, terraces, and fan remnants. The broad low-relief bajadas are covered with braided shallow sandy washes. Hills and low mountains in the planning area such as the Sheep, Arrow Canyon, and Las Vegas ranges have soils that are very shallow to shallow, having developed largely in sedimentary rock. These islands of residual soils have high percentages of rock fragments throughout the profile and on soil surfaces, minimizing erosion.

Hydrology—Adapted from the USGS Groundwater Atlas of the United States HA 730-B (USGS 1995).

The Basin and Range aquifers are located under most of Nevada and the southern California desert (Figure 7). The water-yielding materials in this area are in valleys and basins and consist primarily of unconsolidated alluvial-fan deposits, although local flood plain and lacustrine (lake) beach deposits may yield water to wells. Many of these valleys and basins are internally drained. Water from precipitation that falls within the basin recharges the aquifer and ultimately discharges to the land surface and evaporates within the basin. Groundwater is generally under unconfined, or water-table, conditions at the margins of the basins, but as the unconsolidated deposits become finer grained toward the center of the basins, the water becomes confined.

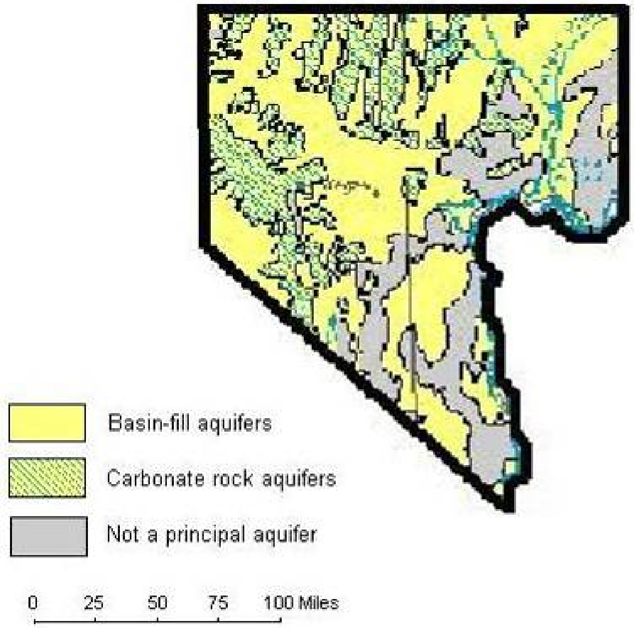

Figure 7. Hydrology of the Basin and Range Aquifer system in Clark County, Nevada (Source: USGS 1995).

Because the desert basins receive little precipitation during the year, surface and groundwater are scarce and population growth in the region is limited. The Colorado, Virgin, and Muddy Rivers are the only significant perennial surface waters in Clark County. The individual basin-fill aquifers, together composing the largest known groundwater reserves in the area, receive little annual recharge and are easily depleted. The Mojave Desert consists primarily of closed depressional basins which receive water from the surrounding uplands and mountains. During heavy precipitation and during the winter rainy season these basins may contain surface water but soon evaporate because of the high solar radiation, temperature, and aridity of the Mojave environment. Nevertheless, high-intensity storms or rapid snowmelt in the mountains bordering the basins may cause flash flooding.

Southern Nevada is encompassed by two major hydrographic basins, the Central Region, which covers most of central Nevada into the Eldorado and Piute valleys, and the Colorado River Basin, which covers all of Southeastern Nevada. These major hydrographic regions are subdivided into minor hydrographic areas. Precipitation recharges area aquifers and feeds several springs in the area, providing intermittent or perennial surface waters.

Hydrology of the Coyote Springs DWMA—The planning area sits atop the White River Groundwater Flow System, which extends from southern Jakes Lake Valley in the north to Upper Moapa Valley in the south. The Coyote Springs ACEC is entirely contained within the Colorado River Basin and is covered by three minor hydrographic areas: the Coyote Springs Valley, which spans the northern and eastern portion of the planning area into Lincoln County; the Hidden Valley, which covers the southeastern portion of the planning area; and the Garnet Valley, which encompasses the southern portion of the planning area (Figure 8) (Stockton et al. 2003).

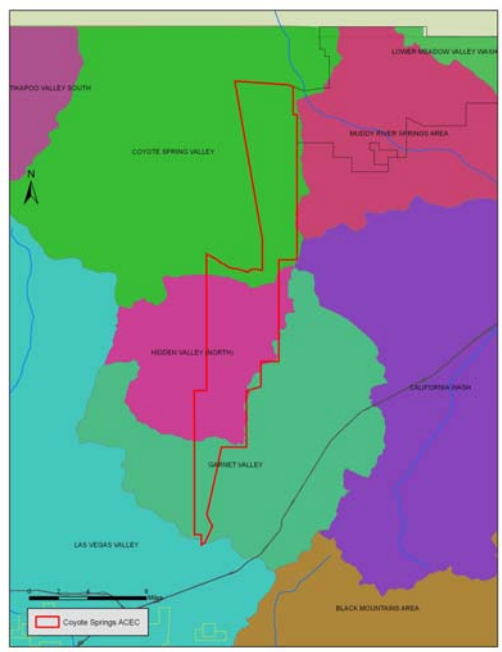

FIGURE 8. Minor hydrographic basins of the Coyote Springs ACEC.

Groundwater moves southward from Lincoln County to the upper Moapa Valley. Higher elevations and lower temperatures in the northern half of the basin lead to high amounts of recharge, which results in about 70% of the aquifer recharge in this area. Conversely, in the lower half of the basin the water table is close to the surface, and approximately 62% of the discharge occurs in portion, mainly to the Pahranagat Wash (Stockton et al. 2003).

Within the basin formed by the Sheep Range, Las Vegas Range, Arrow Canyon Range, Delamar and Meadow Valley mountains, sheet flow from intense summer storms is channeled into valley bottomlands along an extensive network of ephemeral washes. In the valley bottoms, these washes become broad channels that cleave through the alluvial soils of the surrounding upland bajadas. In the Coyote Springs Valley, there are several regional and large springs, including the perennial Coyote Springs. The surrounding community of phreatophytic plants indicates the water table proximity in this particular location. Throughout most of the rest of the planning area, the water table is found well below the desert surface (BLM 1998).

Dominant Vegetative Communities—According to the LVRMP (BLM 1998), nearly 94% of the 3.3 million acres of land in the BLM Las Vegas District, which covers all of Clark County, is southern desert and Mojave shrub. Pinyon-juniper accounts for approximately 4%, while salt desert shrub makes up about 1.7%. Less than 1% of the district is covered by mountain shrub, grassland, mesquite, conifer, and riparian vegetation. The characteristic vegetation in and around the planning are described below.

Creosote-Bursage Scrub—Creosote bush (*Larrea tridentata*) and white bursage (*Ambrosia dumosa*) comprise the desert scrub in the broad valleys, plains, and gentle rolling bajadas between mountain ranges. Typically, these elevations are below 3,000 to 3,500 feet.

Creosote bush is the dominant vegetation, while white bursage is absent in two landscape situations: local low depressions or “semi-playas” where creosote bush occurs with four-winged saltbush (*Atriplex canescens*) and desert tomato or wolfberry (*Lycium andersonii*), and sandy xeroriparian floodplains that rarely actually flood where it occurs with four-winged saltbush and desert rhubarb (*Rumex hymenosepalus*). White bursage is also usually absent or rare over 4,000 feet, where individuals of creosote bush are found in blackbrush or yucca woodland communities (see below). Occasionally, local bajadas will have alluvial deep and heavy soils with large individuals of almost a pure creosote bush community. However, white bursage is still present in small numbers. In loose aeolian sandy soils under “dune-like” conditions, creosote bush and big galetta grass (*Pleuraphis rigida*) dominate the community, and white bursage is present in reduced numbers.

In the northern Mojave Desert (southern Nevada), the creosote-bursage community above 2,000 to 2,500 feet also contains Mojave yucca (*Yucca schidigera*) or Mojave yucca and Joshua trees (*Yucca brevifolia*). Montane creosote-bursage scrub communities are more diverse in species composition than lower valley scrub. Major shrub species include: blackbrush (*Coleogyne ramosissima*), Mormon tea (*Ephedra* spp.), indigo bush (*Psorothamnus fremontii*), shadscale (*Atriplex confertifolia*), spiny hopsage (*Grayia spinosa*), desert thorn (*Lycium* spp.), ratany (*Krameria erecta*), and brittlebush (*Encelia farinosa*). Catclaw acacia (*Acacia greggii*), honey mesquite (*Prosopis glandulosa*), cheesebush (*Hymenoclea salsola*), and sweetbush (*Bebbia juncea*) can be found along washes.

Montane Shrub Communities—This community is characterized as shrubland dominated by blackbrush and typically *Yucca*, Mojave yucca (*Yucca schidigera*) and Joshua trees (*Yucca brevifolia*), and less frequently banana yucca (*Yucca baccata*). This community is found on the upper bajadas and slopes of the Arrow Canyon and Sheep Ranges. The blackbrush community is sometimes viewed as a transitional habitat between the Mojave and Great Basin Deserts. However, it is more correctly an elevation transition zone community, and sometimes indicates poorer and shallower soils. Blackbrush typically occurs between 3,800 to over 6,000 feet. At the higher elevations of this community, Utah juniper (*Juniperus osteosperma*) and single-leaf pinyon pine (*Pinus monophylla*) may be present, and associated shrubs may include spiny hopsage, Mormon tea, shadscale, and desert thorn, Black gamma grass (*Bouteloua eriopoda*) may also be common in the planning area.

The big sagebrush (*Artemesia tridentata*) community represents both the transitional community between the Mojave and Great Basin Deserts, and also elevation zone plant community change.

Pinyon-Juniper—The pinyon-juniper community is typically found over 5,500 feet in southern Nevada and is found on the upper slopes of the Arrow Canyon and Sheep Ranges. Pinyon pine and Utah juniper codominate this conifer woodland community type. Mountain mahogany (*Cercocarpus* spp.), big sagebrush, rabbitbrush (*Chrysothamnus* sp.), Gambel's oak (*Quercus gambelii*), antelope bitterbrush (*Purshia tridenta*), and cliffrose (*Cowania mexicana*) are primary associated shrubs.

Wildlife of the Coyote Springs DWMA—Clark County has an estimated 173 rare species and 9 federally listed threatened and endangered species (Table 3) (NNHP 2001, NNHP 2002). It is the intent of Clark County and USFWS that the habitat in the DWMA is managed not only for desert tortoise and other sensitive species, but also for Mojave Desert's native biological populations, natural community landscape patterns, and ecological processes (RECON 2000). A prime motivation is the prevention of future species or population listings under the ESA.

While the target of this CMS is the desert tortoise, there are many other native and rare species in the planning area concurrent with desert tortoise habitat, particularly other rare and sensitive reptile species identified in the MSHCP (RECON 2000). In the DWMA, the desert tortoise will serve as a "focal" or "umbrella" species. CAs for the tortoise may improve the habitat for additional species as well. The DWMA offers a unique opportunity to experimentally test the hypothesis that conservation efforts aimed at one focal species can have beneficial impacts on other species. For instance, protection of tortoises in the Desert Tortoise Natural Research Area in California resulted in higher species richness and abundance of native plants and animals than in unprotected areas, including annual plant and soil seedbank biomass, density of nocturnal rodents, and greater abundance of lizards (Brooks 2000). The DWMA offers a unique opportunity to experimentally test the hypothesis that conservation efforts aimed at one focal species can have beneficial impacts on other species.

TABLE 3. Federally listed threatened and endangered species in Clark County.

Category	Species Name	Common Name	Federal Status
Fish	*Cyprinodon diabolis*	Devils Hole pupfish	Endangered
	Empetrichthys latos latos	Pahrump poolfish	Endangered
	Gila elegans	Bonytail chub	Endangered
	Gila seminude	Virgin River chub	Endangered
	Moapa coriacea	Moapa dace	Endangered
	Plagopterus argentissiums	Woundfin	Endangered
	Xyrauchen texanus	Razorback sucker	Endangered
Reptiles	*Gopherus agassizii*	Desert tortoise	Threatened
Birds	*Sterna antillarum**	Least Tern	Endangered

Source: NNHP 2002.

2.4 Species Conditions

2.4.1 Habitat Description

The Coyote Springs DWMA, according the DTRP, is mostly on USFWS lands on the DNWR bounded by the Nye County line on the west, the DNWR boundary on the north and south, and U.S. Highway 93 on the east. The Coyote Springs ACEC is located in the Coyote Springs DWMA west of U.S. Highway 93 and within the Mormon Mesa DWMA east of U.S. Highway 93. The DWMA is characterized by a high elevation gradient where the valley meets the slopes of the Arrow Canyon Range on the east and Sheep Range on the west. The valley has prime tortoise habitat in bajadas between the ranges, but its narrow shape and small size may have implications for conservation efforts. The DWMA is unique in that, in combination with the Mormon Mesa DWMA, it provides a primary link between the DNWR and conservation lands in northeastern Clark County, Utah, Arizona, and Gold Butte. Thus, although it is the smallest DWMA, it represents a critical area to facilitate movement of tortoises and other wildlife.

2.4.2 Habitat Condition

The Coyote Springs DWMA is almost entirely preferred desert tortoise habitat (creosote-bursage and mixed montane scrub). The landscape has numerous braided shallow washes with high densities of cheesebush, sweetbush, and larger, more vigorous representatives of upland species. While the rocky bajadas may appear bleak, they are home to an abundance of lizards, snakes, kangaroo rats, pocket mice, and invertebrates. Kangaroo rat burrows are very abundant all over the extensive bajada (Krzysik 2004, personal observation).

Excellent creosote-bursage habitat with Mojave yucca is found six miles south of the intersection of U.S. Highway 93 and S.R. 168 (2,400 ft). Mojave yucca is less abundant here, but there is still good plant diversity with Pima rhatany and several species of cactus prominent. The bajada extending north from this area represents extensive tortoise habitat, although with an abundance of red brome, an invasive grass introduced from the Mediterranean region. Approximately 11 miles south of the intersection of U.S. Highway 93 and S.R. 168 is an unusual playa depression in the creosote scrub (2,623 ft). Playas are low depressions to large basins in deserts where there is standing water after precipitation. The soils with the accumulation of clay and silt tend to be finely textured (and therefore not well-aerated), alkaline, and saline. Creosote is typically found on well-drained soils but can be found on heavier soils that do not become excessively water-logged or anaerobic. The light-colored patches are highly cracked soils, providing evidence of pooled-water evaporation. The darker areas are highly developed cryptogrammic crusts. These crusts are biologically active and important nitrogen fixers in arid environments. Their surface integrity also retards wind and water soil erosion. They consist of lichens, bacteria, and cyanobacteria (blue-green algae). Kangaroo rat burrows and occasional OHV tracks were present. Eroded caliche caves at the edges of washes provide desert tortoises with natural burrows, providing critical hibernacula for desert tortoises. Caves are very important landscape elements for bats and also offer shelter for a wide variety of organisms.

The Pahranagat Wash, between the northern boundary of the DWMA and the proposed CSI development site, displays vibrant and diverse habitat with loamy sand to sandy soils and vigorous growth of burroweed, creosote bush, big galleta grass, sweetbush, and four-winged saltbush. This riparian biological community represents some of the highest biodiversity in the Mojave Desert (Krzysik 2004, personal observation).

In addition to the desert tortoise, there are a number of other sensitive species included in the MSHCP whose habitat overlaps the Mojave scrub being managed in the DWMA for the tortoise (RECON 2000). Table 4 summarizes species covered or potentially covered under the MSHCP and emphasizes the regional scale of the MSHCP.

2.4.3 Tortoise Population Estimates

Population densities of animals are extremely difficult to estimate (Krzysik 2002). Estimating desert tortoise densities is particularly difficult because tortoises are distributed on landscape scales, typically occur at low densities, are patchy in distribution, exhibit a high variability in surface activity (spending over 95% of their lives in burrows) making sample observations highly opportunistic, and occupy a greater variety of habitats than typically acknowledged (Krzysik 2002). These characteristics severely challenge sampling design and statistical analysis. At this time, the distribution of desert tortoise populations in the Coyote Springs DWMA is largely unknown, but USFWS (1994b) has estimated densities at approximately 47 adults per square mile (1992 data).

Desert tortoise populations in the Mojave Desert have been monitored by BLM since the early 1970s in permanent long-term 1-mi^2 plots using mark-recapture and the stratified Lincoln Index (Berry 1984). The DTRPAC report analyzed population trends from the permanent BLM plots in two different ways: DWMAs as currently assigned to RUs; and the 2003 DTRPAC report's recommended reassignment of DWMAs to DPSs. The BLM data were available from 1976/1977 to 2002, but each plot was not surveyed each year, and data representation among the plots and years were highly variable (Tracy et al. 2004). Table 5 provides the landscape locations of the BLM plots that were associated with the four Clark County DWMAs.

Mormon Mesa, Coyote Springs, and Gold Butte DWMAs are discussed together because they are all located in the Northeastern Mojave RU, and recommendations for adjustments of RUs in the 2003 DTRPAC report would not result in reassignment of any of these DWMAs to different DPSs. However, for the DTRPAC analyses there were two fewer BLM plots in the 2003 DTRPAC report's recommended DPS than in the current RU. This was because the BLM plots west of the Sheep Range were not included in the 2003 recommended DPS. Both the current RU and the recommended DPS include the following BLM plots: Gold Butte, Littlefield, Mormon Mesa, Overton, Coyote Springs, Beaver Dam Slope, Beaver Dam Enclosure, River Mountain, Virgin Slope, and Woodbury Hardy. The current RU also includes Sheep Mountain and Trout Canyon BLM plots. Both of these plots are located southwest of Las Vegas.

There was no significant difference observed in desert tortoise populations in either BLM plots or over time for the 2003 report's recommended DPS. However, there was a significant difference measured among sites, but not in years when Sheep Mountain and Trout Canyon plots were included in the analysis based on the current RU. The low tortoise population densities in these two plots combined with the high variance associated with the data resulted in statistical significance.

It is encouraging that there was no significant decline observed within the parameters of the research design in overall desert tortoise density in the 2003 report's recommended Lower Virgin River DPS between 1986 and 2002 based on the BLM plot data. However, sample sizes were very small (3, or 5 if Littlefield and Overton were included), sample years varied among the plots, data variance was very high, and plots were not randomly distributed in the landscape. Therefore, these data are incapable of being reliably interpreted. Despite this caution, an examination of the individual BLM plot data was informative (see Tracy et al. 2004). These data are summarized in Figure 9 for the DWMAs occurring in the 2003 report's recommended Lower Virgin River DPS in Clark County. Desert tortoise population densities at Gold Butte, Mormon Mesa, and Coyote Springs BLM plots

TABLE 4. Clark County MSHCP species with potential habitat or distributions in the Coyote Springs DWMA.

Common Name	Species	Habitat	Status
Banded gecko	*Coleonyx variegatus*	Mojave Scrub/Pinyon-Juniper/Sagebrush/Blackbrush	C
Banded Gila monster	*Heloderma suspectum cinctum*	Mojave Scrub/Pinyon-Juniper/Blackbrush	HPE
California kingsnake	*Lampropelitis getulus californiae*	Mojave Scrub	C
Desert iguana	*Dipsosaurus dorsalis*	Mojave Scrub	C
Desert kangaroo rat	*Dipodomys deserti*	Mojave Scrub/Blackbrush	HPE
Desert night lizard	*Xantusia vigilis*	Mojave Scrub/Blackbrush	HPE
Desert pocket mouse	*Chaeotdipus penicillatus sobrinus*	Mojave Scrub	HPE
Desert tortoise	*Gopherus agassizii*	Mojave Scrub/Sagebrush/Blackbrush	C
Glossy snake	*Arizona elegans*	Mojave Scrub/Pinyon-Juniper	C
Great Basin collared lizard	*Crotaphytus insularis bicintores*	Mojave Scrub/Pinyon-Juniper/Sagebrush/Blackbrush	C
Kit fox	*Vulpes macrotus*	Mojave Scrub/Pinyon-Juniper/Sagebrush/Blackbrush	HPE
Large-spotted leopard lizard	*Gambelia wislizenii wislizenii*	Mojave Scrub/Pinyon-Juniper/Sagebrush/Blackbrush	C
Las Vegas bearpoppy	*Arctomecon californica*	Mojave Scrub	C
Mojave green rattlesnake	*Crotalus scutulatus scutulatus*	Mojave Scrub/Blackbrush	C
Pale Townsends big eared bat	*Corynorhinus townsendii pallescens*	Mojave Scrub/Sagebrush/Blackbrush	HPE
Sidewinder	*Crotalus cerastes*	Mojave Scrub	C
Sonoran lyre snake	*Trimorphodon biscutatus lambda*	Mojave Scrub/Pinyon-Juniper	C
Southern desert horned lizard	*Phrynosoma platyrhinos calidiarum*	Mojave Scrub/Pinyon-Juniper/Sagebrush/Blackbrush	HPE
Speckled rattlesnake	*Crotalus mitchelli*	Mojave Scrub/Pinyon-Juniper/Sagebrush/Blackbrush	C
Sticky buckwheat	*Eriogonum viscidulum*	Mojave Scrub	C
Western burrowing owl	*Athene cunicularia hypugea*	Mojave Scrub/Pinyon-Juniper/Sagebrush	HPE
Western chuckwalla	*Sauromalus obesus obesus*	Mojave Scrub/Blackbrush	HPE
Western leaf-nosed snake	*Phyllorhynchus decurtatus*	Mojave Scrub	C
Western long-nosed snake	*Rhinocheilus lecontei lecontei*	Mojave Scrub	C
Western red-tailed skink	*Eumeces gilberti rubricaudatus*	Pinyon-Juniper/Sagebrush/Blackbrush	C
White Bearpoppy	*Arctomecon merriamii*	Mojave scrub	C
Yellow twotone beardtongue	*Penstemon bicolor ssp. Bicolor*	Mojave Scrub/Blackbrush	HPE

Source: RECON 2000.

Note: Summary includes Covered Species and high-priority evaluation species (HPE).

TABLE 5. Location of BLM 1-mi^2 Permanent Plots in the DWMAs of Clark County, Nevada and eastern Mojave Desert, and survey dates.

DWMA	BLM Plot	Location	Survey Dates
Piute Eldorado	Piute Valley	South extreme Piute Eldorado[a]	1987, 1989, 1994
	Christmas Tree	South extreme Piute Eldorado[b]	1985, 1991, 1994
	Eldorado Valley	North extreme Piute Eldorado[c]	1994
Gold Butte - Pakoon	Gold Butte	South end Gold Butte[d]	1986, 1990, 1994
	Littlefield	North extreme Gold Butte[e]	1998, 2002
Mormon Mesa	Mormon Mesa	Southeast Mormon Mesa[f]	1989, 1994
	Overton	South of Mormon Mesa[g]	1996, 2000
Coyote Springs	Coyote Springs	North end Coyote Springs[h]	1986, 1992, 1995
Fenner	Goffs	Southwest extreme Fenner	1980, 1990, 1994, 2000
Ivanpah	Ivanpah Valley	Northeast Ivanpah	1979, 1986, 1990, 1994, 2002
	Shadow Valley	Northwest Ivanpah	1988. 1992, 2002
Chemehuevi	Chemehuevi Valley	South Chemehuevi	1979, 1982, 1988, 1992
	Ward Valley	North Chemehuevi	1980, 1987, 1991, 1995, 2002

Source: Tracy et al. 2004.

Notes:

a. Piute Valley	West of I-95 and Cal-Nev-Ari, near California boundary.
b. Christmas Tree	East of I-95 and West of Newberry Mountains, in the vicinity of Christmas Tree Pass Road
c. Eldorado Valley	North of I-93, just West of Boulder City; population surrounded by extensive development and I-93 (major highway).
d. Gold Butte	East of Lime Canyon Wilderness, West of Gold Butte Road, South of Red Rock Spring.
e. Littlefield	Extreme northwest Arizona, near I-15 and Virgin River; close to Beaver Dam Slope DWMA.
f. Mormon Mesa	Just north of I-15 in the vicinity of Carp Road.
g. Overton	Overton is a town in the plain of the Muddy River; the geologic Mormon Mesa is the plateau above it to the East; and Valley of Fire State Park is to the West.
h. Coyote Springs	East of I-93, North of S.R. 168, in the vicinity of the CSI development.

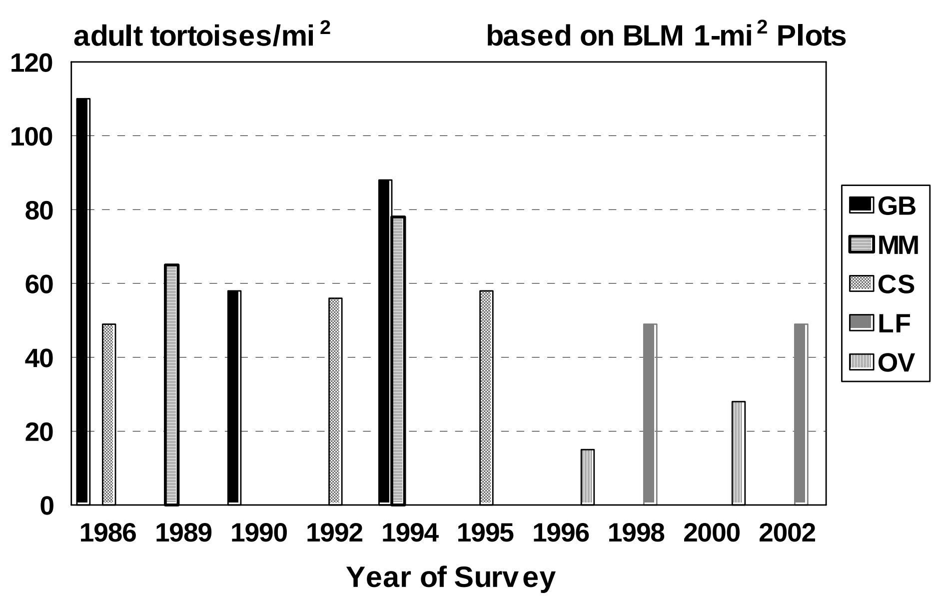

FIGURE 9. Estimated tortoise densities at Gold Butte (GB), Mormon Mesa (MM), Coyote Springs (CS), Littlefield (LF), and Overton (OV) plots in the Lower Virgin River DPS.

were relatively similar between 1986 and 1995, varying between 49 and 110 adult tortoises/mi^2. These are reasonably high densities, implying good population viability. The distressing and critical factor in these data is that between 1996 and 2002 tortoises were not surveyed at these plots, and surveys were conducted in the newly established Littlefield (Gold Butte in Arizona) and Overton (south of Mormon Mesa) BLM plots. These data cannot distinguish between two important factors: (a) are desert tortoise populations declining in the recommended Lower Virgin River DPS or, more likely, (b) does Littlefield, but especially Overton, innately possess lower population densities? These trends cannot be evaluated until additional data is available for analyses.

Population Trends Based on Observation Rates. Data was collected in 2001, 2002, 2003 using line transects and distance sampling. For each DWMA, the ratio of carcasses versus live tortoises was calculated from transect observations (Tracy et al. 2004). According to DTRPAC, ratios much larger than “1” suggest that there is excessive tortoise mortality and, therefore, a decline in tortoise populations. Ratios around “1” indicate a stable population. Table 6 is the ranked carcass–live tortoise ratios from DTRPAC (Tracy et al. 2004).

DWMAs in the recommended Lower Virgin River DPS varied widely in their carcass–live tortoise ratio but were lower than in the eastern Mojave. Gold Butte was the highest with 1.88, Mormon Mesa had 1.58, and Beaver Dam Slope had 1.25 (Table 6). These data suggest that desert tortoise populations in these DWMAs have only experienced a small decline.

Population Trends Based on Kernel Analyses. Kernel analysis requires transects and distance sampling to be randomly or systematically placed in the landscape, as distance sampling itself requires, a condition that was not met in 2002 or 2003. This spatial analysis, similar to home range analysis, uses adaptive kernels to smooth and develop surfaces from live tortoise and carcass observations. Carcasses surfaces without significant overlap with live tortoises would indicate spatial areas of tortoise declines or possibly die-offs. Nine separate kernel analyses were conducted on the 2001 transects and distance sampling surveys that were associated with specific DWMAs (Tracy et al. 2004). Four of these analyses suggested tortoise declines: Piute Eldorado Valley, Coyote Springs, Ivanpah (eastern Mojave), and the western Mojave. Beaver Dam Slope/Mormon Mesa/Gold Butte, Upper Virgin River; Chemehuevi (southeastern Mojave), Chuckwalla (Colorado Desert), and Joshua Tree/Pinto Mountain (Colorado Desert) areas appeared to have stable desert tortoise populations (Tracy et al. 2004).

TABLE 6. Ranked ratios of desert tortoise carcasses to live tortoises at DWMAs.

Dead/Live Tortoises	DWMA	Geographical Location
3.67	Fenner	East Mojave
3.23	Piute Eldorado	East Mojave
2.87	Ivanpah	East Mojave
2.29	Fremont-Kramer	West Mojave
1.94	Chuckwalla	Colorado Desert
1.88	Gold Butte	Northeast Mojave
1.71	Chemehuevi	East Mojave
1.60	Superior Cronese	West Mojave
1.58	Mormon Mesa	Northeast Mojave
1.51	Chocolate Mountains	Colorado Desert
1.51	Desert Tortoise Natural Area	West Mojave
1.40	Joshua Tree	Colorado Desert
1.25	Beaver Dam Slope	Northeast Mojave
1.22	Ord-Rodman	West Mojave
1.08	Pinto Mountains	Colorado Desert

Source: Tracy et al. 2004.

The kernel analysis for Coyote Springs DWMA suggests that desert tortoise populations are in a decline (Tracy et al. 2004). However, this trend is primarily due to the larger number of carcasses found in the northern portion of Coyote Springs. The carcass–live tortoise ratio of 1.50 suggests that the Coyote Springs population is stable (Table 7). However, the few live tortoises and carcasses found, combined with the small sample size (number of transects), makes a conclusive interpretation tenuous.

Additional USFWS Desert Tortoise Data. The USFWS has conducted line-transect distance sampling surveys from 2001 to 2005, covering all of the Mojave Desert tortoise populations range-wide. These data are currently undergoing quality control, clean-up, standardization, analyses, and report writing (Roy Averill-Murray 2005, pers. comm.). Therefore, these important data are not currently available. A draft report using the 2001–2004 data will be available early in 2006 but will not include the 2005 data. At this point in time, a scientific and statistically valid assessment of the distribution and density patterns of desert tortoise populations, either spatially or temporally, in the four DWMAs of Clark County or any other DWMA is impossible. When this report and the associated data become available, a preliminary assessment can be made of the distribution and density patterns of desert tortoises in the Clark County DWMAs and relationships to other DWMAs and DPSs. However, because of the low encounter rates of tortoises on distance sampling transects, sample sizes may be adequate for providing only DWMA scale tortoise density estimates. The relative tortoise distribution/density patterns within individual DWMAs may not be known.

2.4.4 Landscape Context

Spatial integrity and connectivity are two of the most important elements for conservation of landscape biological viability. The USFWS-recommended delineation for Coyote Springs DWMA was the large area north of Las Vegas bounded by U.S. Highway 93 on the east and U.S. Highway 95 on the south, with the north and west boundaries limited to the northern distribution of desert tortoise populations in the valleys of NAFR.

Currently in the Coyote Springs DWMA, the Coyote Springs and Kane Springs ACEC boundaries form a sliver approximately 4 miles wide and 32 miles long. Nevertheless, this is almost pure preferred desert tortoise habitat (creosote/bursage and mixed montane scrub). Many large contiguous landscape parcels that contain desert tortoises are a mixture of soils and plant communities that contain habitat mosaics of varying degrees of value to desert tortoise populations.

TABLE 7. Carcasses and live desert tortoises found on distance sampling line transects in 2001 for selected DWMAs.

DWMA	Live Tortoises	Tortoise Carcasses	Carcass/ Live
Piute Eldorado	6	14	2.33
Ivanpah (CA)	10	33	3.30
Gold Butte (NV)	4	6	1.50
Mormon Mesa	3	10	3.33
Beaver Dam Slope	4	4	1.00
Coyote Springs	4	6	1.50

Source: Tracy et al. 2004 kernel analyses.

Additionally, and much more importantly, the actual Coyote Springs conservation management landscape is much larger than the figure suggests. For example, the tortoise habitat in the area just south of S.R. 168 is actually 10 miles wide. The ACECs do not include the extensive east slope of the Sheep Range which is the DNWR managed by USFWS. Additionally, this area also includes lands managed by NAFR. In actuality, desert tortoises and other species use the entire area, regardless of agency land management. Clark County should work closely with other agencies to ensure species and habitat conservation; and species, habitat, and threat monitoring across jurisdictional landscapes.

Coyote Springs Valley is flanked by the Sheep Range to the west and the Arrow Canyon Range to the east and south of S.R. 168. The Meadow Valley Mountains form the eastern edge of the valley north of S.R. 168. A narrow corridor occurs between the two eastern mountain ranges which allows for desert tortoise movement between Coyote Springs and Mormon Mesa ACECs. S.R. 168 and portions of the proposed CSI development occur within this corridor. The CSI development may be a potential barrier to desert tortoise gene flow. U.S. Highway 93 and S.R. 168 are also barriers that will require tortoise crossings.

Desert Tortoise Spatial Population Structure. Desert tortoise populations are patchily distributed (Duda et al. 2002, Krzysik 2002), which can be exacerbated when there is significant habitat damage (Krzysik 1997). A prime factor would be habitat quality and all its facets: seasonal food resources, mineral or micronutrient availability, soil characteristics for burrowing, caliche caves or deep burrows for hibernacula, local surface water availability after precipitation, hatchling requirements and survivorship, etc. Other important factors could be: social structure, optimal microclimates, reduced predation or competition, reduced parasites or pathogens, or historical events not currently obvious. Although there has been research in this area, no overriding conclusions are evident. Undoubtedly, focused hypothesis-based research could unravel this mystery.

Regardless of the details, the patchiness of desert tortoise distributions suggests a metapopulation structure that may have significant implications for desert tortoise natural history, genetics, and evolution (Hanski and Gilpin 1997; Hanski and Gaggiotti 2004). The DTRPAC report emphasizes that the management, recovery, and long-term viability strategies of tortoise populations are quite different under metapopulation versus continuous population models. Important considerations under metapopulation models include: landscape and local habitat fragmentation, road effects, connectivity (corridors) among habitat patches, the relationship between habitat quality and its patchiness, spatial structure of habitat mosaics, spatial asynchrony in metapopulation dynamics, role of habitat elements (e.g., washes, caliche caves), the importance and protection of suitable habitat without tortoises, habitat restoration and enhancement, genetic management, and translocation strategies and considerations.

The USFWS 1994 DTRP estimated that the desert tortoise density for Coyote Springs is up to 90 adult tortoises/mi^2 (USFWS 1994b). This is the general estimate of tortoise densities obtained from BLM plots in the eastern Mojave Desert and DWMAs occurring in the DTRPAC report's recommended Lower Virgin River DPS before 1996, and discussed above, with the exception of Goffs (Fenner DWMA, CA) pre-1995 densities, which were significantly higher.

Estimated tortoise densities at the single BLM plot in the vicinity of the proposed CSI development in Coyote Springs were relatively stable and robust before 1996 and were comparable to those at Mormon Mesa, Gold Butte, and Piute Eldorado. The population at the Coyote Springs plot may have been a little lower than at the other four BLM plots. After 1996, estimated densities are not available for this plot, and there is no other nearby plot.

Using the ratio of carcass–live tortoises as an indicator of population stability or decline, Table 6 indicates a ratio of 1.50. This indicates a population that is stable or in only slight decline. However, this ratio is based on only a small sample of carcasses and live tortoises. Kernel analysis suggests that tortoise populations have declined at Coyote Springs. However, the analysis results are due to the greater number of carcasses found in the northern portion of the DWMA.

Trends evident in the body of tortoise data available provide strong evidence that the overall abundance of desert tortoise populations and metapopulations have declined in southern Nevada since the early 1980s, probably precipitously in some localities. However, the data do not permit the elucidation of spatial changes in distribution or the detailed assessment of population distribution and abundance patterns or status and trends in any of the four DWMAs of Clark County. Two major projects require immediate attention in order to assess and monitor the distribution and condition-trend patterns of desert tortoises in Clark County DWMAs. Two CAs are recommended, creation of a comprehensive database housing and the development of a long-term desert tortoise monitoring program to address this data gap. Both items are discussed in Section 5.2, the priority conservation section of this document. It is important to remember that this assessment is based on the data and analyses discussed above, including the significant shortcomings and inadequacy of the currently available database. There were five serious problems with the available desert tortoise population data used by Tracy et al. (2004) in their analyses: small sample sizes; inadequate coverage of the DWMAs; nonrandom distribution of the BLM permanent plots and the 2002–2003 distance sampling transects; different BLM permanent plots inconsistently sampled in different years; and very little plot data after 1994, possibly the critical time when tortoise populations began to significantly decline, especially in the eastern Mojave Desert. Tracy et al. (2004) clearly recognized the inadequacy of the databases they used.

2.4.5 Biotic and Abiotic Factors

Fire has not traditionally played a large role in organizing biological communities in the Mojave Desert, where extremely arid conditions limit the density of vegetation. Mojave Desert plants are particularly vulnerable to fire. Although some species are capable of resprouting following a low-intensity fire, few can tolerate severe or frequent burns (USGS 1999). However, recent invasions by alien annuals from the Mediterranean area such as red brome (*Bromus madritensis*), Mediterranean grass (*Schismus arabicus*, *S. barbatus*), and heron's bill (*Erodium cicutarium*) are suspected of increasing the fire frequency, which could be detrimental to the native plant and animal species (Brooks 1999a, 1999b; ;rooks and Esque 2002). While it is difficult to reconstruct long-term fire histories in desert systems, records from Federal land management agencies show an increase in Mojave Desert fires over the past two decades, due partly to expanding human use (USGS 1999). However, the increase in fire frequency is most likely due to alien annual grass invasions. These grasses prosper with heavy rainfall and, unlike many native annuals, their dry stalks remain after they die, providing a lasting fuel source.

2.4.6 Current and Future Threats

Humans are using the desert for an ever-increasing diversity and intensity of activities: off-road exploration and "thrill-driving," casual shooting and target practice, personal or commercial collection of animals and plants, searches and digging for minerals and gems, geocaching (GPS-guided stash hunts), and even the production of illegal drugs (especially methamphetamines). Desert tortoise shells found in the Mojave Desert with bullet holes were examined forensically with the finding that the tortoises were alive when they were shot (Berry 1986). The collection of vertebrates and invertebrates for commercial exploitation may be a serious threat to native wildlife and biodiversity in southern Nevada and requires serious investigation. Many of the major threats and stressors in southern Nevada to desert tortoise populations, biodiversity, wildlife, listed and sensitive species, habitat integrity, and ecosystem processes can be directly or indirectly linked to desert urban sprawl and human impacts. The Coyote Springs DWMA currently does not have a high degree of human interaction, as there are no mining operations or residential communities in the DWMA. However, there is increasing OHV usage of the land and, due to CSI, there will be increased residential community usage of the land directly adjacent to the DWMA. The DWMA contains creosote-bursage scrub habitat on gentle plains and bajadas, the acknowledged preferred habitat of the desert tortoise. For the most part, these valleys appear to possess good- to high-quality habitat; however, primary and secondary roads and, in particular, the potential for ROW development and human interaction as a result of the CSI development and interstate utility transmission projects may introduce serious threats to the future viability of desert tortoise populations in Coyote Springs. TNC identified "active threats" to this DWMA as development, roads, utility ROWs, grazing, and recreation (TNC 2003). The DTRPAC report clearly indicated an increased level of threats in all of the eastern Mojave DWMAs, with Coyote Springs (in combination with Mormon Mesa) increasing from a threat ranking of 3 to a threat ranking of 4 (out of 5) since the USFWS 1994 recovery plan was published (Tracy et al. 2004).

For a detailed discussion and literature review on threats and stressors to desert tortoise populations see Boarman (2002a), which is available through U.S. Geological Survey (USGS) and in the Final Environmental Impact Report and Statement of the West Mojave Plan (BLM 2004c). An analysis of sources of stress can also be found in The Site Conservation Plan for the Coyote Springs DWMA (TNC 2003). Threats and stressors to desert tortoises are cumulative, synergistic and interactive, diverse, serious, and include:

- Habitat loss, degradation, and fragmentation from urbanization, grazing, agriculture, OHVs and other recreation activities, and mining
- Water drawdown and overuse
- Drought
- Presence and activities of humans and their pets or human-associated species
- Roads of all sizes: direct mortality and many other serious effects
- Establishment and spread of exotic and invasive species
- Human-driven overabundance of ravens.

The USFWS 1994 recovery plan identified the number of threats to desert tortoise populations in each DWMA (USFWS 1994a). In 2003, the Desert Tortoise Management Oversight Group reevaluated the threats. Threats to desert tortoise populations in Coyote Springs increased over this time period.

In this section, the current and future threats to desert tortoise populations are emphasized in the context of the five listing factors in the ESA (USFWS 2005a). Nevertheless, all of these also represent equal and major threats and stresses to biodiversity, wildlife, listed and sensitive species, rare species, and species with small or disconnected distributions, habitat integrity, and ecosystem processes. Therefore, discussions of other species are also illustrative. In other words, we address threats and stressors to regional ecological integrity.

Factor 1: The present or threatened destruction, modification, or curtailment of the species' habitat or range—

Development. The development of the CSI parcel for residential and commercial uses may pose a significant threat to DWMA conservation efforts. Urban development can impact desert ecosystems through the loss, fragmentation, and alteration of habitat. Habitat loss can result in a decrease in population size of the affected species, and fragmentation can divide the original population, creating a cluster of subpopulations (Begon et al. 1990). Habitat fragmentation has considerable effect on ecosystem physical structure and species composition (Andrews 1990; Saunders et al 1991; Forman 1995; Freidenburg 1998); and is the major contributor to biodiversity loss, population viability of wildlife, and threat to threatened and endangered species (Noss and Cooperrider 1994; NRC 1995; Beissinger and McCullough 2002; Fahrig 2003). Habitat fragmentation in southern Nevada can be of two types, fragmentation within DWMAs and fragmentation among DWMAs. Habitat degradation and fragmentation within already protected areas (e.g., DWMAs) are primarily caused by: roads, utility corridors, unauthorized and illegal vehicle use, invasive alien species, livestock grazing, and mining. Habitat loss, degradation, and fragmentation in the landscape matrix among DWMAs and other protected conservation lands are also caused by these same factors with the addition of urban residential sprawl and commercial and industrial development. These human developments are responsible for habitat loss and represent barriers to the movement of desert tortoises and most wildlife.

Urban development also increases human interaction with the DWMA by encouraging recreational activities, increasing the likelihood of collection, handling, vandalism of tortoises and other desert wildlife, and illegal dumping. Human interaction can also alter the predator regime by introducing wild dogs and attracting raven populations. Release of captive tortoises may introduce URTD (upper respiratory tract disease)-infected tortoises into the wild population, increasing the risk of disease. Singularly, many of these factors do not pose a great threat to the persistence of wildlife populations, but the cumulative impacts may be detrimental to the preservation of the desert ecosystem. Still, there is some evidence that less intensive development projects, such as the industrial site developed for wind energy generation in the Colorado Desert, can be compatible with desert tortoise conservation (Lovich and Daniels 2000).

Construction projects, including linear disturbances (pipeline, transmission line), mining, and landfill projects can influence desert populations through the loss of habitat, incidental destruction of habitat and tortoise burrows, damage to soil, handling of tortoises, entrapment, and attraction of ravens. There is little data on the extent of the threat, as most projects are temporary disturbances, unlike urban development. Studies suggest that differences in the extent of the threat are related to the scale of the project, the ability of crews to avoid disturbing burrows, and timing of construction to avoid peak activity periods of tortoises (Boarman 2002a).

ROWs (utility lines, towers, buried pipelines, communication sites) create linear disturbances across the landscape. In addition to the discrete disturbance points formed by towers and lines, maintenance roads and repeated operations can: (1) introduce continuous sources of disturbance and (2) offer potential sites for invasion of exotic species (Boarman 2002a). ROWs can cause habitat destruction and alteration where vegetation is minimal, possibly increasing mortality, directly or indirectly (Olson et al. 1992; Olson 1996). Utility towers in creosote habitat provide raven nesting sites where none existed previously, increasing predation and reducing juvenile populations in a localized area (Boarman et al. 1997).

Roads. Roads are innately responsible for many important ecosystem and landscape impacts in the Southwest and may be particularly devastating in the Mojave Desert. Roads result in direct mortality to vertebrates and invertebrates, provide human access for consumptive and nonconsumptive uses, generate immediate access to OHV use (including the use of washes), create severe erosion problems, and provide direct invasion routes and habitat generation for invasive weedy plants. Roads represent a number of diverse and serious ecological problems for wildlife, local biodiversity, ecosystem function, and the design and management of conservation reserves (Langton 1989; Andrews 1990; Forman and Alexander 1998; Spellerberg 1998; Findlay and Bourdages 2000; Trombulak and Frissell 2000; Sherwood et al. 2002; Forman et al. 2003; Macdonald 2004). Forman (2000) estimated that minimally one-fifth of the U.S. land area is directly affected ecologically by its system of roads. In an arid desert scrub landscape, the impacts of roads could be significant due to a number of factors, including: the openness of the habitat (e.g., trees are more effective at containing noise, light, and fugitive dust), larger home ranges in a less productive environment, greater seasonal or annual movements because of more severe weather extremes, and increased metapopulation dynamics (i.e., population dispersals) because of local extinctions due to local extremes in drought and flooding.

Physical and chemical environments are also impacted by roads (Larsen and Parks 1997; Forman and Alexander 1998; Trombulak and Frissell 2000). Roads have greater than suspected severe impacts on streams and washes, increased sediment loads, and altered hydrology (Debano and Schmidt 1989; Forman and Alexander 1998; Jones et al. 2000; Trombulak and Frissell 2000). The broad range of negative impacts has profound consequences for the ecological processes and native biodiversity of the affected landscapes.

Roads also provide access to humans, and this may be one of the most unappreciated negative impacts of roads. There are, of course, both legitimate and detrimental uses of roads in wildlands and conservation reserves. However, roads crossing streams also provide access to illegal and ecologically detrimental, but often well-intentioned, introductions and releases of: fish, amphibians, turtles, mollusks, and other aquatic organisms. These can be game species, bait, excess or unwanted pets, or species captured in different parts of the country.

Roads can change animal behavior and physiology (van der Zande et al. 1980; Forman and Alexander 1998; Trombulak and Frissell 2000). Noise, dust, and lights at night are major problems, but it is also suspected that animals change their home ranges or migration routes to avoid roads. Animals are exposed to greater physiological stress by the sudden or excessive noise, lights, or near-misses along roads. Roads usually significantly degrade habitat through:

- Affecting water quality and soils through input of sediments, nutrients, road salt, hydrocarbons, organic and inorganic chemicals, and heavy metals
- Changes in local hydrology
- Pesticide applications, especially herbicides to maintain road-side clearance, but also insecticides (e.g., mosquitoes)
- Fugitive dust covering plants and reducing photosynthesis, respiration, and transpiration; common in deserts, and destructive to lichens and mosses
- Increased soil compaction
- Microhabitat higher temperatures, lower moisture and humidity, and increased light intensity.

The USFS has conducted research demonstrating that even small dirt roads generate a great deal of erosion and contaminate streams with sediments. Runoff sediment and bank erosion are the most significant component to stream and river water quality, substrate integrity, and hydrologic function (Leopold et al. 1964; Debano and Schmidt 1989; Naiman 1992; Malanson 1993; Rosgen 1996; Wohl 2004; Naiman et al. 2005).

The ecological effects of roads are directly related to their location, nature and condition of adjacent habitats, age, traffic density, vehicle speed, road width, and road surface material. Many roads are constructed over old trails along rivers and streams, an area of high wildlife activity and value. Wide hard-surfaced roads pose much more of a barrier and a crossing hazard than narrow country dirt roads. This is a function of traffic density, vehicle speed, noise, lights, time involved to make a safe crossing, and substrate suitability. The surface of a dirt road represents a more familiar habitat experience to an animal than asphalt or concrete, excluding the attraction of snakes to warm surfaces.

Roads are commonly implicated as barriers for wildlife, especially the wide, interstate, high-speed highways (Oxley et al. 1974; Swihart and Slade 1984; Langton 1989; Andrews 1990; Harris and Scheck 1991; Forman and Alexander 1998). This would certainly be the case for species that are small, have limited mobility, are slow moving, sensitive to desiccation, high habitat specialists, or poor dispersers. Carabid beetles and wolf spiders are abundant and diverse worldwide and important components of ecosystem function. They are effectively blocked by roads as narrow as 2.5 meters wide (Mader 1984). Some forest species of butterflies will not cross open areas such as fields or roads. Correspondingly, some field butterflies will not enter the shade of a forest. Some species of butterflies may occasionally follow roads, possibly because the vegetation is more vigorous from increased precipitation runoff. In this case, roads may act as dispersers.

Roads can also act as corridors for some species. This is desirable in specific cases for wildlife population or metapopulation dispersal or where a corridor is needed. Dispersal is not desired if the movement negatively affects desired population distribution, or it guides individuals to higher mortality, either on roads or in lower quality habitat.

Roads can provide a means for the spread of alien or invasive species (both plants and animals), or parasite and disease organisms (Trombulak and Frissell 2000). Roads are strongly implicated with the maintenance and spread of alien, invasive, and noxious weeds (Schmidt 1989; Tyser and Worley 1992; Greenberg et al. 1997; Parendes and Jones 2000). Vehicles, humans, and pets disperse weed seeds along roads. Additionally, most weedy plants are dependent on disturbed soils, the elimination of native competitors, patches of bare ground, or increased light levels. Many exotic species are planted along roads to control erosion or as decorative landscaping.

A major effect of roads is direct highway mortality. It is very difficult to accurately assess highway wildlife mortality, especially in the arid Southwest. However, an estimated 51,000 wild vertebrates were killed in a year in and around Saguaro National Park, Arizona (Arizona Daily Star, Tucson, A.E. Araiza, 16 May 2005; available at http://www.cnah.org). This includes both the east and west sections which are separated by 50 km on opposite sides of Tucson. These data does not include invertebrates such as tarantulas and scorpions. The vertebrate mortality was as follows: reptiles (27,000), amphibians (17,000), mammals (6,000), and birds (1,000). There are massive kills of Red-spotted Toads (*Bufo punctatus*), Green Toads (*Bufo debilis*), and Couch's Spadefoots (*Scaphiopus couchii*) at Saguaro National Park, with evidence that the road kill is seriously affecting Green Toad populations.

Herpetologists have long recognized that during population explosions in some frog species there is a great deal of dispersal among habitat patches with very high road mortality (Langton 1989; Fahrig et al. 1995; Hels and Buchwald 2001). Local road kills can be so high that the slippery carcasses become a hazard to motor vehicles (e.g., Northern Leopard Frog [*Rana pipiens*]) (Krzysik 2004, personal observation). During explosive breeding episodes, many species of amphibians, including salamanders, frogs, and toads, require road crossing when going to and from permanent or temporary breeding sites. Ten percent of the resident adult populations of three species of frogs were annually killed by vehicles on a two-lane, 8-m-wide highway in Denmark that has a traffic density of 3,200 vehicles over a 24-hour period (Hels and Buchwald 2001). Observations of road mortality of raccoons, skunks, opossums, and other mammals appears greater in the spring and fall, likely because habitat use, winter shelters, hibernacula, and spatial home ranges may vary seasonally, especially between winter and summer. Highway mortality for deer increases during both small game and deer hunting seasons, as the number of people and disturbances increase in the habitat and there is gunfire.

Snake populations are highly affected by road mortality, and road kills for snakes have been documented in the scientific literature since at least 1931 (Rosen and Lowe 1994; Andrews and Gibbons 2005). Field experiments have documented that interspecific differences in ecology and behavior affected how snakes reacted to and crossed roads (Andrews and Gibbons 2005). Snakes are typically nocturnal (nighttime) and/or crepuscular (late evening and early morning) in their activity levels. They are highly fossorial during the day and retreat to rodent burrows and rocky crevices or bury themselves in loose sandy soils to avoid high temperatures and predator exposure. When they begin to actively forage in the evening and night, they are often strongly attracted to warm blacktop or concrete road surfaces where they may rest a significant amount of time, exposing themselves to accidental or purposeful vehicle mortality.

The presence of roads may also have a strong detrimental effect on desert tortoise populations (Nicholson 1978; Boarman 1994; Boarman et al. 1997; von Seckendorff Hoff and Marlow 2002). Lori Nicholson was the first to suggest that desert tortoises are virtually absent within 1 km from paved roads. Sometimes, the effect of roads occurred up to 4,000 meters from a road, depending on the traffic level (von Seckendorff Hoff and Marlow 2002). Roads cause direct tortoise mortality when they try to cross roads or concentrate tortoises foraging on the more abundant and vigorous annuals. Importantly, roads provide access for poaching (Berry et al. 1996), and roads are responsible for habitat degradation, fragmentation, and a wide variety of ecological impacts, as this section discusses. Also see Boarman (2002a).

Studies indicate that tortoise-proof fencing reduces road mortality in tortoises and other terrestrial vertebrates (Boarman et al. 1997). Paved roads in the planning area, in particular Highway 95 and S.R. 164, have been fenced or have had existing fences retrofitted with tortoise exclusion fencing to reduce the direct mortality of tortoises. Although fencing mitigates the harmful effects of vehicular mortality, it also fragments the tortoise habitat. Tortoises and other animals are able to cross Highway 95 via the Piute Wash culvert. While some studies suggest that culverts are used by tortoises and other desert wildlife to cross highways (Boarman et al. 1997), whether they reduce the fragmenting effects of fenced highways is unknown. Habitat fragmentation has a cascade of negative impacts on species, including limiting access to food sources and reproductive opportunity, disrupting seasonal migrations, and preventing genetic exchange between populations (Nicholson 1978). Further research is required to determine what volume of traffic and at what width roads become effectively impassable to a variety of species of concern.

Factor 2: Overutilization for commercial, recreational, scientific, or educational purposes—

The presence of humans near or within conservation reserves (e.g., DWMAs) and wilderness areas often creates severe threats and stress to animal populations and their long-term viability. Even participation in outdoor recreational activities that are typically considered environmentally benign may have serious consequences on wildlife behavior and their population viability (Weeden 1976; Wilkes 1977; Boyle and Samson 1985; Pomerantz et al. 1988; Eltringham 1990; Knight and Gutzwiller 1995). Cole and Landres (1996) provide a particularly excellent review and synthesis of human threats to wilderness landscapes and include an excellent source of references. Large mammals have abandoned preferred foraging areas (Geist 1978) and food sources (Klein 1971) because of human disturbances.

Human encroachment is particularly damaging to large mammals and carnivores. Desert bighorn sheep, a reclusive and declining species in southern Nevada, are intolerant of human activities (Monson and Sumner 1980; Krausman et al. 1999). When disturbed at their water holes in Death Valley, Welles and Welles (1961) reported that desert bighorn would abandon them. Death Valley National Park in the northwestern Mojave Desert is one of the hottest and driest areas in North America.

Grazing. Whereas the impacts of grazing specific to this DWMA were not analyzed for this section, it has been reported that livestock grazing has occurred in the Mojave Desert since 1885. The Taylor Grazing Act of 1934 was passed as an attempt to "stop injury to public lands by preventing overgrazing and soil deterioration." While grazing has been prohibited since 1998, the effects of historic grazing throughout the Mojave Desert are evident in soil compaction, destruction of cryptogamic soil crusts, bank erosion of fluvial channels, impact on hydrology dynamics, especially disturbance of riparian and wash channels, and changes in the species composition and physiognomy (structure) of native vegetation (Webb and Stielstra 1979; Boarman 2002a). Livestock grazing increases soil compaction, reduces water infiltration rates, and increases surface erosion (Boarman 2002a). Spring habitats are also impacted by grazing through altered water dynamics (TNC 2003), and many of the natural springs in the planning area have been diverted into pipes or livestock-watering tanks. Decades of trampling by livestock utilizing the piped and tanked spring outflows have removed vegetation, significantly altered the nutrient composition of the soils, and obliterated the original paths of the spring brooks (TNC 2003). While active grazing in the DWMA has been eliminated, the resulting habitat alterations continue to impact desert wildlife and trespass cattle remain a problem in this area as the DWMA is accessible to cattle.

Recreation. Recreational uses include both motorized and non-motorized vehicles, as well as less intrusive uses (e.g., hiking). Motorized vehicles are discussed in the most detail, as they have the greatest potential impact on desert tortoises. There are numerous studies pointing to the damaging effects of OHVs on desert ecosystems, including direct wildlife mortality, crushing of tortoise burrows, soil compaction, vegetative destruction, and toxins emission (Busack and Bury 1974; Vollmer et al. 1976; Bury et al. 1977; BLM 1980; Webb and Wilshire 1983; Prose 1985; Prose et al. 1987; Latting and Rowlands 1995; Lovich and Bainbridge 1999; Wheat 1999; Bury and Luckenbach 2002). There is also a great deal of published evidence that desert tortoises are directly impacted by OHV activities (Bury 1978; Burge 1983; Woodman 1983; Berry et al. 1986; Goodlet and Goodlet 1992; USFWS 1994a; Jennings 1997; Bury and Luckenbach 2002). OHVs and desert tortoises most frequently and directly encounter each other in washes, a landscape element favored by both desert tortoises and OHVs (Woodbury and Hardy 1948; Burge 1977, 1978; Baxter 1988; Goodlet and Goodlet 1992; Jennings 1997; Krzysik 2004, personal observation). Desert tortoises utilize washes for their high production of annual plants, dense vegetation cover, and the availability of deep caliche caves for winter hibernacula.

OHVs may remain a problem even if the number of dirt roads in the habitat is minimal. There will always be service roads for utility corridors, microwave towers, and other equipment. Also, there will always be washes, a most common avenue for OHVs. OHVs have long been established as a threat to soils, vegetation, and fauna of the arid Southwest (Busack and Bury 1974; Vollmer et al. 1976; Bury et al. 1977; BLM 1980; Luckenbach and Bury 1983; Webb and Wilshire 1983; Prose 1985; Prose et al. 1987; Latting and Rowlands 1995; Lovich and Bainbridge 1999; Wheat 1999; Bury and Luckenbach 2002; Belnap and Eldridge 2003). Important environmental impacts include: direct mortality of plants and animals, serious long-term soil compaction, severe damage and elimination of cryptogamic crusts, facilitation of alien plant invasions, interference with plant succession, substantial wind and water erosion, significant fugitive dust, and importantly, noise and air pollution. Cryptogamic or biological soil crusts provide surface integrity and nitrogen fixation to arid and semiarid soils worldwide (Belnap and Lange 2003). Therefore, they are critical in preventing wind and water erosion, determining landscape hydrology dynamics, and providing nitrogen to plants, the major limiting nutrient in arid ecosystems. The disruption of desert soil surface integrity by OHVs can be so severe that it can be observed by satellite imagery (Bowden et al. 1974; Nakata et al. 1976). Lovich and Bainbridge (1999) estimated that over a billion dollars would be required to restore OHV damaged areas in the Mojave and Colorado Deserts of southern California. OHVs and human ecological disturbance of sand dunes and sandy soils is not limited to the landscapes of the Southwest, and has been reported for eastern barrier beaches as well (Vaske et al. 1995).

Bury and Luckenbach (2002) found 1.7 times the number of live plants, nearly four times the plant cover, and nearly four times the number of desert tortoises on an undisturbed plot than on a plot used by OHVs. Because this study was not replicated, it is difficult to determine if OHV use or an undetermined factor was primarily responsible for differences among plots. In addition, subsequent OHV use in the unused plot negates the possibility of long-term monitoring. In one of the few manipulative experiments, Adams et al. (1982) demonstrated that plant density, biomass, and cover was reduced with any level of OHV disturbance, but motorcycles required a greater number of passes than did four-wheel drive vehicles to achieve the same damage. The need for controlled, long-term, replicated studies on the effects of OHV use is evident.

Non-OHV recreation, including camping, nature study, rock collecting, sight-seeing, hunting, horseback riding, and mountain biking is gaining popularity in the Mojave Desert. While few, if any, scientific studies have investigated the impacts of these activities, likely threats include handling and disturbance of tortoises; loss of habitat to campgrounds, picnic areas, scenic pull-outs, vandalism, and other support facilities; increased road kills; and increased raven populations resulting from organic garbage (Boarman 2002a). Off-trail travel by hikers, bikers, and horses can damage cryptogamic crusts and result in soil compaction and loss of a host of biological values provided by this system. As interest in non-motorized recreation is increasing, studies should be directed at determining the impacts on desert tortoise populations.

Scientific. All manipulative research involving desert tortoises must be permitted by USFWS and NDOW to ensure that risk of harm to the tortoises is minimized. USFWS closely evaluates methods and qualifications of researchers before issuing a permit. There is very little written on the effects of research manipulation (Boarman 2002a). However, there is evidence that suggests that these activities, especially at the rate at which they are gaining in popularity and participation, may have moderate to severe impact on both habitats and wildlife (Knight and Gutzwiller 1995).

Factor 3: Disease or predation—

Disease. Disease can weaken individuals, reduce reproductive output, and cause mortality. Disease can particularly be catastrophic if an epidemic breaks out in small or declining populations such as the desert tortoise. There are two diseases documented in populations of desert tortoises in the Mojave Desert. The most common is URTD. The other is cutaneous dyskeratosis.

URTD is caused by *Mycoplasma agassizii*, which is transmitted via contact with an infected individual or by infected aerosols (Brown et al. 1994). URTD attacks the upper respiratory tract, causing lesions in the nasal cavity, excessive nasal discharge, swollen eyelids, sunken eyes, lethargy, and even death. While some studies point to the correlation between the incidence of URTD and high rates of mortality, there is little direct evidence to link the two (see Boarman 2002a for review). Currently, incidence of infected individuals in the Coyote Springs DWMA is rare (TNC 2003), and the most effective preventative measure may be to monitor release of captive tortoises to curtail future outbreaks. However, a major problem is that clinical signs of URTD vary in onset, severity, and duration, and diagnosis is difficult because an infected tortoise may appear clinically ill or healthy at any given time (Brown et al. 1999, 2002).

The presence of URTD in desert tortoise populations and associated die-offs has been observed (Jacobson et al. 1995, Berry 1997). However, a cause–effect relationship between the vector and range-wide desert tortoise population declines has not been satisfactorily established (Tracy et al. 2004). Respiratory mycoplasmal infections usually have high morbidity but low mortality (Brown et l. 2002). Epidemiological effects in desert tortoises have varied dramatically from high mortality, to low mortality, and recovery. To further complicate the issue, *Mycoplasma* can evolve rapidly into new strains, and thus increase or decrease its virility in tortoise populations (Brown et al. 2002). Despite the incredible amount of field and laboratory research and clinical efforts to understand URTD and its effects on wild desert and gopher tortoise populations, there remains a great deal of unknowns and uncertainties (Tracy et al. 2004).

Cutaneous dyskeratosis affects the shell, causing lesions along the scute sutures and the carapace (Jacobson et al. 1994). Although there is no conclusive evidence, speculations of its cause included environmental toxins, a bacterial agent, or a nutritional deficiency. It is unknown whether the disease is lethal or otherwise affecting the declining tortoise populations and scientific data concerning it is severely lacking. There is no information regarding the incidence of cutaneous dyskeratosis in the DWMA.

Predation. Natural predators of desert tortoises include coyotes, kit foxes, feral dogs, bobcats, skunks, badgers, common ravens, and golden eagles, but the extent that predation impacts tortoise populations is largely unknown. Available evidence strongly implicates ravens as the primary predator, and only ravens are known to eat juvenile tortoises in large quantities (Boarman 2003). In tortoise populations, losses of juveniles to ravens and other predators may “decrease the stability or at least prevent recovery” (Boarman 2002a). As they prey extensively on juvenile tortoises, ravens are of particular concern. Many studies investigated this issue, despite difficulties inherent in monitoring juveniles and finding juvenile carcasses (Berry 1985; Boarman 2002b, 2003).

Population densities of the common raven (*Corvus corax*) have increased dramatically in the Southwest, following humans and urbanization into the desert with the associated road kills, refuse, landfills, dumpsters, illegal garbage dumps, picnic scraps, agricultural fields, stock feedlots, sewage ponds, water development; and perching-nesting structures such as electric transmission towers, telephone poles, fences, overpasses, and buildings (FaunaWest 1989; Boarman 1993; Knight et al. 1993). Farrell (1989) estimated that along identical survey routes in the eastern Mojave Desert of

California and extreme southern Nevada, raven populations increased by 350–875% between 1967–1969 and 1988–1989 surveys. USFWS (1994a) has used figures reflecting as high as 15-fold increases of raven populations in the Mojave Desert, based on USFWS annual breeding bird surveys (Robbins et al. 1986; BLM 1990). Boarman and Berry (1995) reported that ravens increased 10-fold in the Mojave Desert, 14-fold in the Sonoran-Colorado Desert, and 76-fold in California's Central Valley over a 24-year period.

Ravens exhibit surprisingly complex behavior, including feeding and foraging (Heinrich 1999) and are considered generalist omnivores due to their broad diet (Harlow et al. 1975; Engel and Young 1989; Stiehl and Trautwein 1991; Camp et al. 1993). Ravens are active predators (vertebrates and invertebrates), scavengers, rob food from other animals (especially birds); and feed on grains, seeds, and fruit (Knight and Call 1980; Heinrich 1989).

Ravens have been implicated in feeding on hatchling and juvenile desert tortoises, sometimes substantially (Berry 1985; Esque and Duncan 1985; Woodman and Juarez 1988; Farrell 1989; BLM 1990; Boarman 2002b, 2003). High concentrations of 50–250 hatchling and juvenile shells with characteristic holes pecked in their carapace or plastron were found in the 1980s, associated with raven nests and perching sites (summarized in Boarman 2003, page 206). Ravens prey on hatchling and juvenile tortoises in two different ways: they peck through their soft shells or pull out their legs and head to access muscle tissue and soft viscera. The age when desert tortoise shells harden is variable and undoubtedly depends on nutrition, as well as being a function of weather and habitat condition. Typically, shells of desert tortoises are soft when they are less than seven years old (Boarman 2002b). Research studies on hatchling and juvenile desert tortoises require overhead screened enclosures to prevent raven predation (Morafka et al. 1997). Ravens quickly eliminated hatchling desert tortoises from enclosures before overhead screening was in place (D.J. Morafka 1991, pers. comm.).

Raven predation is considered a very serious threat to the viability and persistence of desert tortoise populations (Boarman 1993, 2002b, 2003; Kristan and Boarman 2003). It is often assumed in conservation biology that population viability of species that possess delayed reproduction, long life-spans and high survivorship as adults (e.g., desert tortoise) are very sensitive to adult mortality, while high mortality in juvenile stages is not critical (e.g., Doak et al. 1994). Prominent examples of species with this life history and very high natural juvenile mortality are: sea turtles, freshwater turtles, tortoises, sharks, and some fish. Many snakes and salamanders also fit this general life history strategy. Nevertheless, conservation effort directed to the survivorship of all life-stages of long-lived species is considered the best approach, because of underlying demographic complexities and high variances in their metrics (Carr 1967; Crouse et al. 1987; NRC 1990; Congdon et al. 1993; Frazer 1997).

Raven control by lethal methods has not only met with substantial public resistance and political problems, but ravens have proved to be difficult to kill reliably in significant numbers, because of their high learning capacity to avoid toxic baits, traps, and shooting (Boarman 1993, 2002b, 2003). There is no evidence that lethal removal will have long-term effects on raven population densities (Skarphedinsson et al. 1990; Boarman 2003). However, Boarman (2003) does recommend lethal removal as a short-term local solution for specific raven individuals that are identified as preying heavily on tortoise hatchlings and juveniles. This would not be practical for DWMAs or regional application. The most successful approach to control raven populations in the desert Southwest is to remove, contain, and manage the anthropogenic resources that are responsible for their population increases (Boarman 1993, 2002b, 2003; Schneider 2001; Kristan and Boarman 2003). These important resources would be residential and commercial refuse, landfills, and water pools. Although landfill management technologies and the use of sealed refuse cans at parks and recreational facilities can be successfully implemented, refuse access, pet food, water leaks, and pools in residential areas depend on education and are difficult to manage. A water leak forming a large pool of water at Fort Irwin, an active Army training facility, consistently attracted 10-30+ ravens (Krzysik 2004, personal observation). Ravens fly at least up to 65 km a day and several hundred kilometers annually (Boarman 2003). Therefore, they forage and locate water sources over large landscape scales, suggesting that local efforts at food and water management would be unsuccessful for population control. Raven management and population reduction is a regional-scale problem that may be completely insurmountable in the face of increasing urbanization with the unavoidable increases in roads and associated road kills, and perching/nesting structures. Efforts could be increased and researched to minimize road kills by providing “underpasses” and culverts for wildlife.

The recent explosion of raven populations in the desert southwest, their role as generalist opportunist predators, and predation on desert tortoise hatchlings and juveniles has been well documented. In addition, the high raven population density may represent significant predation on other Mojave Desert wildlife, particularly snakes, lizards, invertebrates, small mammals, and birds (especially eggs and nestlings). Raven predation on other endangered species has been documented and addressed (e.g., Avery et al. 1995), however, the potentially substantial impact of raven predation on native biodiversity and ecosystem function has not been adequately addressed.

Little data exists on the impact of other predators, such as coyotes and feral dogs. Adult desert tortoises frequently possess canid shell scars in populations that are adjacent to rural areas where dogs are free to roam tortoise habitats, and dogs have been observed chewing on tortoises (Krzysik 2004, personal observation). As reviewed in Boarman (2002a), Berry reported evidence of canid or felid predation at 4 out of 12 study plots in California, while Bjurlin and Bissonette (2001) indicate that feral dogs and dog packs cause a significant amount of adult tortoise mortality, though evidence was lacking. Nonetheless, as human interaction with the desert increases, predators such as ravens and feral dogs likely to be associated with human populations (Boarman 2003) may become a significant threat warranting more research.

Domestic dogs are strongly implicated in killing and seriously creating stress in wildlife, but published data on wildlife disturbances attributed to companion dogs are lacking (Sime 1999). Most of the published data from dogs and wildlife conflicts are focused on deer because of their high value to sportsmen (Ward 1954; Progulske and Baskett 1958; Lowry and McArthur 1978). Experimental evidence demonstrated that the heart rate of free-ranging mountain sheep significantly increased when dogs were present, and this effect was independent of the presence of accompanying humans (MacArthur et al. 1979, 1982). Dogs commonly harass desert tortoises and may possibly kill smaller individuals. Many instances of “residential dog packs” harassing desert tortoises were observed , and most tortoises that were examined in the southwestern portion of Marine Corps Air Ground Combat Center in 1995 had chew scars on the edges of their carapace (upper shell) and plastron (lower shell), and in many cases the long gulars (a narrow forward protruding part of the plastron) of males were chewed off (Duda and Krzysik 1998). The Marine base is located adjacent to Twentynine Palms, California. Dogs were also reported to harass desert tortoises at this installation in 1985 (Baxter and Stewart 1986). The problem of dogs, coyotes, and kit fox predation on juvenile desert tortoises is being investigated at the Marine installation (Bjurlin and Bissonette 2001). Kit foxes probably do not harm adult tortoises. An adult desert tortoise with a radiotelemetry unit hibernated within a large active kit fox burro complex and emerged in the spring without any signs of chewing (Krzysik 2004, personal observation).

Feral, abandoned, and free-ranging domestic cats directly prey on native wildlife worldwide (Jones and Coman 1981; Liberg 1984; Churcher and Lawton 1987; Clarke and Pacin 2002) and compete with native predators (George 1974; Liberg 1984). Domestic cats, even when well fed by their owners, killed prey (Warner 1985). Songbirds and small mammals constitute the major prey items of domestic cats (Parmalee 1953; Eberhard 1954; Wilcove 1985; Coleman and Temple 1993; Dunn and Tessaglia 1994). Rodents represent dominant elements of ecosystem function and prey items in the Mojave Desert (Krzysik 1994), while songbirds contribute significant biodiversity to arid riparian ecosystems (Krzysik 1990).

The keeping of horses in rural desert settings for recreational riding is generally perceived as innocuous. However, horses strongly attract cowbirds, a serious brood parasite of native songbirds. Cowbirds are not found on avian surveys in desert scrub, but they are present and parasitize native species in the vicinity of human dwellings and horse corrals (Krzysik 2004, field survey data). Cowbirds are considered one of the major reasons for the decline of songbird populations in the United States (Robinson et al. 1995; Smith et al. 2000).

Factor 4: The inadequacy of existing regulatory mechanisms—

The LVRMP (BLM 1998) directs resource management for specially designated desert tortoise habitat (ACECs or DWMAs). As of 2002, the DTRPAC estimated that 85% of the recovery actions recommended for the Coyote Springs DWMA in the DTRP have been at least partially implemented by management agencies (Tracy et al. 2004) such as the BLM.

ACEC lands are designated as ROW avoidance areas and unavailable for disposal through the FLPMA or SNPLMA. Livestock grazing is prohibited and the appropriate management level set for wild horses and burros is zero. Commercial collection of flora is prohibited and commercial collection of fauna is restricted to scientific permits. The BLM is in the process of designating roads in the Coyote Springs, Mormon Mesa, and Gold Butte ACECs, which will restrict motorized and mechanized vehicles to only those roads designated as open. Such use is limited to a certain number of events and by the type of event. No speed portions of OHV events (races exceeding 25 mph) can occur within tortoise ACECs. Up to three non-speed events (not exceeding 25 mph) can occur in each ACEC during the tortoise active season between March 1 and April 1 and June 2 to August 15 (per the BLM's Resource Management Plan and programmatic biological opinion [BO]).

The BLM has not specifically prohibited the discharge of firearms in the DWMA, and according to DTRPAC (Tracy et al. 2004), fencing and culverts had not been installed as of 2002. However, the BLM notes that reducing tortoise mortality from vehicles is a priority (Seidlitz 2005). The DTRP (USFWS 1994a) recommended the withdrawal of mining in the DWMA, and while the Las Vegas BLM has significantly restricted mining practices, some mining operations continue within the DWMA (BLM 1998). Lands are closed to locatable minerals and solid leasables, but fluid mineral leasing remains open, subject to no surface occupancy stipulations. Material site ROWs are restricted to within a half mile of U.S. Highway 93 and S.R. 168.

Although these actions have alleviated some pressure from human impacts, they may not be sufficient to facilitate recovery of the desert tortoise and prevent future listings. Most importantly, while some monitoring programs recommended by the USFWS (1994a) have been initiated, there is a lack of communication among agencies and a need to coordinate dissemination of monitoring and research results among involved parties. Boarman et al. (2005) note that effectiveness of CAs and evidence of recovery cannot be determined without a long-term monitoring plan. In this case, such a plan must specifically include a communication component.

According to DTRPAC, one of the problems with the current recovery plan (USFWS 1994a), is the tendency to focus on individual threats, rather than emphasizing the cumulative, interactive, and synergistic threats to desert tortoise populations throughout the Mojave (Tracy et al. 2004). Failure to address multiple threats acting simultaneously to affect tortoise populations may diminish the benefit of CAs. For example, while the elimination of grazing may benefit the tortoise, impacts due to invasive species and roads can offset the benefits gained from elimination of grazing.

Conservation management strategies must address all of the anthropogenic threats and stressor issues on desert tortoise populations as an integrated landscape and regional problem. Individual threats cannot be singled out and separately addressed. These threats and stressors must be considered as "cumulative effects." Cumulative effects result from minor separate and independent events and decisions that individually are considered benign or insignificant at local spatial or time frames, but collectively in the larger spatial context and/or longer time frames are considered significant environmental impacts. "Evidence is increasing that the most devastating environmental effects may result not from the direct effects of a particular action, but from the combination of individually minor effects of multiple actions over time" (CEQ 1997). The title of Bill Odum's (1982) article clearly expresses the concept: "Environmental Degradation and the Tyranny of Small Decisions."

Cumulative effects are conceptually well established in environmental assessment and planning (Stakhiv 1988; Magnuson 1990; Spaling and Smit 1993; Spaling 1994; Canter and Kamath 1995; Smit and Spaling 1995; CEQ 1997). Nevertheless, predictive detection, the use of multivariate analysis and modeling tools, and complex unexpected synergisms make cumulative effect assessments technically challenging and uncertain (e.g., Paine et al. 1998). Besides technical difficulties, political and policy obstacles have significantly retarded cumulative effects considerations at the project level (Burris and Canter 1997; Cooper and Canter 1997). Cumulative effects and impacts are often considered in ecological risk assessment (Hunsaker et al. 1990; Suter 1993).

Cumulative effects have been particularly relevant and applied to watersheds in the context of forestry management and the quality and integrity of aquatic ecosystems (McComb et al. 1991; Aust and Lea 1992; Naiman 1992; Doppelt et al. 1993; Kohm and Franklin 1997; Lindenmayer and Franklin 2002). Naiman's edited book is particularly informative. The general approaches, principles developed, and lessons learned from these diverse watershed studies are applicable to desert basins as well. Ecological effects from cumulative impacts are probably only absent or minimized in very large ecological reserves with minimal human disturbances (Cocklin et al. 1992a; 1992b; Noss and Cooperrider 1994; Margules and Pressey 2000; McIntosh et al. 2000).

The original DTRP (USFWS 1994a) did not adequately consider cumulative and synergistic threats and stressors (Tracy et al. 2004). Tracy et al. (2004, pages 109-120) clearly appreciate the importance of addressing cumulative effects for the recovery and sustainability of desert tortoise populations, and have developed a "threats network topology" for cumulative threats assessment (Tracy et al. 2004, Figure 5.1, page 113).

Factor 5: Other natural or manmade factors affecting the species' continued existence—

Invasives. The control and management of invasive alien species is one of the most serious problems facing western land managers in government and private agencies and has reached global proportions (Baskin 2002; Tellman 2002; Ruiz and Carlton 2003; Mooney et al. 2005). An invasive species is "a species that is alien to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health" (NAL 2005). In the Mojave Desert, invasive plants have emerged as a significant threat to desert conservation. Common invasive plants in the planning area include Mediterranean grass (*Schismus arabicus*, *S. barbatus*), red brome (*Bromus madritensi*), heron's bill (*Erodium cicutarium*) and Russian thistle (*Salsola tragus*). Interestingly, Russian thistle is classified as a noxious weed, and when it dries it becomes extremely sharp and spiny, but in the early spring it may be one of the most succulent plants in the habitat and may be used as an important food and water source. In California, the state endemic and threatened Mohave ground squirrel forages on abundant Russian thistle in the spring and summer (Krzysik 2004, personal observation).

Invasive plants are opportunistic species that can compete with native plants in disturbed systems (Brooks 2000). Although desert tortoises forage on exotic species of both forbs and grasses, evidence is accumulating that they prefer native vegetation, and select plants for high nutritional value (Jennings 1997, 2002; Esque 1994; Oftedal et al. 2002). Jennings (1997) found that although at least 71 species of ephemeral plants were available to desert tortoises, over 80% of their diet consisted of only 10 plant species, and 95.3% of their bites were on native vegetation. There is evidence to suggest that foraging on invasive species offers less nutritive value, resulting in deficiencies that may further stress a species already impacted by anthropogenic habitat loss and degradation (Avery and Neibergs 1997; Jennings 1997, 2002; Nagy et al. 1998; Hazard et al. 2001).

The upland desert scrub of the Mojave and Colorado Deserts is dominated by alien annuals, which can comprise 66–97% of the total annual plant biomass (Brooks 1999b; Brooks and Esque 2002), causing unnaturally high fuel loads. Fire represents a major threat to community structure and dynamics, including desert tortoise populations, because fire was not a major influence in these deserts with native vegetation (Brooks 1999a; Brooks and Esque 2002). Invasive species have altered the fire regime in the Mojave Desert, increasing the frequency of fire in a largely fire-intolerant system, further promoting the dominance of invasive plants (Brooks 2001). Invasive grasses such as red brome and split grass can increase the fire intensity, as well as the horizontal fuel continuity, thus increasing the frequency and extent of fire (Brooks et al. 2004). Invasive species rapidly colonize a burned area, becoming established before native species, thus dramatically altering the community composition in favor of invasive species (Brooks 2001), which may create an invasive plant-fire regime cycle drastically different than the natural fire regime in the system (Brooks et al. 2004). The effects of fire depend largely on the intensity of the fire, the characteristics of the plants, and post-fire precipitation (Esque and Schwalbe 2002). Fire management techniques, including prefire suppression, active fire suppression, and postfire rehabilitation may promote invasions by allowing weeds to spread along firebreaks and using mulch or seeding containing invasive plant propagules to stabilize slopes (Brooks 2001). The human population may also increase sources of ignition via development or recreational use, which when coupled with fire-loving invasives, could have disastrous consequences for the fire-intolerant Mojave ecosystem.

Human interaction with desert wildlife may increase as development and recreational opportunities connect the human population with the desert ecosystem, bringing the potential for the collection and vandalism of tortoises. The desert tortoise has been protected under Nevada Law since 1969 (NRS 501.110), and collecting has been a Federal offense since 1989 (USFWS 1994a). However, according to the DTRP, illegal collection is occurring despite its protected status (USFWS 1994a). There is little evidence that collecting tortoises is widespread, and it is difficult to evaluate the extent of the threat. The best prevention is ongoing enforcement.

Incidents of vandalism, or the “purposeful killing or maiming of tortoises” (Boarman 2002a), are typically anecdotal, and, quantitatively, gunshot deaths are most common. Although a substantial threat, vandalism and gunshot deaths do not appear to be a significant cause of mortality in the eastern Mojave (1.5% of carcasses) (Berry 1986).

2.5 Human Issues and Opportunities

2.5.1 Economic

Although the natural resource sector employs only a small percentage of Clark County's population (0.05%; see Figure 6), it can be a significant factor in the economy of rural Nevada. The LVRMP (BLM 1998) directs management of grazing and mining on BLM lands, historically the most common commercial uses on BLM lands and those likely to be affected by management actions resulting from this CMS.

Mining—Mining in Southern Nevada began with the discovery of ore in the Potosi Mine in 1857 and was made famous with the discovery of gold in the Keystone Mine, stimulating activity in the Goodsprings Area. Although BLM lands have historically been used for mining, there has been little production from BLM-administered lands in Clark County in the last 30 years, except for sand, gravel, and silt. Locatable mineral material operations existing before the LVRMP in approval 1998 have continued to operate, subject to validity determinations. As such, restrictions on mining operations resulting from DWMA management are unlikely to have a substantial economic impact on the county's mining industry. The LVRMP directs minerals management in the DWMA and has already restricted a number of activities (BLM 1998):

Salable Mineral Material Sites. Saleable materials, such as sand, gravel, and other construction materials, are sold and permitted under the Mineral Materials Sale Act of 1947. The planning area has a high potential for saleable mineral materials, and its location near metropolitan Las Vegas and the CSI development may make it a reliable source of materials for local construction projects. However, the LVRMP restricted material site ROWs to government agencies and they can only occur along the U.S. Highway 93 corridor as identified on LVRMP Map 2-12. Under the BLM's existing biological opinion, a maximum of 1,000 acres of desert tortoise habitat may be disturbed as a result of expansion of existing material pits, including both ROWs and free-use permits, within desert tortoise ACECs (BLM 1998).

Locatable Mineral Material Sites. Locatable minerals require a claim rather than a lease issuance under the Mining Act of 1872. Most of the DWMA has low potential for locatable minerals, although the northern portion of the DWMA near the Arrow Canyon Wilderness Area has moderate potential (BLM 1998).

Gas and Oil Fluid Leases. The planning area has moderate potential for oil and gas; however no leases currently exist in the DWMA (BLM 1998). Any future fluid mineral leases in the area would be subject to "no surface occupancy" provisions. The land-use decision or stipulation identifies the no surface occupancy area and allowed or excepted uses in the area. No surface occupancy stipulations are used on oil and gas leases where drilling and/or operations impacts cannot be adequately mitigated but fluid mineral resources may be recovered by directional drilling. The LVRMP (BLM 1998) eliminated solid mineral leasing and locatable mineral practices and conducted validity determinations on pre-existing mining claims in the DWMA.

Environmental Conditions. While mining is traditionally associated with negative environmental impacts such as poor water quality and wildlife mortality, strict regulations of mining practices from exploration to reclamation have reduced these effects. The Nevada Bureau of Minerals and Geology estimates that $560 million in reclamation bonds are currently posted to restore former mine areas to pre-mining conditions (NBMG 2004). Existing or historic mining operations are unlikely to inhibit tortoise recovery, provided these operations are subject to new and future environmental regulations.

Agriculture—Agriculture is not a major economic factor in Clark County. The county's 253 farms comprise only 1% of the total agricultural acreage in Nevada. In 2002, Clark County ranked tenth in total market value of product sold in Nevada, generating $6,626,000 in crop products and $10,378,000 in livestock (NASS 2002). However, this economic contribution is relatively minor compared to the $39 billion revenue generated by gaming and tourism during the same year (CBED 2005). Additionally, the BLM estimates that most farm and ranch inputs are purchased outside Clark County in Utah or California, thus contributing little income for the County (BLM 1998).

Still, farming and ranching are noteworthy sources of income and, moreover, a lifestyle in Nevada's rural communities. The major agricultural commodities in Clark County are predominately livestock, with forage, grain, alfalfa, and dairy (NASS 2002). Farming is concentrated in valleys, while rangelands provide grazing for livestock.

BLM land occupied by the planning area has provided an opportunity for ephemeral public use of rangeland in the past, but regulations instituted in the LVRMP (BLM 1998) effectively discontinued use of the DWMA for grazing. Historically, the Arrow Canyon, Pittman Well, and Dry Lake grazing allotments encompassed the DWMA. While the latter two allotments have not been grazed since at least 1980, the Arrow Canyon allotment had 255 animal unit months in 1980 (NDA 2005). All grazing allotments within the planning area have been purchased from prior permit-holders using land development mitigation fees as part of the Clark County MSHCP process and administratively closed by the BLM. The Battleship Wash portion of the Arrow Canyon allotment, outside of DWMA boundaries, remains open under BLM management (BLM 1998).

The elimination of grazing allotments in and near the DWMA has resulted in lost of opportunities for ranchers relying on the land for their economic survival. However, because the DWMA has been closed to grazing since 1998 and the BLM continues to offer public land for grazing adjacent to the DWMA and elsewhere in the county, repercussions of continuing these management actions is not expected to have widespread consequences for the area's rural population.

2.5.2 Social

Recreation—Tourism is a major economic force in Clark County; the county offers a myriad of opportunities for recreation, both in the urban setting of Las Vegas and on Federal lands. In 2004, nearly 38 million tourists visited Las Vegas, contributing $33.7 billion to the local economy (CBED 2005).

Nevada has over 57 million acres of public lands used for outdoor activities ranging from hunting to water sports. The USFWS reports that 762,000 individuals participated in wildlife-related activities in Nevada in 2001, including fishing, hunting, and wildlife watching (observing, photographing, and feeding fish and wildlife). Wildlife watching was participated in by 83% of those surveyed, while only 29% were sportspersons. Table 8 identifies the number of participants, days, and total expenditures by individuals in Nevada for each activity in 2001.

TABLE 8. Number of participants, recreation days, and total expenditure for anglers, hunters, and wildlife watchers in Nevada in 2001.

	Number of Participants	Days	Total Expenditure
Fishing	172,000	1,575,000	$216,721,000
Hunting	47,000	490,000	$134,102,000
Wildlife Watching	543,000		$250,145,000
Total	**762,000**	**2,065,000**	**$600,968,000**

Source: USFWS 2002.

Clark County has 5 state parks, 2 national recreation area (856,000 acres), 18 wilderness areas (451,915 acres), and over 2 million acres of BLM public lands (DCNR 2002). The state park trail system offers 277 miles of trails for hiking, equestrian, mountain biking, and limited motorized use, while BLM estimates that 85% of their land is open to motorized use on 622 miles of trails statewide (DCNR 2002). However, there are more 981 miles of roads and trails inventoried within the seven ACECs in the northeastern portion of Clark County alone. In 2003, over 6.4 million visitors used BLM-managed lands for recreation statewide, mostly on dispersed lands (i.e., not specially designated) (BLM 2003). Recreational fees and permits contribute substantially to Nevada's economy. For instance, the BLM collected $2,497,512 from recreation enthusiasts in 2004, primarily from entrance permits (BLM 2004b). Figure 10 illustrates the most popular recreational activities identified by Nevadans in a survey by the Nevada Division of State Parks.

Within the planning area, recreational opportunities are classified by the BLM primarily as roaded natural areas (BLM 1998). Roaded natural areas are multiuse areas with opportunity for both motorized and nonmotorized recreation. The CSI development does have the potential to increase recreational use of the DWMA given the increase in population and the attraction for tourists along U.S. Highway 93 from Las Vegas.

Over 70% of recreational visits in 1997 were to parks with water amenities, and water-related activities were identified as the most popular recreation use by Nevadans (DCNR 2002). With one of the highest visitation rates of any national park, the Lake Mead National Recreation Area (LMNRA) averaged over 8 million visitors per year from 2001 to 2003 (NPS 2005a, 2005b).

Recreational Opportunities in the Coyote Springs DWMA. The Coyote Springs DWMA offers a number of recreational opportunities, including hiking, mountain biking, and wildlife watching. In addition, the DWMA offers a unique opportunity to promote desert education and appreciation. Management of the DWMA could consider guided walks, a visitor's center, and periodical educational materials to further conservation education.

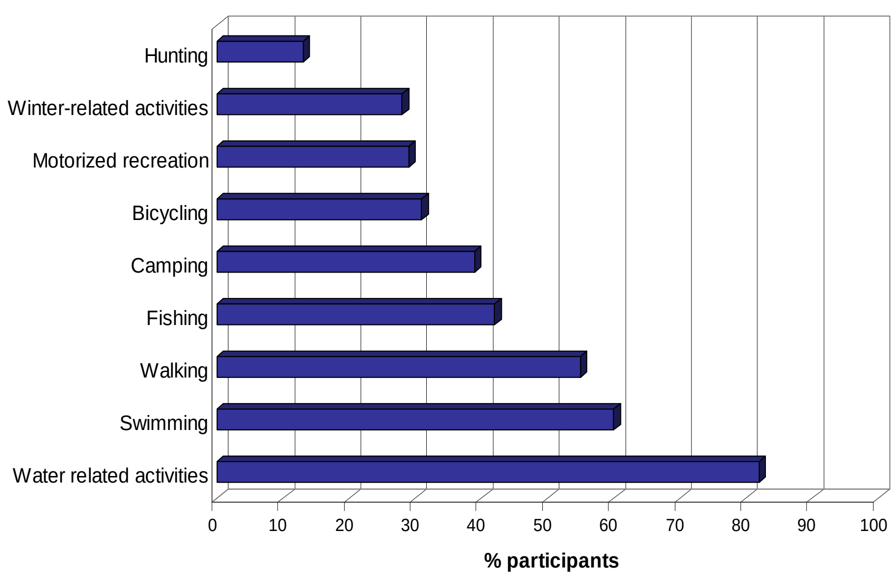

FIGURE 10. Proportion of Nevada residents age 16+ participating in select recreational activities in 2000 (Source: Deloney 2002).

Cultural—Clark County has a rich cultural history from the prehistoric and historic Indians whose culture is evident in the numerous petroglyphs, or historic rock art panels on the mountainsides, to the historic mining ghost towns of the 19th and early 20th centuries. There are 48 archeological sites presently identified in or near the Coyote Springs DWMA, including rock shelters and rock art, campsites, and historic remains (BLM 1998). The Muddy River area is particularly rich in structural and historic remains, and part of the Arrow Canyon Range is designated an ACEC for its wealth of archeological resources (BLM 1998). Clark County contains 12 caves of national or regional significance as well as two backcountry byways. Additionally, the county has 49 national heritage sites and the Hoover Dam National Historic Landmark (SHPO 2005).

Native American culture in Nevada is prominent, and Clark County has three Indian reservations and a population of over 300 Native Americans (NSLA 2000). The Moapa Band of Paiutes or "Nuwuvi" are part of the Southern Paiute Nation, whose traditional territory covered much of present southern Nevada, northern Arizona, and southern Utah. The Moapa Band hunted small game and gathered plant foods in the southern Nevada's Moapa Valley, the prehistoric flood plain of the Muddy River which today flows southward through the valley and drains into Lake Mead.

While this conservation management strategy does not deal specifically with cultural resources, many of the implemented proposed CAs will protect these historic properties. Additionally, cultural resources have Federal protection via a number of policies, including the National Historic Preservation Act of 1966, the Archaeological Resources Protection Act of 1979, and the American Indian Religious Freedom Act of 1978.

2.5.3 Political

Desert tortoise conservation is a collective effort, and, as such, interagency cooperation and communication will be critical to achieving the goals set forth in the recovery plan. The USFWS RUs were designated using the best scientific data available and do not adhere to political or administrative boundaries. For instance, the Lower Virgin River DPS includes portions of four states, six BLM districts, the USFWS DNWR, the U.S. Department of Energy Nevada Test Site, the U.S. Air Force Weapons and Tactics Center Range Complex, and a variety of other land administrations (BLM 1998).

The BLM, National Park Service (NPS), and the State of Nevada manage large amounts of land within and adjacent to the planning area. In addition, local and county governments must be involved in the planning and implementation process. The Clark County MSHCP and SNPLMA will potentially fund conservation projects within the planning area and must, therefore, also be involved in implementation of a conservation strategy in the DWMA.

It is important to look at conservation efforts on a number of spatial scales from regional to local. As such, interagency cooperation and the dissemination of monitoring and research results among agencies will be paramount to desert preservation from an adaptive management standpoint.

3. CONSERVATION OBJECTIVES

3.1 Related Mandates and Policies

Federal Land Policy and Management Act of 1976 (FLPMA)—Established public land policy and guidelines for the administration, management, protection, development, and enhancement of the public lands.

Endangered Species Act of 1973 (ESA)—Established to conserve the ecosystems upon which endangered and threatened species depend and to conserve and recover listed species. The ESA defines a threatened species as "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range," and an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range."

> *Section 4* requires that recovery plans be developed describing the steps needed to restore a species to health and provides for designation of critical habitat defined as habitat essential to the conservation of the species.
>
> *Section 10* relieved restrictions on private landowners wishing to develop land inhabited by endangered species by issuing an "incidental take permit." This permit allows development to move forward following approval of a HCP providing for the conservation of the species.

Nevada Revised Statutes (NRS)—The NRS are the current, codified laws of the State of Nevada and the Nevada Administrative Code (NAC) are the codified, administrative regulations of the executive branch. In 1969 a revision of the NRS allowed the State to classify wildlife and provided for the preservation and protection of wildlife through the creation of the Nevada Board of Wildlife Commissioners and county advisory boards.

The desert tortoise has been afforded protection since 1969 (NRS 501.110), later protected as threatened (NAC 503.080) with further regulations provided by NRS 503.090 and NRS 503.093. Several plant species are protected as critically endangered and protected by State law from removal or destruction (NRS 527.270 and NRS 527.050), and collection of for commercial and scientific purposes (NRS 527.070 and NAC 503.094). The State also lawfully authorizes a program for the conservation, protection, restoration, and propagation of selected species of flora and for the perpetuation of the habitats of such species (NRS 527.260 and NRS 527.300). Appendix B contains a list of Nevada's Federal and State protected species. Detailed information on Nevada's protected species is available through the Nevada Natural Heritage Program (http://heritage.nv.gov).

NRS chapter 244 details the role of county governments in the State of Nevada. In 1991, Clark County proposed an amendment to chapter 244 related to the governing of natural resources, which authorized the imposition of a development fee. NRS 244.386 imposed a fee of no more than $550 per acre for developing lands upon which a threatened or endangered species if found, later directing that its revenue be used in the conservation of the endangered or threatened species as well as unlisted species deemed worthy of protection in the MSHCP.

3.2 Goals for the Coyote Springs DWMA

The purpose of this CMS is to implement a plan to protect desert habitat which will ensure the maintenance of suitable habitat and viable wildlife populations in the absence of ESA protection. This purpose can be achieved through the following objectives, which were developed through detailed review of the objectives of existing management plans and the purpose of the CMS, and prioritized based on professional judgment of needs specific to the Coyote Springs DWMA:

Objective 1: Recovery and delisting of the desert tortoise, which can occur only after the following criteria have been met:

- The population within a RU must remain at target density or trend towards target density for at least 25 years with population lambdas maintained at or above 1.0.
- The habitat within a RU must be able to sustain or be managed to sustain a long-term viable tortoise population.
- Regulatory mechanisms or land management practices that provide long-term protection for desert tortoises must be implemented within the RU.
- The population in the RU is not likely to need protection under the ESA in the foreseeable future.

The intent of the DWMA is to mitigate for the incidental take permit issued to Clark County by the USFWS. The primary objective of this CMS is to protect and eventually recover the desert tortoise in Clark County so as to no longer need the protection of the ESA.

Objective 2: Facilitate exchange of information between various management agencies with the goal of approaching desert conservation from a regional perspective.

This CMS, in conjunction with the MSHCP, is an integrated effort to provide regional protection for the desert tortoise, and in turn, other covered species. As a holistic program, open communication among participating agencies is crucial to the fulfillment of all objectives of this CMS.

Objective 3: Implement research studies and an effective monitoring strategy to eliminate gaps in knowledge preventing development of a CMS.

Elimination of gaps in knowledge will be a critical component in achieving the objectives of this CMS. An adaptive CMS develops over time; the knowledge gained from specific research and monitoring programs will allow managers to determine the most effective strategy for desert conservation.

Objective 4: In conjunction with other specially designated lands and conservation programs, provide for long-term protection of habitats and species on a regional basis.

Clark County has a unique opportunity to set aside a large amount of land specifically for the long-term protection of Mojave Desert habitat. This objective requires adaptive management through extensive research and monitoring and largely depends on communication among participating agencies.

Objective 5: Prevent listing additional species by protecting suitable habitat and monitoring population trends of other covered species, and mitigating and minimizing impacts that may reduce the survival potential of the species.

The incidental take permit is driven by the ESA and applies solely to the desert tortoise as a threatened species. Thus, the primary goal of the DWMA is not to protect other species covered under the MSHCP. However, through the long-term protection of habitat and implementation of a suite of CAs targeting specific uses incompatible with desert conservation, covered species will be protected and additional ESA listings prevented.

The prioritization of these objectives does not attempt to quantify importance but to provide a framework for the implementation of CAs recommended in this CMS. These objectives were developed specifically to comply with the terms of the DTRP (USFWS 1994a), Clark County Desert Conservation Plan (RECON 1994), Las Vegas Resource Management Plan (BLM 1998), Clark County MSHCP (RECON 2000), and the Site Conservation Plan for the Coyote Springs DWMA (TNC 2003).

3.2.1 Desired Future Conditions

In order to provide an overarching framework on which to base management recommendations, the following operational long-term vision for the planning area is proposed:

The Coyote Springs planning area is intended to serve as a contiguous block of habitat of sufficient quality and quantity to promote the survival, growth, reproduction, and maintenance of viable populations of Mojave Desert flora and fauna. The protection of this area is intended to mitigate the loss of habitats and the species that formerly depended upon them in the greater Las Vegas Valley and urbanized areas in Clark County, Nevada. Additionally, the Coyote Springs planning area should be recognized as just one part of a larger Northeastern Mojave wildlife conservation and recovery effort. In this regard, the planning area must be viewed as an essential corridor, connecting other ecologically critical habitats within the region for both the desert tortoise and other unique species in this system. In particular, the connectivity between the Mormon Mesa DWMA and the Coyote Springs DWMA along S.R. 168 and U.S. Highway 93 should be maintained to allow movement of wildlife between the DNWR and other conservation areas east of the Arrow Canyon Range.

4. CONSERVATION ACTIONS

Conservation goals define the objectives of a conservation strategy and serve as an endpoint by which conservation successes can be measured. Achieving DCP conservation goals requires a biologically-based suite of CAs unifying the efforts of multiple land and wildlife management agencies. To this end, CAs proposed for the Clark County MSHCP (RECON 2000) and in The Site Conservation Plan for the Coyote Springs DWMA (TNC 2003) were examined and applied to the specific goals of the DWMA. These actions were arranged into the following categories:

- **Management Actions** (MAs) regulate development and recreational and commercial uses including road and OHV use, herd management, and mining practices.
- **Protective Measures** (PMs) restrict organismal collections and trail development activities and implement protection measures that will minimize impacts associated with ROW maintenance, to preserve sensitive habitat.
- **Restoration Efforts** (REs) direct rehabilitation of degraded habitats, including spring and riparian habitat.
- **Public Outreach, Partnership, and Education Actions** (POE) advise for outreach programs and town hall meetings informing the public about the DWMA management process and the importance of desert conservation. Communication among management agencies with Interagency Transfer Workshops is also encouraged.
- **Inventory and Monitoring Actions** (IM) recommend survey and monitoring plans to provide a foundation for making adaptive management decisions.
- **Applied Research Actions** (Rs) identify areas of study targeting data needed to develop a cohesive CMS, particularly concerning the desert tortoise.
- **Impact Mitigation** (Mt) minimizes threats hindering conservation success by removing or bypassing the hazard, for instance fencing roadways to prevent tortoise mortality.

Proposed CAs for each category are summarized in Section 4.1. Section 4.2 describes the expected benefits to of the various CAs. Section 4.3 identifies a preliminary assessment of funding sources and staffing requirements. Finally, Section 4.4 expresses both impacts and opportunities for the residential desert community associated with the suite of CAs.

4.1 Proposed Conservation Actions

The Clark County MSHCP contains 459 collective actions that could be implemented within the 30-year permit term by BLM, NPS, Nevada Department of Wildlife (NDOW), NDOT, U.S. Forest Service (USFS), and USFWS provided funding is available and the action is deemed appropriate. Many actions among and within agencies were similar or shared, and cross-comparison of these duplicative actions condensed the original total considerably. The Site Conservation Plan for the Coyote Springs DWMA (TNC 2003) also offered 20 actions specific to the DWMA. Compiling and integrating these actions resulted in 49 CAs identified for possible implementation in the Coyote Springs DWMA. Table 9 prioritizes proposed CAs for the Coyote Springs DWMA according to effort and potential benefit to the DMWA and lists the agencies that prescribed each action. It is important to note that in Table 9, the Agency column references the agency and CA number prescribed in the MSHCP (cross-references in Appendix E), and does not indicate the agency responsible for implementing the action in the DWMA. Actions proposed by TNC in the Site Conservation Plan (TNC 2003) are also recommended for implementation but are not directly supported through the MSHCP or by any Federal or State agencies.

TABLE 9. Proposed Conservation Actions for implementation in the Coyote Springs DWMA from the Clark County MSHCP.[a]

Rank	Conservation Action	Category	Agency	Benefit
Level 1: On-going time, effort, or cost commitment with very high overall benefit to DWMA.				
1	Ensure adequate law enforcement presence to deter new road incursions and protect the resources.	MA	USFWS 28 BLM 98	Enforcement of road designations would deter vehicle misuse and new road incursions and promote resource conservation.
1	Design public outreach campaign in DWMA assessment area to increase public land user compliance with use restrictions and to highlight the importance of habitat conservation for species of concern.	POE	USFWS 2 USFWS 1 BLM 5	Responsible road use protects sensitive habitat from ground disturbance and promotes growth of native vegetation.
1	Organize interagency transfer workshops to develop modes of communication and disseminate information among land management agencies.	POE	USFWS 3	Distributing information among agencies will improve management coordination, ultimately assuring effective management.
1	Cooperate with other agencies to (1) prevent negative impacts on critical threatened and endangered habitat, (2) increase species of concern populations, and (3) avoid listing additional species by maintaining populations, critical habitats, and ecological processes. Consider additional protective designations when appropriate and enforce implementation of CAs.	POE	NDF 3 NDOW 20 BLM 98 BLM 99	Species do not adhere to land management boundaries and successful management can be achieved only through interagency cooperation.
1	Implement comprehensive monitoring program for all covered species in coordination with MSHCP. Evaluate inventory needs on an annual basis and coordinate with BLM on maintaining a digital inventory database for Clark County.	IM	NDOW 13 NDOW 14 NDOT 5 USFWS 11 BLM 13 BLM 15 BLM 17 BLM 19	Annual inventories provide important baseline information concerning the status of conservation targets enabling managers to measure the effectiveness of management and to adapt actions and policies to meet the changing needs of conservation targets.
1	Use remote sensing and satellite imagery to track land use and establish a baseline for non-disturbed habitat.	IM	TNC	Management actions can define and focus protection based on data.
1	Develop long-term hypothesis-based studies targeting management issues for recovery of desert tortoise populations.	Rs	TNC	Identifying critical threats and monitoring recovery of populations will allow managers to recognize and address inadequacies in an adaptive management process.
1	Sign and rehabilitate new road incursions in a timely fashion.	MA	USFWS 40 NPS 50 NDOT 27	Proper signage promotes responsible road use, enhancing native species' habitat and facilitating quick detection and rehabilitation of new incursions.
1	Prohibit commercial and casual collection of plant and animal materials in DWMA assessment areas	PM	NDF 2 NDOW 6 NDOW 18 USFWS 12 BLM 51	Eliminating collection reduces loss of species due from this source. Enforcement will deter poaching and protect species.
1	Restore the health of water resources by eliminating exotic fish and plant species in and around springs, particularly tamarisk, and do not allow the introduction of new non-native fish or wildlife.	RE	NPS 45 NPS 46 NPS 47 USFWS 37 NDOW 23 BLM 142	Eliminating exotic species will enhance the native community and reestablish a natural fire regime, protecting the desert community from the threat of wildfire.

Rank	Conservation Action	Category	Agency	Benefit
1	Develop and implement long-term surveys for key avian species to document population trends, critical nesting and breeding habitat, and seasonal distributions.	IM	NPS 8 NPS 9 NPS 10 USFWS 8 BLM 15 BLM 19	Effective conservation efforts aimed at recovery of avian species can be implemented through identification of key nesting and breeding habitat.
1	Protect and improve sensitive habitat such as nesting areas and migration routes, as well as riparian, mesquite woodland, and aquatic habitats.	PM	USFWS 16 USFWS 17 BLM 20 BLM 117 BLM 302	Protection of sensitive key habitat ensures suitable habitat to promote native species recovery.
1	Enhance cooperation among animal control entities to reduce raven and feral animal populations in all DWMA assessment areas	Mt	NDOW 37	Reducing predator populations may increase desert tortoise survival.
Level 2: Low time, effort, or cost commitment with moderate to high overall benefit to the DWMA.				
2	Restrict access to private utility maintenance roads with gates in the Coyote Springs assessment area*	MA	TNC	Gating maintenance roads will discourage public land users from accessing sensitive areas, protecting native species.
2	Utilize permanent and temporary road closures to manage road use in sensitive habitats. Whenever possible, prohibit new road construction in areas of sensitive habitat and within 0.5 miles of active desert tortoise burrows or 100 yards of water sources.	MA	USFWS 24	Closing roads, even temporarily during sensitive times, will address threats due to vehicle misuse, enhancing species recovery. Excluding new road construction prevents further habitat loss and fragmentation in sensitive habitats.
2	Modify highway maintenance practices to minimize damage to wildlife and flora by restricting maintenance activities to NDOT ROWs, conducting preactivity surveys for biological resources, avoiding or relocating individuals or habitat as necessary, and avoiding maintenance activity during sensitive times (i.e., breeding, nesting, spawning, or overwintering).	PM	USFWS 5 USFWS 26 NDOT 3 NDOT 9 NDOT 10 NDOT 11 NDOT 14 NDOT 21 NDOT 25 NDOT 29 NDOT 30	Restricting maintenance to NDOT ROWs will minimize habitat destruction to areas adjacent to ROWs. Avoiding Covered Species will reduce mortality and avoiding maintenance during sensitive times avoids interrupting natural cycles and promotes population viability.
2	Implement balanced spring restoration techniques and restore spring brook communities by developing techniques to address nutrient loading, vegetative overgrowth, and exotic species. Protect, restore, monitor, and maintain historic surface flow, water chemistry, temperature, and clarity of water sources. Remove existing water developments and debris from springs, provided it has no historical significance and is not used by wildlife.	RE	USFWS 6 BLM 114	Reducing nutrient loads and vegetative overgrowth will improve water quality and protect springs for wildlife. Removing competitive exotics will enhance conditions for recovery of native spring communities.
2	Install fencing or other spring protection to exclude livestock and wild horses.	RE	BLM 90	Fencing will enhance native vegetation recovery and improve water quality in springs.
2	Do not permit organized speed based portions of OHV events in Coyote Springs DWMA**	MA	NDOW 15 BLM 71 BLM 210	BLM's observations indicate that permitted events in the ACEC cause less impacts than casual use by the public. This is mainly due to BLM's ability to require that the event be operated in a manner to minimize impacts and enforce stipulations associated with the event

Rank	Conservation Action	Category	Agency	Benefit
2	Withdrawal of mineral entry in DWMAs.	MA	BLM 200 BLM 89	Future mineral and material demand is uncertain, and initiating the withdrawal process by halting new claims would reduce habitat disturbance, protect water sources, and increase survival.
2	Avoid further ROWs in DWMA by restricting any future ROWs to the existing designated ROW corridor when feasible.	MA	BLM 301 USFWS 46	Avoiding ROWs minimizes linear habitat disturbance and opportunities for invasive species while protecting species from predation.
2	Fence heavily traveled transportation corridors in DWMA assessment area. Monitor and inventory all culvert/bridge crossings and tortoise fencing within assessment area and ameliorate existing or install new culverts/bridges to allow passage of terrestrial species.	Mt	NDOT 4 NDOT 6 NDOW 11 NDOT 23 NDOT 24	Fencing prevents desert tortoise road kills while culverts allow movement of wildlife across roadways and alleviates impacts due to fragmentation. Monitoring these structures aids in upkeep and repair.
2	Install highway runoff pollution control devices in areas where covered aquatic species may be impacted by Highway runoff.	PM	NDOT 19	Highway pollution control devices will improve water quality by eliminating runoff pollution.
2	Inventory bat populations and roosts and create a plan to identify and protect abandoned mines as bat habitat.	IM	NDOW 7 NDOW 35	An inventory and designation plan for bats will minimize loss of critical bat roosts due to closure of mines.
2	Use pesticides to treat exotic pests and disease outbreaks as a last resort (when threat to public safety, private property, or in extreme fire danger), or when scientific evaluations indicate a need; and use only EPA registered and approved formulations at their minimum effective rates in the least invasive method, such as single tree treatment. Determine potential impact of pesticides on species of concern and avoid their use in sensitive habitat whenever possible.	PM	USFWS 18 NDOT 18	Limiting pesticide use will reduce the potentially harmful impacts of pesticides on native communities.
2	Restrict access to private utility maintenance roads with gates in the Coyote Springs assessment area*	MA	TNC	Gating maintenance roads will discourage public land users from accessing sensitive areas, protecting native species.
Level 3: Low time, effort, or cost commitment with low to moderate overall benefit for the DWMA.				
3	Allow no net loss of Las Vegas bearpoppy and implement the memorandum of agreement with USFWS.	PM	USFWS 30 BLM 107	Affords full protection of the endangered Las Vegas bearpoppy.
3	Study feasibility of Green Sticker licensing for off-road vehicles in the State of Nevada, with funds earmarked to restore areas impacted by OHVs and/or establish alternative recreation sites.	Rs	TNC	Funds generated by licensing program could be used to restore road incursions and fund road inventories, maintenance, and signage.
3	Focus recreation activities (OHV activity, mountain bikes, and heavy foot traffic) into less sensitive areas to protect habitat of the species of concern.	PM	USFWS 19	Designating less sensitive areas as recreational use eliminates habitat disturbance in sensitive habitat.
3	Provide an environmental assessment of the effects of the expansion of any public use areas, especially effects on species of concern.	MA	USFWS 48	An environmental assessment will ensure minimal negative impacts to species of concern and associated habitats.

Rank	Conservation Action	Category	Agency	Benefit
3	Ensure new roadside structures are designed and constructed to prevent animals from becoming trapped. Encourage retrofitting existing structures that pose a trapping problem.	Mt	NDOT 17	Avoiding possible entrapment will immediately eliminate mortality of fauna associated with trapping.
3	Ensure that roads are engineered to adequately spread runoff to minimize erosion.	PM	USFWS 27	Minimizing erosion will enhance soil stability and enhance native vegetation and wildlife recovery.
3	During emergency situations (e.g., casualties, disasters, flooding, fire, national defense, security), public safety is first priority. Work on roadways in Covered Species habitat will be conducted in an expedited manner and confined to the road shoulder or previously disturbed area.	PM	NDOT 22	Ensuring public safety is a priority in any public land use area.
3	Assure implementation of integrated Pest Management Plans	PM	USFWS 44	
3	Allow no net loss of Las Vegas bearpoppy and implement the memorandum of agreement with USFWS.	PM	USFWS 30 BLM 107	Affords full protection of the endangered Las Vegas bearpoppy.
Level 4: Very high time, effort, or cost commitment with low overall benefit to DWMA.				
4	Improve or maintain springsnail habitat and reestablish populations. Pipe water downstream of the source where snails are present when developing water sources.	RE	BLM 106	Improving habitat will promote population viability and piping water downstream will ensure protection of springsnail populations.
4	Where appropriate and within available budget allocations, pursue acquisition or reservation of water rights and in-stream flows on a willing seller basis for maintenance of aquatic habitats for wildlife.	RE	NDOW 24 BLM 120 BLM 121	Acquisition of water rights will facilitate restoration of historic water flows and spring communities.
4	Acquisition/exchange of key privately held lands within the Coyote Springs DWMA	MA	BLM 164	Acquisition/exchange will provide immediate relief from development pressures and ensure long-term conservation of critical habitat.

a. Actions are ranked by level (defined in table) and prioritized within level according to perceived benefit to desert tortoise. Agency identifies related CAs proposed by multiple agencies:

Agency		
BLM	=	Bureau of Land Management
NPS	=	National Park Service
NDOT	=	Department of Transportation
NDOW	=	Nevada Department of Wildlife
TNC	=	The Nature Conservancy
USFWS	=	U.S. Fish and Wildlife Service
USFS	=	U.S. Forestry Service
NDF	=	Nevada Division of Forestry

Category		
MA	=	Management Actions
POE	=	Public Outreach, Partnership, and Education Actions
IM	=	Inventory and Monitoring Actions
RE	=	Restoration Efforts
PM	=	Protective Measures
Rs	=	Applied Research Actions
Mt	=	Impact Mitigation

b. BLM does not issue exclusive ROWs; therefore, once a maintenance road is created, it has unrestricted use.

c. Organized non-speed OHV events are currently authorized within the Coyote Springs Mesa ACEC. Such use is limited to a certain number of events and by the type of event. For instance, up to three non-speed events can occur in each ACEC during the tortoise active season between March 1 and April 1 and June 2 to August 15 (per our LVRMP and programmatic BO). Outside the ACEC, events can occur throughout the year, in accordance with minimization measures required in the BO. Organized OHV events require stipulations in the permit to ensure that impacts to MSHCP Covered Species are minimized.

4.2 Expected Benefits

Human interactions are one of the most pervasive threats in the DWMA. Many CAs already proposed concentrate on minimizing human impacts such as road use, motorized recreation, camping, trail and road incursions, industry, and development. Table 9 prioritizes 47 existing CAs by defining four levels of importance based on time, effort, and economic considerations. Ongoing actions with the greatest potential benefit to wildlife in the DWMA are defined as the most pressing, while actions that appear to be prohibitively expensive are categorized as the least important for implementation.

Combined, these recommendations constitute a suite of CAs developed by multiple agencies. It is important to implement these actions and monitor their effectiveness before obscuring conservation efforts with additional actions. Monitoring how the proposed actions impact the desert tortoise and other Covered Species in the DWMA will provide quantifiable evidence to assess which actions are successful and which areas are in need of further protection. This Section summarizes the benefits of implementing actions at each level outlined in Table 9.

4.2.1 Level 1 Actions

Level 1 actions require an ongoing time and effort commitment, but offer the widest geographic and temporal range of benefits for the desert tortoise and other DWMA species, which is why we feel they are the highest priority. These CAs target enforcement, education, monitoring, and road use. We recommend devoting the majority of funds, time, and effort to implementing and enforcing level 1 actions.

Enforcement. Enforcement of existing and new CAs is crucial to the success of DWMA management. All actions implemented, either through the MSHCP, BLM, or via this CMS, must be enforced throughout the DWMA. In order to do so, not only does there need to be adequate presence in the DWMA, but officers must have the ability to enforce regulations through the assessment of fines or citations. The success of this CMS relies directly on the ability of officers to enforce CAs in the DWMA.

Currently, the MSHCP provides funding for four BLM law enforcement rangers. One of the rangers patrols within the Coyote Springs DWMA. The Logandale resident ranger patrols from Halfway Wash to the Desert National Wildlife Range and down to Logandale and Overton. Although additional enforcement needed although additional full-time officers may be prohibitively expensive, supplementary part-time or seasonal employment may be pursued during high-use periods (e.g., weekends and holidays). Abuse of public lands may be less likely to occur in the future if public land users are penalized for noncompliance with DWMA regulations.

Education. Public education is one of the most valuable conservation measures in a land manager's toolbox. Public outreach materials reach a wide audience, both within the DWMA and in the surrounding community. A successful CMS depends on public support, which in turn, requires that the public understand why conservation is important and the regulations designed to improve protection for wildlife in the DWMA. If the public is well-informed, they may be more inclined to participate in protecting their natural resource.

Outreach methods include public service announcements, educational signs, and kiosks in the DWMA, informational brochures targeting specific user groups, wildlife awareness training for NDOT and other workers in the DWMA, and educational programs in school. Clark County currently has a successful public outreach infrastructure in the Mojave Max program. We recommend that this program be continued and improved upon to reach a range of groups, from students and their parents to recreational users.

The Clark County Desert Conservation Programs Public Involvement and Education (PIE) survey (PIE 2004) revealed that over 95% of the population in Clark County values desert conservation. The three most popular sources of public information identified by the PIE survey were television, major newspapers (Las Vegas Review Journal or Las Vegas Sun), and radio (PIE 2004). Implementing outreach in the DWMA should include distributing public service announcements through these outlets. Additionally, an effective outreach tactic identified in the survey was the Desert News, an online newsletter summarizing conservation efforts and achievements. The DWMA CMS includes the quarterly Desert Wash Newsletter, which is available online and in hard copy and updates residents about the status of conservation efforts, future directions, and upcoming meetings.

However, these traditional media sources may not reach rural residents. Annual town meetings should be organized to contact the rural desert populace. Meetings should be lead by community-based organizations and academic professionals, as residents identified these sources of information as more "trustworthy" than traditional government. If the public is included in the CMS, they may be more likely to contribute to DWMA conservation, particularly if successes are celebrated in the community.

The Mojave Max program includes an educational program implemented by the DCP to target school-aged children and reinforce the importance of desert conservation. The PIE survey revealed that most residents feel positively about the Mojave Max program, and DWMA actions should build upon the current curriculum. Partnerships with local teachers must be fostered and units should be taught throughout the school year to familiarize students with desert conservation, which may be more effective than intermittent exposure.

Monitoring and Research. Extensive monitoring programs targeting covered species and habitat parameters will determine the current status of the desert tortoise and other covered species in the short-term and provide data to assess the effectiveness of CAs in the long-term. Without a baseline status for comparison, managers will be unable to assess if the existing actions are adequate or to identify trouble areas in need of further action.

Monitoring should focus on mapping the density and distribution of tortoises and other covered species as well as habitat extent and quality. Monitoring must be standardized among agencies for transfer of information and meta-analysis. Data should be compiled for all DWMA-related monitoring surveys and organized in a Geographic Information System (GIS) database.

Road Incursions. Misuse of roads has an overwhelmingly negative impact on the desert tortoise and is one of the most destructive threats in the Coyote Springs DWMA (TNC 2003). Casual OHV use should be deterred in the DWMA to reduce associated habitat degradation. Actions related to road use will have wide-reaching benefits for the desert tortoise and other covered species by minimizing disturbance to critical habitat.

Designating and rehabilitating roads and posting adequate signage will promote responsible road use and prevent new incursions, minimizing surface disturbance and facilitating recovery of desert washes and creosote-bursage habitat. This protection may promote native vegetation growth and provide food and cover for the desert tortoise and other wildlife. Soil crusts, delicate communities easily destroyed by frequent ground disturbance, may also recover, which will return a host of benefits to the system including soil stability and growth of native vegetation.

Invasive Species. Past grazing and other anthropogenic disturbances have introduced a number of exotic species into the Mojave Desert community. Managers must assess the current distribution of invasive species in the DWMA, particularly invasive weeds, in order to determine where to focus their efforts. Implementing ongoing weed surveys to establish the extent and severity of invasion and evaluating techniques to eradicate aquatic invasive species as they become available will improve the long-term ability to control and prevent new invasions.

Aggressive invasive species introduce a host of problems for the long-term protection of the desert tortoise and other covered species. Invasive weeds may offer low nutritional value for tortoises (Nagy et al. 1998) and may also increase the frequency of fire in a largely fire intolerant system (Brooks 2001). Other invasive species, such as tamarisk or crayfish, may compete with native species in spring systems (Krzysik 2004, pers. comm.). Controlling the spread of invasives will improve conditions for native vegetation, offer wildlife a more varied diet, and may reduce stress on native species competing with aggressive invasives. These benefits may foster tortoise recovery and may prevent additional ESA listings in the DWMA.

4.2.2 Level 2 Actions

Level 2 actions require a lower time, effort, and funding commitment than level 1 actions but may not benefit DWMA wildlife as widely as level 1 actions. Because they are readily implemented and do not require a substantial ongoing commitment, but do present a host of benefits for covered species, we recommend these actions receive a high priority. These actions include protective measures and restoration efforts. These actions should be implemented following level 1 actions.

Road/ROW Maintenance. The disruption of vegetation and take of species during ROW activities presents a potential threat to ongoing conservation efforts. Because ROW maintenance cannot be discontinued, we recommend instituting protective measures to minimize disturbance of habitat. Protective measures during ROW construction and maintenance may protect the desert tortoise and other covered species. Requiring road closures and limited maintenance activities during sensitive times (e.g., breeding or nesting) and modifying highway maintenance activities to avoid wildlife mortality would minimize the loss of sensitive species. Minimizing disturbance associated with ROW maintenance and construction may encourage timely recovery of the native community and reduce opportunities for exotic species invasion.

Restoration. Springs are one of the most degraded habitats in the DWMA due to outflow modification, nutrient loading, and invasive species. In this water-limited environment, perennial and intermittent springs provide indispensable water sources and support a number of covered species. The protection of this unique resource will ensure that quality habitat is available for the long-term persistence of covered species. Restoring surface flows, reducing nutrient loading, and reestablishing native vegetation will improve water quality and provide bighorn sheep, bats, amphibians, birds, fish, and other wildlife with quality spring habitat.

Prohibitive Events. The MSHCP recommended withdrawal of several activities within the DWMA, including, organized OHV events, mining operations, and the development of new ROWs. Negative impacts associated with these uses are not compatible with the fulfillment of CMS objectives. However, BLM observations indicate that permitted events in the ACEC may cause less impact than unauthorized casual use by the public, mainly due to BLM’s ability to require that the event be operated in a manner to minimize impacts and enforce stipulations associated with the event. Therefore, organized OHV events are currently authorized within the Coyote Springs ACEC. Such use is limited to a certain number of events and by the type of event. For instance, up to three non-speed events can occur in each ACEC during the tortoise active season between March 1 and April 1 and June 2 through August 15 per the LVRMP and programmatic BO. Outside the ACEC, events can occur throughout the year, in accordance with minimization measures required in the BO. Speed-based portions of OHV events are not permitted with the Coyote Springs ACEC.

For mining operations, material site ROWs are open to governmental agencies only, and they must be within 0.5 miles of the Federal highways listed in the LVRMP (BLM 1998, maps 2-12 and 2-13). Coyote Springs is segregated and withdrawn for locatable minerals, therefore no new mining claims are issued. Fluid mineral leasing is subject to timing, and there is no surface occupancy permitted. Salable mineral mining is restricted to material site ROWs issued to government agencies and they can only occur along the U.S. Highway 93 corridor as identified on LVRMP Map 2-12. Under the BLM's existing biological opinion, a maximum of 1,000 acres of desert tortoise habitat may be disturbed as a result of expansion of existing material pits, including both ROWs and free use permits, within desert tortoise ACECs (BLM 1998).

New ROW development should, when possible, be restricted to existing corridors. However, the needs of the communities within the DWMA cannot be overlooked. If new ROWs cannot be avoided when providing local communities with necessities such as power or water, then every precaution should be taken to minimize habitat disturbance and the managing agency for ROW development will be required to restore disturbed habitat to predisturbance conditions in temporary-use areas and portions of the ROW that can be replanted without affecting operation and maintenance of the ROW.

Fencing/Culverts. Remedying impacts of past actions thorough mitigation measures will promote habitat preservation and species recovery. Eliminating hazards to covered species will provide long-term protection and prevent negative impacts from livestock improvements or road mortality. Fencing and culverts would minimize mortality due to vehicle collisions while allowing passage across roadways, thus reducing the impacts of habitat fragmentation. The movement patterns of covered species should be monitored to identify where culverts should be located for optimal use, and the culverts should be monitored following installation to ensure their use by desert tortoise and other covered species. Existing hazards, such as livestock improvements, should be removed and alternative sources of open water provided for bats and other wildlife.

4.2.3 Level 3 Actions

Level 3 actions require a low time and effort commitment but do not pose a significant benefit for the tortoise and other wildlife. These are mainly policy actions and do not require a large commitment of funding or effort. However, these actions do not directly benefit the tortoise in the way that level 1 and 2 actions would. Restoration policies, requiring environmental reviews prior to development of new recreational facilities, protecting specific habitats or species, and maintaining procedures for the health and safety of the public may directly or indirectly benefit the tortoise.

In some cases, more information is needed (e.g., species distribution, geographical location of habitat) in order to develop a specific CA. These policies may be revisited following intensive monitoring efforts in order to develop specific actions. Because level 3 actions need information provided by level 1 or 2 actions, or are policies related to other actions, we recommend level 3 actions be pursued following the enforcement of level 1 and 2 actions.

4.2.4 Level 4 Actions

Level 4 actions are the lowest priority for implementation in the DWMA. Benefits from level 4 actions like acquisition of land or water rights do not warrant the massive expense. There is little private land in the Coyote Springs DWMA, and acquisition of this land is not likely to significantly benefit the tortoise or other covered species. Also, while outflow modifications have degraded springs, the benefit from the acquisition of water rights and restoring natural hydrologic flows is not likely to outweigh the substantial cost involved.

In lieu of exhausting budgets on these actions, a more beneficial expenditure would be to improve water quality and eradicate invasive species. Although development poses a major threat across the range of the desert tortoise, there are currently no major development projects being considered in the DWMA. The CSI property is outside DWMA boundaries and threats from this development are primarily related to human interactions. Consequently, we feel it would be unwise to expend valuable funds on land acquisition. Level 4 actions are not recommended; rather, we recommend allocating funds for more immediate needs such as enforcement, education, and monitoring.

4.3 Funding Sources and Staffing Requirements

Implementation of CAs will rely on considerable funding from a number of sources as well as a multitude of employees and volunteers. Major funding for DWMA CAs will be generated from three sources: (1) Transportation Equity Act of the 21st Century (TEA-21), (2) Clark County MSHCP, and (3) SNPLMA.

The TEA-21 was created to provide funding for transportation-related projects, environmental protection, and scenic preservation projects between 1999 and 2003. The act, reauthorized through 2009 as the Safe, Accountable, Flexible, Efficient Transportation Equity Act (SAFETEA-LU), authorizes the Surface Transportation Program, which supports transportation enhancements including environmental restoration. Additionally, this act authorizes the Recreational Trails Program, which generates funds for the maintenance and restoration of existing trails and construction of new trails. Currently, SAFETEA-LU is scheduled to expend an average of $41 billion per year programwide through 2009, including an average of $5.45 billion per year for the Surface Transportation Program and $60 million per year for the Recreational Trails Program (USDOT 2005).

The MSHCP estimates providing $1.65 million per year for the first 10 years and $1.35 million per year for the following 20 years to fund conservation projects in Clark County. MSHCP Section 10 funds are generated from mitigation fees ($550/acre) imposed by USFWS Section 10 incidental take permits. MSHCP Section 7 funds are produced from remuneration fees associated with projects occurring on Federal lands and provided for those projects specifically aimed at desert tortoise recovery.

From 2001 to 2003, MSHCP expended $5,250,391 to fund 29 projects for 14 agencies and contractors with Section 10 funds (BRRC 2004). Projects included law enforcement, habitat restoration, road inventory, and desert tortoise fencing. During this time, MSHCP also distributed $1,312,030 in Section 7 funds for seven projects with four agencies and contractors (BRRC 2004). Projects included burro removal, native plant nursery production, fencing, and upland restoration.

The SNPLMA, enacted in 1998, generates funds from the sale of BLM lands. Eighty-five percent of the proceeds from the sales are made available for four categories of expenditures: (1) acquisition of environmentally sensitive lands in Southern Nevada; (2) infrastructure on federally designated lands in Clark County; (3) park and trail development; and (4) MSHCP development. In 2001–2003, SNPLMA awarded Clark County $4,648,334, funding 22 projects with six agencies and contractors (BRRC 2004). Projects included plant and wildlife inventories, research, and development of a GIS database.

The MSHCP and SNPLMA distribute monies to a number of Federal and State agencies, as well as private contractors. According to the Clark County DCP 2001-2003 Biennial Report (BRRC 2004), the following agencies and contractors were awarded funding by the MSHCP and SNPLMA:

- Bureau of Land Management
- Clark County Desert Conservation Program
- Clark County Desert Tortoise Fencing Program
- Las Vegas Springs Preserve
- Michael Creathbaum
- Muddy River Regional Environmental Impact Alleviation Committee
- National Park Service
- Nevada Division of Forestry
- Public Information and Education Committee
- Southern Nevada Environmental, Inc.
- SNWA
- United States Department of Agriculture-Wildlife Services
- USFWS
- USFS
- The Conservation Fund
- The Nature Conservancy
- University of Nevada, Reno-Biological Resources Research Center

In addition to funding considerations, implementation of CAs requires additional staff, from volunteers to full-time staff. Achieving conservation goals will require multiple full-time officers patrolling DWMAs to ensure compliance with CAs. Rangers that conduct law enforcement patrols on BLM lands must be Law Enforcement Rangers. The Law Enforcement Rangers are typically at GS-11 pay grade. GS-11 Law Enforcement Rangers in southern Nevada earn pay between $51,972 and $67,567 per year (based on locality), plus additional authorized uncontrollable overtime, which can be up to 15% of their base pay. Habitat restoration, plant and wildlife inventories, and a number of other conservations actions demand a force of specialists, biological technicians and aides, and volunteers. A wildlife biologist will be needed to design and implement research and monitoring studies. A wildlife biologist may earn a GS-7 to GS-13 pay scale, equivalent to $34,149 to $72,035 per year (OPM 2005a, 2005b). Biological technicians needed to perform surveys earn a GS-4 to GS-7 pay grade, depending on experience and education, which is equivalent to $11.81 to $16.36 per hour initially (OPM 2005c). Biological science aides, typically undergraduate students seeking hands-on experience, can also be involved in surveys. Biological science aides typically earn a GS-3 to GS-4 pay grade, equivalent to $9.64 to $11.81 per hour (OPM 2005c). A GIS specialist implementing a GIS database to coordinate and disseminate information among agencies may start at a GS-9 pay grade ($41,772 per year).

One of the most critical CAs, public education and outreach, will require full- or part-time instructors to coordinate outreach programs both on-site and in local schools. Integrating desert conservation materials into existing programs in local schools can be carried out by local teachers, which will not require additional employees. A park ranger can be given educational responsibilities within the DWMA, including coordinating and performing educational programs.

The BLM, among other Federal agencies, has an extensive volunteer network. In 2001, the BLM program earned over one-million man hours in the United States, which is equivalent to

$2,617,322 (BLM 2001b). An excellent model for a community-based volunteer program is Friends of Red Rock, a force of over 500 volunteers in the Red Rock Canyon National Conservation Area who donated over 14,000 hours in 2001. This group manages the visitor's center, develops educational materials and programs, and donated $100,000 in 2001 for conservation projects (BLM 2001b). The development of a similar volunteer network should be investigated for implementation in the DWMA.

4.4 Human Impacts and Opportunities

Implementation of CAs may result in some inconveniences for the desert populace and public land users. Road closures and trail relocation will restrict access, and ROW rerouting may increase the cost of power transfer in some areas. Land acquisition will eliminate development opportunities in some areas and may disrupt mining operations. Locating saleable materials outside DWMA boundaries will increase costs associated with transporting these materials. Restricting highway maintenance activities and requiring sophisticated restoration techniques may also increase costs, particularly for Clark County taxpayers. Therefore, ROWs will be avoided in ACECs and will be allowed to occur only when no other reasonable alternative exists, provided sufficient minimization measures are taken.

However, CAs also provide a number of opportunities. Habitat protection and restoration activities will enhance the natural beauty of the desert, increasing its scenic and recreational value. Public outreach programs provide opportunities for community development and education and will enhance the value of recreational activities such as hiking and backpacking. Willing landowners will have the opportunity to sell their property for a fair price. Reestablishing native vegetation will return the system to a natural, infrequent fire regime, protecting the community from the threat of wildfires. The DWMA presents a unique opportunity for scientific research on restoration techniques, habitat enhancement, and maximizing the applicability of CAs.

5. CONSERVATION STRATEGY

The goal of this conservation strategy is to achieve recovery and delisting of the desert tortoise in support of the Section 10(a)(1) incidental take permit for Clark County, Nevada, by eliminating or minimizing threats to tortoise survival within the DWMA. In addition to the 49 existing CAs that need to be implemented and enforced under the MSHCP this CMS recommends an additional 12 CAs. The strategy requires establishing the current status of recovery efforts and baseline data, assessing and improving exiting CAs, organizing data for periodic review of the strategy under an adaptive management framework, and implementing a long-term research and monitoring plan.

5.1 Prioritization Criteria

Section 4.2 lists CAs developed from the suite of actions recommended in the MSHCP (RECON 2000) and other actions developed by TNC (TNC 2003). The implementation of these CAs is prioritized based on the relative time and effort required compared to the overall benefit to the DWMA. In this Section, we have developed and prioritized 12 additional actions that build on the existing base of CAs. These actions are ranked according to their ability to facilitate the development, implementation, or review of this CMS (Table 10). Long-term projects were given a low ranking, not because they are not viable and important actions, but because they require more than 10 years and coordination with other research scientists in order for results to be available for this CMS. These actions, if implemented in conjunction with existing actions, would represent a comprehensive management strategy to achieve CMS objectives, including the recovery of the desert tortoise.

These proposed actions involve three major themes: (1) establishing the current status of recovery in the DWMA, (2) addressing gaps in knowledge needed to develop, implement, and validate recovery actions, and (3) developing a long term research and monitoring plan (Figure 11). The strategy is organized by theme, with sub-themes described under each heading and specific projects prescribed for each sub-theme. While this CMS focuses on the desert tortoise as an umbrella species, the strategy presented in Figure 11 is intentionally general and may be applied to any covered species within the DWMA.

The first priority is to assess the current status of recovery efforts in the DWMA (see Table 9). This action is ranked highest because it is critical to immediate development and implementation of the CMS. This includes developing a comprehensive database and monitoring tortoises, habitat condition, and the spatial extent and severity of threats within the DWMA. The second priority is to address gaps in knowledge that will establish additional CAs or enable managers to assess the validity of the current strategy, including tortoise-movement research and evaluating the efficacy of CAs in addressing threats and improving habitat condition or tortoise survival. The last priority is to implement a long-term research and monitoring plan that would increase the tortoise biology and ecology knowledge base.

TABLE 10. Criteria for prioritizing recommended CAs.

Rank	Criteria
1	Action will facilitate immediate implementation of CMS.
2	Action will facilitate the immediate assessment of the CMS in minimizing impacts of threats on tortoise populations.
3	Action will facilitate the development of new CAs for integration into existing CMS.
4	Action will facilitate the review and assessment of the existing CMS under adaptive management framework.
5	Action related to long-term research needs to improve decision making within the adaptive management framework.

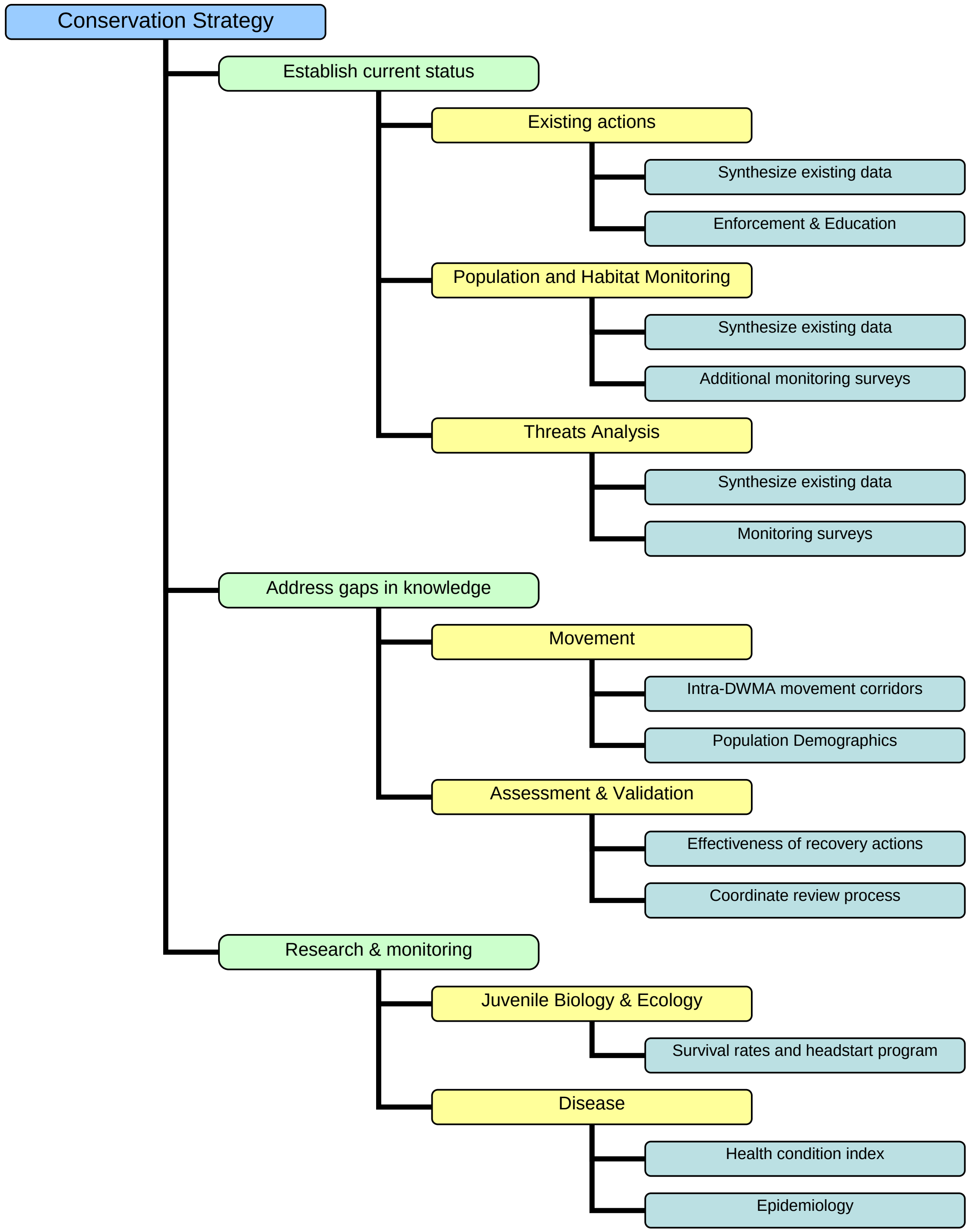

FIGURE 11. Outline of conservation strategy.

5.2 Priority Conservation Actions

The intent of this conservation strategy is to provide a straightforward, cost-effective plan to improve the population status of the desert tortoise so as to no longer require ESA protection. In addition, this CMS is designed to contribute to regional desert conservation efforts and to offer protection for covered species that occur within the DWMA. CAs for immediate implementation are presented as three separate priorities: (1) evaluating current recovery status and improving existing actions, which encompasses the need for baseline data on covered species and habitat condition; (2) addressing gaps in knowledge, which includes research needed to implement additional actions as well as validate and review the existing CMS; and (3) implementing long-term research and monitoring.

5.2.1 Current Recovery Status

In lieu of providing a host of new, costly actions to implement, it is imperative to establish the current extent of recovery efforts within the DWMA. In Chapter 4, existing CAs were summarized and prioritized for implementation in the DWMA based on the balance of effort by managing agencies and the potential benefit within the DWMA. Before new actions are recommended, three main questions that need to be answered are:

1. Where have CAs been implemented and to what degree?
2. What is the density and distribution of tortoises and other covered species and the condition of habitat within the DWMA?
3. What are the types, spatial extent, and severity of existing threats within the DWMA?

Currently, communication among agencies as to the degree to which CAs have been implemented is inadequate. While the Biennial Adaptive Management Report (BAMR) regularly updates the implementation status of CAs for each agency (e.g., initiated or completed), there is little information regarding the extent of implementation, and little spatial data is submitted, despite availability. The BAMR should, in the future, increase the detail included in update reports so that managing agencies may track the extent of implementation and spatial locations of current conservation efforts.

While monitoring of tortoises has been initiated, we are no closer to understanding the status of the population because there has been little integration or release of data collected over the past several years by the USFWS, and Biological Resources Research Center at University of Nevada, Reno (BRRC) (Tracy et al. 2004). Moreover, existing knowledge on the density and distribution of other covered species is nearly nonexistent. Finally, while there is substantial literature on threats to tortoise populations, there is little experimental evidence of direct impacts to tortoises or other covered species and limited understanding of the extent and severity of threats within the DWMA. To address the need for better coordination of monitoring and other recovery efforts throughout the range of the tortoise, the USFWS established the Desert Tortoise Recovery Office for the purpose of directing range-wide recovery efforts and population monitoring. The Desert Tortoise Recovery Office recently released a summary report on range-wide population monitoring results from 2001–2005. The range-wide monitoring program is designed to detect long-term population trends. However, density estimates from any brief window of time (e.g., 2001–2005) would be expected to detect only catastrophic declines or remarkable population increases. Therefore, following the first five years of the long-term monitoring project, the goal is not to document trends within this time period but to gather information on baseline densities and year-to-year and recovery unit-to-recovery unit variability. This information will also reflect transect-to-transect variability in observations as well as regional variability in detection functions.

Detailed knowledge of the implementation process and geographical location for each CA implemented will enable managers to effectively establish baseline data on a regional scale, as well as avoid duplicative actions or misuse of funds. Furthermore, regulations need to be enforced within the DWMA, which underscores the need for adequate law enforcement presence, and the public should be kept informed of conservation efforts in their community. Because proper routes of communication, monitoring, adequate law enforcement, and education are crucial to effective development and implementation of the CMS, we have given the subsequent actions the highest priority ranking in the CMS.

(Priority CA 1) Establish the extent of implementation and geographical location of existing CAs. In the MSHCP, numerous CAs are recommended to be implemented in the DWMA (see Table 9), including controlling vehicle access, eliminating livestock and feral animal grazing, enforcing regulations, and developing environmental education programs (RECON 2000). The DTRPAC estimated that only 44% of the CAs recommended by the USFWS in the Recovery Plan had been at least partially implemented (Tracy et al. 2004). Whereas the 2004 update for the BAMR indicated that many of the MSHCP's CAs had been "initiated," details on the extent of implementation or geographical location were not given. Furthermore, many actions lacked effectiveness monitoring and accountability to the MSHCP. In order to assess the status of conservation in the short-term and quantify the effectiveness of CAs in the long-term, we need a complete understanding of what actions are active, identified from both the Recovery Plan and the MSHCP, and where in the DWMA these actions have been initiated. Again, future BAMRs should help provide a mechanism for the managing agencies to track the status of implementation and spatial locations of current conservation efforts.

CAs are intended to protect Clark County's sensitive species, in particular, those species covered under the MSHCP. Protective measures are being implemented on a regional scale, and as such, conservation should be regulated on a regional scale. With multiple agencies around Clark County participating in conservation efforts, it will be important for managers to effectively communicate and disseminate information. The BAMR has initiated this communication, but the current strategy does not provide enough detailed information for DWMA managers. The MSHCP provides a centralized management unit to organize and store information on CAs throughout Clark County. We feel the BAMR strategy would be improved by requiring agencies to submit data on specific projects and geographical locations related to CAs in the DWMA.

The first priority is for managers to establish the degree to which recovery actions listed in Table 9 have been implemented in the DWMA through communication with participating agencies. The DTRPAC recommended "a coordinated, range wide effort…to assess the level to which Plan recommendations have been implemented within each DWMA" (Tracy et al. 2004). If managers know which actions have been initiated in the DWMA and which are being enforced, they can then assess existing actions and determine which resources are not adequately protected. From this analysis, managers can initiate an effectiveness monitoring program to evaluate if a particular action contributes to the recovery or preservation of species or habitat in the DWMA through the elimination of a threat.

It will also be important in the Coyote Springs DWMA to coordinate with private agencies assigned to environmental issues surrounding development of the CSI property. Development impacts on both the Mormon Mesa and Coyote Springs DWMAs could be severe. This property may offer high-quality habitat or unique habitat for DWMA-related wildlife, and managers should determine if the DWMA can serve as a refuge for displaced species and establish the location of areas of similar habitat for active protection. A HCP is being developed for the CSI property and should be reviewed for consistency with the objectives of the CMS to ensure that impacts from development will be adequately mitigated in both the Mormon Mesa and Coyote Springs DWMAs.

To summarize, managers need to define the extent of projects initiated to protect the DWMA in order to plan effectiveness monitoring programs and determine where additional actions are needed, both within the DWMA and on surrounding land. This action is given the top priority because it directly impacts the development and implementation of other CAs.

(Priority CA 2) Ensure adequate law enforcement presence through analysis of available spatial data and coordination with agency personnel. Many CAs listed in Table 9 and provided here will be of no benefit in the DWMA if not enforced. Deterrence of negative human interactions such as littering, vehicle misuse, physical damage to vegetation or wildlife, and pet tortoise release requires an adequate law enforcement presence. Officers must be able to enforce regulations through the use of fines and citations.

An adequate law enforcement presence should be able to patrol the majority of DWMA land area each week, with regular patrols in high-use areas. One officer is not sufficient to patrol four DWMAs county-wide. Officers should be capable of patrolling each DWMA regularly to identify and quickly remedy abuses not consistent with conservation efforts. This action is currently being initiated by the BLM, and effort should be made to monitor the effectiveness of current law enforcement presence. If additional full-time officers are too costly, managers should pursue the possibility of hiring part-time, seasonal officers during peak periods (e.g., holidays and weekends). While the price for adequate law enforcement may be high, CAs cannot be effective if they are not enforced.

(Priority CA 3) Continue to develop and expand the Mojave Max program to reach recreational user-groups, NDOT construction and maintenance workers, the desert community, and students in secondary grades (7 to 12); initiate monitoring to establish the effectiveness of materials. The 2004 BAMR update indicates that all participating agencies have initiated development of educational materials, including brochures and signs. While these materials and programs may effectively reach children and public land users, outreach and education measures must be monitored to ensure their effectiveness in capturing the target audience. In combination with enforcement of protective measures, education is an effective way to reach a large audience and educate the desert community about their natural resource. The infrastructure for a county-wide program already exists, which greatly reduces the expenditure on outreach, and this action will reach the widest audience, which justifies the high priority assigned to this action.

In response to the DTRP recommendation for the implementation of educational programs and facilities (USFWS 1994a), Clark County DCP developed the Mojave Max program as a tool to educate the public about desert conservation and the MSHCP. The program provides an excellent opportunity to teach current and future land users to respect their natural resources. This successful outreach program should be expanded to include details specific to conservation efforts in the DWMA. Additional materials developed for the DWMA should tier off of this program.

Land managers should develop recreation-specific information brochures detailing sustainable use of the DWMA to distribute at information booths at desert recreation areas (e.g., Red Rock Canyon National Conservation Area, LMNRA and local visitor and tourist bureau and welcome centers). It is important that materials convey a positive message (e.g., where recreational opportunities exist, not where they are prohibited) to promote responsible recreation in the DWMA.

Informational signs and kiosks along high use trails and at DWMA access points would also inform recreation users about regulations and restrictions. The estimated cost of a public outreach campaign is $20,000, while signs and kiosks range from $25 per sign for trail signs and $5,000 per kiosk, plus installation and maintenance (estimated at $5,000/year) (BLM 2004c). Given the cost, managers may consider installing a single kiosk at a central location, such as the visitor's center, and supplementing the kiosk with educational signs along trails.

Informing the local community about advances in desert wildlife conservation will reinforce the concept of the DWMA as a wildlife reserve, and evidence of success may minimize misuse of the DWMA by public land users. To distribute this information, updated conservation information should be included in public service announcements, published in local newspapers, and aired on local radio and television stations. An extensive public outreach campaign can range from $30,000 to $60,000 (BLM 2004c). The project website is a resource that can be used to inform the community, and its existence should be well-publicized.

Sensitive wildlife training should continue to be required for all ROW maintenance and construction workers working within the DWMA. Working in the DWMA poses a direct threat to the tortoise and other covered species, and training is needed so this impact will be minimized. Currently, all ROW maintenance personnel are given desert tortoise training as required under the pertinent biological opinion for the project and a stipulation of their ROW grant. Activities operating under the MSHCP permit should also include desert tortoise/sensitive species training to minimize impact to the species. Training should be led by monitoring experts and should teach workers what to look for and avoid when working in sensitive areas. NDOT and other agencies may need to hold only one session per year for new employees.

The curriculum and intensity of the existing (K-8) Mojave Max program should be expanded to include a curriculum in secondary school. The existing program is an excellent introduction to conservation education at young ages and should be expanded to expose high school students to more advanced concepts in ecology and conservation biology. This program offers an opportunity to introduce advanced ecological concepts using local ecology while reinforcing the importance of responsible use of natural resources.

Students in upper grades could follow the progress of conservation management to reinforce the link between CAs and tortoise recovery. While an education coordinator may earn $85/hour, and a full-time biology teacher an annual salary upwards of $30,000, the infrastructure for the program already exists. Expanding it to high school classrooms by creating partnerships with local secondary teachers may need only an initial expenditure to create the curriculum.

An additional way to involve older students, such as local community college and high school students, is to have them participate in monitoring surveys. Long-term monitoring will require manpower, and at least some studies have suggested that inexperienced volunteers, when properly trained, can be effective surveyors (Freilich and LaRue 1998). Using students to conduct surveys will provide older students with valuable first-hand field experience while immersing them in scientific research. The recommended use of distance sampling may lend itself to the use of inexperienced surveyors because in this method attention to survey technique is more important than observational ability (Kryzsik 2004, personal observation). Encouraging relationships between current and future land users and the biological community may promote the responsible use of the DWMA. However, results of the 2001–2005 distance sampling indicate that long-term, experienced crews have better, more consistent survey results (ability to detect all tortoises along the line). This would indicate that it might be better to spend money on long-term crews than using inexperienced or volunteer surveyors.

Many of these recommendations have been initiated in Clark County, but lack of detailed communication between the MSHCP and participating agencies is again inadequate. Detailed summaries of current education materials, including spatial information if available (e.g., locations of education kiosks and signs), would allow managers to establish if all areas of outreach are being utilized. Also, monitoring (e.g., questionnaires) should establish which outreach programs are most effective and which need more attention to fully impact land users and the local community.

(Priority CA 4) Establish monitoring program for covered species and habitat and develop a database to organize survey data. The DTRPAC was formed to assess the efficacy of the USFWS 1994 recovery plan based on new research and available information (Tracy et al. 2004). According to the report, "implementation of effective management strategies to recover the Mojave population of the desert tortoise requires an accurate characterization of population structure, threats to population persistence, and the effectiveness of protective measures" (Tracy et al. 2004, p.19). The 2004 BAMR update suggests that some monitoring of some covered species has been initiated, and managers should acquire the results of surveys completed under the MSHCP, by the BRRC, USFWS, USGS, or by other land-management agencies to estimate the distribution and density of tortoises and other covered species in the DWMA based on current knowledge. Without baseline data establishing the existing characteristics of population density and distribution and habitat characteristics (type, vegetative cover) in the DWMA, managers will not be able to effectively implement CAs or monitor recovery progress. Many covered species do not have established monitoring programs, and very little is known about their distribution and abundance. Monitoring of covered species should begin immediately if the DWMA is to serve as a refuge for MSHCP covered species in addition to mitigating for the USFWS incidental take permit.

A long-term monitoring program for the desert tortoise requires development (Appendix F). Based on the analysis in this conservation management plan, traditional empirical abundance estimation methods (e.g., mark-recapture, distance sampling) are technically and economically not feasible for rare populations surveyed on landscape and regional scales. Innovative new technologies are in order, based on occupancy estimation modeling that is guided by computer intensive methods to assess, select, and generate sampling sites (Appendix F). We recommend continuing monitoring surveys coordinated by the Desert Tortoise Recovery Office, the BLM, and involving local students as part of a scientific fieldwork curriculum. Surveys should employ a standardized data collection method, such as line transect distance sampling stratified by habitat type or plant community (see Krzysik 2002 for example of landscape survey methods), and surveyors should use Global Positioning System (GPS) to assign UTM coordinates to tortoise signs (live tortoise, carcass, burrow, scat). Surveys should be scheduled to coincide with tortoise activity periods, March to October, excluding the hottest summer months when temperatures are above 103 degrees Fahrenheit (generally June 2 through August 15) to maximize tortoise sighting potential outside of burrows. Tortoise monitoring surveys should be coordinated with surveys of vegetation, habitat condition, threats analysis, and/or surveys of other covered species to test the hypothesis that tortoises are an adequate focal species. That is, CAs that protect the desert tortoise also protect other covered species in the DWMA. Surveys of invasive weeds should be initiated, if not already, to identify problem areas for restoration and eradication actions. A cost estimate for distance sampling is $75,000 per year (BLM 2004c) and may decrease if student volunteers are employed at per diem rate of $31 for meals and incidentals (OPM 2005d). Monitoring transects are inherently expensive, but it is the only method of estimating population and habitat trends in the DWMA. This information is critical to implement, assess, and update this CMS and to enhance protection for the desert tortoise and other covered species consistent with the DTRP and MSHCP. Additionally, information gathered from presence/absence and clearance surveys that are collected for projects is underutilized. Currently, data collected for projects, like a ROW, are not used for population monitoring. This data may be useful and its value should be analyzed to supplement tortoise survey and population-monitoring data.

DWMA managers should pursue the use of remote sensing and satellite imagery to establish the spatial distribution of habitat types within the DWMA. Habitat distribution can play a major role in determining distribution of DWMA populations and can often be more easily monitored than individual species. Monitoring habitat distribution and condition via remote sensing will complement more traditional monitoring surveys and may offer new, cost-effective techniques to track conservation progress.

Both SPOT imagery and TM Landsat imagery have been used to quantify vegetation cover and other unique features (e.g., riparian areas and springs). SPOT imagery is also useful to track vegetation changes over time but may have limited value in the Mojave Desert because the sparse distribution of vegetation may interfere with the ability to define specific community types (Jensen 2000, but see Wallace et al. 2000). Satellite imagery may also be used to track changes in Pahranagat Wash. The wash represents the headwaters of the Muddy River, along with the Meadow Valley Wash, and may be the only near-surface or perennial surface water source in the DWMA. A remote sensing specialist may earn between $16 and $30 per hour depending on experience (OPM 2005c). Imagery cost estimates can be expensive, ranging from several hundred to several thousands of dollars, but will only have to be done approximately every five years due to the slow-growing nature of desert vegetation.

Managers should consider gradsect sampling (Gillison and Brewer 1985; Austin and Heyligers 1989) to describe vegetation characteristics of habitat types, ground-truth image surveys, and quantify changes in vegetation in high biodiversity areas. In gradsect sampling, transects are selected to contain a high environmental gradient (e.g., temperature, elevation, precipitation), which better describes the full range of biotic variability. Because implementation of specific actions demands extensive monitoring, it may be valuable for managers to explore efficient monitoring techniques and to investigate multiple measures of conservation success. This sampling design has been shown to minimize cost and effort while maximizing sampling efficiency (Wessels et al. 1998). Transects should be selected to cover the greatest variability in elevation, temperature, and precipitation (based on current values) and can be selected for ease of accessibility to reduce cost. Transects should include areas in both the Pahranagat and Meadow Valley Washes. Sampling data should include measures of species occurrence (presence/absence), frequency (probability of occurrence), and cover (proportion of ground occupied by vertical projection).

An effective monitoring plan is one of the most crucial items in this CMS (Appendix F). This CMS represents a platform for conservation in the DWMA, from which new, detailed CAs will be developed and implemented based on the results of monitoring. Not only will managers be unable to implement specific actions without monitoring, they will have no capacity to assess the effectiveness of actions in preserving covered species and habitat within the DWMA. Thus, they will not know if the objectives of this CMS are being achieved without sufficient monitoring to provide data for analysis. Because the ability to implement and evaluate CAs depends directly on monitoring, this action is given a top priority in this CMS.

(Priority CA 5) Establish the spatial extent, frequency, intensity, and temporal variability of threats to covered species. According to the Desert Tortoise Management Oversight Group, the Coyote Springs DWMA relative threat ranking has increased since 1994, from 3 to 4 out of 5 in 2003 (Tracy et al. 2004). Minimizing or eliminating anthropogenic threats that contribute to habitat degradation in the DWMA, such as vehicle misuse, grazing, and development, is the primary focus of actions presented in Table 9. In order to effectively prioritize CAs and develop actions to specifically reduce a particular threat, we must have knowledge of the extent and severity of threats in the DWMA. However, threats specific to the Coyote Springs DWMA have not been adequately characterized (TNC 2003). In order to implement specific actions to eliminate threats and safeguard populations of covered species, managers need to recognize the spatial extent, frequency, predictability, and intensity of threats in the DMWA (Tracy et al. 2004). Existing research and monitoring results related to the characterization of threats within the DWMA should be collected and new methods of assessing the extent of threats should be investigated.

Managers should begin monitoring human impacts in the DWMA immediately. In combination with other monitoring programs, line distance surveyors can document signs of degradation, such as vehicle mortality, trespass cattle, littering, illegal collection, and OHV tracks outside of designated roads and trails. Surveyors should also characterize the distribution of invasive weeds such as red brome and Mediterranean grass during vegetation transects or remote sensing studies.

Law enforcement personnel should submit quarterly and annual reports summarizing enforcement activities and disturbances discovered during patrols. Currently, law enforcement officers funded by the CCMSHCP submit quarterly and annual reports, although the names and identities of the parties involved are removed for their privacy. Data can be compiled from citations as well as anecdotal evidence of human interactions (e.g., dump sites, violated animals, OHV tracks). It is important to the development and implementation of this CMS that the extent and severity of existing threats are adequately characterized.

If threats to covered species are not minimized within the DWMA, the objectives of this CMS will not be met. However, in order to address hazards, managers need to know which threats are the most disturbing and where threats are the most prevalent. Because the implementation of additional actions will be generated from this CA, we have given the analysis of threats a top priority in this CMS.

(Priority CA 6) Continue development of a quantitative database to synthesize existing data and direct monitoring programs, and to track changes in population distributions, habitat condition, vegetative cover, and threats. Research has shown that "recovery tasks and monitoring were significantly more likely to be implemented for plans with a recovery coordinator or committee and a centralized recovery database" (Tracy et al. 2004). All data collected by BLM, USFWS, other agencies, consultants, and private institutions needs to be contained in a single location and placed in a computer database, including originals or copies of the actual field data collected. High-quality control on data entry and revalidation and database management are required. These data are very valuable because of their historical content, but they require innovative data analyses methods to extract the information required. A CMS database, which may be coordinated with the MSHCP database, will organize and store results of monitoring data, including site-specific baseline measures (e.g., miles of authorized/unauthorized roads and trails, number of active mining operations, number of springs, miles of fencing, and traffic levels on primary and secondary roads), and the results of habitat and population monitoring. The database should also be used to track the implementation of CAs and monitoring surveys region-wide.

Managers can access this database to analyze changes in the distribution or density of covered species, habitat characteristics, or physical parameters (e.g., precipitation, soil moisture). The database will also allow mangers to perform queries to assess the impacts of specific CAs on different parameters to determine which actions are successful and which actions need adjustment. Technicians should coordinate with other Federal, State, and local agencies to capture information regarding both local and regional recovery efforts. A comprehensive database will be invaluable during strategy review to assess the status of recovery efforts into the future. Annual salary for GIS database support is approximately $40,000 per year (BLM 2004c), but cost may be reduced if folded into current MSHCP GIS database.

The quantity of CAs being implemented and volume of monitoring data required demand a comprehensive database to track the status of conservation efforts. Without a centralized unit to organize and store data, managers will be unable to easily assess the current status and make timely decisions regarding the development and implementation of new actions. This action has been given a high priority because a database is central to the implementation of this CMS.

5.2.2 Gaps in Knowledge Base

Priority actions described in this Section include studies to identify potential alternative recovery success indicators and the development of a strategy to review the status of recovery efforts. Notably, there is no research currently being done to assess the effectiveness of existing CAs, and virtually nothing is known about tortoise movement, which may lead to new CAs aimed at restoring and maintaining natural movement corridors. Actions targeting these gaps are given high to moderate priority because this information is needed in order to implement specific actions and enable managers to review the CMS in an adaptive management scenario.

(Priority CA 7) Investigate alternative indicators of tortoise recovery. The ability to assess conservation success is compromised due to a lack of quantitative measures to evaluate trends in tortoise populations, as well as other covered species (Tracy et al. 2004). The desert tortoise is a long-lived species with delayed sexual maturity that spends much of its life in burrows, complicating detection and monitoring (USFWS 1994a). These characteristics also make it difficult to evaluate the effectiveness of CAs or achievement of objectives because tortoises may be slow to respond. Consequently, managers should pursue cost-effective alternative indicator metrics to quantitatively assess and monitor tortoise populations, habitat conditions, and trends.

Suitable species used as alternatives would possess similar habitat and vegetation requirements. Indicators must respond more quickly to change than tortoises and may include trends in threat intensity (requires baseline knowledge), alternative species or community measures, habitat characteristics (e.g., soil moisture or composition, presence of preferred forage), or a combination of factors.

Surveyors should coordinate tortoise monitoring with vegetation and habitat characteristic monitoring, along with the collection and analysis of existing precipitation, soil, and vegetation data to assist in establishing viable surrogate indicator metrics. A comprehensive database will complement this action by allowing access to a wealth of monitoring data for cross-referencing. Remote sensing and GIS technologies can be used to compare the density and distribution of tortoises with soil, microclimate, and vegetation characteristics, or with the distribution of other species (e.g., covered species monitored in the DWMA).

In order to achieve the directives of this CMS, managers must have a reliable measure of conservation success. The tortoise may not be the most effective measure of recovery because it responds slowly to change, and more valuable alternatives may exist. Alternative metrics may offer a more opportune evaluation of conservation success in the DWMA, and the pursuit of alternatives should be given a high priority.

(Priority CA 8) Establish a protocol for assessment and validation of the CMS through effectiveness monitoring, regular updates, and hypothesis-based experiments. Monitoring the progress of the CMS and responding to the need for new approaches are key components of the adaptive management framework. To achieve the goals of the CMS, managers must be able to quantify the impacts of CAs on covered species and identify areas that need adjustment. Baseline data and periodic monitoring are needed for comparative analysis, which will evaluate if the DWMA is adequately protected. To this end, an effectiveness monitoring program should be established for each CA to monitor its impact on covered species as well as any potential alternative indicators.

Monitoring the value of CAs requires hypothesis-based studies that measure response variables (e.g., community composition, vegetation cover, tortoise abundance, mortality rate, reproduction) under experimentally controlled conditions. Some recovery actions could be implemented in an experimental framework and appropriate response variables measured to determine the effectiveness of those actions. Studies should employ a scientific design to compare control (no action) and experimental (action) plots, or use a Before-After-Control-Impact (BACI) design (Smith 2002) to compare response variables before and after implementation of recovery actions. Ideally, experimental designs should include multiple plots to replicate the experiment, providing greater statistical power in analyzing the data (Mead 1990).

The need to better understand the capacity for CAs to diminish threats may require establishing "experimental management zones" where prohibited activities are allowed in an experimental context (Tracy et al. 2004). Experimental management zones, which should not exceed 10% of the size of the DWMA, control the research conditions. To maintain the integrity of the DWMA and preserve conformance with the RMP, locations for the experimental management zones should be selected within the district, but outside the DWMA in areas where the type and highest intensity of use could be authorized. For instance, to assess the effectiveness of restricting OHVs to designated roads, an experimental zone may be divided into 12 equal sized plots (e.g., 25 m × 25 m each), where unrestricted OHV use is allowed in 6 of the 12 plots and OHV use eliminated from the other 6 plots. Treatment (OHV or no OHV use) should be randomly assigned to each plot. Analysis of biological parameters (e.g., plant community composition, burrow damage, percent vegetative cover, soil characteristics, tortoise mortality) compared between the two treatments will indicate the effectiveness of OHV off-road restrictions. Similar research studies can determine the impacts of grazing, construction and maintenance activities, disease, invasive species, and predation and the effectiveness of various actions designed to reduce these impacts.

Because of the nature of the studies and the biological characteristics of the desert tortoise, this research will be a long-term project. However, results of these studies will provide land managers with data needed to assess the validity of the existing CMS and develop an effective plan. The necessary study duration may vary depending on the action and response variable; long-term studies will be likely, given the life history of the tortoise (Tracy et al. 2004).

(Priority CA 9) Schedule regular CMS review and updates. Finally, a timeline for strategy review and updates should be developed to take advantage of research and monitoring results as they become available. Ecological systems are in constant flux as they respond to natural and anthropogenic disturbances. This, combined with the paucity of information currently available, requires a CMS to be adaptive in nature to respond to changes in the physical environment and in species' populations. This CMS must be revisited on a regular basis to ensure that the strategy effectively meets its objectives.

To incorporate the data and knowledge that has been made available since the start of the development of this CMS, along with the information from the upcoming release of the update for the 1994 DTRP from the Desert Tortoise Recovery Office, the first revision of this CMS should begin upon the release of the update for the DTRP. The CMS should then be reevaluated approximately every five years after the completion of the first revision. Updates should take full advantage of the current existing information available at the start of the revision process, the comprehensive database, including analysis of threat severity, trends in covered species populations, and hypothesis-based experiments, such as those described above.

An interagency data transfer workshop should be held approximately each year or as deemed appropriate in pursuit of communication and dissemination of information among land management agencies as well as provide for the formal submittal of data to the comprehensive database.

A CMS review workshop should be held approximately every five years after the initial revision to the CMS update in coordination with the Clark County DCP, BLM, NPS, USFWS, and other Federal, State, and local agencies. It is anticipated that the revision process will require two years from the CMS review workshop to the completed revised CMS. This CA is given high priority because by adapting the existing CMS using the best available scientific data to evaluate the effectiveness of recovery efforts, managers will craft the most successful strategy and implement the best suite of actions to ensure that the objectives presented herein are met.

(Priority CA 10) Pursue resources to investigate movement patterns and demographic characteristics of desert tortoise. "The paradigms of population/metapopulation dynamics need to be re-evaluated. This may require explicit experimental research to dissect the driving ecosystem processes important to long-term persistence of desert tortoise populations or metapopulations" (Tracy et al. 2004). Tortoises are typically patchy in their landscape distribution (Duda et al. 2002; Krzysik 2002), particularly in a disturbed and fragmented landscape (Krzysik 1997). If, as the DTRPAC suggests, tortoise distribution represents a metapopulation structure, facilitating movement among patches will be critical in maintaining long-term recovery. Dispersal of tortoises among patches maintains heterozygosity and can allow recolonization of patches negatively impacted by site-specific disturbances (e.g., fire) (Meffe and Carroll 1997). Identification of local and regional tortoise movements can also disclose underlying source/sink dynamics and indicate crucial movement corridors for conservation. In order to identify key sites among DWMAs to maintain connectivity, managers must implement a monitoring plan to uncover patterns of tortoise movement.

To allow natural movement of tortoises within and among DWMAs, preservation of spatial linkages among distinct patches may be as important as the protection of patches themselves. In order to maintain regional tortoise populations over the long term, natural movement corridors should be identified and restored to predisturbance conditions. Natural corridors of movement between the Mormon Mesa DWMA and the Coyote Springs DWMA, as well as between Coyote Springs DWMA and the DNWR should be identified and maintained. A narrow strip along S.R. 168 between the Arrow Canyon Range and the proposed CSI development is the only likely corridor for movement of tortoises between the Mormon Mesa and Coyote Springs DWMA. This corridor is particularly important because it links the Coyote Springs DWMA and DNWR in the west with conservation areas in northeast Clark County as well as Utah and Arizona. Particular attention should be devoted to monitoring use of this corridor by tortoises and other wildlife and ensuring that future development does not interfere with movement.

In conjunction with tortoise monitoring surveys, managers could employ techniques (e.g., mark-recapture or radio telemetry) to track patterns of tortoise movement and dispersal within the DWMA, particularly movements among high- and low-density patches and along regional movement corridors. Radiotelemetry on a limited number of desert tortoises may also provide useful data regarding reproductive processes, home ranges, pattern of burrow use, and the accuracy of distance estimations of burrow/tortoise ratios in desert tortoises within and surrounding the DWMA. While mark-recapture monitoring is expensive, even limited monitoring during tortoise activity periods can relay useful information on the movement patterns of tortoises. Coordinating this type of research with local graduate programs may be one cost-effective option. In addition, managers should pursue radiotelemetry or mark-recapture experiments on other covered species if funds allow, particularly those species found to be adequate surrogates for tortoise recovery.

This CA is given a moderate priority for implementation in the DWMA. The previous nine CAs are more pressing at this time, but following their implementation, a research program to identify tortoise movement patterns should be pursued. The insight into tortoise demographics and movement patterns provided by this research will allow managers to focus efforts on key areas for long-term maintenance of tortoise populations through the installation of mitigation measures (e.g., fencing, culverts) to sustain movement.

5.2.3 Long-term Research and Monitoring

Conservation biology is often called a “crisis discipline” because managers are forced to make quick decisions and implement regulations without a complete understanding of the system (Meffe and Carroll 1997). In addition to the high priority conservation recommendations stated above, there are a number of avenues which require further investigation couched in a long-term research and monitoring plan. Immediate research needs include juvenile tortoise ecology and biology and the prevalence of disease in the DWMA. These actions are given a low priority and should be pursued only after other actions have been implemented. That is not to say, however, that the information provided by these actions is not important to the overall recovery effort.

(Priority CA 11) Pursue research on juvenile tortoise biology and ecology. Tortoises have a prolonged juvenile life stage because of their delayed sexual maturity, yet comparatively little is known about the biology and ecology of juvenile tortoises (Tracy et al. 2004). The lack of research on juvenile age-classes represents a significant gap in the knowledge base relevant to tortoise recovery (Tracy et al. 2004). We recommend developing long-term research studies to identify the natural history parameters and ecological requirements of juvenile and hatchling tortoises, survival rates, and how they relate to population/metapopulation viability and persistence. If the contribution that juvenile age classes give to the long-term stability of the population is understood, measures such as headstart programs may be explored to ensure that vulnerable age classes are protected.

Headstart programs, in which tortoises are protected from predation and fed highly nutritional food in hatcheries, have experienced some success in California (BLM 2004c) and Arizona (Brooks 2005). The program represents a unique opportunity for tracking individuals after release to determine patterns of movement, survival, disease transmission, foraging and shelter seeking, and juvenile social behavior (Hazard and Morafka 2002). To quantify survival rates and dispersal in an experimental setting, we recommend radio-tracking head-started juveniles after release. Juveniles can also be released into experimental plots inhabited by adult tortoises to identify if juveniles have a behavioral impact on adult tortoises.

(Priority CA 12) Pursue research on prevalence of disease among covered species in the DWMA, particularly the desert tortoise. Disease has been a prevalent issue throughout the tortoise’s range, but little is known about the epidemiology of tortoise diseases and no direct cause–effect relationship between disease and tortoise die-offs have been established (Tracy et al. 2004). URTD and, to a lesser extent, cutaneous dyskeratosis, have been linked to declining tortoise populations. However, currently, the primary action taken to prevent disease is to isolate or kill supposedly infected individuals, despite our inability to adequately diagnose an infected tortoise (Tracy et al. 2004). The DTRPAC suggested “refocusing the general approach to research on disease, treating it as part of a network of threats to tortoise populations, which, because of negative and positive feedback loops to other threats, cannot be addressed effectively without reference to the threats network” (Tracy et al. 2004). If disease poses a major threat to species within the DWMA, techniques to prevent invasions and control its spread will be needed.

Rather than focus on isolating individuals, we should consider the extent and severity of disease, and devote research funds identifying key aspects of the pathology and epidemiology of URTD. These research studies should be aimed at recognizing, diagnosing, and treating URTD. We recommend developing, improving, and extending diagnostic tests. This includes developing less expensive and more field-portable testing. DWMA managers should coordinate with epidemiologists, population biologists, and other agency managers to disseminate information regarding disease and desert tortoises and ensure that all important information is made accessible to researchers.

Also, the epidemiology of disease is not well understood, for instance, it appears that the effects of URTD are most damaging to tortoises experiencing stress from other causes, such as nutritional deficiency, but a link between individuals and population dynamics has not been established (Tracy et al. 2004). We recommend establishing a health condition index (e.g., nutritional status, habitat conditions, physiological response to drought and other threats) by which the current health status of a tortoise can be assessed and compared among other individuals (Tracy et al. 2004). This can be coordinated with long-term monitoring efforts and should be a cooperative effort among agencies in charge of tortoise conservation in the Mojave Desert. A health condition index can facilitate the development of clear standards to determine whether individuals in a population are healthy and/or stressed and can provide an accurate health status of the tortoise population (Tracy et al. 2004).

6. IMPLEMENTATION PLAN

This section outlines the implementation plan for the recommended CAs. The dates and time schedule were developed based on the assumption that funding and staff capacity is in place to implement the recommended CAs. Realistically however, funding and staff resources will most likely need to be established for many of the CAs. As such, this section is meant to act as a guide representing the recommended consecutive steps to be followed for the implementation of the CAs based on the knowledge that was available at the start of the development of this CMS. As additional information is collected and analyzed and/or funding and resources fluctuate, priorities may shift, requiring some adjustment in the CAs and their corresponding implementation ranking.

The top ranking CAs were ranked with the highest priority for implementation. . These include actions that will facilitate implementation of the CMS, and thus are of immediate consequence. Beginning in June 2007, Clark County DMWA managers should coordinate with other land management agencies to synthesize and integrate data regarding (1) the current status of recovery implementation, (2) recent tortoise survey results, and (3) information about potential threats in the DWMA. Additional enforcement officers and educational and outreach programs should be implemented in summer of 2007. Educational programs for grades 7 to 12 should be implemented during the 2008–2009 school year.

Monitoring of tortoise distribution and density, vegetation type and cover, habitat condition, and potential threats should begin in spring and continue through October 2007 (tortoise active period). This monitoring should continue annually from March to October until 2010, and then biennially until at least 2026. Initially, monitoring should focus on establishing a baseline for data comparison. Later, monitoring should be used to detect trends in tortoise populations, habitat conditions, and the extent or frequency of threats.

A comprehensive database to store and manage data should be an implementation priority and development should begin in June 2007. This database will serve to manage information gathered from coordination by approximately December 2007.

Second-tier actions, which will facilitate the assessment of the existing management strategies, are also ranked for immediate implementation. Human impact monitoring should begin and be coordinated with other tortoise and threat monitoring and should be recorded by enforcement personnel during patrols beginning in June 2007, or upon hire. The need for alternative indicators, given the inherent difficulty in monitoring tortoises, is also a high priority. These indicators will allow managers to focus monitoring effort on those parameters most likely to provide a reliable sense of recovery success and will be used during CMS reviews to assess the CAs effectiveness. This research and monitoring should begin in the tortoise active season following CMS approval, March 2008.

After the existing recovery status and baseline biological data is known, third-tier actions will facilitate the development of additional actions. Tracking desert tortoises is not an immediate need but should be done before the first CMS review. It is recommended that the research begin approximately March 2008 and it could be done in conjunction with other tortoise monitoring surveys.

Fourth-tier actions are directly related to the review process, which will not begin until after a baseline is established. However, these actions require a sufficient time period to capture the information that will be needed during reviews. Law enforcement progress reports should be implemented in the first quarter after officers are hired and trained, suggested in December 2007. The first annual report would be submitted in December 2008. Establishing experimental management zones will require extensive knowledge of the DWMA ecosystem and cannot be implemented until after baseline monitoring has been completed. To provide at least one tortoise active season prior to CMS review, it is recommended that the research be implemented on threat impacts in experimental management zones beginning in March 2009.

It is important to the overall success of the conservation plan that funding and effort be devoted to those actions that will immediately affect the development, implementation, or review of the CMS prior to addressing long-term research needs. Consequently, the lowest priority actions for implementation are long-term research and monitoring projects. The data resulting from this research will be valuable for long-term tortoise conservation but do not represent an immediate need. Establishing a health condition index is the highest priority of these actions and will require long-term monitoring, which can be coordinated with ongoing tortoise monitoring beginning in March 2008. Other research projects, including juvenile ecology and URTD epidemiology, will be valuable in later reviews and should be implemented, with available funding, beginning in March 2010, at the earliest.

6.1 Timeline for Strategy Review and Assessment

Adaptive management is a “flexible, iterative approach to long-term management of biological resources that is directed over time by the results of ongoing monitoring activities and other information” (RECON 2000). In this manner, science and active management are linked, and a more complete and effective conservation strategy can be developed by learning from the outcomes of the management process (Halbert 1993). The implementation of the adaptive management process for the CMS is based on that described in the MSHCP (RECON 2000).

The USFWS Desert Tortoise Recovery Office may choose to take the lead in analyzing the results of research and monitoring data, which would maximize the integration of scientific data into the decision-making process. This data would include results of tortoise monitoring, threat monitoring, research conducted to experimentally assess the effectiveness of CAs, and other research conducted in the DWMA or by other research scientists. Based on analysis of trends in tortoise populations or other defined indicator metrics, relative effectiveness will be assessed of the current strategy, with possible alterations of the current management strategy to better meet the objectives of the CMS.

Based on this review, the CMS will be continually revised to produce the most effective plan over a 25-year timeline with strategy review and updates approximately every five years after the initial revision. An initial revision is recommended given the lack of data supporting the recommendations in this CMS, and the upcoming release of tortoise monitoring data from 2001 to 2005. The initial revision should be initiated within approximately two years after the release of the update for the 1994 DTRP from the Desert Tortoise Recovery Office. The CMS should then begin the revision process approximately every five years after the initial revision is complete.

A review and assessment of the existing CMS should occur approximately two years before a scheduled update. The initial review process should begin with a CMS Review Workshop. Members from each Federal, State, and local management office involved in desert wildlife recovery efforts, including the USFWS, BLM, NPS, USFS, Clark County DCP, NDOT, NDOW, and the Desert Tortoise Recovery Office would be invited to participate in this workshop. During this workshop, each entity should present the results of research and monitoring studies from the past five years and assess the current recovery state in the various management units. The focus of the workshop should be on applied research and monitoring, with the intent to integrate science and management. Not only will the workshop facilitate the dissemination of information regarding Mojave Desert conservation efforts, but it will also provide an avenue for managers to coordinate regional tortoise recovery efforts.

By implementing the recommended actions and, more importantly, following this implementation with monitoring and periodic review in an adaptive framework, managers will better understand the needs of the desert tortoise and the effectiveness of the existing plan. Adapting the CMS by altering management actions based on monitoring and research may result in a CMS that more effectively meets the needs of the desert tortoise and will successfully meet the objectives of the CMS.

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8. LIST OF ACRONYMS

ACEC	Area of Critical Environmental Concern
BACI	Before-After-Control-Impact
BAMR	Biennial Adaptive Management Report
BLM	Bureau of Land Management
BO	Biological Opinion
BRRC	Biological Resources Research Center, University of Nevada, Reno
CA	Conservation Action
CCMFP	Clark County Management Framework Plan
CMS	Conservation Management Strategy
CSI	Coyote Springs Investments
DCP	Desert Conservation Plan
DNWR	Desert National Wildlife Refuge
DPS	Distinct Population Segment
DTRP	Desert Tortoise Recovery Plan
DTRPAC	Desert Tortoise Recovery Plan Assessment Committee
DWMA	Desert Wildlife Management Area
ESA	Endangered Species Act
FLPMA	Federal Land Policy and Management Act of 1976
FLTFA	Federal Land Transfer Facilitation Act of 2000
GIS	Geographic Information System
GPS	Global Positioning System
HCP	Habitat Conservation Plan
HPE	high-priority evaluation species
I-15	Interstate-15
IM	Inventory and Monitoring Actions

IMA	Intensively Managed Area
LMNRA	Lake Mead National Recreation Area
LVRMP	Las Vegas Resource Management Plan
MA	Management Actions
MSHCP	Multiple Species Habitat Conservation Plan
Mt	Impact Mitigation
MVNWR	Moapa Valley National Wildlife Refuge
NDF	Nevada Division of Forestry
NDOT	Nevada Department of Transportation
NDOW	Nevada Department of Wildlife
NPS	National Park Service
NRS	Nevada Revised Statutes
OHV	Off-Highway Vehicle
PDF	Portable Document Format
PIE	Public Involvement and Education
PM	Protective Measure
POE	Public Outreach, Partnership, and Education Actions
RE	Restoration Effort
ROW	Right-of-Way
Rs	Applied Research Actions
RU	Recovery Unit
SAFETEA-LU	Safe Accountable Flexible Efficient Transportation Equity Act of 2003
SNPLMA	Southern Nevada Public Land Management Act
SNWA	Southern Nevada Water Authority
S.R.	State Route
TEA-21	Transportation Equity Act of the 21st Century

TM	Thematic Mapper
TNC	The Nature Conservancy
URTD	Upper Respiratory Tract Disease
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator

Appendix A
DWMA Newsletters

Final Draft will include:

- Desert Wash Volume 1, Issue 1 (October 2004)
- Desert Wash Volume 1, Issue 2 (February 2005) and associated full-length articles
- Desert Wash Volume 1, Issue 3 (June 2005) and associated full-length articles

Appendix B
Scoping Summary Report

Clark County DWMA Public Response Summary

Clark County, Nevada represents a fragile desert ecosystem with many exceptional plant and animal species. It also encompasses a growing urban community, which often conflicts with the recovery of sensitive desert species. To mitigate for species losses suffered during urban expansion, the US Fish and Wildlife Service issued a permit for Clark County, the cities of Clark County, and the Nevada Department of Transportation (NDOT) allowing incidental take of protected species. In exchange, the permittees agreed to set aside Desert Wildlife Management Areas (DWMAs) in other parts of the county for protection and recovery of desert species. To aid in the development and prioritization of Conservation Management Strategies, Clark County requested public comments describing concerns and issues regarding DWMAs. Survey participants had the option of submitting a completed questionnaire or map. Twelve respondents completed the survey while one chose the map option. The following is a summary of these concerns including sample statements from the public questionnaires.

Importance of DWMAs

All twelve questionnaire participants addressed the question regarding the importance of the DWMAs. The majority of questionnaire respondents found the issues and concerns facing all DWMAs very important, particularly Coyote Springs (83%) and Gold Butte-Pakoon (83%).

Public Uses

Every questionnaire respondent identified several personal uses of the DWMA and adjacent lands. The public recognized a number of uses, from geo-caching to horseback riding to target shooting. The most popular activity, indicated by nearly 92% of participants, was scenery and wildlife. Among other popular uses were hiking and backpacking (83%), camping (75%), astronomy/stargazing (58%), rock hounding (42%), horseback riding (33%), rock climbing (25%), and individual, designated road Off Highway Vehicle (OHV) use (25%). Table B-1 contains a complete list of DWMA uses.

Preservation

Ten of the twelve respondents addressed the issue of preservation of open and wild areas in the DWMAs. Over half of the respondents valued preservation of open areas and nearly 42% thought all habitats should be preserved. Two individuals did not see a need for managed preservation of open space and valued multiple use management over preservation. One respondent maintains that open areas are naturally preserved by the terrain of the landscape and restrictions over-protect public lands.

> "Remaining wild or open space portions of the DWMAs should be preserved without habitat we cannot support viable wildlife populations" (UNR Field Office, Henderson, NV)

TABLE B-1. Activities and number of participants in the DWMA and adjacent areas.

Activity	Percent	Activity	Percent
Rock Climbing	25	Artifact Collecting	—
Mountain Biking	8	Target shooting/plinking	17
Scenery & Wildlife	92	Partying	—
OHV use (organized speed events)	—	Rock hounding	42
OHV use (organized non-speed)	—	Hunting, Fishing, Trapping	17
OHV use (commercial tours)	—	Horseback Riding	33
OHV use (individual, designated roads)	25	Wild Horses and Burros	8
OHV use (individual, cross-country)	8	Landscape artistry	8
OHV Unauthorized use	—	Scientific Flora/Fauna Collecting	8
Geo-caching	8	Commercial Flora/Fauna Collecting	—
Model Airplane/Rocketry	—	Personal Flora/Fauna Collecting	8
Ultra-light/Sailplane	—	Refuse or Dead Animal Dumping	—
Ballooning	8	Religious Pursuits	8
Camping	75	Mining or Quarrying	—
Snow-play	—	Livestock Grazing	8
Skiing/Snowboarding	—	Dry Lake Wind Sailing	—
Boating	8	Falconry	—
Hiking/Backpacking	83	Dog Trials	8
Commercial Scenic Touring	8	Pet abandonment	—
Sunday Drives	58	Commercial Utilities/Industry	—
Existence value	8	Astronomy/Viewing Night Sky	58
Road use (vehicles)	8	Realty Speculation	—

Several individuals were in favor of habitat restoration, although most participants did not address this issue. Two individuals advocated restoration only when cost-effective or in minimally damaged habitat. One respondent wished to prioritize rehabilitation of livestock impoundments for wildlife habitat and restoration of habitat for Threatened and Endangered species.

Ecological Values

Eight of twelve respondents addressed the issue of ecological values in the DWMAs. Biodiversity in the DWMAs was the most common ecological value identified by respondents. Several individuals noted habitats as areas for particular attention due to high biodiversity, including riparian areas, washes, and perennial and intermittent streams. Others specified locations needing conservation attention, such as Meadow Valley Wash, upper Muddy River, Piute Eldorado near Searchlight, the Mormon Mountains, and the Newberry Mountains in Piute Eldorado. Arrow Canyon near Coyote Springs was identified by two respondents as having great ecological value. One individual encouraged MAs to pursue tamarisk removal in this area. Another individual urged rehabilitation of the livestock impoundments in Gold Butte for suitable wildlife habitat. In addition, respondents identified Joshua trees, bajada in creosote habitat, and all sensitive habitats as ecologically valuable.

> "As a hiker of the creosote, I must also mention the importance of the bajada. It is the keeper of the Tortoise, and also wild flowers in spring and fall, bird nests, lizards, great bugs…" (N. Hall, Mesquite, NV)

One individual submitted maps of the DWMAs highlighting areas of particular ecological value and locations of species of concern (Appendix A). Tortoise habitat and other reptile habitats, areas of high local biodiversity, invasive species' occurrences, wildlife corridors, and diverse riparian and wash habitats were recognized in each DWMA. Areas that may experience disturbance due to the Kern River Pipeline were cited in Coyote Springs and Mormon Mesa. Among the areas identified for exceptional habitat were Meadow Valley Wash, Gold Butte and Mormon Mesa riparian habitat along the Virgin River, and the Castle and Newberry Mountains in Piute Eldorado.

Cultural Values

Eleven of twelve respondents addressed the issue of cultural values in the DWMA. All identified cultural resources as an important value needing protection under the DWMA plans. Some of the specific areas highlighted were Gold Butte, Coyote Springs near Arrow Canyon, the Mormon and Virgin Mountains, and Christmas Tree Pass. One respondent cited the cultural and historical significance of all DWMAs as a reason for allowing unlimited public use, and another defended responsible use of DWMAs. Finally, one respondent requested that "treasure" hunters defacing petroglyphs be stopped.

> "There are multiple sites in the Gold Butte area that contain prehistoric and historic petroglyphs and pictographs, pottery shards, and lithic scatters. These need to receive recognition and protection." (A. McConnell, Las Vegas, NV)

Scenic and Recreational Values

Eleven of twelve individuals addressed the scenic and recreational values of the DWMAs. All identified these values as important to them, and many of the popular activities listed in Table 1 are related to scenic values. Gold Butte vistas, the Mormon, Sheep, and Virgin Mountains, and sand communities of Gold Butte were all highlighted as scenic areas, as were washes and wash tributaries. The popularity of scenic resources in the DWMA resulted in public concerns regarding road closures and restricted access.

> "Keep plenty of roads and keep people on them. All areas are scenic and worthy of recreation." (A. Wachten, Mesquite, NV)

Public Concerns

All twelve of the respondents identified and ranked issues facing the DWMAs. OHV use and exotic species were most frequently proposed; OHV use ranked highest in importance. Accessibility and dumping of refuse and dead animals were also frequently cited as important to the general public. Multiple issues were raised by only one or two respondents, of these multiple use, habitat fragmentation, and development were ranked most important. Table B-2 contains a complete list of issues selected by the participants. In the following sections, concerns are categorized and described in further detail.

TABLE B-2. Critical issues facing DWMAs identified by public respondents (1 being the most important).

Issue	Number of Responders	Average Importance	Conservation Action
Development	2	1	Land acquisition/easement
Multiple-use	1	1	Road inventory and designation
Habitat fragmentation	1	1	Road closures
Access	3	1.3	Road inventory and designation
OHV use	8	1.5	Road designation, organized event restrictions, increased law enforcement
Artifact collectors	2	2	Increased law enforcement, public outreach
Ground disturbance	1	2	OHV speed-based event restrictions, road designation, increased law enforcement
See results for $ spent on conservation efforts	1	2	
Public education	2	2.5	Public outreach and signage
Desert dumping	4	2.75	Increased law enforcement
Private lands	1	3	
Livestock trespasses	2	3	Livestock removal, acquisition of grazing allotments
Aquifer integrity	1	3	Spring rehabilitation and grazing allotment acquisition
Exotic species	6	3.2	Surveys and restoration techniques, road designation
Illegal animal & plant collection	2	3.5	Increased law enforcement
Dirty Campsites	4	4	Increased law enforcement and public outreach
Private owners treated fairly	1	4	
Sand removal	1	4	Mining and industry restrictions
Information	1	4	Public outreach and education
Public Involvement	1	5	Public outreach and education
Loss of cultural resources	1	5	Increased law enforcement, road designations, and public outreach

RECREATION

A number of respondents were concerned that protection of DWMAs would eliminate these lands from public use, and maintained that the recreational value should be a priority over conservation. Several respondents were strongly in favor of multiple use or unrestricted recreation which allowed public land use by all, while another individual favored non-invasive recreational use. One participant suggested wilderness management practices be used to manage road use.

Road closures and OHV access were two of the most prominent concerns among individuals responding to the questionnaire. One individual was concerned that road closures would limit access for her disabled husband, who enjoyed the scenic resources of the DWMAs. OHV use was equally divided between those in favor of responsible OHV use and those opposed on the grounds that it disturbs native habitat. One individual recommended specific campgrounds and areas designated for OHV users to promote responsible OHV use. Of the OHV users responding to the questionnaire, all were individuals who claim to use designated roads responsibly.

> "I feel that responsible use should enable the public to be allowed to use and access our desert. I do not feel that motorized or multiple use should be curtailed." (L. Egan; Moapa, NV)

> "Define the term public lands as lands that the MOST people get to enjoy." (A. Wachten, Mesquite, NV)

> "Mud Wash at one time was a wildlife corridor to Lake Mead. Now it is an ATV highway. A recent hike…showed there are no longer wildlife tracks in the wash, the owls have left the area, most likely replaced by the Ravens, and there was trash along the way… Quail Springs wash, Cottonwood Wash…all the large wash tributaries will treat you to wildlife viewing…and great birding; these are extremely valuable areas." (N. Hall, Mesquite, NV)

WILDLIFE AND HABITAT CONSERVATION

Overall recreational uses were a more pressing concern for participants than wildlife issues. Of the respondents that did identify wildlife issues, most valued biodiversity in the DWMAs and sought protection for specific areas in Gold Butte and Piute Eldorado. Several individuals were concerned with the spread of invasive species, including tamarisk, Sahara Mustard, and the effect these species have on natural fire regimes. One individual cited inappropriate uses of the fragile ecosystem, such as OHV use other than individuals on designated roads, industry, realty speculation, animal and plant collection, and livestock grazing.

> "The washes provide biodiversity hotspots. The Joshua trees are very easy for even novices to the desert to appreciate." (Anonymous)

> "…the threat of Sahara Mustard spreading on the Mormon Mesa… last year there was 1.5 miles of Sahara Mustard along the Carp/Elgin Road and in some places [it] is beginning to spread into the desert." (N. Hall, Mesquite, NV)

ADMINISTRATION

One individual felt the government exercises too much control over public lands, leaving them over-protected. This individual felt that the government is susceptible to special interest groups, who push their own agenda by threatening law suits. Additionally, this individual would like to see managing agencies held responsible for providing results, thus having accountability for expenses.

> "We have too many government programs which basically spend money with no accountability or success. " (D. Magoon, Bunkersville, NV)

DEVELOPMENT & PRIVATE LANDOWNERS

Two issues that were acknowledged by several participants were development and private landownership. Most of the individuals who noted development as an issue were opposed to future development in the DWMAs or requested that it be restricted to specified areas. One respondent, concerned with loss of recreational opportunities, suggested that BLM disposal lands be managed for activities prohibited on public lands, rather than being sold for development.

> "More should be done to preserve existing DWMAs from development." (UNR Field Office, Henderson, NV)
>
> "I think that the BLM disposal areas should be designated, managed, developed, and maintained for various types of activities that are otherwise restricted or prohibited on public lands instead of being sold for more development." (L. Egan, Moapa, NV)

Several individuals were concerned with impacts of DWMA on private landownership and the fair treatment of private landowners. Landowners expressed concerns over their ability to maintain and manage private lands when encountering widespread conservation. Several commented that the government did not give them enough control over their lands.

> "I do not agree with polices that make people feel that their only option is to be a willing seller" (L. Egan, Moapa, NV)
>
> "Keep private lands private. Ninety-five percent of Nevada is in Federal control" (A. Wachten, Mesquite, NV)

PUBLIC OUTREACH AND LAW ENFORCEMENT

Several individuals were concerned with public outreach and educational programs, specifically signage in cultural areas. Several felt that public outreach should be a priority, educating users about responsible land use. One respondent requested that the public be informed and involved in management decisions.

> "Need to educate new residents on how to respect the desert." (A. Wachten, Mesquite, NV)
>
> "Put up signage about cultural areas." (J. and E. Holmes, Las Vegas, NV)

Increasing law enforcement was a concern for many participants. In particular, one individual was concerned with the lack of communication among law enforcement officers (LEO) in separate districts, and proposed a hotline for the public to report incursions.

> "Regardless of public input the rural off road community should not be in charge of policing themselves…With more law enforcement coverage you can encourage the public to keep watch and there will be someone available to answer the calls. I… suggest an MOU between the LEO's of Las Vegas and Ely Districts as well as NPS, Sheriff, and City police." (N. Hall, Mesquite, NV)

Conservation Management Priorities

Eight of the twelve respondents addressed prioritization of conservation actions (CAs), and opinions were diverse. Several individuals identified ecological values as a priority, including wetlands, desert tortoise recovery, biodiversity, habitat restoration, and surface disturbance. On the other hand, many identified recreational uses as a priority, specifically multiple use and public access. One individual was strongly in favor of protecting aquifer systems in the DWMAs.

All twelve respondents ranked criteria used to prioritize CAs. On average respondents identified threat level, or level of vulnerability, as the most important criterion. One individual stipulated that evaluation of threat level be based on "real" science. Both the chance of success and ecological benefits were identified as moderately important criteria, while cost and complexity was the least important criterion for the public. One individual identified compatibility with human uses as the most important criterion in prioritizing CA.

Conservation Actions

All twelve respondents indicated their level of support for CAs in question 10, while only seven individuals addressed additional CAs that they felt should be considered. Participants indicated strong support for most CAs, particularly for desert tortoise highway fencing and public outreach. Support for additional research and wash closures varied among those who strongly agreed and those who strongly disagreed. Table B-3 summarizes public support for CAs.

Only six of twelve respondents addressed additional comments in question 12. All comments were related to their concerns, and were identified in this summary in the detailed explanations of public concerns in Section 7.

TABLE B-3. Public support for select conservation actions. Numbers indicate number of respondents in each category.

Conservation Actions	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know
Public educational programs (brochures, signs, displays, etc)	8	4	—	—	—
Desert tortoise hwy fencing	7	3	1	1	—
Evaluate existing road networks to determine closure and rehabilitation feasibility	6*	5		1	—
Habitat enhancement projects	6	4	1	1	—
Habitat restoration projects	6	4	1	1	—
Increase law enforcement presence	6	4	1	1	—
Close washes to motorized/mechanized vehicle (mountain bike) use	6	1	2	3	—
Land acquisition- willing seller	4	3	1	2	—
Purchase and exchange grazing allotments	4	3	-	2	—
Conservation easements	4	3	1	1	—
Additional research and species inventories	3	3	2	2	—
Limit non-commercial animal and plant collection	3	3	1	2	1
Limit deadwood collection	1	6	2	2	1

Note:

* One responder strongly agrees only with road inventory and appropriate use, not closures.

Summary

The most pressing public concerns involved balancing recreational use with habitat conservation, development, and public outreach programs. Table 2 lists the public's concerns and identifies corresponding CAs from the current list of proposed actions.

Ensuring population recovery of protected species and habitats while maintaining access for recreational uses such as OHV and mountain biking can be difficult. However, completing road inventories and designation will allow recreational access while promoting habitat protection. The recommended CAs will not eliminate OHV use, but allow OHVs in designated areas while species recovery progresses in sensitive areas. Major routes will remain open for vehicular traffic, while less traveled secondary roads and roads through washes will be investigated for possible closures.

Non-invasive recreation, such as hiking and wildlife watching, will not be restricted under the current MAs. Rather, these uses should be encouraged through public outreach programs aimed at educating the public about their natural resources and the importance of responsible use for the future health of the desert ecosystem.

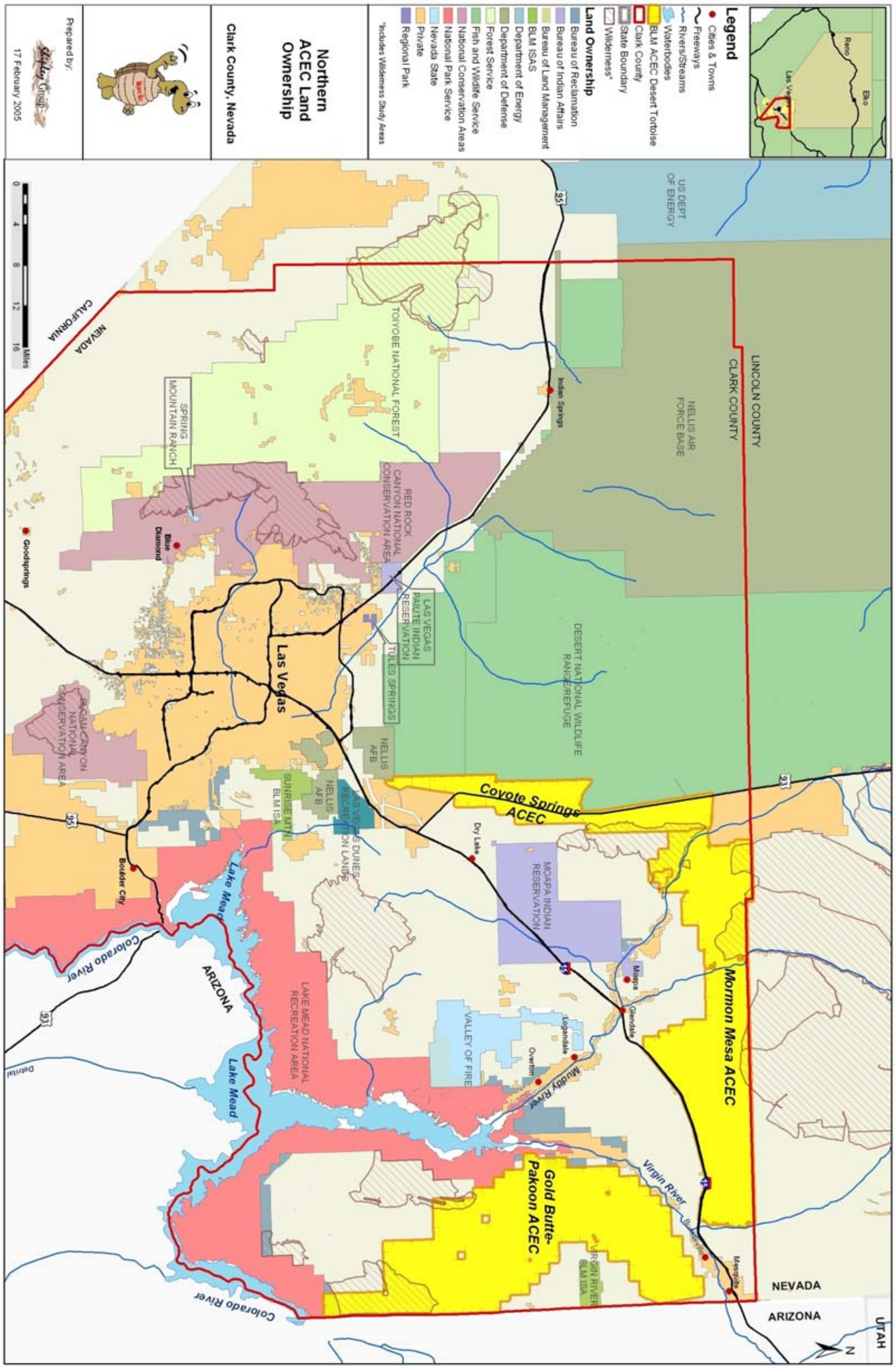
While most individuals favored restricting new development, many were concerned with impacts on private landowners. Acquisition of the private lands will provide long-term protection of wildlife, but managers should be cautious in approaching landowners. CAs should be aimed at acquiring large tracts of land slated for development, and conservatively address individual private landowners. Support from landowners will only be earned by respecting these individuals, not pressuring them into easements or settlements

Biodiversity, the primary ecological concern, is addressed by nearly every recommended CA. Road designation will minimize habitat degradation from road incursions while restoration of spring habitat, acquisition of grazing allotments, and restriction on right-of-way (ROW) development will provide cumulative benefits for wildlife.

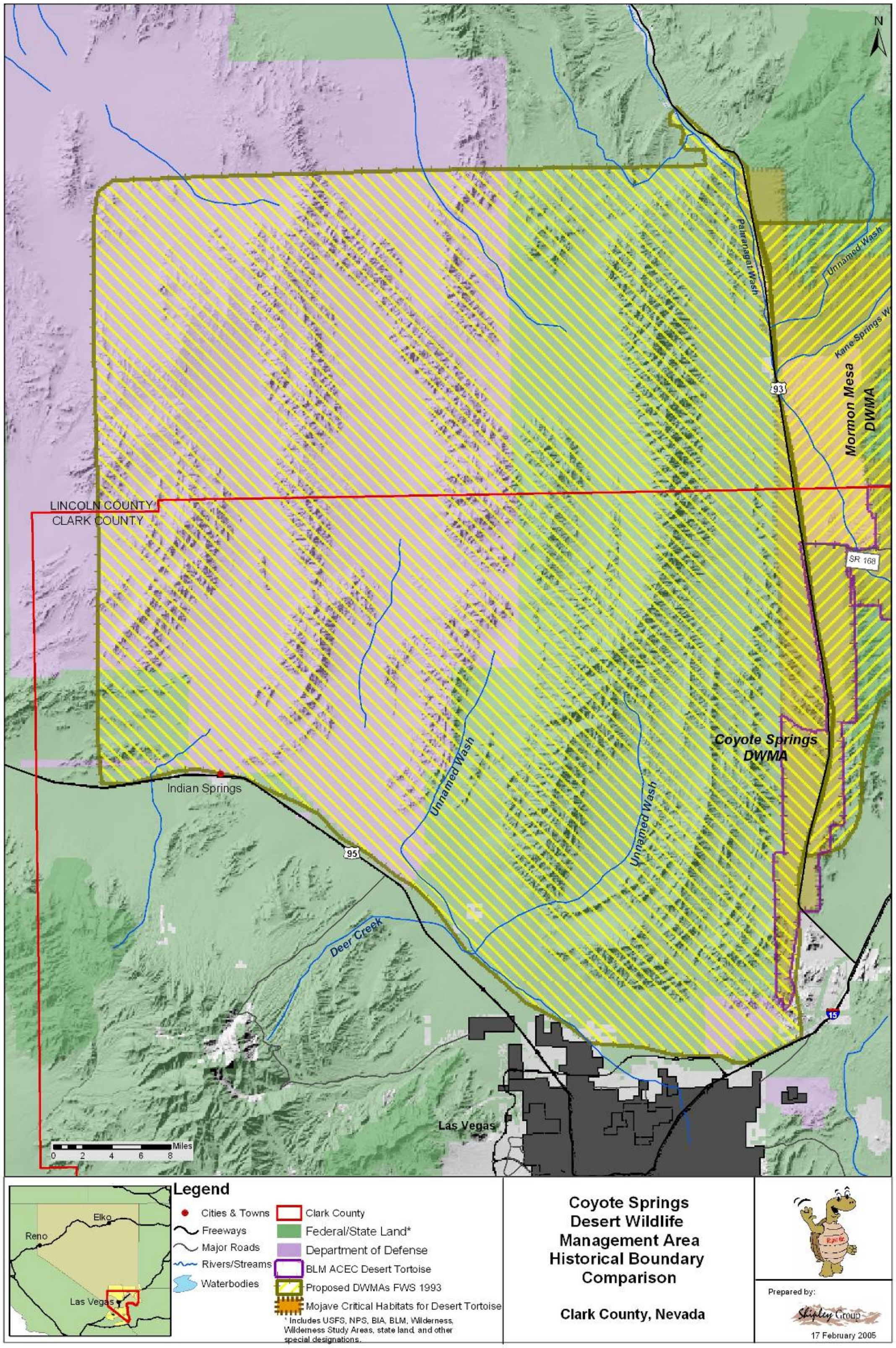
Successful implementation of CAs hinges upon adequate law enforcement to impose restrictions. Several respondents identified law enforcement as a principle concern, and CAs must address this adequately. Opening lines of communication among law enforcement districts will be critical in ensuring restrictions are upheld.

Nearly all concerns identified by the public are addressed with current recommended CAs. However, managers should further consider how the public will be notified of accomplishments and successful conservation. Additionally, planners should consider the concerns of the individual who submitted a map with specific ecological areas highlighted by investigated the current status of these areas. In general, the public comment survey highlights three CAs which will address most of the public's concerns: (1) completing road inventories and road designations for each DWMA; (2) providing adequate law enforcement to oversee implementation of CAs and ensure responsible use; and (3) developing a comprehensive public outreach campaign to educate the public about the desert ecosystem and responsible use of this valuable natural resource.

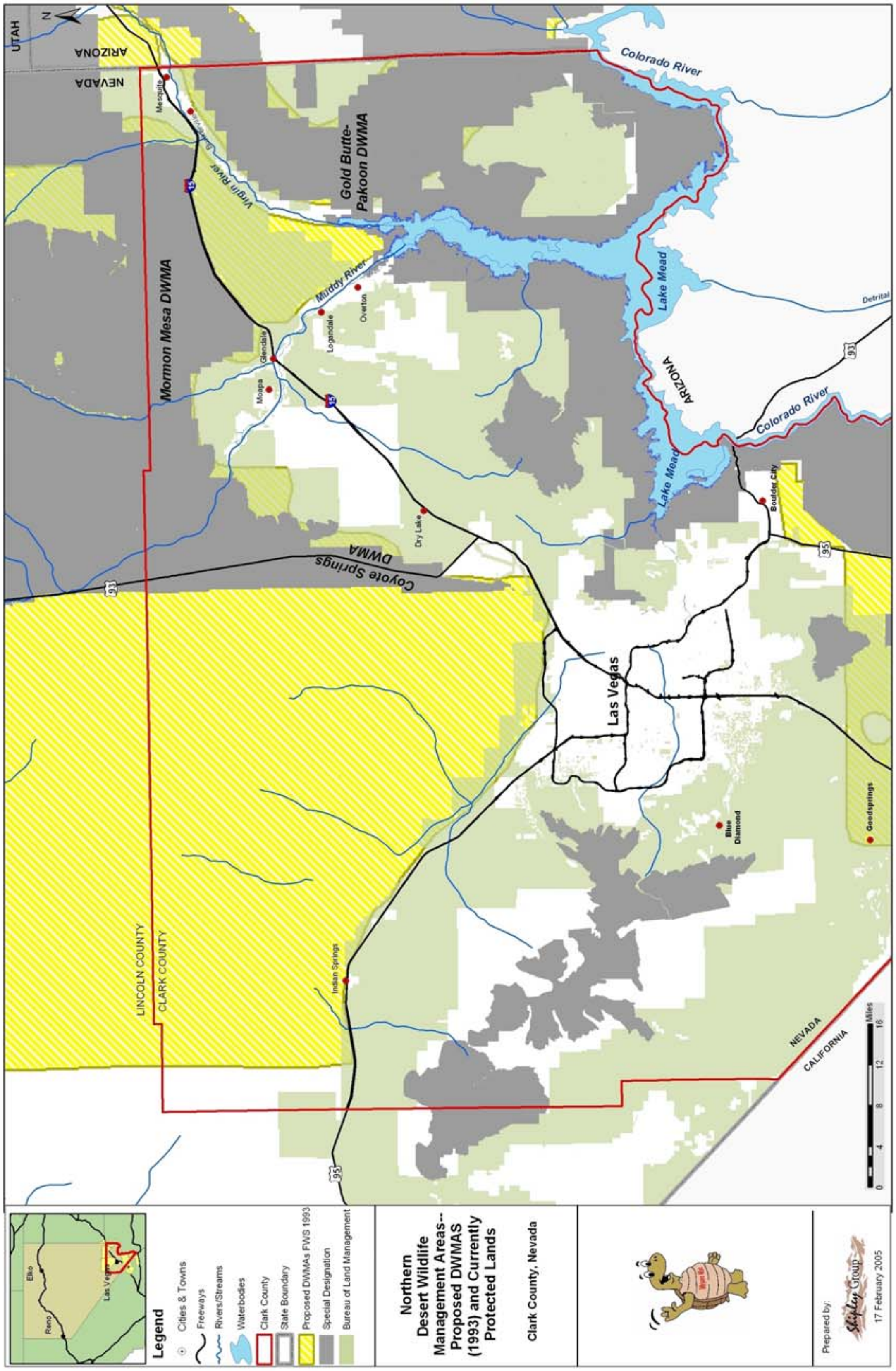
Appendix C
Maps



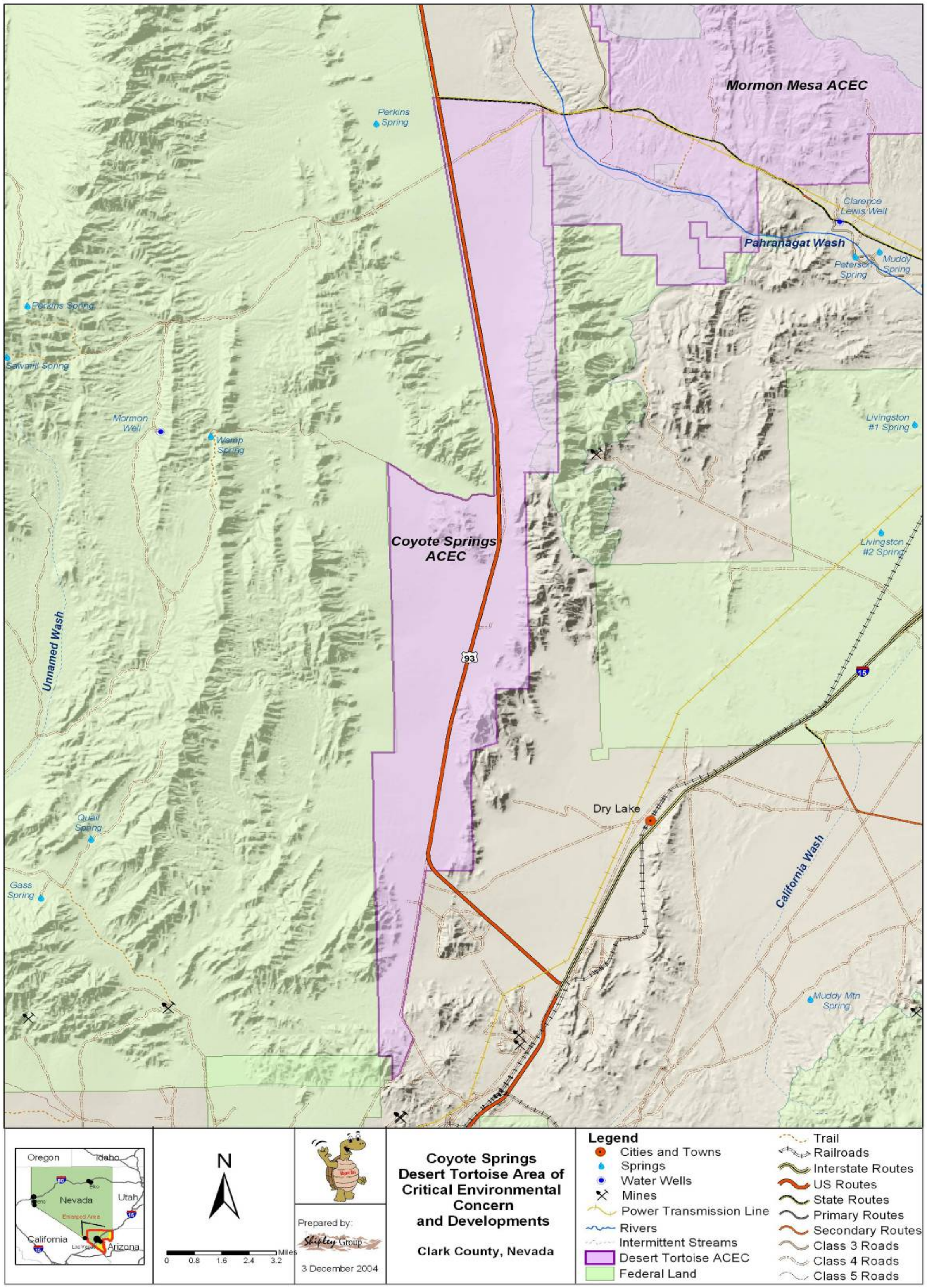
Map A. Land ownership and designation in the northern ACECs including Mormon Mesa, Coyote Springs, and Gold Butte



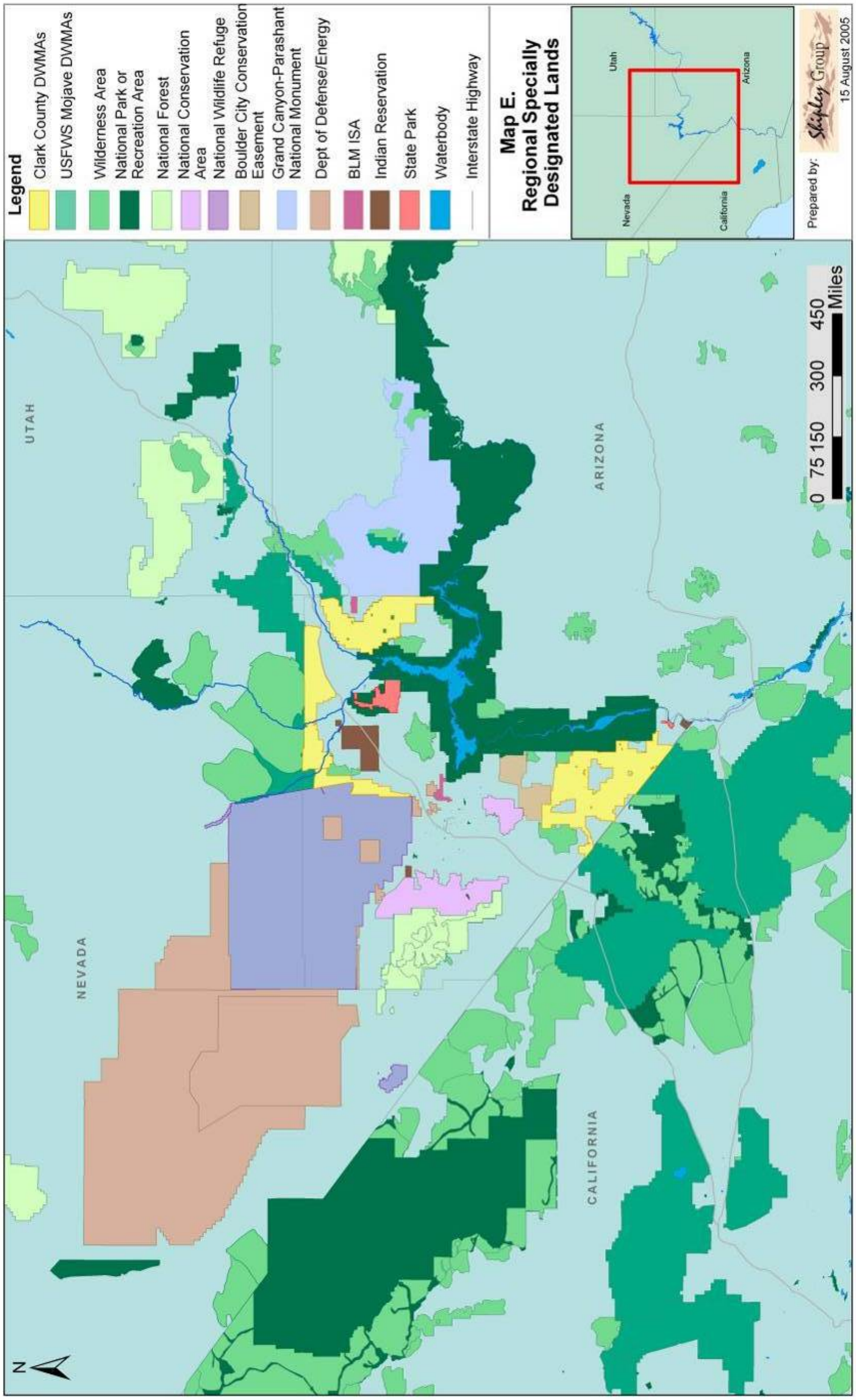
Map B. Coyote Springs DWMA boundary proposed by USFWS in 1994.



Map C. Protected lands surrounding the northern Clark County DWMAs, including Mormon Mesa, Coyote Springs, and Gold Butte.



Map D. ROWs and other human-induced infrastructure in the Coyote Springs ACEC.



Map E. Regional specially designated lands surrounding Clark County, Nevada.

Appendix D
MSHCP Conservation Actions

Companion Document for Table 9

LEVEL 1 ACTIONS

Ensure adequate law enforcement presence in all DWMA assessment areas to deter new road incursions and protect the resources.

USFWS 28/NPS 32 Ensure that adequate law enforcement and ranger patrolling is implemented within the DNWR (DNWR; NPS Policy).

BLM 98 Provide adequate law enforcement presence to ensure that management actions and restrictions are implemented for the conservation of covered and/or evaluation species.

USFS 171, USFS 189 Develop and maintain partnerships with multiple user groups.

Design public outreach campaign in and around all DWMA assessment areas to increase public land user compliance with use restrictions and to highlight the importance of habitat conservation for species of concern.

USFS 15 Educate the public to the value of Wilderness, not just as a non-motorized recreation area, but as a place of natural processes and of personal risks. (FS OBJ 12.13). Policy

USFWS 2 Coordinate outreach actions and publications with PIE where deemed appropriate by USFWS ad Clark County. (Ecological Services and DNWR)

USFS 12 Work cooperatively with Federal, state, local agencies, tribal governments, and other to increase public education and awareness of resource values and interpretation opportunities throughout the SMNRA Policy: (FS OBJ 0.30)

USFWS 1 Develop interpretive outreach program highlighting unique habitat and the biotic communities of Clark County. (Ecological Services and DNWR)

NPS 1/BLM 5 Develop brochures, pamphlets, interpretive signs, and exhibits for Covered Species and the habitats on which they depend in coordination with the MSHCP I & M Committee.

USFWS 3 Encourage the development and dissemination of knowledge regarding the ecosystems in Clark County.

Cooperate with other agencies to 1) prevent negative impacts on critical threatened and endangered habitat, 2) increase populations of species of concern, and 3) avoid listing additional species by maintaining populations, critical habitats, and ecological processes. Consider additional protective designations when appropriate and enforce implementation of CAs.

USFS 162/163 Prevent the destruction or adverse modification of critical threatened and endangered habitat, increase populations of threatened and endangered species, avoid the listing of additional species as threatened or endangered by maintaining populations and ecological processes necessary to their sustainability.

USFS 164 Provide sufficient habitat to support the continued existence of all native resident and migratory species throughout the planning area. Restore desert bighorn sheep to their historic range. (FS-OBJ-0.11)

NDF 3 Cooperate, to the maximum extent practicable, with Clark County, and enter into agreements, as appropriate, with Clark County an other Participants in the MSHCP for the administration and management of any areas established for the conservation, protection, restoration, and propagation of species of native flora which are threatened with extinction (NRS 527.300).

BLM 98 Provide adequate law enforcement presence to ensure that management actions and restrictions are implemented for the conservation of covered and/or evaluation species.

BLM 99 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: Las Vegas bearpoppy, white-margined penstemon, and phainopepla.

USFS 54/NDOW 20 Consider, as appropriate, developing additional protective designations to protect the species of concern and other ecological resources.

Implement comprehensive monitoring program for all Covered Species in coordination with CCMSHCP. Evaluate inventory needs on an annual basis and coordinate with BLM on maintaining a digital inventory database for Clark County.

USFWS 11 Monitor populations and population trends of Covered and Evaluation Species on the DNWR as appropriate (DNWR).

USFS 20 Inventory for populations of rare flora and fauna on an annual basis. A Native Species Site Survey Report will be used to record new records of species occurrence, and copies of this form will be provided to the Nevada Natural Heritage Program. Species and area priorities identified to date are as follows: (CA 2.1)

USFS 21 Evaluate inventory priorities on an annual basis and coordinate in development of inventory strategies. (CA-GC)

NDOW 13 Pursue additional funding to conduct inventories of evaluation and watch species where needed.

NDOW 14 Coordinate with the Adaptive Management Program in setting species priorities, selecting survey methods, and evaluation of data collected.

BLM 13 Continue to conduct inventories as determined by the BLM and I & M Committee on special status plant species to determine their distribution, abundance, and potential threats and take appropriate actions to protect the habitat of these plant and animal species.

BLM 15 BLM will cooperate with the Nevada Division of Wildlife and Clark County I & M Committee to implement surveys to determine the distribution, abundance, and potential threats on the southwestern willow flycatcher, phainopepla, summer tanager, Arizona Bell’s vireo, yellow-billed cuckoo, and blue grosbeak and other species as necessary.

BLM 17 BLM will develop and maintain a digital data base for all inventory data collected and cooperate with other participants in establishing and maintaining a repository for digital biological data covering Clark County.

BLM 19 Inventory and monitor mesquite and acacia habitats in Amargosa Valley Area, Stump Springs, Pahrump Valley, Hiko Wash, Piute Wash, Meadow Valley Wash, and other areas determined to be important as resting an/or nesting habitat for resident and neo-tropical migrants.

NDOT 5 Compile an inventory of Covered Species and valuable habitat lands that occur on NDOT rights-of-way. This inventory will be accumulated on a project-by project basis during NDOT’s environmental review process.

Conduct weed surveys in all DWMA assessment areas, prioritization of existing infestations for action within Clark County, and abatement of new weed infestations in a timely fashion. Where possible, remove exotic plants manually.

USFS 132 Where possible, remove obvious exotic plants (dandelions, cheatgrass) in the Wilderness manually. (FS GU 12.2)

USFS 113 Organize volunteer work parties to manually remove exotic plants and noxious weeds along the ridgeline trails and other high elevation routes (CA 5.9).

Develop long-term hypothesis-based studies targeting management issues for recovery of desert tortoise populations.

USFS 19 Development of a recreation use monitoring strategy to determine amount, type, and timing of recreation trail use. (CA6.2l)

Sign and rehabilitate new road incursions in a timely fashion.

USFWS 40/NPS 50 Restore/rehabilitate all key access points of closed roads and areas (DNWR) except Road 106 and 1B, which were closed due to road hazards and not resource damage.

NDOT 27 Scarify, recontour, and reseed NDOT material sites after project completion if the site is not expected to be used for another project in the near future.

Prohibit commercial and casual collection of plant and animal materials in DWMA.

NDF 2 Prohibit the removal or destruction of native flora listed as fully protected (NRS 527.270) except by special permit.

NPS 25 Prohibit commercial collection of fauna and flora. (NPS National Policy)

NPS 36 Enforce existing prohibition of collecting and deter poaching through increased routine ranger patrols.

NDOW 6 Consider and authorize, as appropriate, in conjunction with the USFWS, utilization of wildlife collected pursuant to this plan for research and educational programs.

NDOW 18 Evaluate the need to regulate commercial collection of wildlife species.

USFWS 12 Allow collection by permit only; permits granted only for scientific research that furthers the USFWS mission (DNWR).

USFS 71 Collection of threatened, endangered , and sensitive plant species requires a permit from the Regional Forester, except for traditional use by American Indians (FSST 0.28).

BLM 51 Prohibit commercial collection of vegetative specimens within WSAs. Hobby collection may be allowed for personal use but not for commercial use, as long as the collection activity method meets the non-impairment criteria.

Restore the health of water resources by eliminating exotic fish and plant species in and around springs, particularly tamarisk, and do not allow the introduction of new non-native fish or wildlife.

NPS 45 Where necessary, enhance stands of willow and cottonwood by removing the competing tamarisk and replacing with native species.

NPS 47 Eliminate exotic fish and plant species in and around springs where appropriate and feasible.

NDOW 23 In cooperation with USFWS and other, support efforts to eradicate tamarisk and/or restore native vegetation communities on public and private lands

USFWS 37/ NPS 46 Enhance mesquite and catclaw stands by removing the competing tamarisk and replacing with native species.

BLM 142 Control and/or eradicate tamarisk. Rehabilitate the area with native species to help reduce the potential for tamarisk reestablishment and improve ecosystem health.

USFS 185 Do not permit introduction of new non-native species of fish or wildlife. (FS-ST-0.40)

Develop and implement long-term surveys for key avian species to document population trends, critical nesting and breeding habitat, seasonal distributions.

USFWS 8 Develop and implement long-term bird surveys to assess population trends, to document breeding and nesting activity in southern Nevada in the spring, and to assess occurrence in southern Nevada during the summer months.

NPS 8 Develop information on the population distribution of summer tanager, Arizona Bell's vireo, yellow-billed cuckoo, and blue grosbeak in the study area. Surveys are needed in the spring to document breeding and nesting activity in southern Nevada. Protect existing riparian habitat.

NPS 9 Inventory and monitor mesquite and acacia habitat that may be important as nesting and/or nesting habitat for resident and neotropical migrants.

NPS 10 Develop information on the population distribution in the study area and the subspecific relationship of the southwestern willow flycatcher in southern Nevada. Survey in the spring to document breeding and nesting activity in southern Nevada.

BLM 15 BLM will cooperate with the Nevada Division of Wildlife and Clark County I & M Committee to implement surveys to determine the distribution, abundance, and potential threats on the southwestern willow flycatcher, phainopepla, summer tanager, Arizona Bell's vireo, yellow-billed cuckoo, and blue grosbeak and other species as necessary.

BLM 19 Inventory and monitor mesquite and acacia habitats in Amargosa Valley Area, Stump Springs, Pahrump Valley, Hiko Wash, Piute Wash, Meadow Valley Wash and other areas determined to be important as resting and/or nesting habitat for resident and neo-tropical migrants.

Protect and improve sensitive habitat such as nesting areas and migration routes, as well as riparian, mesquite woodland, and aquatic habitats.

BLM 117 Protect key nesting areas, migration routes, important prey base areas, and concentration areas for birds of prey on public lands through mitigation of activities during National Environmental Policy Act compliance.

BLM 302 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.

USFWS 16/NPS 33 Protect existing stands of mesquite and catclaw (DNWR/NPS Policy)

USFWS 17 Protect existing riparian habitat from the effects of recreational activities.

BLM 20 Improve aquatic, riparian and mesquite woodland habitats including Meadow Valley Wash.

Enhance cooperation among animal control entities to reduce raven and feral animal populations in all DWMA assessment areas.

USFS 47 Facilitate, with Clark County, enforcement of leash laws, and control of feral cats and dogs in areas where adverse effects on Palmer's chipmunks and other wildlife have occurred, particularly adjacent to the private developments of Mt Charleston, Deer Creek, and Lee Canyon (CA 4.4)

NDOW 37 Facilitate enforcement of leash laws and feral animal control in the Spring Mountains NRA

NPS 30 Remove feral animals and uncontrolled domestic animals. (NPS National Policy)

LEVEL 2 ACTIONS

Complete road inventory and designation via public process for entire planning area; route roads out of washes.

USFS 122 Close all undesignated spur roads in riparian areas; close other spur roads on a case by case basis, after site specific analysis. (FS-GU 0.63)

USFS 123 Relocate existing roads outside of washes, riparian areas, and 50-year floodplains if relocation will result in better resource conditions. Priority should be given to relocating roads when major maintenance is required and to roads that 1) are located in vital habitat for plant or animal species of concern and 2) receive higher levels of use. (FS-GU-0.64)

USFS 199 Allow motorized vehicle use only on designated roads and trails, except for snowmobile use in approved areas. Close washes to motorized use. (FS ST- 0.65)

Utilize permanent and temporary road closures to manage road use in sensitive habitats. Prohibit new road construction in areas of sensitive habitat and within 0.5 miles of active desert tortoise burrows or 100 yards of water sources.

USFS 76 Use temporary closures (roads, trails, dispersed areas) to protect important seasonal habitat for species of concern (animals, plants, insects) in coordination with appropriate state and local agencies (FS GU 0.34) FS Policy

USFWS 24 Prohibit highway and road construction on the Refuge (DNWR)

USFS 181 New facilities and roads will be sited so as to avoid vital populations or habitats of species of concern. (FS-ST-0.35) NEPA Compliance

USFS 74 Design new roads and motorized trails to maintain a minimum 0.5 mile distance form active or recently active desert tortoise burrows (FS GU 0.32)

USFS 215 Construct any new roads outside riparian areas, washes, and the 50-year

floodplain; and at least 100 yards away from existing water sources, except at crossings perpendicular to the water course. (FS-ST-0.141)

Modify road maintenance to minimize damage to wildlife and flora by restricting maintenance activities to NDOT ROWs, conducting preactivity surveys for biological resources, avoiding sensitive habitat or relocating individuals as necessary, and avoiding maintenance activity during sensitive times (i.e. breeding, nesting, spawning, or overwintering).

NDOT 14 Restrict maintenance and construction activities to NDOT rights-of-way.

NPS 37 Include MSHCP Covered Species as sensitive species in evaluations of road construction or maintenance activities on Federal lands.

USFS 59 Coordinate with Nevada Department of Transportation and USFS road crews to ensure that road maintenance activities (eg shoulder work, road salting) do no adversely affect the species of concern (CA 4.16)

USFS 137 Conduct pre-activity surveys for the species of concern prior to any actions that may affect them, and design projects to minimize or avoid adverse effects. Ensure that surveys consider unique habitat components of the species of concern (e.g., mud and puddles for butterflies) (CA-GC 1.0(4)) NEPA Requirement

USFWS 5 Conduct preactivity surveys for biological resources before implementing projects which may impact resources; and avoid sensitive species to the extent possible (DNWR).

USFWS 26 Conduct biological surveys prior to road maintenance and retrofit activities

NDOT 9 Survey maintenance and construction activities conducted in undisturbed habitat by NDOT's Environmental Services Division prior to disturbance. For the purposed to he MSHCP, undisturbed habitat will include those areas that NDOT had not historically graded, excavated, and so on, in the previous two years (24 month period) in association with rights-of-way maintenance and construction activities, and/or those areas which NDOT biologists or NDOT approved biological consultants deem to have potential habitat values for Covered Species.

NDOT 10 Avoid any Covered Species discovered in disturbed or undisturbed habitat in proposed maintenance or construction areas, if possible. If unable to avoid, best efforts will be made to relocate/salvage species. Relocation/salvage will only be attempted if the species is highly likely to survive the action and it is reasonably cost effective. This will be determined by NDOT's Environmental Services Division.

NDOT 11 Relocate desert tortoises and chuckwallas within 1000 feet of encounter on public lands or approved private lands if there is a direct threat to their safety/survival.

NDOT 30 Coordinate with BLM to perform plant salvages prior to work in undisturbed habitat and/or when Covered plant species cannot be avoided, especially cactus and yucca species.

NPS 29 Prohibit woodcutting and shrub clearing and limit other human disturbance of existing roadways. (NPS National Policy)

NDOT 21 To the maximum extent practicable, avoid such construction and maintenance projects in habitats during sensitive times, such as breeding or nesting or overwintering (e.g. near bat hibernacula, mowing of potential butterfly habitat, or in rare plant habitats).

NDOT 29 If possible plan construction/maintenance projects that occur in aquatic habitat, during times when spawning/nesting is unlikely. In general, the colder winter months are when such work is preferred. Best management practices should be employed during such activities. Implement any other US Army Corps of Engineers terms and conditions required by the specific permit.

NDOT 3 Develop a reference binder which contains natural history information on all species covered under the MSHCP and make this binder available to all workers, including construction and encroachment permittees, involved in activities on NDOT rights-of-way. Binders will be available at NDOT's District I (Las Vegas) office and appropriate maintenance stations. Binder will also be available at construction sites that occur in the permit area.

NDOT 25 All other appropriate requirements as stated in the DCP will apply to NDOT for this conservation plan, as many avoidance and minimization measures apply to and overlap for species in both plans, including: To minimize any impacts on the desert tortoise, NDOT maintenance personnel will perform the following tasks while performing routine maintenance activities. When moving, a worker will walk in front of the mower and inspect for the presence of the desert tortoise or burrows, except in areas where fencing has been installed. Also, NDOT will stay within its right-of-way during all routine maintenance, as identified in section 2.4.1.4. Any moving of a tortoise will only be done by trained NDOT personnel. Monitoring will be coordinated through NDOT's Environmental Services Division and will include reports of any takes by the maintainers. Funding to implement these mitigation measures of this habitat conservation plan will be provided by NDOT. Should NDOT personnel identify a tortoise within the rights-of-way during maintenance activities the tortoise will be moved out of harm's way. This will be done by carrying the tortoise up to 1000 feet from the point of encounter and placing the tortoise in an undisturbed area. Burrows inhabited by tortoises will be excavated using hand tools. All burrows found in the maintenance zone will be collapsed to prevent reentry. NDOT staff handling tortoises will have been issued the appropriate state permit form the Nevada Division of Wildlife. Desert tortoises must be handled in a fashion consistent with standards promulgated by the USFWS, from time to time, whether or not hey are set forth in this plan. IF tortoises are located within the project site they will be moved to adjacent suitable undisturbed habitat outside of the rights-of-way. If suitable undisturbed habitat is not available the tortoises will be moved to the closest acceptable location. Desert tortoises will only be moved within 1000 feel from the point where they are encountered to ensure that they remain within their home ranges and do not adversely affect other populations. During the summer months, tortoise will be relocated to another burrow or placed under a shrub. If removed from a burrow, the tortoise will be place in an existing similar unoccupied burrow. During winter months, tortoises will be placed in an artificial burrow. An artificial burrow will be constructed on public land, or approved private lands adjacent to NDOT's rights-of-way, that is approximately the same size, depth, and orientation as the original burrow. Prior to maintenance activities, a qualified desert tortoise biologist shall advise all workers through an educational program which is consistent with educational requirements as set forth in Section 7 biological opinions issued from time to time by the USFWS that the area is desert tortoise habitat and threat the desert tortoise is a threatened species. In addition, workers shall be advised of the definition of "take" they will be informed that they are responsible for avoiding impacts to desert tortoises and that potential penalties for take of desert tortoise could be up to $50,000 in fines and one year in prison per violation.

In the event that the USFWS determines, as a result of periodic reports submitted by NDOT and the County, that routine maintenance or emergency maintenance activities within IMAs, LIMAs, or desert tortoise critical habitat are resulting in significant numbers of desert tortoises being taken (more than 69 per year), it may prescribe maintenance practices different from those set forth herein in order to reduce the number thus taken. During emergency circumstances, NDOT will conduct maintenance activities on highways in tortoise habitat in an expedited manner. Emergency situations involve acts of God, casualties, disasters, national defense, or security emergencies. During emergency situations, such as flash floods in which the highway is destroyed or obstructed, NDOT will take immediate steps to contain an emergency in order to protect public safety prior to initiating any form of consultation.

Some emergencies may deposit soil from upland areas onto the roadbed and shoulder areas. This situation may also damage existing edge of roadways or culverts. In this situation, NDOT would work within the shoulder area (previously disturbed areas) to remove deposited soil from the roadbed. The roadbed and shoulder would be restored to pre-emergency conditions and no additional desert tortoise habitat would be disturbed. In the event that the roadbed and shoulder is disturbed by a flood or other emergency, the NDOT road crew may create a detour around the roadbed and over undisturbed desert tortoise habitat. Prior to any disturbance of desert tortoise habitat, the NDOT road crew would survey the area for the presence of any desert tortoises. Should a desert tortoise be found, it would be removed from harm's way. Mitigation will include payment of the $550 per acre development fee to Clark County. In addition, NDOT will recontour and rehabilitate the disturbed desert tortoise habitat upon roadway clearance and repair.

Prior to any disturbance of desert tortoise habitat, construction sites associated with road widening, new highway construction, and establishment and operation of material sites will be survey by NDOT biologists or approved NDOT consultants for the presence of any desert tortoises. Should a desert tortoise be found, it would be removed from harm's way following the procedures described above for routine maintenance activities. Material sites and construction sites will be fenced subsequent to the tortoise survey and translocation to avoid impacts to tortoises which might wander back onto these sites. Fencing will be maintained during the time that construction or operational activities continue on these sites. Construction and material sites need not be fenced when no tortoises or tortoise sign are found within the construction are or within 400 meters of the construction area. If it is more cost effective, NDOT may choose to have a biological monitor instead of fencing. If construction occurs during the tortoise inactivity period (November – February), fencing or monitoring may not be required, as determined by the NDOT approved biologist subsequent to the initial clearance survey.

Implement balanced spring restoration techniques and restore spring brook communities by developing techniques to address nutrient loading and vegetative overgrowth. Protect, restore, monitor, and maintain historic surface flow, water chemistry, temperature, and clarity of water sources. Remove existing water developments and debris from springs, provided it has no historical significance and is not used by wildlife.

USFWS 6/NPS 39 Monitor and protect water sources and water flows (springs, seeps, and streams) to assure adequate water is provided for sensitive species (DNWR).

USFS 160 Maintain historic conditions of water chemistry, temperature, clarity, and surface flow. (FS-OBJ-0.7)

USFS 131 Restore water sources to historic flows in the Wilderness (FS OBJ 12.7)

USFS 68 Maintain/restore open pools of slow moving water (0.5 m in diameter) at some historic water sources, well distributed throughout the range. Develop open pools of water at least 0.5 m in diameter at newly developed/diverted water sources (FSGU-0.6)

USFS 155 Maintain or restore the health and size of riparian areas at natural water sources, and at human-made water sources where native and desired nonnative species have become accustomed to using them (e.g., broken pipelines). (FS-OBJ-0.2)

USFS 117 Remove existing water developments and debris from springs, providing they no longer serve their original purpose, are not critical to wildfire, and the items are not of historical significance. (FS-ST-0.13)

BLM 114 Manage public lands adjacent to the Ash Meadows ACEC and Moapa National Wildlife Refuge to compliment spring and aquatic habitat for special status species, including projects that may affect ground water levels or spring flows.

Install fencing or other protection where required to exclude livestock and wild horses from springs.

NPS 40 Install fencing or other protection of springs in identified sensitive habitat, where required to exclude cattle, wild horses, or burros.

BLM 90 Provide protection (such as fencing) around springs and riparian habitats to prevent habitat degradation from excessive use by grazing animals.

Do not permit organized off-highway vehicle events within DWMA assessment areas.

NDOW 15 Prohibit driving off-road in OWMA (NAC 504.115)

USFS 75 For organized, motorized events on unpaved roads or trails within 0.5 mile of active desert tortoise burrows, require special permit provisions for desert tortoise protections (FS GU 0.33) Policy-Guideline

NPS 42 Prohibit commercial OHV tours and events in IMAs and LIMAs. (Local Park Policy)

BLM 71 Limit motorized uses in the Piute/Eldorado “Conserved Habitat” to designated roads and trails.

BLM 210 Do not allow OHV speed events, mountain bike races, horse endurance rides, four-wheel drive hill climbs, mini events, publicity rides, high speed testing, and other similar speed based events within tortoise ACECs. These restrictions apply to other ACECs except that horse endurance rides and mountain bike events may be allowed on a case-by-case basis.

Withdrawal of mineral entry in DWMAs.

NPS 61 Close desert tortoise critical habitat to new mining. Develop criteria for review of mineral lease requests that require a finding for any new mineral leases that such leases would be consistent with the purposed of the MSHCP.

BLM 200 Withdraw from entry under locatable mineral laws 11,014 acres comprising the Desert Tortoise Conservation Center Management Area. Also do not authorize (or renew) material sites rights-of-way, mineral material disposal, and solid and fluid mineral leasing within the CCMA.

USFS 61 Manage all active claims and abandoned mines to minimize effects on natural, visual, and heritage resources and provide protection for the public (FS-OBJ 0.34)

BLM 89 Where feasible, proposals for saleable materials in essential habitats for special status species will be avoided.

Avoid further ROWs in DWMA by restricting any future ROWs to the existing designated ROW corridor when feasible.

BLM 301 Limit the construction of new roads for the development of utility lines within special status species habitat.

USFWS 46/NPS 60 Consolidate utility corridors to the extent feasible on Federal lands (DNWR)

Fence heavily traveled transportation corridors in ACECs in all DWMA assessment areas. Monitor and inventory all culvert/bridge crossings and tortoise fencing within assessment area and ameliorate existing or install new culverts/bridges to allow passage of terrestrial species.

NDOT 24 Ameliorate existing or install new, under-road culverts to allow passage of terrestrial species. MSHCP funds can be pursued for this activity if NDOT is unable to secure funding in-house.

NDOT 6 Compile an inventory of all culvert/bridge crossings and tortoise fencing within the permit area.

NDOW 11 Pursue state funds to monitor tortoise populations and recovery within Nevada and other Covered and Evaluation Species, as appropriate.

NDOT 4 NDOT will continue to monitor tortoise fencing along NDOT rights-of-way at specific sites designated as field testing areas for the tortoise barrier program. At this time, fencing within NDOT rights-of-way at the translocation site is the only site being monitored.

USFS 121 Remove all structures related to grazing activities that are not necessary for current management, or of historic value.

USFS 82 Manage designated and informal use trails that are causing resource damage to reduce damage and restrict use to a single trail.

NDOT 19 Install highway runoff pollution control devices in areas where Covered aquatic species may be impacted by highway runoff.

Inventory bat roosts and populations and create a plan to identify and protect abandoned mines as bat habitat.

NPS 7 Inventory bat populations and roosts in selected areas, with priority given to proposed project.

NDOW 35 Participate in inventories of NRA species of concern and habitats including Townsend’s big-eared bat; bat roosts (Column and Pinnacle Cave); Allen’s lappet browed bat; bat roosts (cliff climbing areas); bat water roosts (unsurveyed springs); neotropical migratory bird habitat (riparian areas); raptor inventory; fringed myotis.

NDOW 7 Coordinate in efforts to inventory bat roosts (including mines prior to closure) and foraging areas to aid in the understanding of bat ecology in Clark County.

USFS 207 Abandoned mine entrances may be closed for public safety after surveys to determine the locations of biological and heritage resources have been conducted.

USFS 46 Develop and implement a plan to protect bat roosts in mines and caves. The plan will address the following protective measures: Gating or closing mines and caves to protect bat roost sites, removing important bat roost mines and caves from future additions of NRA maps, avoiding identification of exact location of maternity roosts, caves, and occupied mines to the general public, determining the need to close roads to mines and caves, and avoiding use of heavy equipment near mine and cave roosts (CA 4.3)

Create new open water resources for bats and other wildlife

USFS 68 Maintain/restore open pools of slow moving water at some historic water sources, well distributed throughout the range. Develop open pools of water at newly developed/diverted water sources (FS-GU-0.6).

USFS 69 Develop new perennial sources of water, including guzzlers, only to benefit native species, to improve distribution of non-native species, where historic water sources have disappeared, or where access is limited. Only develop water sources in the Wilderness or WSAs to improve desert bighorn sheep habitat. These developments must preserve wilderness character.

USFS 129 Provide water sources for wildlife adjacent to or within developed facilities. Maintain public restrooms to prevent access by wildlife (Palmer's chipmunk).

Use pesticides in the treatment of exotic pests and disease outbreaks only as a last resort (when threat to public safety, private property, or in extreme fire danger), or when scientific evaluations indicate a need; and use only EPA registered and approved formulations at minimum effective rates in the least invasive method, such as single tree treatment. Determine potential impact of pesticides on species of concern and avoid their use in sensitive habitat whenever possible.

USFS 184 Permit application of herbicides and insecticides only to avoid or control epidemic outbreaks of insect and plant diseases where there is a threat to public safety, private property, or extreme fire danger. When applied, use only formulations registered by the EPA for the intended use, at minimum effective rates, and using selective methods. Avoid use in habitat for threatened, endangered, or sensitive species, or species of concern whenever possible. Single tree treatment will be used. (FS-ST-0.39)

USFS 236 Allow for treatment of exotic pests within the Wilderness when scientific evaluations indicate a need. Only use pesticides when no other options are available and then use the least persistent chemical or biological pesticide. Avoid use in habitat for species of concern whenever possible. (FS-GU-12.3)

USFS 42 Prior to use of pesticides and other chemicals, determine potential impacts to the species of concern (e.g. butterflies, bats) and implement strategies to avoid impacts to those species (CA-GC 4.0 (6))

USFWS 18 Manage pesticide use consistent with integrated pest management program. Apply only approved pesticides, with certified applicators, and according to label instructions (DNWR).

NDOT 18 Restrict spraying herbicides or other chemicals that are toxic to aquatic organisms 100 feet from the aquatic habitats such as well developed riparian areas, wetlands, or perennial waters, including tributaries to such lands. Use mechanical and/or herbicides/chemicals non-toxic to aquatic organisms when working in such lands. No herbicide spraying within 100 feet to known covered invertebrate habitat.

LEVEL 3 ACTIONS

Require state of the art minimization and restoration techniques to recover flora and fauna in ROWs in and around all DWMA assessment areas.

USFS 104 Ensure that restoration projects focus on protection and enhancement of the species of concern and do not inadvertently cause irretrievable damage to the habitats of the species of concern (e.g. open water for bats, mud puddles for butterflies) (CA GC 5.0(3))

Allow no net loss of Las Vegas bearpoppy and implement the memorandum of agreement with USFWS.

USFWS 30/NPS 21 Implement the memorandum of agreement between USFWS and managing agencies for Las Vegas bearpoppy (Ecological Services)

BLM 107 Allow no net loss of Las Vegas bearpoppy habitat on Public Land from Federally approved projects through mitigative actions including avoidance and rehabilitation.

Focus recreation activities (OHV activity, mountain bikes, and heavy foot traffic) into less sensitive areas and limit use to designated roads or trails to protect habitat of the species of concern.

USFWS 19 Focus recreation activities into less sensitive areas (DNWR)

USFS 40 Identify specific areas of exceptional sensitivity where conservation management will be emphasized over recreation (CA-GC 4.0 (4))

USFS 43 Protect habitat of the species of concern from dispersed recreation (heavy foot traffic, off-road vehicles, mountain bikes) and the adverse effects of wild horses and burros (CA-GC 4.0 (7))

USFS 200 Allow bicycle use only on established and/or designated roads and trails. (FS ST- 0.66)

USFS 214 Provide alternative parking sites, road alignments, and fencing where feasible to allow for continued recreational use outside of riparian areas. (FS-GU- 0.140)

Develop new trails outside biodiversity hotspots and conduct NEPA review and analysis prior to recreational development projects.

NPS 31 Conduct NEPA review and analysis for development of new areas for intense recreational use.

USFS 135 Develop new trails and encourage trail use outside of biodiversity hotspots to avoid further adverse effects on rare and sensitive species. (CA-GC 1.0(2))

USFS 249 Maintain large undisturbed blocks of vegetation in a non-fragmented condition without new roads or motorized trails.

USFWS 48 Provide an environmental assessment of the effects of the expansion of any public use areas, especially effects of species of concern.

NDOT 17 Ensure new roadside structures are designed and constructed to prevent animals from becoming trapped. Encourage retrofitting existing structures that pose a trapping problem.

USFS 62 Maintain roads to a standard necessary for public safety and as needed to respond to resource management objectives, including resource protection and recreation through maintenance of road surfaces and minimizing erosion. (FS-OBJ-0.37)

USFWS 27 Ensure that roads are engineered to adequately spread runoff to minimize erosion.

NDOT 22 During emergency situations (i.e. casualties, disasters, flooding, fire, national defense, security), public safety is first priority. Work on roadways in Covered Species habitat will be conducted in an expedited manner and confined to the road shoulder or previously disturbed area.

USFS 158 Maintain air quality at a level that is adequate for the protection and use of resources (Air Quality Related Values) and that meets or exceeds air quality standards as set by Clark County Health District.

USFWS 44 Assure implementation of integrated Pest Management Plan.

LEVEL 4 ACTIONS

Maintain historic floodplain operation by restoring channel width, slope, and gradient.

USFS 159 Maintain historic/natural operation of floodplains, where possible.

USFS 67 Where possible, maintain historic floodplain and channel width, slope, and gradient (FSGU-0.5) FS Policy

Improve or maintain springsnail habitat and reestablish populations. Pipe water downstream of the source where snails are present when developing water sources.

USFS 70 When developing water sources, pipe water from a point downstream of the source if snails or other sensitive species are present, or if the spring sources has not been previously developed.

BLM 106 Take appropriate protective actions to maintain or improve springsnail habitat, including the reestablishment of populations of springsnails.

Where appropriate and within available budget allocations, pursue acquisition or reservation of water rights and in-stream flows on a willing seller basis for maintenance of aquatic habitats for wildlife. (NDOW 24)

BLM 120 Determine water needs to meet management objectives. File for appropriate water rights on public and acquired lands in accordance with the State of Nevada water laws for those water sources that are not Federally reserved.

BLM 121 Determine instream flow requirements and apply for necessary water rights on the Virgin River and Meadow Valley.

Conservation easement acquisition on key privately held lands within the DWMA.

NPS 55 As appropriate for conservation of biological resources in the planning area develop conservation agreements or easements with adjacent willing landowners with habitat for Covered Species.

Acquisition/exchange of key privately held lands within the DWMA.

USFS 219 All private lands within the planning area outside of developed subdivisions are suitable for acquisition on a willing seller basis, through purchase, exchange, or donation.

BLM 164 The following are land acquisition priorities on a willing seller basis:

1. Private lands required to meet management objectives within designated ACECs, WSAs, T&E habitat and areas containing special status species.

2. Private lands along the Virgin River south of Riverside bridge.

3. Lands not specifically identified for acquisition could be acquired on a case-by-case basis for the following reasons: a) protection of T&E and special status species; b) to provide resource protection; c) to facilitate implementation of the Resource Management Plan; d) to provide a more manageable land ownership pattern; or e) to maintain or enhance public uses and values.

Appendix E
Conservation Management Strategies:
A Multispecies Conservation Planning Approach

Foundations and Guidelines of Conservation Biology

CMSs for Clark County DWMAs in the northeastern Mojave Desert are in the general context similar to those in any ecoregion. The general principles for developing scientifically based technical guidelines for the protection and conservation of landscapes (Noss 1983, Edwards et al. 1994, Schwartz 1997, Soule and Terborgh 1999, Askins 2002), ecosystems (Beatley 1994, Noss and Cooperrider 1994, Szaro and Johnston 1996, Noss et al. 1997), and populations (Soule 1987, McCullough 1996, Beissinger and McCullough 2002, Lande et al. 2003) are established and well known. Conservation biology has recently established itself as a major discipline (e.g., Fiedler and Kareiva 1998, Soule and Orians 2001, Primack 2002, Groom et al. 2005). The major problem is the political and social will, desire, and motivation to implement significant long-term conservation objectives. Nevertheless, two major important technical hurdles are usually present. The most obvious one is that the reserve or series of reserves that are the focus of conservation planning have already been degraded and fragmented to some degree before protective measures are in place. The other is the assumption or faith of agency planners that the biological data relevant to the conservation effort is complete and available. The stressors and risks to populations and ecosystems are reasonably easy to assess. However, there are usually large knowledge gap in the status of species and community viability. In other words, the details of individual species distributions and population sizes are typically not known. For example, the desert tortoise is arguably the most studied species in the Mojave Desert, yet spatially explicit accurate and reliable data concerning its distribution, abundance patterns, and population dynamics do not appear to exist.

This general guidance is required because it provides the theoretical ideal basis and the initial template for multispecies conservation. There are xx general conservation principles for reserve design and management for multispecies and focal species conservation. There are overlaps in these categories because of their integrative nature and interdependencies.

Definitions

Nature abhors boundaries, classifications, the distinction between "black and white," and favors the variance over the mean. Nevertheless, we require terminology definitions.

Biological Populations

A population of biological organisms is a group that is characterized by its genetic integrity with the theoretical capability that any two individuals of opposite gender in the population are equally likely to reproduce and produce viable offspring. However, some species are parthenogenic, with only females in the population, and others exhibit complex sex switching and asexual reproduction. For parthenogenic vertebrates Dawley and Bogart (1989) is an excellent source of information. The definitions of populations and species are innately similar, and the two terms are often used interchangeably. Populations are typically associated with a defined spatial component, for two reasons: clines (Endler 1977) and metapopulations (Hanski and Gilpin 1997, Hanski 1999). The Western Chorus Frogs from northern Canada and southwest of Utah are the same species and can be considered the same population, because they form a contiguous gene pool. However, individuals from the opposite ends of their distributions, or "populations" separated by rivers or mountains have virtually a zero chance for reproduction. This is termed a population cline where local populations adjacent to each other have a higher probably of genetic exchange than those further away. This results in a cline of genetic differences (i.e., geographic character gradients) along the entire range of a species, as local populations adapt to local biotic and abiotic environments. Metapopulations have been recently recognized as critical in conservation planning. I feel that they are even more critical in deserts, because of the natural fragmentation of habitat patches and aquatic resources, and the severity and high temporal and spatial variability of environments increase the probability of local extinctions.

METAPOPULATIONS

Metapopulation had its original roots in theory (Gilpin and Hanski 1991), but has progressed into practical conservation planning (McCullough 1996, Hanski and Gaggiotti 2004). The application of metapopulation structure and dynamics in conservation planning recognizes that a population is not spread evenly and continuously over the landscape. In other words, the distribution map of a species or population provides the overall geographic limits of the population, but does not provide the finer spatial details of the location of individual population patches. Landscapes are not uniform, and consist of habitat patches. The suitability, quality, or value of a given patch of habitat is species specific. The details of this reality may be easy or very difficult to determine. It is related to the species survival and successful reproduction. Important factors include the general categories of food, water, shelter, and reproductive sites. But the details are intertwined into the interactive factors of physical and chemical environments (e.g., temperature and moisture and its variability), and the often not appreciated biotic environment: competitors, predators, parasites, and pathogens. Therefore, the actual distribution of a population on the landscape is in the form of small patchy-dispersed metapopulations. Because a given metapopulations is small and localized, it has a much higher probably of extinction due to localized events such as catastrophes or local severe environmental fluctuations (e.g., fire, flooding, drought, temperature extremes), or local natural biotic impacts (e.g., predators, parasites, disease), or local anthropogenic pollution or habitat destruction/disturbance (e.g., logging, mining, OHVs). Aquatic pollution is an important stressor in this context.

Metapopulation theory and empirical data are based on the following model. As unfortunate individual metapopulations become extinct, they are recolonized from other viable metapopulations that in the probability sense have done particularly well and have excess individuals that will immigrate to the vacant extinct patches. One can think of the model as lights blinking on and off on a dark landscape as local populations go extinct and are later colonized by immigrants. However, such a model although theoretically pleasing, may be more complex and variable in the real world (Hastings and Harrison 1994).

Birds, especially socially structured species, such as the Florida Scrub Jay (Woolfenden and Fitzpatrick 1984) and Acorn Woodpecker (Koenig and Mumme 1987) have been studied in the context of metapopulations, because they are good dispersers and easy to observe. Anurans that occupy isolated desert springs, in the majority of cases, would not be considered metapopulations, because they are incapable of dispersing across the arid habitat, unless of course, the springs were particularly close to one another or they possessed a stream corridor.

ECOLOGICAL COMMUNITIES

An ecological community is the collection of biological populations in a given spatial context. It is therefore a purely biological concept. For example, there can be plant communities, rodent communities, and predator communities in a section of landscape. Populations within an ecological community may exhibit very strong to very weak interactions with one another: competition, predation (including herbivory), parasitism, mutualism (e.g., hummingbird–flower interaction), commensalism (one species benefits, neutral for the other), or some species within a community may lead independent lives from one another without interacting (e.g., suspected in many plant communities).

ECOSYSTEMS

An ecosystem is the ecological community with the addition of all environmental abiotic factors in a user defined spatial context. The abiotic factors are the nonliving physical and chemical components: detritus or dead organic matter, nutrients and minerals, water, air, sun's energy, and parameters such as temperature, humidity, pH, and other chemical parameters. Ecosystems are frequently characterized by not only their "static" composition of biological, physical, and chemical parameters; but additionally, the dynamics of energy flow, nutrient/matter transfers and recycling, and organism movements BOTH into and out of an ecosystem. The key concept is that energy, matter, and biological organisms flow/move INTO and OUT OF an ecosystem. Ecological systems do not exhibit one-way flow. The delineation of ecosystems is strongly user dependent. Ecosystems vary immensely in scope and size: an acorn, a bromeliad in a tropical rain forest, a deer's rumen, patch of soil, a Mojave Desert spring, the Colorado River watershed, the Mojave Desert, the Pacific Northwest Temperate Rainforest Biome, the Southwest, North America, the Earth. These can all be considered an ecosystem. For the purpose of this report we consider an ecosystem as a specific community with its abiotic processes (e.g., creosote/bursage scrub, pinyon-juniper woodland, a riparian zone, a spring).

LANDSCAPES

A landscape is a geographical spatial unit. Like ecosystems, landscapes are user spatially defined, but traditionally in a larger sense, from square kilometers to regional sizes (e.g., the desert Southwest). The concept of landscapes is based on the reality that the land surface is heterogeneous, consisting of patterns and mosaics of different kinds of ecosystems, succession seres (i.e., different ages of specific ecosystems), and effects of disturbance (natural and human-induced). Increasingly, landscape patterns are more and more reflecting anthropogenic disturbance patterns on global scales. Agriculture, pastures, logging, urbanization, and reservoirs are dominating once natural ecosystem mosaics on the landscape. Native original habitats are increasingly viewed as "patches" on human dominated landscapes. Landscape ecology is an emerging science, which has its own terminology and approach (Forman and Godron 1986, Turner and Gardner 1991, Forman 1995, Turner et al. 2001). Despite the spatial complexity of landscapes, the mosaics and patterns essentially consist of only three major elements: patches, matrix, and corridors. The common example as one flies across Midwestern U.S. is the patches of woodlots in the background matrix of agricultural fields with riparian zones as corridors. The corridors are the links among patches. Along the East Coast are patches of remnant forests surrounded by a matrix of residential development, and corridors of riparian habitat and highways, replacing the once eastern forest deciduous forest matrix and meadow patches created by disturbance (e.g., severe storms, fire, or insect outbreaks). Landscape ecology currently plays a critical and central role in conservation planning and wildlife management (Bissonette 1997, Gutzwiller 2002, Bissonette and Storch 2003).

Deserts not only consist of a broad tapestry of patch mosaics, but patches occur at an incredible range of spatial scales (Wells and Haragan 1983, Cooke et al. 1993, McClaran and Van Devender 1995, Whitford 2002). The patchy nature of desert soil deposition and formation, soil water distribution, presence of shallow bedrock or hardpans, local geomorphology, and fluvial dynamics, all guide and maintain extremely patchy plant communities (McAuliffe 1994). The Southwest is geologically classified as the "Basin and Range," adding mountains to increase the larger scale mosaics of higher altitude ecological communities. The large degree of exposed bedrock, hardpans (e.g., caliche), shallow soils, low ground and shrub cover, and absence of higher canopy vegetation, combined with occasional severe thunderstorms mold the mountainous and rolling landscape into a visually dominant and impressive (especially from aerial views) complex of multi-order dendritic washes, arroyos, and canyons. Based on size and stream-order (and therefore water persistence) these form the xeroparian, mesoriparian, and hydroriparian ecosystems, so critical to desert biodiversity. Perennial surface waters (hydroriparian) in desert environments are rare and unique, and require exceptional protection and a substantial conservation safety net.

REGIONS

A Region is the large geographic context of a continent, and because of its latitude, longitude, location with respect to major land and ocean masses (including wind and ocean currents), and geological history, shares a common general climate and soils. Regional differentiation of local soils and vegetation (i.e., landscapes and ecosystems) are primarily dependent on elevation, geology, geomorphology, and biotic interactions.

Aquatic Resources and Their Classification

The basic classification is from Krzysik (1998). For a more formal treatment see Cowardin et al. (1979), and for an ecoregional and conservation context see Abell et al. (2000).

SURFACE WATERS

Surface waters consist of lakes, ponds, rivers, streams, and playas. Human constructed lakes and ponds are usually called reservoirs when large, and tanks or guzzlers for western small ponds. It is critical to recognize that surface and groundwater are functionally and intimately connected (Hauer and Lamberti 1996, Jones and Mulholland 2000). Wetlands constitute a broad diversity of aquatic resources (Cowardin et al. 1979, Allan 1995, NRC 1995, Keddy 2000, Mitsch and Gosselink 2000). The classification of wetlands is complex and relies on key soil, plant species, and hydrology indicators (EDF and WWF 1992, NRC 1995, Tiner 1998, 1999). Springs are the surface flows originating from groundwater or perched aquifers. The occurrence of seeps are similar to springs except there is only adequate water for local wet soils. However, temporary pools of water can form during periods of heavy precipitation. Marshes are open wetlands characterized by emergent herbaceous vegetation in water-saturated soils, while swamps are characterized by the presence of trees or shrubs. Pocosins are evergreen shrub wetlands limited to local coastal areas of the Southeast. Bogs are peat accumulating highly acidic wetlands with no inflow or outflow, characterized by specific mosses and plant species associations. They develop in northern or alpine moist to wet environments. Fens are their counterpart when there is water flowing into the wetland and the conditions are less acidic. Playas are temporary lakes in arid region low basins that collect water from the surrounding uplands and mountains during the wet season or after significant storms. Because of their nature of receiving runoff water that evaporates, they possess fine silty and clayey soils that are saline and alkaline. They are devoid of vegetation, but their boundaries (riparian habitat) possess characteristic plant species. Floodplains are the wetlands associated with the high flows of rivers and streams.

Lentic—Stationary waters: lakes, ponds, sloughs, quiet pools of streams, temporary pools (including floodplains).

Lotic—Running waters: rivers and streams, springs. Lotic systems are readily classified into stream orders (e.g., Strahler 1964).

Perennial waters—Permanent water—characterized by the presence of fish in most cases, fish were naturally absent in most alpine lakes, and where waterfalls were barriers. The associated riparian zone is called hydroriparian.

Intermittent waters—Predictable seasonal water, present at least for several months to most of the year, generally absent in mid-summer through fall. Characterized by some aquatic insects and crustaceans that are able to complete their life cycle, because of the predictability and duration of surface water, or seek subsurface water during arid periods. Some species of fish (e.g., Fantail Darter) may be able to survive and even feed in interstitial spaces in subsurface water. The associated riparian zone is called mesoriparian. Vegetation in mesoriparian communities is usually very similar to hydroparian because groundwater is typically close to the surface.

Ephemeral waters—Unpredictable waters of shorter duration, lasting from minutes to several hours (e.g., in desert washes), to several weeks, and usually less than one or two months. The associated riparian zone is called xeroriparian. Although the presence of water in first or second order desert washes is very ephemeral, the vegetation along these washes is more diverse and vigorous than the surrounding uplands. This is due to the higher concentration of water, as well as, the presence of ground water closer to the surface for longer periods than in the uplands. Playas are ephemeral waters, in arid regions like the Mojave Desert.

Temporary waters are highly significant landscape elements, but their ecological roles are not appreciated, and typically their conservation status is unplanned and unmanaged. Their ecology is poorly known (Williams 1987). Vernal pools have been signaled out as hot spots of rare or ancestral taxa, and identified as endangered ecosystems (Zedler 1987, Colburn 2004). Vernal pools can be small and ephemeral, but the larger and biologically unique ones are more accurately classified as intermittent.

SUBSURFACE OR SUBTERRANEAN WATERS

The interface or mixing zone of surface and groundwaters is termed the hyporheic zone. The unexpected diversity and abundance of the fauna (including insects and crustaceans) and extent (several kilometers) of the hyporheic zone is just beginning to be appreciated (Sedell et al. 1990, Ward 1992, Stanford and Ward 1993). This zone is even present in desert streams (Boulton et al. 1992, Stanley and Boulton 1993).

RIPARIAN ZONES, COMMUNITIES, OR ECOSYSTEMS

Riparian zones or ecosystems are an integral component of aquatic habitats (Gregory et al. 1991, Malanson 1993, Naiman and Decamps 1997, Naiman et al. 2005). This is the vegetation and soil interface or transition zone between surface or groundwater and the terrestrial environment. This community is characterized by extremely steep physical and chemical gradients, and has very high biological productivity and diversity. Typically in the West, the stream itself is integrally classified with the riparian zone as the riparian community or ecosystem—"the thin green line" that stands out so well in the arid landscape. Riparian ecosystems are classified respectively according to their association with perennial, intermittent, or ephemeral waters: hydroriparian, mesoriparian, and xeroriparian. Riparian ecosystems in the local or regional context are the landscape corridors and central elements of biodiversity and wildlife values (Johnson and Jones 1977, Warner and Hendrix 1984, Johnson 1989, Krzysik 1990, Chambers and Miller 2004).

Conservation Biology Foundations and Principles
Reserve Size

LARGER IS BETTER THAN SMALLER

Larger spatial areas possess larger habitat patches, more habitat patches, and a greater variety of habitat patches. Habitat patches can also be interpreted as biological communities or as ecosystems.

Larger areas innately incorporate the opportunity for more complex patterns and mosaics of habitat patches, including successional stages. Many species depend on this landscape structure, especially edges, the intersection of habitat patches or mosaics.

Importantly, larger areas can withstand more severe, more frequent, or longer duration natural disturbances (e.g., fire, flooding, drought, pest or pathogen outbreaks). Additionally, these natural disturbance regimes are necessary to maintain some biological communities, and also to provide the landscape patch mosaics of multi-sere plant communities or uneven aged forest stands necessary for species coexistence and increased local diversity. Two endangered birds in central Texas require different aged juniper stands. The Black-capped Vireo requires young early succession juniper stands, while the Golden-cheeked Warbler only nests in mature stands. In southeastern U.S., the endangered Red-cockaded Woodpecker only nests in open understory pine forest, while Bachman's Sparrow requires understory thickets. Current active habitat management for the Woodpecker may be having its toll on the declining populations of Bachman's Sparrow. Historically, regional natural landscapes were large enough to support a variety of disturbance mediated patch mosaics throughout the U.S. However, it is becoming increasingly difficult to manage desired patch mosaic patterns in dwindling natural landscapes.

- Larger areas have a more significant probably of including representative regional landscapes, ecosystems, plant communities, and habitat elements.
- Larger areas have a greater chance of possessing regionally rare habitat patches: unique plant communities or physiognomy, unusual soil types or geology, unique geomorphology or hydrology, rare habitat elements, or unique combinations of these.
- Larger areas innately provide a greater number and variety of ecologically important habitat elements: canyons, cliffs, caves, rocky or boulder outcrops and escarpments, talus slopes, springs, seeps, other wetlands.
- Larger areas have more species of plants and animals. The classic "theory of island biogeography" verified continually by empirical studies.
- Larger areas have a greater chance for the presence of rare species of plants and animals.
- Larger areas have larger population sizes of plants and animals, reducing extinction risk from:
  - natural or anthropogenic catastrophies
  - environmental variance (e.g., temperature extremes, droughts, floods)
  - demographic variance (birth and mortality rates, sex ratios)
  - genetic problems, including inbreeding depression.

These four are listed in general decreasing order of importance. However, in some populations, inbreeding and genetic bottlenecks may be a more serious problem.

Larger areas have a greater chance of being a "source population" rather than a "sink population." Source populations provide surplus individuals to recolonize local metapopulation extinctions, or even to colonize new areas. On the other hand, sink populations require recruitment from outside the area to continue their existence.

REPRESENTATION OF REGIONAL LANDSCAPES, ECOSYSTEMS, PLANT COMMUNITIES AND HABITAT ELEMENTS

It is important that reserves, especially those designed for multispecies regional conservation include the full range of:

1. regional landscape patterns and mosaics, including successional seres;
2. plant communities and ecosystems, including aquatic resources and hydrology;
3. rare and unique: plant communities, soil types, geological formations, geomorphology;
4. habitat elements, common and rare

Ecologically important habitat elements include: riparian zones, springs, seeps, other wetlands, canyons, cliffs, talus slopes, rocky or boulder outcrops and escarpments, caves, aeolian sand dunes, desert pavements, and unique geological formations.

Reserve Habitat Condition

NATIVE, WITH NATURAL DISTURBANCE REGIMES IS BETTER THAN ANTHROPOGENIC DISTURBED, DEGRADED, OR POLLUTED

Optimal ecological conditions within a reserve dictate the restoration of damaged or polluted habitats, assessment and management of exotic and invasive plants and animals, and the removal of anthropogenic impacts: mining, grazing, dumping, pollution, recreation trash, closure and restoration of excess roads, restoration of OHV trails and damage, collecting of plants and animals, buyout of private holdings, and sometimes disturbance to wildlife (e.g., nesting peregrine falcons or eagles). Water quality and pollution, air pollution, and noise pollution entering the reserve may be difficult to deal with, but may also be locally or regionally important.

Fragmentation Within Reserves

NONE TO MINIMAL

Habitat Fragmentation within reserves should be eliminated by habitat restoration, including OHV trails and activity; the closure of major roads and excess roads; and the buyout of private holdings. See Reserve Habitat Condition.

Fragmentation Among Reserves

NONE DESIRABLE, BUT MINIMAL IS USUALLY THE GOAL

Reserves should be continuous across political boundaries and jurisdictions, such as agencies, counties, states, and countries. Private land may be an important issue, especially with the current sensitivity and politics of "private-property rights." Ecological processes and biological populations do not recognize agencies or political boundaries. Ideally, reserves need to be broadly spatially connected across these boundaries, or there needs to be an ecological corridor in place. Common landscape corridors are riparian zones and mountain ridges, but habitat ribbons such as forest or grassland strips may be locally of value. If a defined ecological corridor is impossible, there needs to be a transition buffer zone between reserves. The distance between reserves is very critical. The shorter the better, of course, but in some cases, the habitat quality of the buffer zone may be more important than the fragmentation distance. It is important that problems and management decisions are mutually discussed and consensus is reached across jurisdictional and political boundaries.

Partnerships should be actively sought and developed among all land agencies and owners: Federal, state, county, private, and conservation groups (e.g., The Nature Conservancy, local private groups).

Aquatic Resources

AQUATIC RESOURCES ARE A CRITICAL AND INTEGRAL COMPONENT OF RESERVES, PARTICULARLY IN ARID AND SEMIARID REGIONS

Aquatic resources are considered all surface waters and the ground waters and aquifers that sustain them (Johnson and Jones 1977, Cowardin et al. 1979, Warner and Hendrix 1984, Mutz and Lee 1987, Mutz et al. 1988, Gresswell et al. 1989, Johnson 1989, Malanson 1993, NRC 1995, Jones and Mulholland 2000, Keddy 2000, Mitsch and Gosselink 2000, Chambers and Miller 2004). Aquatic resources are both natural and human created, and are physically and chemically extremely diverse, which in turn, makes their biota extremely diverse. Aquatic ecosystems vary from very large reservoirs, lakes, and major rivers, to small streams, springs, seeps, playas, and a broad variety of wetlands (Cowardin et al. 1979, NRC 1995, Keddy 2000, Mitsch and Gosselink 2000). See Aquatic Resources and Their Classification in the Definitions section.

Aquatic resources are critical ecosystems or landscape elements in all global ecoregions, but nowhere are they more important for characterizing the landscape, mediating ecological processes, and determining local and regional biodiversity than in deserts and semiarid landscapes (Krzysik 1990). In the U.S. and Canada 90% of the anurans, 84% of salamanders, 81% of chelonians, and 41% of snakes are riparian or aquatic species. Although a major evolutionary response for reptiles and amphibians in North American deserts has been to increasing aridity, only 37% of the species are nonriparian. Five common lizards typically considered and classified as upland desert scrub species (Tree, Desert Spiny, Collared, Side-blotched, and Western Whiptail [*Cnemidophorus tigris*] lizards), are nevertheless much more abundant near and in riparian communities and associated washes. The same association is also true for desert snakes. Invertebrate and vertebrate prey are more abundant, active, and predictable in and around riparian zones and springs.

Birds are particularly attracted to riparian communities for breeding, over-wintering, and migration rest-stops (Krzysik 1990). Carothers and Johnson's (1975) estimated 2,118 birds per 40 hectares in an Arizona cottonwood/willow riparian zone. This was the highest concentration of breeding birds recorded in the continental U.S. Johnson et al. (1977) reported that 71% of the bird species nesting in the nonmontane Southwest preferred or required riparian habitat. Riparian mammals have not been studied to the same extent as bird communities, but the use of riparian zones and surface water has been well-established for game species and predators. Bats are well-represent both is species and numbers in the Southwest deserts, and they extensively forage over the canopy of riparian vegetation. In the arid central Mojave Desert, three species of rodents have only been captured in riparian zones or at springs despite extensive sampling in all available communities: Cactus Mouse (*Peromyscus eremicus*), Desert Pocket Mouse (*Chaetodipus penicillatus*), and Western

Harvest Mouse (*Reithrodontomys megalotis*) (Krzysik, data). These species are found in other habitats in more mesic parts of their range.

Presence of Nonnative and Alien Species in Reserves

AS A GENERAL RULE NONNATIVE PLANTS AND ANIMALS SHOULD BE REMOVED FROM THE RESERVE

The issue of nonnative or alien species is one of the most complex, and a truly difficult one to deal with from virtually all dimensions: biological, economic, political, social, and ethical. Most would agree that the removal of noxious, invasive, or fire hazard weeds is very desirable. However, how about the removal of trout, salmon, largemouth and smallmouth bass, and walleyes from outside their respective native ranges? Science can discuss the trade-offs made, technical consequences (but often unknown), and potential ecological damage of exotic fish introductions, and this must be considered and balanced against the desirable objectives and goals of a recreational fishery, a social and moral context. Nevertheless, fish transplants, particularly in the West, were made long before there was scientific guidance, ecosystem considerations, or legal oversight. Besides game fish, Bullfrogs, aquatic turtles, crayfish, and now mollusks (mussels, clams, snails) represent nonnative species that are invading U.S. aquatic habitats. The introduction of the mosquito fish for mosquito control or “just because a spring held no fish” was perceived as beneficial or at the worst harmless. Nevertheless, this tiny fish has wrecked aquatic ecosystems all over the planet. These planned and accidental introductions are having deleterious and profound impacts on native resident species. These aquatic species, but especially invasive plants (both terrestrial and aquatic), are very difficult to remove once established. They cover extensive areas, and in the case of terrestrial plants, have a significant seed bank to deal with. Exotic large mammals such as burros and horses can damage local springs and waterways, and compete for forage and water with native desert bighorns. Although these mammals are relatively economical to eliminate, public emotions have run high when removal was planned. In this case, live-capture and relocation or adoptions are expensive options for budget-constrained agencies.

Roads

THE FEWER THE BETTER

The automobile (or is it now the SUV and pick-up) and the necessary associated roads are possibly the major characteristic of the U.S. and the American way of life. Roads represent a number of diverse and serious ecological problems for our biota, and the design and management of conservation reserves (Langton 1989, Sherwood et al. 2002, Forman et al. 2003, Macdonald 2004). A major effect of roads is of course direct highway mortality. An estimated 51,000 wild vertebrates were killed in a year in and around Saguaro National Park, Arizona (Arizona Daily Star, Tucson, A.E. Araiza, 16 May 2005; available at http://www.cnah.org). This includes both the east and west sections which are separated by 50 km on opposite sides of Tucson. These data does not include invertebrates such as tarantulas and scorpions. The vertebrate mortality was as follows: reptiles (27,000), amphibians (17,000), mammals (6,000), birds (1,000). There are massive kills of Red-spotted and Green Toads (*Bufo debilis*) and Couch’s Spadefoots at Saguaro National Park, with the evidence that the road kill is seriously affecting Green Toad populations.

It is very difficult to accurately assess highway wildlife mortality, especially in the arid Southwest. Ravens, and other scavengers, are very effective at rapidly locating and completing removing smaller and manageable road-kills. Snakes, lizards, and amphibians are quickly removed from sight. Raven populations have increased significantly in the Southwest, following humans into the desert and their associated road kills, refuse, perching-nesting structures, and water development.

Farrell (1989) estimated that along identical survey routes in the eastern Mojave Desert of California and extreme southern Nevada, raven populations increased by 350–875% between 1967–1969 and 1988-1989 surveys. USFWS (1994) has used figures as high as a 15-fold increase of raven populations in the Mojave Desert, based on USFWS's annual breeding bird censuses. Ravens have been heavily researched and identified as an important predator (at least in some populations) on Desert Tortoise hatchlings, but the species must also be a significant predator on other wildlife as well (e.g., snakes, lizards, small mammals, and birds and their nests).

Large carnivores such as bears, mountain lions, wolverine, grey wolf, lynx, and fisher possess very large home ranges, and possess very low adult mortality rates. For these reasons they are significantly susceptible to the effects of road mortality, even though their absolute mortality numbers may be low. The highway death toll for the Florida Panther, a rare listed endangered species, has severely hampered recovery efforts. When I80 was first constructed in central Pennsylvania, running the entire state from east to west, it was reported to have the highest mortality of black bears in the country.

Roads can change animal behavior and physiology. It is suspected that animals change their home ranges or migration routes to avoid roads. Animals are exposed to greater physiological stress by the sudden noise, lights, or near misses along roads.

Herpetologists have long appreciated that during population explosions in some frog species (e.g., Northern Leopard Frog) there is a great deal of dispersal among habitat patches with very high road mortality. Local road kills can be so high that the slippery carcasses become a hazard to motor vehicles. Many species of amphibians, including salamanders, frogs, and toads make long journeys for explosive breeding episodes in permanent or predictable temporary aquatic habitats. These migrations often require road crossing when going to and from breeding sites. An observant motorist will note that the road mortality of raccoons, skunks, opossums, and other mammals is greater in the spring and fall. This is because habitat-use, hibernacula, and spatial home ranges may vary seasonally, especially between winter and summer. Again roads must be crossed. Highway mortality for deer increases during both small game and deer hunting seasons, as the number of people increase in the habitat and there is gunfire.

Snake populations are highly effected by road kills. Most snakes are highly fossorial during the day and retreat to rodent burrows, rocky crevices, or bury themselves in loose sandy soils to avoid high temperatures and predator exposure. They begin to actively forage in the evening and morning, and are often strongly attracted to the warm black-top or concrete road surfaces where they spend a significant amount of time. Many species of desert snakes were assumed to be extremely rare until night road surveys by herpetologists discovered that they were common to very abundant (e.g., night snakes [*Hypsiglena*], long-nosed snakes [*Rhinocheilus*]). Pet trade collectors may concentrate their efforts on night road collecting. To make a bad situation even worse, experimental studies using Styrofoam models placed on roads with a hidden observed, verified that motorists tried to avoid hitting rabbit, squirrel, bird, and turtle models; but some actively attempted to run over snake models.

The ecological effects of roads are directly related to their location, nature and condition of adjacent habitats, age, traffic density, vehicle speed, road width, and road surface material. Many roads are constructed over old trails along rivers and streams, an area of high wildlife activity and value. Wide hard-surfaced roads pose much more of a barrier and a crossing hazard than narrow country dirt roads. This is a function of traffic density, vehicle speed, noise, lights, time involved to make a safe crossing, and "substrate suitability. The surface of a dirt road represents a more familiar habitat experience to an animal than asphalt or concrete, excluding the attraction of snakes to warm surfaces.

Roads are commonly implicated as barriers for wildlife, especially the wide interstate heavily traveled high-speed highways. This would certainly be the case for species that are small, have limited mobility, slow moving, sensitive to desiccation, high habitat specialists, or poor dispersers. Some forest species of butterflies will not cross open areas such as fields or roads. Correspondingly, some field butterflies will not enter the shade of a forest.

Roads can also act as corridors for some species. This would be good in specific cases where dispersal is desired. However, it could also be harmful if roads spread alien or invasive species (both plants and animals), or parasite and disease organisms. Dispersal is not desired if the movement negatively affects desired population distribution, or it guides individuals to higher mortality, either on roads or in lower quality habitat.

Roads may improve the habitat around them. Vegetation is often denser, taller, more diverse, and more vigorous along roads, because of the increased water runoff from roads from precipitation. This is evident even along small dirt roads. Additionally, road associated drainage ditches may retain water pools longer and more predictably. The vegetation and/or surface water may attract some species, increasing their chances of becoming a road kill. Desert Tortoises are frequently observed along roads feeding on blooming winter annuals. These annuals are significantly more abundant and vigorous along road-sides than in the surrounding desert.

Roads may also significantly degrade the habitat around them including:

- Affecting water quality and soils through input of: sediments, nutrients, road salt, hydrocarbons, organic and inorganic chemicals, and heavy metals
- Changes in local hydrology
- Pesticide applications, especially herbicides to maintain road-side clearance, but also insecticides (e.g., mosquitoes)
- Fugitive dust covering plants and reducing photosynthesis, respiration, and transpiration; common in deserts, and destructive to lichens and mosses
- Increased soil compaction
- Microhabitat higher temperatures, lower moisture and humidity, and increased light levels.

Roads may provide significant pollution effects that are not usually considered, acknowledged, or even appreciated. Air pollution (e.g., ozone, nitrogen oxides, and hydrocarbons) from vehicle exhaust is the most obvious, including at one time a significant source of environmental lead. The effect of hydrocarbons (oil, hydraulic fluids, gasoline, grease, and antifreeze) on aquatic ecosystems and soils is much less appreciated, because the contaminant concentrations are typically so low that they are considered benign, unless of course, there is a major spill or accident. The hazards and risks of even parts per billion environmental hydrocarbon concentrations are being increasingly brought to the publics attention (e.g., Ott 2005 and pers. comm.). The Forest Service has conducted research demonstrating that even small dirt roads generate a great deal of erosion and contaminate streams with sediments. Runoff sediment and bank erosion are the most significant component to stream and river water quality and substrate integrity. In the eastern U.S. and elsewhere, the use of winter road salt has increased the salinity of local soils and stream, resulting in the mortality of road-side pines.

Roads are strongly implicated with the maintenance and spread of alien, invasive, and noxious weeds. This occurs for a number of reasons. Weed seeds are dispersed along roads by vehicles, humans, and pets. Additionally, most weedy plants are dependent on disturbed soils, the elimination of native competitors, areas of bare ground, or increased light levels. Many exotic species are planted along roads to control erosion or as decorative landscaping.

Roads crossing streams provide access to illegal and ecologically detrimental, but often good-intentioned, introductions and releases of: fish, amphibians, turtles, mollusks, and other aquatic organisms. These can be game species, bait, excess or unwanted pets, or species captured in different parts of the country.

It is no accident that major residential and commercial development occurs along highways, mainly expressways, but even small roads—the "Ribbon Sprawl" (Enger and Smith 2002). The public road system in the U.S. was estimated to cover approximately 1% of its land area, but the ecological effects and footprint of roads was estimated to cover one-fifth of the U.S. landscape (Macdonald 2004).

Roads provide access to humans. This is another unappreciated negative impact of roads. There are of course, both legitimate and detrimental uses of roads in wildlands and reserves. See the section below dealing with "Humans in Reserves."

Reserve Ecological Processes and Biological Communities and Populations

This is the bottom line and represents the ecological integrity and biological viability of the reserve. Ecological integrity and biological viability can be defined thusly; ecosystems and their patterns on the landscape are fully functional, interactive, and sustainable in ecological time and populations possess the demographics, genetic capacity, and variability for evolutionary potential. Evolutionary potential is critical, because this represents the ultimate long-term adaptive response of populations to biological, chemical, and physical selective pressures. This is a most critical requirement in the era of rapidly changing environments from: anthropogenic disturbance and fragmentation, invasive alien species, and global warming.

The assumption is made that if all previous reserve parameters are optimized to a high degree, this one will fall into place. Although this is a justifiable assumption and a working hypothesis, the concept of "source and sink" habitats has opened, at least slightly, the door to exceptions. The most profound and documented example is probably the decline of eastern neotropical migrant birds in most parts of their range. Although habitat destruction and degradation has occurred throughout their breeding, migratory, and wintering ranges, this is not the complete story, because sink populations exist in good habitats. The overall problem is that forest fragmentation has directly exposed nesting songbirds to cowbird brood parasitism, and both tree and ground nest predation at habitat edges. Nest predators include: raccoons, skunks, foxes, coyotes, feral cats, crows, grackles, jays, and rat snakes. All these predators either find the hunting more rewarding, or are more efficient at habitat edges. Cowbird populations have dramatically increased as a result of: forest fragmentation, the availability of winter forage at stock feed lots, and agricultural crop residue in the field. Cowbirds avoid large continuous blocks of eastern forest, and generally do not penetrate beyond 1 km.

Pathogens, diseases, and parasites, although components of natural ecosystems, and can be classified with ecosystem biological processes, nevertheless, can cause minor to severe problems in managed target populations. This was not typically a problem (or so we think) in natural landscapes that were very large, because the vector would not be active "everywhere" and with large and widely dispersed host populations, some would have a greater degree of immunity. However, when reserve size and/or protected population numbers are smaller, pathogens can have a serious effect. We have also added two additional anthropogenic effects to make a bad situation worse: populations may be physiologically stressed from other cumulative impacts; and humans or their pets have spread disease organisms far beyond their original native boundaries. Therefore, great appearing habitats and high productivity, may not always indicate that things are going well for target species management.

Humans in Reserves

Anthropogenic effects on regional ecology, landscapes, ecosystems, and biological populations are well known and well documented. They are of two general and quite different natures. The large-scale obvious transformers of wildlands and habitats that drive the creation of reserves are simply the direct products of civilization and its economics. These impacts include: agriculture, timber and forest products production, mining, fossil fuel extraction—production—energy-use, grazing, animal stock operations, and development of residential, commercial, and industrial landscapes with all their associated infrastructure, including highways and roads. All of these impacts directly consume natural landscapes, but their air, water, and land pollution effects reach far beyond their immediately impacted footprints.

The other nature of human impact is the effect that humans have on wild landscapes, including conservation reserves. There is no denying that people require roads for backcountry recreation, including access to hiking, camping, bird-watching, wildlife photography, fishing, hunting, meditation, stress relief, and just plain getting away and enjoying nature. These are all legitimate pursuits that should be encouraged, because in the end citizens will support preservation of wildlands and their associated fish and wildlife. These activities are typically well-managed and regulated by professional natural resources and wildlife/fish agencies. Nevertheless, roads provide ready access to wild areas where the public can and do damage habitats and resident species. It is difficult to protect and enforce regulations in large remote areas. These activities, although probably carried out by a small minority of the public, can do significant damage and generate disproportionate negative publicity. These activities include: off the road OHV use; casual shooting of animals or large plant specimens, extensive collecting of plants and animals for themselves, landscapers, or the pet trade (including night snake collecting along roads); trash dumping, purposeful or accidental disturbance of wildlife or bird nesting; and the potential for purposeful or accidental fires.

Agency Listed Threatened, Endangered, Special Concern, or Sensitive: Species, Subspecies, Populations, or Metapopulations

Federal and state laws and regulations mandate the protection, management, and restoration of listed species, including the designation of critical habitat. The designation of critical habitat has often been either delayed, inadequate, or blatantly ignored. The planning and designation of optimal or at least adequate conserve reserves to protect representative regional landscapes and ecosystems as outlined in this summary would theoretically at least supercede the need for species or population listings. In other words, if species maintain adequate population sizes and genetic variability, and their landscape pattern and ecosystem needs are met in terms of size and quality, they will not get on anyone's endangered species list. Ignoring, of course, natural background extinctions (Lawton and May 1995). After all, this is the purpose of multispecies conservation plans and reserves, to prevent the listing of species.

The fact that many species are currently listed, an even greater number require listing (but are denied because of political pressure and inadequate resources), and that the majority of listed species are not recovering, leads to the conclusion that regional landscapes and ecosystems are not adequately identified, protected, and managed. The biological challenges and political stumbling involved in saving listed species are incredible in scope and operation (Tobin 1990, Kohm 1991, Rohlf 1991, Scheuer 1993, Tear et al. 1993, Wilcove 1993, NRC 1995, Burgess 2001, Czech and Krausman 2001).

Global Warming

The global warming issue is a daily occurrence in newspapers and both the popular and scientific literature. Global warming has primarily been attributed to the increase of atmospheric green house gasses, primarily carbon dioxide (CO_2), as a result of burning fossil fuels (coal, oil, natural gas), deforestation, and agriculture. The effects on biodiversity, wildlife, and their habitats are continually being debated (Schneider and Root 2002, Lovejoy and Hannah 2005). That global warming is a reality is uncontested by credible scientists. The problem for long-term reserve design is that reserves will be subjected to more severe and frequent weather disturbances such as droughts or floods, and become drier or wetter. Their plant communities could effectively be moving further north or higher up the mountain. The only buffer for these long-term effects is again directed to the basic principles discussed above. Large size, regional representation, minimal degradation, minimal fragmentation, high landscape connectivity, adequate buffer matrix and zones, minimal impacts on aquatic resources; would all directly and substantially benefit the persistence of landscape reserves in the face of global warming.

Optimal Assessment and Monitoring of Reserves

It is technically difficult and economically prohibitive to assess and monitor the major and important ecological processes: productivity, biogeochemical cycling, microbial dynamics, disturbance, succession, and community interactions; or community populations of plants, vertebrates, and invertebrates. As an ecological surrogate for these detailed and complex processes and population structures it may be sufficient to broadly and generally assess the continued spatial extant of current major plant communities and presence of vertebrate species and subspecies. Plant communities could be monitored with satellite imagery backed-up with ground-truthing. Vertebrates could be assessed and monitored with relatively simple and straightforward survey designs for presence/absence and relative numbers.

Appendix F
Future Considerations for Desert Tortoise Sampling, Assessment of Conditions and Trends in Metapopulations, and Long-Term Monitoring

Desert Tortoise Spatial Population Structure:
Low Density Populations and the Case for Metapopulations

Historical desert tortoise population densities of greater than 250, to over 1,000–2,000 per square mile have been reported by Berry (1984) in her long report on the status of the desert tortoise. Bury and Corn (1995) extensively reviewed early naturalist observations and the technical literature, and challenged these high density estimates, and even recent declines in population densities. As more density estimates data became available in the 1990s, it became apparent that much lower desert tortoise population densities, on the order of <50/mi^2 (<19/km^2) or even <20/mi^2 (<8/km^2) were more typical, with occasionally local populations reaching 200/mi^2 (77/km^2). It also appears that since the late 1970s desert tortoise densities have declined, sometimes catastrophically, in many parts of their range (discussed in Section, Status and Trends of Desert Tortoise Populations). We completely agree with Bury and Corn (1995) that desert tortoise densities of <20/mi^2 represent viable and critical population segments for one or more logical and important reasons. These “low” population or metapopulation densities may represent:

- the “normal” historical densities in the majority of desert tortoise habitats,
- “corridor or peripheral populations” that recolonize or maintain genetic integrity among more dense “core populations,”
- a new colonizing population,
- a newly recovering population.

Currently we cannot distinguish among these alternatives, and they may all be important to the long-term sustainability of desert tortoises throughout their range.

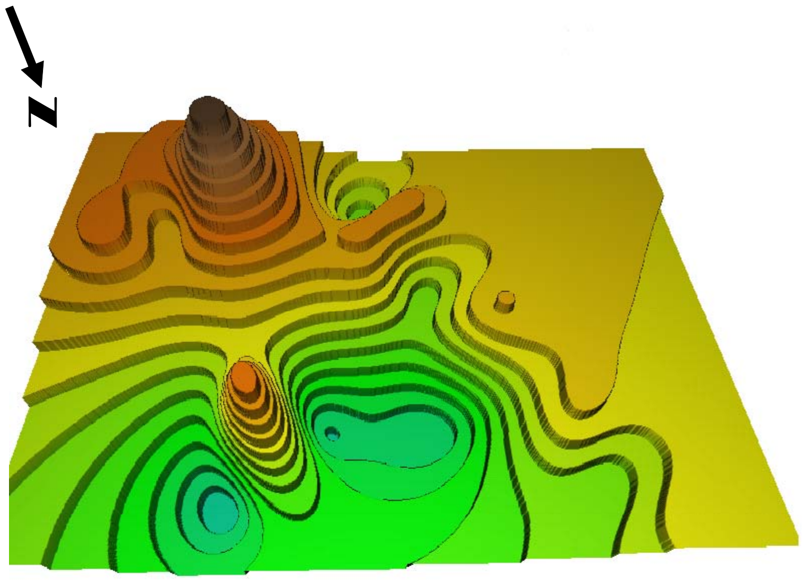


FIGURE F-1. Thin-plate spline representation of desert tortoise distribution-density surface at Sand Hill, Marine Corps Air Ground Combat Center, Twentynine Palms, California, southern Mojave Desert. Note that the orientation of the figure is to the south. Krzysik 2002, Figure 8. Note the high local density of desert tortoises in the southeastern portion of Sand Hill, an area planned for more intense military training activities, before these data were collected. Also note the low density of desert tortoises in the central portion of Sand Hill, an area designated as a desert tortoise conservation zone.

Desert tortoise populations are very patchy on the landscape (Duda et al. 2002, Krzysik 2002, Figure F-1). The patchiness becomes extreme when there is significant habitat damage and fragmentation (Krzysik 1997). The patchy landscape spatial distribution of desert tortoises has been acknowledged and appreciated by experienced field biologists. Why are desert tortoise populations so patchy in the landscape? A prime factor would be habitat quality and all its facets: seasonal food resources, mineral or micro-nutrient availability, soil characteristics for burrowing, caliche caves or deep burrows for hibernacula, local surface water availability after precipitation, hatchling requirements and survivorship, etc. For example, big galetta grass (*Pleuraphis rigida*) is associated with sandy soils and is patchy in its distribution, and may be important summer forage for the desert tortoise (A.J. Krzysik, personal observation). Other important factors could be: social structure, optimal microclimates, reduced predation or competition, reduced parasites or pathogens, or historical events not currently obvious. Although there has been research in this area, no overriding conclusions are evident. Undoubtedly, focused hypothesis based research could unravel this mystery. Regardless of the details, the patchiness of desert tortoise distributions suggests a metapopulation structure that has significant implications for desert tortoise natural history, genetics, survival, and ultimately evolution (Hanski and Gilpin 1997, Hanski 1999, Hanski and Gaggiotti 2004). The DTRPAC report correctly emphasizes that the management, recovery, and long-term viability strategies of desert tortoise populations are quite different under metapopulation contrasted to continuous population models (Tracy et al. 2004). Important considerations under metapopulation models include: landscape and local habitat fragmentation, road effects, connectivity (corridors) among habitat patches, the relationship between habitat quality and its patchiness, spatial structure of habitat mosaics, spatial asynchrony in metapopulation dynamics, role of habitat elements (e.g., washes, caliche caves), the importance and protection of suitable habitat without tortoises, habitat restoration and enhancement, genetics management, and translocation strategies and considerations.

Estimating Distribution and Density Patterns of Biological Populations

Population densities of animals are notoriously difficult to estimate accurately (Krzysik 2002, see Introduction and References). New information since this publication, have further elucidated the statistical uncertainties and spatial problems involved in assessing and monitoring species and population distribution and density patterns on landscapes (Borchers et al. 2002, Pollock et al. 2002, Scott et al. 2002, Buckland et al. 2004, Thompson 2004, Amstrup et al. 2005, MacKenzie et al. 2006). Estimating desert tortoise densities are particularly difficult because tortoises: must be sampled on landscape scales, typically occur at low densities, are patchy in distribution (possess high spatial variability), exhibit a high variability in surface activity (spending over 95% or their lives in burrows) making sample observations highly opportunistic, and occupy a greater variety of habitats than typically acknowledged (Krzysik 2002). Even when desert tortoises are at their highest peak of surface activity, the spring following heavy winter rains, they spend a little over half of their diurnal period in their burrows (Krzysik 2002, Figure F-2).

All these characteristics of desert tortoise populations severely challenge sampling designs, statistical inference, and interpretation of statistical analyses. A major universal problem when monitoring biological populations on landscape and regional scales, regardless of which approach and sampling design is used, is the uneven distribution of target organisms on the sampling frame. Biological organisms actively select and differentially distinguish different habitats, microclimates, spatial patches, or environmental gradients in the landscape, sometimes in a predictable way, sometimes not. Despite the fact that both field biologists and statisticians have always fully appreciated this situation, the problem persists both technically and operationally.

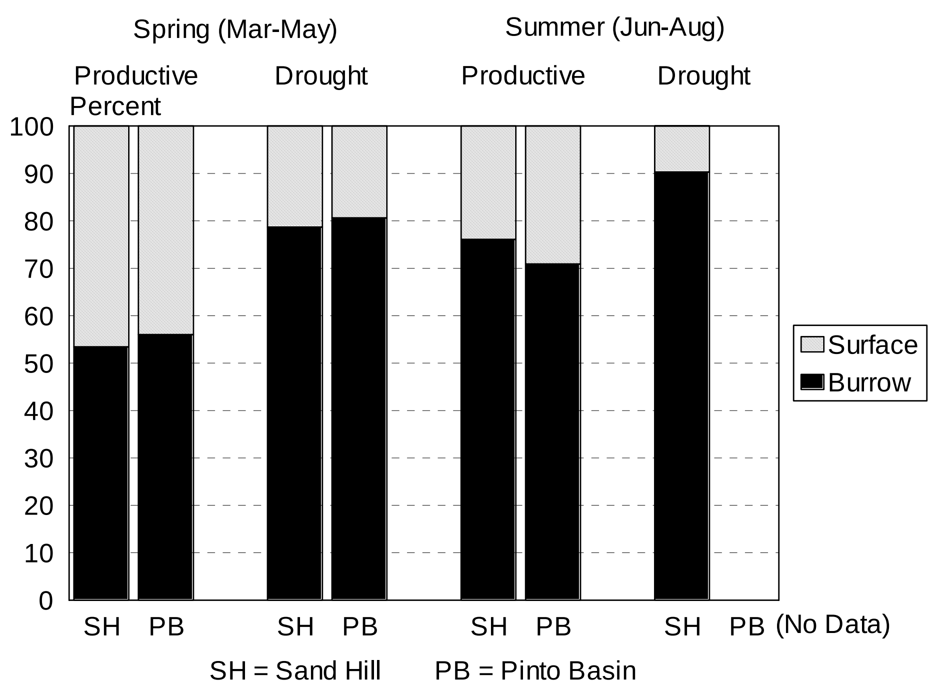


FIGURE F-2. Distribution of desert tortoises on the surface and in burrows at Sand Hill and Pinto Basin during the spring and summer of a productive year (1995) and a drought year (1996). The data was collected from tortoises that were fitted with radiotelemetry transmitters. Sand Hill $n = 29$, Pinto Basin $n = 9$; data from Duda et al. 1999.

The critical and initial component of any ecological or population monitoring effort, especially a long-term program, is the development and specification of objectives and goals. Additionally, in order to be scientifically defensible and justifiable for management options and decisions, the monitoring program must be driven by a priori generated hypotheses that represent important, valid, and attainable conservation criteria. For example, when the distribution and/or density patterns of desert tortoise populations defined by a quantitative metric "N" decline by "X%" in time period "Y," with "Z" the error term (e.g., 90% confidence interval) of X, then management option "M" is implemented. The relative values of these metrics are derived from the integrative efforts of ecologists familiar with the natural history of desert tortoises and their habitats and the implications and complexities of long-term monitoring, sampling design, and statistical analyses; resource managers responsible for implementation and monitoring; and the public and agency decision makers that represent societal values and future desired conditions. The monitoring efforts of an apparently declining species at low population densities that has a patchy distribution on landscape and regional scales represents a significant technical, operational, and economic challenge.

Statistical Power

Statistical power is critical to any sampling design, but this is rarely considered (Toft and Shea 1983, Cohen 1988, Fairweather 1991, Thomas and Krebs 1997, Bausell and Li 2002). The high inherent variability of environmental responses and population fluctuations presents formidable obstacles to designing monitoring programs with adequate power to detect changes and trends (Peterman 1990a, Pechmann et al. 1991, Ose2nberg et al. 1994). Peterman (1990b) found that 98% of papers in fisheries and aquatic sciences that did not reject a null hypothesis failed to report statistical power. Statistical power is tied to three factors: the 1) desired "difference" or "effect size" one considers important at a 2) chosen level of statistical significance and 3) sample size. For example, what is the statistical power in the following hypothetical distance sampling (DS) assessment of estimating tortoise densities at five DWMAs based on a total of 120 samples (i.e., DS transects, not number of tortoises observed)? Assume that each DWMA had 24 very long transects, and that an average 30 tortoises/transect are observed at each DWMA. Suggested sample size for DS density estimates is 60–80, but 40 may be adequate (Buckland et al. 1993, page 14), and good results have been achieved with N = 20-30 (A.J. Krzysik, DS data analyses and modeling). Let us assume that we wish to detect "significant" population changes in pair-wise comparisons of these DWMAs at the 0.05 significance level (two-tailed, and the common significance level used in ecological studies) where we want to detect the difference in DWMA means that is at least 80% of the pooled standard deviation. Assume that one of the DWMAs had an estimated 75 tortoises/mi^2, and another 50 tortoises/mi^2, and the standard deviation (pooled for all 5 DWMAs) of density estimates was 30 tortoises/mi^2 (tortoise sample variances are typically very high so this is a conservative value). The statistical power for this comparison is 50%. This of course is unacceptable. Although there are no absolute standards, power levels on the order of 80–90% are usually desirable, and certainly those below 50% are inadequate to have confidence in statistical significance. If one had to judge if the difference of 6 tortoises/mi^2 between two populations was statistically significant, we would be doing this at a statistical power of 2%. However, if we were comparing population density change over a specific time period in a single DWMA at a sample size of 60 transects/DWMA we could detect a change (up or down) of 15 tortoises/mi^2 with a statistical power of 77%.

Recall that this hypothetical discussion required the observation of 3600 tortoises (120 transects × 30 tortoises/transect). Six live tortoises were reported in 166 km of transect surveys in 2001 in Piute Eldorado (Tracy et al. 2004, page 87). If this is indeed an accurate estimate of the tortoise encounter rate in Piute Eldorado, it would take a total of 830 km of transects for a sample size of 30 tortoises for DS estimation for a *single* population sample. Of course, smaller numbers of tortoises could be modeled with DS, but this would increase the variance of estimated tortoise density on a transect. It is important to remember that we are dealing with two variances (uncertainties or error estimates) when estimating densities at a given DWMA: the variance associated with a single transect density estimate, and the variance among transects. Clearly, there are significant technical, economic, and logistical challenges in sampling landscape scale desert tortoise populations.

Type I and Type II Errors

The desired accuracy in estimating tortoise densities both spatially and temporally for making land management and conservation planning decisions in the context of adequate statistical power and balancing Type I and Type II errors remains a significant challenge. Type I error is the rejection of a true null hypothesis, while Type II error is the failure to reject a false null hypothesis. In other words, one has to decide whether Type I or Type II error is more important (or risky) to the statistical inference of interest. Do we imprison some innocent citizens to make sure we get all the guilty (Type I), or do we let some guilty free to make sure we don't imprison some innocent (Type II)? In conservation biology we should desire to minimize Type II error. Type II error in conservation biology or planning is the failure to detect population declines, habitat deterioration, increasing pollution levels, or global warming. An appropriate strategy for a "balancing act" to minimize both Type I and Type II errors is to strive for the combination of: (1) decrease α (the statistical significance level or probability of making a Type I error), (2) use conservative statistical methods, and (3) increase sample sizes. Also, the best way to increase statistical power is with higher sample sizes. The other two alternatives for increasing power are not as desirable: choosing a larger and less stringent α (increases Type I error), or increasing the magnitude of the "effect size" that is considered "biologically significant." Of course, the "effect size" to detect desert tortoise population density trends is critical for adaptive conservation management. Fortunately, there are several statistical hypotheses or experimental design features that can help to reduce effect size, such as: blocking or stratification to reduce inherent among sample variance; using metrics that are reliable, precise, and/or sensitive; using repeated measure as a design feature; basing hypotheses on main effects and not interactions; and using direct rather than indirect dependent variables, indicators, or indexes.

Stratification of Sampling

Sampling designs that incorporate stratification are usually considered better than those using pure systematic and/or random designs (Green 1979, Levy and Lemeshow 1999, Lohr 1999, Manly 2001, Thompson 2002). The sampling intensity or sample sizes per stratum are determined by area size or relative proportion of expected encounters of the sampling unit of interest. In the case of landscape sampling for desert tortoises, separate strata for sampling could include: creosote/bursage scrub <900 m (2,953 feet), creosote/bursage scrub >900 and <1200 m (3,937 feet), mountain scrub >1,200 and <1,600 m (5,250 feet), yucca woodland, and saltbush scrub. Stratification could also be based on relative landscape disturbance, soil type, substrate texture, slope, slope aspect, or topographic complexity. Sample sizes in each stratum could be based on relative spatial extents of the strata or modeled expected relative densities of tortoises. Indeed these strata could be made subsets of the primary strata based on plant communities and elevation. The purpose of stratification goes far beyond the interest in developing a species-habitat model, although this is surely important. The desert tortoise, indeed any species, is not evenly or randomly distributed on the landscape, but demonstrates habitat preferences, based on many biotic and abiotic factors, often unknown. Therefore, a purely random or systematic sampling design shows a great deal of spatial variance (high sampling variability) for population densities. This makes both spatial and temporal statistical inferences more tenuous unless statistical power and sample sizes are increased. By analyzing spatial or temporal data incorporating strata, sample variance decreases, statistical inferences become more confident, and statistical power for a given sample size increases. Therefore, analyses are more efficient, reliable, and economic. However, it must be remembered that at smaller spatial scales (e.g., within the species-selected habitat) distribution of population individuals may be very even (e.g., territorial songbirds), or completely random (e.g., spider distribution in a grassland).

Stratified sampling may be difficult to accomplish with desert tortoises for several reasons: low population densities, sampling required on very extensive landscapes, the species is relatively a habitat generalist, and the delineation of sampling strata is not as clear-cut for the desert tortoise in Mojave scrub as it may be for other species in other regional landscapes. McDonald (2004) suggests that stratification may not be useful for rare populations. Domain estimation may be an important way to identify subgroups or subpopulations (strata) during the analysis phase when sampling is strictly systematic or random (i.e., unstratified) (Cochran 1977, Lohr 1999). However, we don't believe that this has been attempted with biological populations.

How does this information help in designing desert tortoise sampling and monitoring programs? The issue to stratify, not to stratify, or incorporate domain estimation for desert tortoise sampling is a most important one, and requires additional field explorations and statistical modeling. Another important design element is the achievement of adequate statistical power and sample sizes (both tortoises and transects) for accurate density estimates, as well as, the statistically valid and reliable detection of population density trends. The collection of large sample sizes is expensive. Unfortunately, the estimation of tortoise densities that are statistically reliable to assess population changes on landscape scales may be economically unfeasible. A more practical strategy may depend on the use of indicators, indexes, and/or indirect metrics that are biologically and ecologically relevant to desert tortoise viability and long term persistence. Indirect metrics include the monitoring of habitat condition, physical and biological indicators, and threat/stressor parameters. In the next section we will review traditional approaches used for monitoring desert tortoise populations, identify problems and shortcomings with these methods, and discuss novel techniques and state of the art monitoring approaches for rare populations.

Current Status of Approaches to Assessing and Monitoring Desert Tortoise Populations

Field biologists and statisticians recognize that there are many approaches and specific methods to estimate spatially explicit population densities of biota. There are major differences among approaches in accuracy, precision, efficiency, and economy, but nevertheless, the primary determinant for design and methodology directly rests with relevance to conservation planning and land manager objectives. For example, is it worth 80% more time and effort to obtain 10% more accuracy? The answer can be either yes or no, depending on the relative importance of accuracy, desired conservation planning objectives, and the availability and cost of dedicated resources, including time and labor.

Permanent Plots

Permanent 1-mi^2 square plots were established by BLM in California in the early 1970s, Nevada and Utah in 1981, and in Arizona in 1987 (Berry 1984, reviewed in Tracy et al. 2004, see Table 4.2, page 48). Although a number of desert tortoise biology and habitat parameters were monitored, the plots were also intended to provide time-series population trends. Unfortunately, these plots cannot be used to provide landscape, DWMA, or regional, reliable and statistically valid population trends. There are a number of significant reasons:

- small sample size,
- lack of randomization in location,
- inadequate coverage of landscape or region of interest,
- inadequate number of years of data for a given plot,
- unbalanced plot-year sampling design, different plots were surveyed in different years,
- mark-recapture data provide “number of animals” not density estimates.

These problems negate both spatial and temporal comparisons or trends because of statistical validity issues, low statistical power, spatial unrepresentation, and reliable density estimation. In order to estimate density from mark-recapture numbers, the “effective trapping area” or “area of influence” must be estimated, and this is a formidable task (Seber 1982). Even a carefully designed multiyear mark-recapture study by Freilich et al. (2000) on a 1-mi^2 plot refrained from estimating desert tortoise densities because of this difficulty.

There is no question that the use of permanent or temporary plots and mark-recapture methods is economically unfeasible for estimating spatial and temporal patterns of desert tortoises on the scale of DWMAs or regions. The time, effort, costs, and person-power required to increase sample sizes, setup systematic-random plots throughout the landscape of interest, and conduct intense mark-recapture, “removal,” or capture effort sampling would far exceed the benefits gained from such a strategy. The sampling effort required for statistical validity and adequate statistical power would appear to be economically impossible. However, intensively researched plots could be immensely useful for investigating and elucidating important desert tortoise life history details: microhabitat selection, patterns of burrow use, behavior (especially social interactions, courtship, nesting, and response to various disturbances and noise), food habitats, and health profiles. Especially important would be assessing comparative differences among males, females, subadults, juveniles, and hatchlings. The knowledge of these life history characteristics is essential for developing conservation management strategies for desert tortoise populations and their habitats on landscape and regional scales.

Triangular Strip-Transects

Triangular strip-transects (1.5 mi long, 10 yd wide) were used for estimating desert tortoise densities by BLM and others since the late 1970s (Berry 1984, Krzysik and Woodman 1991). These surveys count tortoises, but primarily their sign (essentially burrows and scats), and make density estimates based on calibrating tortoise sign at the survey sites with tortoise/sign ratios concurrently derived at the permanent plots where tortoise densities are estimated by an intense mark-recapture effort. There are identified weaknesses with the strip-transect method (Krzysik 1997, 2002). There has also been a strong resentment of using “indexes,” “surrogate metrics,” or “sign counts” to estimate relative population densities of desert tortoises by the developers of DS (e.g., Anderson 2001), and for other wildlife populations as well (Conn et al. 2004). Nevertheless, sign counts and indexes have routinely been used for monitoring and spatial and temporal population comparisons of wildlife populations for a long time (Robbins et al. 1986, Lancia et al. 1996, Slade and Blair 2000, McKelvey and Pearson 2001, Hutto and Young 2002, Conn et al. 2004). The major criticism has been that variation in detection probabilities is a source of variation in count indexes. Detection probability represents a major theoretical and practical issue in estimation population densities (Pollock et al.

2004). Detection (or capture) probably can vary by species, spatial or temporal differences in behavior or other natural history parameters of a specific species, life history stage, habitat, weather, season, and surveyor ability or experience. It would be best to calibrate indexes with robust density estimation methods (e.g., mark-recapture, DS) to verify the justification of using indexes. Count-based indexes may outperform capture-recapture estimators if detection probabilities are similar or capture probabilities are constant over space and time (Conn et al. 2004).

A major problem with using strip-transect desert tortoise sign counts, that has not been appreciated or acknowledged, is the assumption that over a given time frame the ratio of live tortoises to their sign (burrows and scats) is similar across the landscape. This is essential for the strip-transect method, because density at survey sites are estimated from sign counts by calibration from permanent plots where the ratio of sign counts to tortoise density is known. Survey sites may be located 100 km or more from permanent plots, and in different habitat, and possibly even different local precipitation patterns. The ratio of burrows to tortoises was 8.06 at Sand Hill but 20.7 at Pinto Basin in the southern Mojave Desert, areas of similar habitat separated by 64 km (Krzysik 2002). This represents a factor of over 250% difference, and suggests that permanent plot calibrations across landscapes are not justified.

Nevertheless, a great deal of desert tortoise temporal and spatial data have been collected with strip-transects, and these data have potential for constructive analyses. When considering landscape scales, desert tortoises possess relatively small home ranges with respect to landscape sampling frames, especially in a drought year (Duda et al. 1999). Therefore, sampling transects on a large scale and picking up sign counts could provide relative density estimates with careful analyses and selection of spatial comparisons (BLM 2005). The unequal sampling efforts and sample sizes and small samples that are characteristic of strip-transects have been handled with Monte Carlo resampling methods and *exact* nonparametric statistics (Krzysik 1997). The experience and observational abilities of individual surveyors are often adjusted on desert tortoise strip-transects with calibration indexes derived with linear regression (e.g., Woodman et al. 1986). However, an analysis of covariance demonstrated that differences among surveyors were significantly dwarfed by innate large sample variances (Krzysik and Woodman 1991).

Another important and also overlooked factor is that the strip-transect width (i.e., 10 yards, 9.1 m) selected so long ago is very similar to the effective strip width (ESW, actually half of the strip-transect width) of live tortoises and also their burrows in DS (A.J. Krzysik, data analysis from a variety of sites). The DS model estimates ESW, which is the distance from the transect line that all sampled objects are detected, and therefore density is directly estimated. The larger the value of ESW the more visible objects are to surveyors. Therefore, to a very close approximation, with at least some data sets in the southern and central Mojave Desert, density estimates of live tortoises and burrows directly from strip-transects should yield similar density estimates as DS. The ESWs from the 2001 to 2005 USFWS DS efforts should be examined to assess if their values are on the order of 4.5 m. If ESW from DS is indeed similar to this value, and strip-transect surveys were conducted during the spring of a productive year or an effort was made to locate tortoises in their burrows, strip-transect data could directly calculate actual live tortoise and burrow densities. This would be an important result, because a great deal of historical desert tortoise strip-transect data are available at many agencies and consulting firms.

There is a great deal of desert tortoise strip-transect data available and collected since the late 1970s by BLM, other Federal agencies, and private groups. All these data should be gathered together, carefully examined, and standardized for analyses. These data represent a huge time-series for the potential of estimating relative population trends over large areas and time-spans. However, there are significant challenges in using the data, and there will certainly be noise in the data. These problems are due to many factors, including nonrandom and other sampling biases, small sample sizes, inadequate spatial coverage, inadequate time-series for some or most areas, and unequal surveyor experience and ability (but this factor may not be significant).

Distance Sampling: A Multi-Spatial-Scale Sampling Protocol

A landscape sampling protocol was developed in 1995 for estimating distribution and density patterns of desert tortoises at multiple spatial scales (Krzysik 2002). The general approach is also applicable to sampling other biological populations, including plants. Although this was an initial pilot study to assess the feasibility of application, the design appeared to be robust and efficient, and the results were rewarding. The protocol recognized that there were four independent sampling design elements that required integration. Ideally, any landscape population density sampling and monitoring program should have these four design elements. This design optimizes the reliability and economy of obtaining unbiased sample estimates:

5. define the sampling universe,
6. design a landscape sampling frame,
7. select a method for density estimation, and
8. apply a spatial interpolation and smoothing algorithm to develop the landscape distribution-density surface for the population of interest.

The sample universe represents the sampling landscape of interest, including sample stratification. Typically the entire landscape (e.g., a DWMA and surrounding area) would be delineated in a GIS environment based on satellite or aerial derived remote-sensed imagery, assisted by and calibrated by ground-truthing. Stratification is the delineation of land cover and topography into a relevant classification based on, for example: plant communities, soil/substrate classes, elevation zones, hydrology, land-use, and relative disturbance. These six parameters are important to characterize the relative value of habitats for the desert tortoise, and indeed most if not all Southwest and even global species. The motivation behind using sampling strata is not only for identifying habitat selection and associated density patterns of the population of interest, but equally important, to reduce sampling variance and therefore increase statistical power. As discussed above, statistical power is critical for sample sizes required and "effect size" desired for statistical significance in spatial and temporal contrasts.

The landscape sampling frame is the layout of sampling transects, quadrats, or plots spatially on the landscape. A systematic-random design is desirable because "systematic" implies that the entire area of interest is considered and included for sampling, while "random" requires that the actual sampling transects or plots are completely randomly determined in space. The systematic component in the sampling design is also required to generate the complete spatial distribution-density surface. Randomness is important because it insures unbiased sampling, independence of sampling errors (a requirement of statistical inference), and unbiased variance estimation. For a basic introduction to sampling design, statistical analysis, Types I and II errors, and relevant references see Krzysik (1998). Additionally, a number of excellent fundamental books on statistical methods for ecological studies are available that go into much more detail (e.g., Green 1979, Sokal and Rohlf 1995, Underwood 1997, Manly 2001, Quinn and Keough 2002).

A number of methods can be used for population density estimation. Common methods include: mark-recapture, removal, capture effort, and maximum likelihood estimation methods on plots; DS and assessment-line methods with line-transects; DS, trapping webs, nearest neighbor, and point-quarter methods with points; and total count strip-transects or quadrats.

Distance sampling with line-transects (DS) has many desirable statistical properties, practical applications, and has a long history of theoretical development in addition to rigorous statistical foundations (reviewed in Krzysik 2002). The methodology is straightforward and software is available (Buckland et al. 1993, 2004). DS using line transects estimates object densities by incorporating and modeling a detection function of observed object distances from the transect. DS was first applied to estimate desert tortoise densities at Edwards Air Force Base in 1994 and at Marine Corps Air Ground Combat Center and Joshua Tree National Park in 1995 (Krzysik et al. 1995, USFWS 1998, Krzysik 2002). The DS parameter g_0 was not considered to be important for desert tortoise density estimation. This metric takes into account the proportion of tortoises that are in their burrows, and thus unavailable for observation by surveyors. See the section below on g_0.

A spatial interpolation and smoothing algorithm is required to develop the landscape distribution-density surface for the population of interest. This is the three-dimensional surface where the "x and y" coordinates respectively represent easting and northing UTMs, and "z" represents the statistically derived spatially explicit density estimates. This is the primary way that a land manager or conservation planner can view the species' population distribution and density patterns across the landscape of interest (e.g., a DWMA or entire southern Nevada).

Krzysik (2002) incorporated a "nested landscape sampling frame" to incorporate three spatial scales of density estimation: site (80 km^2), plots (9 km^2), transects (1 km^2). The rationale was as follows. It takes a large landscape, on the order of 100 km^2 or even more in the case of low tortoise densities, to obtain an adequate sample of desert tortoise observations for DS estimates. Nevertheless, a land manager may be interested in tortoise distributions and relative abundances within this large spatial frame. The relative observed landscape abundances of live tortoise, their burrows, and their scats were an order of magnitude apart. In other words, if it required sampling on a scale of 100 km^2 to obtain a sufficient sample size to estimate tortoise densities with DS, sampling units on the order of 10 km^2 and 1 km^2 should provide adequate sample sizes for burrow and scat density estimation, respectively. Using sequentially the ratios of live tortoises to their sign, unbiased estimates of *relative* tortoise densities could be estimated at the two nested smaller spatial scales. This provided the data for generating the tortoise distribution-density surface important for land managers making local land-use decisions, and additionally, provided an estimate of the degree of patchiness of tortoises on the landscape. The generated tortoise distribution-density surface (Krzysik 2002, Figure 8) was immediately beneficial to natural resources managers at the Marine Corps Air Ground Combat Center, California, because they could make land-use military training and construction decisions while meeting their compliance with the Endangered Species Act. The installation was planning new training maneuvers in the southeastern portion of Sand Hill, but they were unaware of the relatively high tortoise densities in this area. Interestingly, the central portion of Sand Hill, which possessed low tortoise densities, had previously been designated as a Desert Tortoise Conservation Zone based on other investigators' desert tortoise research and mark-recapture studies.

Distance Sampling: The U.S. Fish and Wildlife Service Protocol

Distance sampling was selected by USFWS to be used throughout the range of the listed Mojave population of the desert tortoise, and was initiated in 2001 (Tracy et al. 2004). DS has also been used in Utah since 1998 (McLuckie et al. 2002). The USFWS transects are 400 m long and shaped in the figure "8." Radiotelemetry is used on ten tortoises to calculate the g_0 metric. Transects were randomly located in 2001, but were not in 2002 and 2003 (Tracy et al. 2004). Surveys were taken at elevations <1,250 m (4,100 feet) and where slope was >30%. Although these topographical windows do cover most desert tortoise individuals, desert tortoises can be found at higher elevations and on steeper slopes. Surveys were excluded from private lands, non-habitat (e.g., playas), areas with roads, and buffer designations. However, these designated parameters for surveys were not consistent over the 2001–2005 survey years (Tracy et al. 2004). Changes were made to survey protocols as additional experience was gained from previous year DS surveys.

The 2001–2005 data are currently undergoing quality control "cleaning and screening" and uniformity checks, database management, analyses, and a draft report will be available in 2006 providing density estimates throughout the range of the Mojave population of the desert tortoise (Roy Averill-Murray, 2005, personal communication). The 2005 data may not be ready for the USFWS report.

Distance Sampling: Efficiency, Problems, and Feasibility on Regional Scales

IS THE DISTANCE SAMPLING PARAMETER G_0 IMPORTANT IN THE ESTIMATION OF DESERT TORTOISE DENSITIES?

The USFWS 2001–2005 DS surveys incorporate a simultaneous radiotelemetry study to calculate g_0, which estimates the proportion of tortoises in their burrows. The following section is taken from Krzysik (2002). The "g_0 problem" refers to the fraction of tortoises undetectable in their burrows, and therefore, not observed on the transect centerline, a violation of a critical DS assumption. Of course, the actual probability of an undetected tortoise buried on the centerline is essentially "0" on any survey. The reality is that if tortoises cannot be detected in their burrows throughout the survey area, and thus unavailable for detection function modeling, this fraction of "lost" tortoises underestimates density proportionally. Because the detection function is evaluated at $x(0)$, g_0 mathematically represents the correction factor for "lost" tortoises that are in reality scattered in the underground realm of the area defined by the detection function. At least in the southern Mojave Desert the majority of burrows used by desert tortoises during their spring-summer activity season, when surveys generally take place, are shallow enough to allow visible detection of their occupants. Tortoise burrow depths remained similar in both highly productive and severe drought years (Krzysik 2002, Figure 7). Approximately 50% of all burrows were <66 cm in depth, 75% were <1 m, 85–90% were <1.3 m, and 98% were<2 m. For the small percentage of burrows that are deeper or strongly curved, tortoises can be acoustically detected by the use of a steel measuring tape or tapping the soil at burrow entrances. These responses were observed in this study, and Medica et al. (1986) reported that both male (83%, n = 144) and female (82%, n = 249) tortoises responded to tapping by a wooden stick and emerged from their burrows. Their study was conducted over two successive years between March and July. Tortoise response may increase as the season warms. Alice Karl (1995, personal communication) tried tapping the soil in front of burrows that contained tortoises fitted with radiotelemetry transmitters, and 80% of her tortoises responded to the tapping and emerged from their burrows. Therefore, on the basis of very few deep burrows in the landscape and a 20% undetection of tortoises in deep burrows, only a very small percentage of tortoises actually avoid detection on surveys. Even these could be effectively sampled for occupancy with the use of a flexible probe mounted to a remote television camera. Interestingly and significant, is that the "effective strip width" of tortoises and burrows is similar, and therefore, the detection capability of tortoises on DS transects above ground or the finding of burrows is essentially the same.

In this study, if burrow estimates were accurate because they were on the surface, but tortoise densities were underestimated (the g_0 problem), the calculated burrow/tortoise ratio would be inflated. However, burrow/tortoise ratios for DS estimates and radiotelemetry values were similar, and if there was a trend, it was in the opposite direction. DS estimates of burrow/tortoise ratios were 4.6 and 10.1, respectively, at Sand Hill and Pinto Basin, while the corresponding radiotelemetry values were 6.6 and 12.6. These data support the accuracy of DS estimated tortoise densities without using g_0. Tortoise surveys can be conducted in drought years, based on the data presented in Krzysik (2002). One would simply find a larger proportion of tortoises in burrows. Tortoises were observed more frequently in their burrows during a drought year than during a productive year in both spring and summer, and were also more frequently found in burrows in summer compared to spring in both productive and drought years. Nevertheless, even in the spring of a productive year, tortoises spent over half of their diurnal time in their burrows. Additionally, they exhibited a great deal of both within and between daily variability in burrow use, actively and rapidly responding to local environmental dynamics (Nagy and Medica 1986, Zimmerman et al. 1994, Henen et al. 1998, Duda et al. 1999). Therefore, locating tortoises in burrows will always be inherent in any tortoise sampling strategy regardless of season, weather conditions, and annual productivity. Tortoises in the northern part of their range (i.e., Nevada and Utah) possess deeper summer burrows and very deep winter burrows (Woodbury and Hardy 1948, Burge 1978, Rautenstrauch et al. 1998, 2002, A.J. Krzysik – personal observation). Surveys cannot be carried out in the winter for three critical reasons: tortoises are in deep burrows where they are very difficult to visually detect, they are inactive and would not respond to tapping, multiple tortoises (possibly many) may occur is these burrows and they cannot be reliably counted even with a television camera probe.

The use of g_0 for DS requires a simultaneous radiotelemetry study to assess the proportion of tortoises in their burrows. Radiotelemetry studies are very resource-, time-, energy-intensive, and expensive (Duda et al. 1999). The dynamics of tortoises going in and out of their burrows, usually being detectable but sometimes not, may be rapid, and may be quite different over small spatial and temporal scales. In order to be meaningful, a telemetry project would have to be spatially and temporally simultaneous with the DS monitoring project occurring over large spatial scales. When tortoises occur in low densities (a common situation) the use of radiotelemetry over large spatial scales with adequate sample sizes may be impossible, and certainly would correspond with unreasonably low sample sizes for estimating the fraction of tortoises undetectable in burrows. Radiotelemetry does not appear practical nor economic, particularly when tortoises are visually or acoustically easily located in their burrows, and remote television probes can be employed in challenging circumstances or in the northern portions of their range. Desert tortoises, even in shallow burrows, could not be identified as present with ground penetrating radar in an experimental field study in the southern Mojave Desert (DESA 1995).

The most practical question is how many desert tortoises do we really miss in burrows?? We measured the depth of 1,567 burrows in the southern Mojave Desert: 75% were <1 m in depth, 85–90% <1.3 m, and 98% <2 m. Using a stainless steel mirror, it was extremely easy to see a tortoise 1 m and deeper in the burrow. When there were very deep and curved burrows, tortoises could readily be heard stirring, either to their response to the insertion of the metal tape measure, or to tapping on the ground at the burrow entrance. This specific "tortoise behavior" has also been observed by other researchers (Phil Medica, Alice Karl, personal communication, 1995). The detectability of either live tortoises or burrows on DS line-transects was similar, at least in our research. Therefore, above ground or below ground tortoises (as long as they can be seen within their burrows, of course) have the identical form of the DS detection function. Of course, there is no problem with the DS method if separate detection functions for above ground tortoises and for in-burrow seen tortoises are required.

Let us assume that we could not see into burrows >1.3 m, and that ½ of these held a tortoise, and ½ of these tortoises did not respond to our "tapping or ruler signals." Because 15% of the burrows are >1.3 m, the percent of the tortoises that we missed without calculating g_0 is very liberally estimated at: 15% × ½ × ½ = 3.75%. This percent is trivial, particularly when contrasted it to the 95% confidence interval values estimated from actual DS data.

Sampling Efforts and Sample Sizes Based on Encounter Rates

Table 8 shows desert tortoise encounter rates (ERs) based on distance sampling line transects from a wide variety of sites and DWMAs between 1995 and 2002. The first DS transects for desert tortoise surveys were conducted in 1994 at Edwards Air Force Base and vicinity, but only two tortoises were found in the drought year (USFWS 1998). Therefore, the 1995 data represent the first ER data on DS transects. The highest desert tortoise ERs were at Pinto Basin, a designated Wilderness Area in Joshua Tree National Park and the Upper Virgin River DWMA in southwestern Utah. These are interesting data, because these sites are at the opposite extremes of the Mojave Desert. Pinto Basin is in the southern extreme of the Mojave, and based on vegetation, it represents an ecotone with the Colorado Desert (northwestern part of Sonoran Desert). The Upper Virgin River DWMA is in the northeastern extreme of the Mojave Desert. The Desert tortoise ER in Sand Hill training area at a Marine Corps base was a little lower, but variability in estimated densities were similar to Pinto Basin. Sand Hill was similar to many military training ranges, in that tactical vehicle habitat impacts were very patchy on the landscape, ranging from low to high local disturbance, while most of the training area was very little or not disturbed. Estimated local patches of tortoise densities at Sand Hill ranged from 18.9 to 1.51 tortoises/km^2, while at the pristine Pinto Basin site local patches ranged from 22.9 to 1.88 tortoises/km^2 (Krzysik 2002).

TABLE F-1. Desert tortoise encounter rates based on distance sampling line transects from a wide variety of locations and DWMAs between 1995 and 2002.

Site or DWMA	Year	N Tortoises [truncation]	Total Transect Lengths (km)	Encounter Rate (tortoises/km)
[A]Pinto Basin, JTNP[1,4]	1995	29 [30 m]	48	0.60
[A]Sand Hill, MCAGCC[2]	1995	31 [30 m]	80	0.39
[B]Upper Virgin River, UT[5]	1998	121 [g(x)=0.15]	201	0.60
[B]Upper Virgin River, UT[5]	1999	150 [g(x)=0.15]	307	0.49
[B]Upper Virgin River, UT[5]	2000	162 [g(x)=0.15]	302	0.54
[B]Upper Virgin River, UT[5]	2001	168 [g(x)=0.15]	314	0.54
[C]Fremont-Kramer[6]	2001	49 [15 m]	338	0.14
[C]Superior-Cronese[6]	2001	39 [15 m]	339	0.12
[C]Ord-Rodman[6]	2001	56 [15 m]	317	0.18
[C]MCAGCC[2]	2001	22 [15 m]	149	0.15
[C]JTNP[1,4]	2001	15 [15 m]	131	0.11
[C]Pinto Mountain[1, 4]	2001	20 [15 m]	128	0.16
[C]Chuckwalla[4]	2001	60 [15 m]	323	0.19
[C]Chemehuevi[4]	2001	54 [15 m]	322	0.17
[C]Shadow Valley[7]	2001	7 [15 m]	133	0.053
[C]Eastern Mojave[3]	2001	8 [15 m]	113	0.071
[D]Piute Eldorado[4]	2001	6 [?]	166	0.036
[E]Mojave Rangewide Mean	2001	421 [?]	2,901	0.145
[E]Mojave Rangewide Mean	2002	379 [?]	4,117	0.092

A. Krzysik 2002.
B. McLuckie et al. 2002.
C. Desert Tortoise Conservation Work Plan. Draft. FY 2003.
D. Tracy et al. 2004.
E. Medica et al. 2003.

www.dmg.gov/documents/dtwp-2003-draft.doc

Locations

1. Joshua Tree National Park.
2. Marine Corps Air Ground Combat Center, Southern Mojave Desert, between Ord-Rodman and Joshua Tree DWMAs.
3. Mojave National Preserve, Eastern Mojave Desert.

Distinct Population Segments (2003)

4. East Mojave and Colorado Desert.
5. Upper Virgin River (Upper Virgin River DWMA).
6. Western Mojave.
7. Northeast Mojave (Ivanpah DWMA).

Desert tortoise ERs of the other DWMAs in Table 8 are very low, and represent sites from the following Distinct Population Segments: East Mojave and Colorado Desert, Western Mojave, and Northeast Mojave. These data of tortoise encounter rates follow very closely the trends discussed above for the widespread declines of desert tortoise populations. It is of importance to note that the 1995 data from the southern Mojave was higher than the range-wide 2001 or 2002 data. Of course these data cannot distinguish between spatial differences or temporal declines in tortoise densities. There is a great deal of historical tortoise data in the hands of agencies and consultants that should be examined with simple analysis such as comparing encounter rates.

The range of tortoise ERs from Table 8 can be represented by 0.60, 0.39, 0.15, 0.092, 0.036. At least 30 tortoises are required for distance sampling density estimates, but 60 to 80 have been recommended. If we consider that 30 tortoises represent adequate sample sizes, then the corresponding transect lengths that are required for distance sampling estimation are respectively in km: 50, 77, 200, 326, and 833. The coefficient of variation (CV) in desert tortoise distance sampling density estimates is reflected in the sample size. Desert tortoise samples of 29 and 31 individuals produced CVs of 27.9% and 25.3% respectively (Krzysik 2002), while tortoise numbers of 121 and 168 produced CVs of 15.8% and 13.8% respectively (McLuckie et al. 2002). In other words, increasing sample size by almost 6-fold decreased CV by a half. Of course, improvements in procedural and design elements can reduce data variability, but sample size will usually be the dominant factor in being able to assess temporal or spatial data trends. If the ability to detect small population trends were a priority and a sample size of 80 tortoises were required, based on the above actual ERs, it would be necessary to walk 133, 205, 533, 870, and 2,222 km of transects to estimate a single population density statistic. Clearly, if encounter rates accurately reflect low population densities of desert tortoises in the 21st century, distance sampling does not appear to be an efficient or economically feasible method to monitor desert tortoise populations and metapopulations in a DWMA or regional context.

Alternatives to Traditional Desert Tortoise Sampling Methods

Excellent foundations and reviews are available for sampling, monitoring, and estimating population densities of animals (Seber 1982, 1986, 1992, Buckland et al. 1993, Sutherland 1996, Hayek and Buzas 1997, Thompson et al. 1998, Seber and Schwarz 1999, Southwood and Henderson 2000, Williams et al. 2002). These are primarily based on contemporary approaches (e.g., mark-recapture methods, removal methods, capture effort, distance sampling, maximum likelihood, and stochastic process models), and are applicable and very relevant to most studies of biological populations. However, estimating distribution and abundance patterns of rare animals, particularly on landscape and regional scales, is probably beyond the scope and practicality of these traditional methods. There is a strong recent interest in creative and novel approaches for monitoring rare or elusive species (Pollock et al. 2002, Thompson 2004, MacKenzie 2005, Stanley and Royle 2005, Vojta 2005). Presence-absence or site occupancy sampling designs appear particularly rewarding (MacKenzie et al. 2002, 2004, 2005, 2006, MacKenzie and Nichols 2004, MacKenzie 2005). There are numerous problems when trying to choose among competitive models for population estimation (see references in Pollock et al. 2002). An important and timely contribution to the selection of alternative models is Burnham and Anderson (2002). It is beyond the scope of this document to review extensively any of these methods, but a summary is essential for ecologists, land and wildlife managers, conservation planners, and decision makers; when reviewing proposals and reports, making decisions on survey approaches for rare or elusive populations (e.g., desert tortoise), and judging the subsequent interpretation and reliability of survey results and data analyses.

Adaptive Sampling

Adaptive sampling (Thompson and Seber 1996) is intuitively appealing and innately implemented by ecologists and natural history experts that are not aware of or don't follow the statistical rigors of sampling theory and experimental design. Field biologists and naturalists are typically very familiar with the natural history and habitat choice of the subjects they are studying. Therefore, when looking for their species of interest they do not sample the landscape randomly or systematically, but go directly to habitat patches that have the highest probably of encounters. This of course represents a statistically biased sample, because occupied (or pre-selected) habitats are disproportionately sampled, and species counts obtained in this way cannot be used for density estimation, calculation of error terms (i.e., standard deviation, standard error, confidence intervals), and importantly, cannot be used for statistical inference.

Populations are often clumped in the landscape, and this is certainly the case for desert tortoises (Duda et al. 2002, Krzysik 2002). Therefore, in order to increase sample sizes for rare clumped populations (i.e., desert tortoise) survey intensity should spatially increase when an individual is encountered in a systematic, random, or systematic-random sampling design. However, as in the previous example, this represents biased sampling and is statistically invalid. Adaptive sampling, based on rather sophisticated mathematical logic, “permits” the statistical bias of increased sampling effort at population clumps and then mathematically accounts for the bias, therefore insuring sampling statistical validity. The advantages of adaptive sampling are increased sampling efficiency, larger sample sizes, and decreased sample variance. Theoretically, adaptive sampling is very appealing. However, its practical application in the field by ecologists has been challenging, and there is the need for appropriate analysis software (Smith et al. 2004).

The spatial characteristics of desert tortoise populations would appear to be well-suited for adaptive sampling. A preliminary experiment with adaptive sampling for desert tortoise was attempted in 1995 (A.J. Krzysik, unpublished data), but nevertheless, a systematic-random multi-spatial design within a defined landscape (80 km^2) was more time-efficient (Krzysik 2002). Adaptive sampling may be an important component of the overall sampling and monitoring design on regional landscapes such as DWMAs, southern Nevada, and even the entire Mojave Desert. A regional adaptive sampling design could be guided by using resource selection functions (Manly et al. 2002) to elucidate habitat selection and occupancy by desert tortoises.

An important advantage of adaptive sampling is that it can be integrated with other sampling designs to increase operational efficiency and reduce sampling variance. Reducing sampling variance is important for sampling economy and increasing confidence in statistical inference. Adaptive sampling could be integrated with traditional labor intensive and expensive methods such as: mark-recapture, removal, capture effort, and distance sampling. Adaptive sampling could also be incorporated with more economical and creative methods employing counts, indexes, presence-absence, and occupancy estimation modeling. Sequential sampling could be used to insure adequate representation of habitat patches with tortoises, but larger sample sizes are usually required for desired accuracy (Christman 2004). Sequential sampling would become more efficient if linked with resource selection functions (Manly et al. 2002) to stratify probability of habitat occupancy before sampling. Domain estimation could also be incorporated to statistically identify and extend additional dimensions of spatial subgroups (Cochran 1977, Lohr 1999).

Counts and Indexes

Counts and indexes have been used a long time for monitoring, and spatially and temporally comparing animal populations. The two major problems facing counts and indexes as population density estimators are identical to those encountered by all population estimation methods: spatial heterogeneity in distribution and detection or capture probability. Nevertheless, these problems are more acute with counts and indexes, especially detection probability. The Audubon spring breeding bird and Christmas winter bird surveys are the well known example of counts to assess spatial and temporal changes in bird populations, and BLM’s triangular strip-transects are a good example of the use of an index (total adjusted sign) to estimate desert tortoise population trends (see Triangular Strip-Transects Section). Counts and indexes have received a great deal of criticism, primarily because detection or capture probabilities are not the same over space, time, or observers. If detection probably is constant across all parameters, counts or indexes are directly proportional to actual population density and therefore, density comparisons and changes are valid over both spatial and temporal sampling frames. However, detection (count, index) of a given species of interest (visual, acoustical, or surrogate indicator) depends on habitat characteristics, weather, time of day, time of year, geography, and surveyor parameters (expertise, experience, disturbance, interest). The detectability of birds, whether visual or vocal, depends on species, vegetation density, topography, and all the other parameters above. Additionally, many count surveys suffer from non-random sampling or do not adequately take into account spatial heterogeneity. For example, avian and anuran surveys are typically conducted along roads, while the rest of the spatial habitat is ignored. The detection of desert tortoise sign (burrows and scats) depends primarily on their age, soil surface texture and color, topographic complexity, litter cover, ground cover density, shrub cover density, and sun angle (Krzysik and Woodman 1991). Observer experience was not a factor in an experimental study to locate desert tortoises (Freilich and LaRue 1998). However, distance sampling was able to assess differences in detectability among surveyors and habitats (Krzysik et al. 1995).

The equality of capture probabilities (e.g., live-trapping for small mammals) is also not constant, because different species and even individual animals inherently possess different capture probabilities (fear or caution or curiosity or novelty in their environment) and trap responses. Trap response refers to the fact that after prior trap experience some species or individuals either avoid traps or become “trap-happy” (increase their entrance into traps because of known food rewards). The capture success of woodland plethodontid salamanders in the litter and under surface cover is highly dependent on soil moisture, and therefore, is highly variable in both time and space (A.J. Krzysik, personal observation). Simple capture-recapture models are based on closed populations, but in reality, especially for long-term studies, births, deaths, immigration, and emigration (i.e., open populations) must be considered. Mark-recapture models and software have been developed that incorporate, heterogeneity in capture probabilities, trap responses, and open populations (Seber 1982, Pollack et al. 1990, 2002, Lebreton et al. 1992).

Despite these shortcomings, counts and indexes are recently attracting attention because they may be more practical in the context of the technical difficulties and economics of sampling rare or elusive species (Pollack et al. 2002, 2004, Conn et al. 2004, Stanley and Royle 2005). Count indexes for desert tortoises on DWMAs and regional scales would be far more efficient and economic than estimator based methods such as mark-recapture and distance sampling. Count-based indexes may outperform capture-recapture estimators if detection probabilities are similar or capture probabilities are constant over space and time (Conn et al. 2004). The unequal sampling efforts and sample sizes, small samples, and possibly even biases, characteristic of strip-transects, can be handled with Monte Carlo resampling methods, randomization and permutation tests, and *exact* nonparametric statistics (Krzysik 1997).

Pollock et al. (2002) in their research for the nation-wide monitoring of avian, fish, and amphibian populations recommend a double sampling monitoring design to address the serious concern of variability in detection probability. Count data are collected at all spatial and temporal points of the complete sampling frame, while detection probabilities are estimated from a small subset of the total sample points. Detection probabilities are based on a more labor and cost intensive estimator method that yields absolute densities, such as mark-recapture or distance sampling. The detection probability metric then adjusts the entire sampling frame counts (spatial and/or temporal) to actual density estimates. The allocation of relative sampling effort is based on the relative costs and coefficients of variation between data collection at the complete and subset sampling frames (Pollock et al. 2002, Thompson 2002). Manly (2004) provides additional and related information on the behavior of variances among strata where population densities vary with habitat strata. Pollock et al.

(2002) stress that a great deal of research is required to refine and implement the design and analyses of double sampling and count/index based monitoring.

Can counts or indexes be used to monitor desert tortoise populations on landscape and regional scales using double sampling or another sampling design? The BLM strip-transect method with calibration by mark-recapture estimates from permanent plots appears to reflect the double sampling method. However, the appearance is superficial. The permanent plots were not randomly allocated, sample sizes and landscape representation were inadequate, area of influence was not estimated to accurately estimate local densities, subset size criteria was not analytically derived, and relative sampling effort based on costs and coefficients of variation were not determined. These are very major shortcomings. Additionally, it appears that the labor and costs for mark-recapture efforts for desert tortoise populations are very high. Based on the current encounter rates of desert tortoises in the Mojave Desert (Table 8), including southern Nevada, distance sampling may also be economically unfeasible. Additional research using experimental field studies and modeling of available strip-transect data are necessary to answer the question posed above. An increased effort is needed to assess the detection probability of desert tortoises and relationships to their burrows and scats. A diversity of factors require additional research, although some of these parameters are either already known or the data are available for creative analyses and interpretation:

- above ground activity versus in burrows, relative to environmental and seasonal factors,
- detection in burrows and burrow depth versus habitat and geographic location,
- habitat and topographic factors,
- productivity factors,
- seasonal activity based on geography and productivity,
- surveyor ability and experience
- use of burrows and/or scats as surrogate indicators
- longevity of burrows and scats relative to weather, habitat, season, etc.

Presence-Absence and Occupancy Estimation Modeling

Presence-Absence and Occupancy Estimation represents a very promising and statistically innovative approach for monitoring rare or elusive populations on landscape and regional scales (MacKenzie et al. 2002, 2004, 2005, 2006, Royle and Nichols 2003, MacKenzie and Nichols 2004, MacKenzie 2005, Stanley and Royle 2005). Presence-absence or frequency of occurrence data have strong intuitive and economic appeal for ecologists and wildlife managers, because empirical population density estimates are so difficult and costly to obtain (Gaston 1994, MacKenzie 2005). Bart and Klosiewski (1989) found that changes in densities and presence-absence from sites were similar in North American avian populations. Negative binomial and other models have demonstrated the relationship between sample presence or site occupancy and population density (Perry and Taylor 1985, Gaston 1994, Boyce et al. 2001). Rarity of course, increases the difficulties in dealing with both spatial heterogeneity in occurrences and detection probability, the two primary headaches in population density estimation.

MacKenzie et al. (2002, 2004, 2005) recommend the use of site occupancy models with the incorporation of detection probability, as an alternative to empirical density estimation for rare species because of these problems. A rich literature has recently developed for occupancy estimation (Vojta 2005). The estimation of site occupancy is far more economic and less labor intensive than traditional abundance estimation (Tyre et al. 2001, MacKenzie et al. 2002). Site or patch occupancy focuses the attention to what fraction of the landscape is occupied by the target organism rather than density per se. The heuristic value in this approach is that it closely parallels the already extensive and quantitative foundations of metapopulation dynamics (Gilpin and Hanski 1991, Hanski and Gilpin 1997, Hanski 1999, Hanski and Gaggiotti 2004), where the state variable of inherent interest is site or patch occupancy. The modeling of patch occupancy and metapopulation dynamics can both use incidence functions to estimate extinction and colonization probabilities (Hanski 1999, MacKenzie et al. 2002, 2003). Occupancy is also the state variable of interest for modeling geographic ranges (Wikle 2003). Site occupancy dynamics may be more important than percent of occupied patches for long-term monitoring, but repeated surveys are required to estimate detection probably (MacKenzie et al. 2003). Royle and Nichols (2003) have taken into account the variation in detection probability among sites caused by differences in local abundance patterns. Tyre et al. (2003) have increased precision and reduced bias by adjusting for false negatives in presence-absence data. The important problem of landscape heterogeneity for both occurrences and detection probably require more research and possibly the incorporation of additional likelihood, jackknife, or Poisson models (MacKenzie et al. 2002). Nevertheless, site occupancy models are generally flexible for the incorporation of covariate information, which can more finely tune the models for habitat variables, ecological heterogeneity, environmental spatial and temporal variance, and patch size.

Sampling and Long-Term Monitoring of Desert Tortoise Populations and Metapopulations

A species is considered rare for three reasons: it is widespread in distribution but at a very low density, or it is locally more abundant but occurs in a patchy fashion across the landscape (Gaston 1994), or it has a low probability of detection (Thompson 2004, MacKenzie et al. 2005). All of these factors appear to characterize the sampling of live desert tortoises. The desert tortoise has undergone dramatic population declines in most of its range, including southern Nevada, based on the literature reviews and analyses presented here. Current methods for monitoring and estimating densities of desert tortoise populations are inadequate for a number of critical reasons: very low encounter rates of tortoises in distance sampling surveys (e.g., Table 8), low statistical power and high coefficients of variation with distance sampling (unless sample sizes are very high), significant shortcomings of using the BLM permanent plots, and the impracticality and high costs associated with traditional empirical abundance estimates on landscape scales (e.g., mark-recapture). The simulation study by Freilich et al. (2005) on a highly researched relative high density desert tortoise population reached the same conclusion. Distance sampling simulations had high ratios of coefficients of variation to density estimates, and were biased 80% of the time. Power analysis revealed a limited ability to detect 50% population declines. Schnabel mark-recapture simulations overestimated population densities because of low recapture rates. They concluded that very large sample sizes and significant increases in statistical power were required to provide reliable estimates of desert tortoise densities.

Current desert tortoise population density estimation approaches based on traditional labor intensive and high-cost methods do not appear feasible on landscape and regional scales, especially when populations and metapopulations are experiencing dramatic declines. Innovative new technologies are in order. An optimal approach for regional long-term monitoring of desert tortoises may be the use of occupancy estimation modeling that is guided by computer intensive methods to assess, select, and generate sampling sites. The theory and application for occupancy estimation modeling are presented in the references summarized above. As discussed, the two primary obstacles to any population estimation method and for all species are the heterogeneity of spatial occupancy and detection probability. In the case of the desert tortoise, detection probability based on presence-absence within a survey patch would be relatively high and consistent in space and time, because burrows in good condition and fresh scats are suitable indexes of tortoise occupancy. These sign are reasonably persistent in the habitat and not affected by environmental variability to the extreme extent as surveys of live tortoises, birds, amphibians, or most species. The detectability of tortoise sign counts does depend on their age, soil surface texture and color, topographic complexity, litter cover, ground cover density, shrub cover density, and sun angle (Krzysik and Woodman 1991), but these covariates can be incorporated to rather accurately develop the probability of detection model. The spatial heterogeneity of desert tortoise occurrence is more of a problem. Several approaches require investigation for computer intensive methods to assess, select, and generate sampling sites: the development of habitat parameters (i.e., soil and vegetation characteristics, elevation, topography) for incorporation of covariates, probability sampling models, Bayesian approaches, neural networks analysis of remote sensing data, and innovative sampling designs based on statistically derived information from field samples and/or remote imagery. Needless to say, a great deal of field experiments and statistical simulations will be required to develop the final sampling design criteria, but the effort will be amply rewarded with sampling efficiency, economy, and reliability.

Conservation Management Monitoring Strategies for the Desert Tortoise

The difficulties, both technical and economic, in assessing and monitoring distribution and density patterns of desert tortoises on regional scales, coupled with the reality that tortoise populations are exposed to a large number of cumulative and synergistic threats and stressors that are increasing in intensity; forges the conclusion that conservation efforts will have to be based on:

- a great deal of additional research knowledge,
- the simultaneous monitoring and multivariate incorporation of four elements, and
- the incorporation of information from monitoring and research to management
- decisions in an adaptive management framework.

Research knowledge needs to be developed in virtually all aspects of desert tortoise ecology and biology (e.g., Tracy et al. 2004). The DTRPAC report clearly identifies and emphasizes that a great deal more research and monitoring integrated with adaptive management needs to be done before desert tortoise populations can be recovered in the Mojave Desert. Guidelines are particularly emphasized in chapters 5 (Linking Impacts, Habitat, and Demography to Recovery), 6 (Monitoring, Evaluation, and Delisting), and 7 (Integrating Research and Management).

Possibly the most important element for desert tortoise conservation is the development of a reliable, efficient, and economic population/metapopulation monitoring program. A reliable, science-based, and statistically rigorous population monitoring program for the desert tortoise that encompasses local to regional scales is technically very difficult to implement and economically challenging. Nevertheless, this is required as the scientific basis to assess if desert tortoise populations and metapopulations are declining or recovering from local to regional scales. This element is discussed above in "Sampling and Long-Term Monitoring of Desert Tortoise Populations and Metapopulations." Even with the successful development of a site occupancy estimation model, the monitoring of desert tortoise distribution and occupancy patterns to assess population trends will not be trivial and will be plagued with the inherent difficulties of sampling rare, patchy, landscape distributed populations; including high sampling variance and potential low statistical power for inference-based decisions. An optimal approach to this problem is to simultaneously monitor other elements that also innately and closely relate to the viability and long-term persistence of desert tortoise populations, but may be easier or cheaper to monitor. Additionally, because there is a great deal of environmental noise (i.e., high variance and statistical error components) in any monitoring effort, the implementation and multivariate integration of several monitoring elements may be more sensitive at identifying significant trends in the data. There are four important elements to assess and monitor that would track the viability and persistence of desert tortoise populations and metapopulations. Importantly, these multidimensional and interacting-interdependent elements need to be analyzed and interpreted in a multivariate statistical context.

1. Determine the condition and trends in distribution and abundance patterns of desert tortoise populations/metapopulations from local to landscape and regional scales in a spatially explicit framework. The appropriate methods that are biologically and statically valid, and economically feasible, have yet to be developed. This element is discussed above in "Sampling and Long-Term Monitoring of Desert Tortoise Populations and Metapopulations.. An optimal approach for regional long-term monitoring of desert tortoises may be the use of occupancy estimation modeling that is guided by computer intensive methods to assess, select, and generate sampling sites. Inherent in the monitoring challenge is continuing research to explore the relative value, utility, economy, statistical validity and power, and biological sufficiency in the context of metric, ordinal (relative), and qualitative data scales.

2. Determine the condition and trends of habitat and plant community parameters, including spatial associations and time-series metrics. Habitat condition and perturbed community trajectories represent an important if not the critical template for desert tortoise survivorship and reproduction. Additionally, this element directly contributes to the development of an effective habitat-tortoise model, so necessary for covariate input into tortoise occupancy estimation models, developing landscape sampling designs, habitat restoration, and conservation land planning scenarios.

3. Determine the condition and trends of threats and stressors in the context of metric, ordinal (relative), and qualitative data scales. Although threats and stressors to desert tortoises are identified and well known, their cumulative and synergistic actions and outcomes have not been tied together quantitatively in the context of their effects on desert tortoise population and metapopulation viabilities.

4. Develop the use of biotic and physical ecological indicators to technically improve and economize the quantification of numbers 1 to 3 above. This component is also in the context of multi-species and biodiversity conservation for the long-term sustainability of ecological integrity of the Northeastern Mojave Desert ecosystem and its processes. This component also recognizes and promotes the conservation value of the desert tortoise as a focal or umbrella species. Figure F-3 presents an example of the use of ecological indicators (i.e., a "Habitat Condition Index") to quantify and monitor landscape disturbance at a military training installation in the Southeast that covers 73,600 hectares (182,000 acres). Note that the index decreases monotonically and rather smoothly as the landscape habitat visually appears more and more disturbed. Also note that that vegetation and soils at disturbance classes 2 and 4 visually appear less disturbed than the analytically derived Habitat Condition Index demonstrates. The statistically derived index variables are specific to the Fall-Line Sandhills, the complex physiographic ecotone between the southeastern Piedmont and Coastal Plain, and specific ecological indicator variables would need to be developed for each ecoregional landscape of interest.

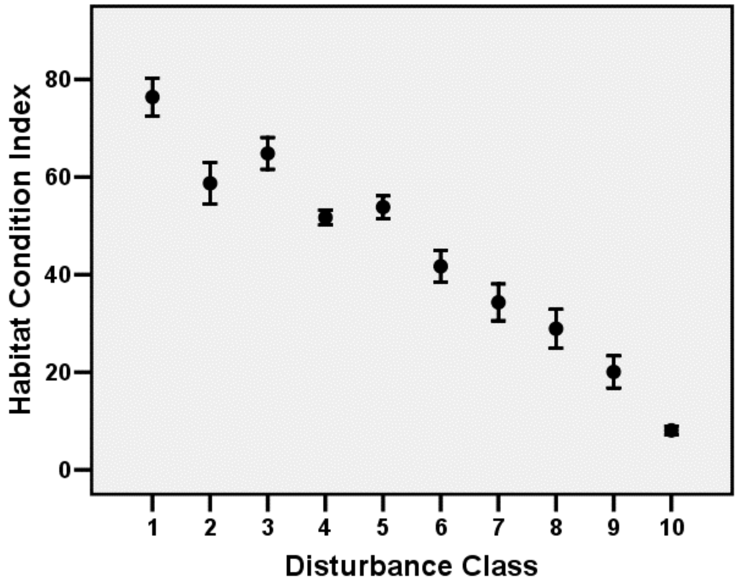


FIGURE F-3. This figure represents an example of ecological indicators. The relationship between a Habitat Condition Index and a landscape disturbance gradient was based on 40 sites selected to represent the complete range of upland vegetation communities and U.S. Army mechanized infantry training land-use (Krzysik et al., manuscripts in preparation). The 40 sites were ranked into ten Disturbance Classes (1=relatively pristine, 10=severely degraded) by a single observer on a visual assessment of military training damage to vegetation and soils *before* habitat data were collected. The Habitat Condition Index was derived as the sum of seven statistically weighed standardized habitat variables, each independently selected by separate statistical criteria. The seven variables were: Soil A-horizon depth, soil compaction, soil organic content, litter cover, canopy cover, basal area, and tree density. The data were collected in the Fall-Line Sandhills of west-central Georgia, and based on four perpendicular randomly oriented transects at each site.

These four elements in an adaptive management framework would not only directly contribute to the conservation and monitoring efforts at the four DWMAs, but also provide important synthesis data for habitat and threat factors and interrelationships that influence desert tortoise population viability and persistence. These are all closely related and integrated in complex ways that include both spatial and temporal dimensions. Desert tortoise demographic, habitat, and threat parameters; and ecosystem biodiversity are all multidimensional, and each of them does not act individually or in a linear additive fashion within its respective category or among ecosystem elements. Synergisms, cumulative effects, and multidimensional nonlinearities are the norm. When trying to integrate these all together into complex predictive models, hypotheses testing, or multivariate analyses, the complexities increase dramatically. Nevertheless, this is the approach that must be taken. A great deal of research remains in order to optimize and provide the specific guidance, methodologies, and measurements for demographic, habitat, threat, and indicator parameters.