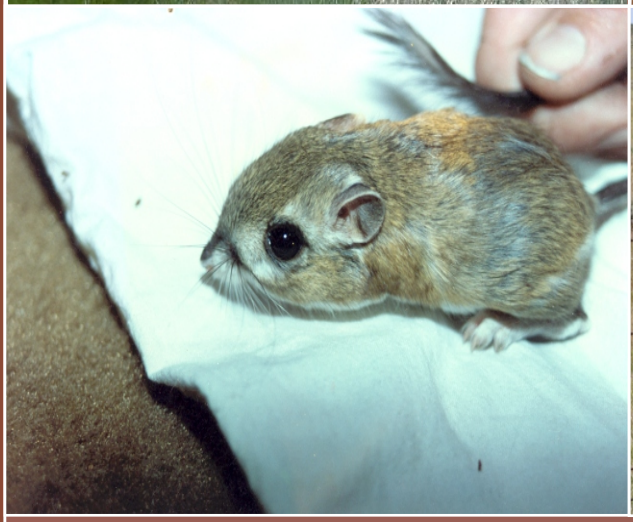
FINAL

Stephens' Kangaroo Rat Habitat Management and Monitoring Plan & Fire Management Plan for RCHCA Lands in the Lake Mathews and Steele Peak Reserves



JUNE 21, 2007

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TABLE OF CONTENTS

Section **Page No.**

1.0 INTRODUCTION 1
1.1 Background of Stephens' Kangaroo Rat Habitat Conservation Plan 1
1.2 Purpose of the Stephens' Kangaroo Rat Habitat Management Plan 2
1.3 Overall Goal and Scope of the Stephens' Kangaroo Rat Habitat Management Plan 2
1.4 Fire Management Plan 4
1.5 Overview of Biological Context and Setting of the Stephens' Kangaroo Rat Habitat Conservation Plan Area 5

2.0 EXISTING SETTING WITHIN THE MANAGEMENT AREAS 5
2.1 Vegetation Communities and Land Covers 5
2.1.1 Lake Mathews Reserve 5
2.1.2 Steele Peak Reserve 6
2.2 Geology, Soils, and Topography 12
2.2.1 Lake Mathews Reserve 12
2.2.2 Steele Peak Reserve 16
2.3 Climate and Hydrology 21
2.4 Fire History 21
2.4.1 Lake Mathews Reserve 21
2.4.2 Steele Peak Reserve 24
2.5 Grazing History 24
2.6 Stephens' Kangaroo Rat 25
2.6.1 Ecology and Life History 25
2.6.2 Stephens' Kangaroo Rat Distribution on RCHCA Lands in the Lake Mathews Reserve 32
2.6.3 Stephens' Kangaroo Rat Distribution on RCHCA Land in the Steele Peak Reserve 34
2.7 Special-Status Species Management Issues 34
2.8 Other Significant Management Issues 37
2.8.1 Invasive Species and Air Pollution 37
2.8.2 Non-native and Urban-related Predators 38
2.8.3 Trespass, Vandalism, Trash Dumping 39
2.8.4 Off-highway Vehicles 39
2.8.5 Illegal Shooting 40
2.9 Public Uses 40

TABLE OF CONTENTS (*cont.*)

Section **Page No.**

3.0 OVERVIEW OF MANAGEMENT GOALS, OBJECTIVES, AND STRATEGIES 41
3.1 RCHCA Reserve Goals and Objectives 41
3.2 Habitat Management Strategies 42
3.2.1 Sheep Grazing 42
3.2.2 Mowing 45
3.2.3 Herbicides 46
3.2.4 Fire 47
3.2.5 Summary of Habitat Management Strategies 49
3.3 Public Use Opportunities 52
3.4 Reserve Security 53

4.0 SKR HABITAT MANAGEMENT PROGRAM 54
4.1 Description of the Management Approach 54
4.1.1 Passive and Active Management 54
4.1.2 Routine and Experimental Active Management Approaches 56
4.2 Description of Monitoring Program 57
4.2.1 Live-trapping of Pre-selected Plots 60
4.2.2 Aerial Photo Mapping and Visual Walkover Surveys 64
4.2.3 Vegetation Assessments 65
4.3 Long-term Population and Habitat Management and Monitoring 66
4.3.1 Lake Mathews Reserve 66
4.3.2 Steele Peak Reserve 87

5.0 FIRE MANAGEMENT PLAN 94
5.1 Introduction 94
5.2 Fire Management Plan Area 96
5.3 Background 96
5.4 Purpose and Need 97
5.5 Fire Management Goals and Objectives 97
5.5.1 Fire Management Goals 97
5.5.2 Fire Management Objectives 98
5.6 Fire Management Plan Area – Description of RCHCA Lake Mathews and Steel Peak Reserves 99
5.7 Fire Environment 99
5.7.1 Climate 99
5.7.2 Topography 101

TABLE OF CONTENTS (*cont.*)

Section **Page No.**

5.7.3 Vegetation/Fuels 104
5.7.4 Vegetation Dynamics 105
5.7.5 Grassland Fire Effects 109
5.7.6 Riversidian Sage Scrub Fire Effects 110
5.8 Fire History 111
5.9 Fire Hazard Situations at Lake Mathews and Steele Peak Reserves 111
5.10 Fire Models and Response 112
5.10.1 Wildland Fire Behavior Prediction 117
5.10.2 Fuels Classification 118
5.10.3 Fuel Models 122
5.10.4 Wildland Fire Behavior Calculations 123
5.11 Fire Management Program 127
5.11.1 Short-term Tactical Fire Suppression Plan 127
5.11.2 Fire Management Units 127
5.12 Primary Actions and Contacts for Wildfire Emergency 130
5.13 Fire Response 131
5.13.1 Roads/Access 132
5.13.2 Staging Areas 132
5.14 Long-Term Strategic Fire Protection Plan 133
5.14.1 Fire Prevention/Fuel Reduction 133
5.14.2 Annual Grass Dominated FMUs 136
5.14.3 Riversidian Sage Scrub Dominated FMUs 138
5.15 Prescribed Fire Program 140
5.16 Post-Fire Activities 142
5.16.1 Erosion Control 142
5.16.2 Research and Monitoring 143
5.16.3 Data Management 144

6.0 ADMINISTRATION, DATA COLLECTION AND REPORTING, AND FUNDING 144
6.1 Administration 144
6.2 Data Collection and Reporting 146
6.2.1 Data Collection, Storage, and Analysis 146
6.2.2 Program Implementation Tracking, Reporting, and Analysis 148
6.3 Funding 149
6.3.1 Staffing Requirements 149

TABLE OF CONTENTS (*cont.*)

Section **Page No.**

6.3.2 Equipment 149
6.3.3 Habitat Management Options 149
6.3.4 Security 150
6.3.5 Public Services 150
6.3.6 Data Collection and Reporting 150
6.3.7 Administration 151

7.0 PUBLIC ACCESS, OUTREACH, AND EDUCATION 151

8.0 DOCUMENTS CITED 152

LIST OF APPENDICES

Appendix A: Live-trapping Monitoring Program

Appendix B: Habitat Suitability Index Model

Appendix C: Vegetation Assessment Methods

Appendix D: Management Costs

Appendix E: Weed Abatement Contractors

Appendix F: Public Access Policy

Appendix G California Department of Forestry Fire Management Plan Input

TABLE OF CONTENTS (*Cont.*)

Page No.

LIST OF FIGURES

Figure 1 Regional Map 3
Figure 2 RCHCA Lands in Lake Mathews Reserve 7
Figure 3 Vegetation Communities/Land Covers on RCHCA Lands in the Lake Mathews Reserve 8
Figure 4 RCHCA Land in the Steele Peak Reserve 9
Figure 5 Vegetation Communities/Land Covers on RCHCA Land in the Steele Peak Reserve 10
Figure 6 Geological Formations on RCHCA Lands in the Lake Mathews Reserve 13
Figure 7 Soils on RCHCA Lands in the Lake Mathews Reserve 14
Figure 8 Topography of RCHCA Lands in the Lake Mathews Reserve 17
Figure 9 Geological Formations on RCHCA Land in the Steele Peak Reserve 18
Figure 10 Soils on RCHCA Land in the Steele Peak Reserve 19
Figure 11 Topography of RCHCA Land in the Steele Peak Reserve 20
Figure 12 Fire History for the RCHCA Lands in the Lake Mathews Reserve 22
Figure 13 Distribution of SKR Habitat on RCHCA Lands in the Lake Mathews Reserve 33
Figure 14 Distribution of SKR Habitat on RCHCA Land in the Steele Peak Reserve 35
Figure 15 Trapping Grids on RCHCA Land in the Lake Mathews Reserve 62
Figure 16 Trapping Grids on RCHCA Land in the Steele Peak Reserve 63
Figure 17 Habitat Management Units on RCHCA Lands in the Lake Mathews Reserve 70
Figure 18 Potential Trespass Access Points to RCHCA Lands in the Lake Mathews Reserve 84
Figure 19 Potential Trespass Access Points to RCHCA Land in the Steele Peak Reserve 92
Figure 20 Fire Management Units on RCHCA Lands in the Lake Mathews and Steele Peak Reserves 102
Figure 21 Fuel Distribution on RCHCA Lands in the Lake Mathews Reserve 106
Figure 22 Fuel Distribution on RCHCA Land in the Steele Peak Reserve 107
Figure 23 East-west trending canyon in FMU 6 dominated by disturbed sage scrub cover 108
Figure 24 Grassland-sage scrub ecotone located in FMU 1. 108
Figure 25 Fire Behavior Analysis (Flame Length, Summer Weather) on RCHCA Lands in the Lake Mathews and Steele Peak Reserves 113
Figure 26 Fire Behavior Analysis (Flame Length, Fall Weather) on RCHCA Lands in the Lake Mathews and Steele Peak Reserves 114
Figure 27 Fire Behavior Analysis (Spread Rate, Summer Weather) on RCHCA Lands in the Lake Mathews and Steele Peak Reserves 115
Figure 28 Fire Behavior Analysis (Spread Rate, Fall Weather) on RCHCA Lands in the Lake Mathews and Steele Peak Reserves 116

LIST OF TABLES

Table 1 Vegetation Communities/Land Covers on RCHCA Lands in the Lake Mathews and Steele Peak Reserves 11
Table 2 Soils on RCHCA Lands in the Lake Mathews and Steele Peak Reserves 15
Table 3 Fire History for RCHCA Lands in the Lake Mathews Reserve 23
Table 4 Summary of SKR Habitat on RCHCA Lands in the Lake Mathews and Steele Peak Reserves 34
Table 5 MSHCP Covered Species Known from or Potentially Occurring on the Lake Mathews and Steele Peak Reserves 36
Table 6 Summary of Alternative Habitat Management Strategies 50
Table 7 Summary of Habitat Management Units and Management Recommendations for RCHCA Lands in the Lake Mathews Reserve 71
Table 8 Summary of Level 1 and Level 2 Management Units 76
Table 9 Description of Lake Mathews Reserve Trapping Grids 78
Table 10 Summary of Lake Mathews Trapping Grids Existing Conditions 79
Table 11 Summary of Grazing and Mowing Recommendation for Lake Mathews Level 1 and 2 Management Units 82
Table 12 Summary of Habitat Management Unit and Management Recommendations for RCHCA Land in the Steele Peak Reserve 89
Table 13 Average Weather Conditions for the Lake Mathews and Steele Peak Reserves by RAWS Station and Season 101
Table 14 Vegetation Coverage in the Lake Mathews and Steele Peak Reserves by Fire Management Unit 104
Table 15 Fuel Model Descriptions and Canopy Cover Classifications 125
Table 16 Weather Inputs 126
Table 17 Fire Management Unit Response Categories 128
Table 18 Individual Fire Management Units Response Category Classification 129
Table 19 Fire Management Unit Staging Areas for Firefighting Operations 132
Table 20 Fire Prevention/Fuel Reduction Prescriptions for Lake Mathews and Steele Peak Reserves FMU High-value Resource Areas 133

1.0 INTRODUCTION

1.1 BACKGROUND OF STEPHENS' KANGAROO RAT HABITAT CONSERVATION PLAN

In October of 1988, the Stephens' kangaroo rat (*Dipodomys stephensi*) was listed as an endangered species by the U.S. Fish and Wildlife Service (USFWS). Under the federal Endangered Species Act (ESA) both the Stephens' kangaroo rat (SKR) and its habitat were protected from any type of disturbance resulting in "take" of the species. The net effect of the federal listing was to freeze new development on more than 22,000 acres throughout western Riverside County. The SKR also was state-listed as threatened under the California ESA in 1971.

The Riverside County Habitat Conservation Agency (RCHCA), a Joint Powers Agency comprised of the cities of Corona, Hemet, Lake Elsinore, Moreno Valley, Murrieta, Perris, Riverside, Temecula, and the County of Riverside, was formed in 1990 for the purpose of developing a Habitat Conservation Plan (HCP), acquiring land, and managing habitat for the SKR.

In August of 1990, the USFWS and California Department of Fish and Game (CDFG) approved the Short-Term HCP as an interim conservation program designed to afford protection to the SKR while a plan to establish permanent reserves was being developed. The Short-Term HCP defined nine "Study Areas" with the intent that they would contribute to a permanent reserve system, provided a process for a land owner to petition to have property removed from a Study Area, allowed for the establishment of a mitigation fee, provided for the ability to "incidentally take", and led to a biological study to fill the information gap in order to develop a plan intended to ensure long-term survival of the species within the HCP area.

In March of 1996, the RCHCA adopted a Long-Term HCP for the SKR which was approved by the USFWS and CDFG on May 6, 1996. At the time of approval, the HCP covered approximately 533,954 acres within RCHCA-member jurisdictions, including an estimated 30,000 acres of occupied SKR habitat. The HCP required the establishment and completion of the seven core reserves, expansion of the core reserves through Bureau of Land Management (BLM) exchange lands, and the ongoing management of the reserves. Only a few of the BLM land exchanges did take place, but, in 2003, with the acquisition of the Potrero site, the USFWS and CDFG confirmed that the land acquisition portion of the reserve expansion requirement was satisfied and that the Reserves had been completed.

Pursuant to the SKR HCP, the Implementing Agreement for the HCP, and the BLM/RCHCA Assembled Land Exchange Agreement, RCHCA lands in the Lake Mathews Reserve were to be

traded to the BLM. Pursuant to the trade, BLM was to assume the management and monitoring obligations for the RCHCA's Lake Mathews property, BLM could consolidate its widely scattered land holdings at Lake Mathews, and RCHCA could sell the BLM exchange lands using the proceeds of that sale to complete the reserves and reserve expansion and benefit the SKR conservation program. Subsequently, the BLM lands were incorporated into the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) as public/quasi public lands for conservation, making the majority of the RCHCA/BLM land exchange significantly encumbered and the sale of BLM surplus lands ultimately unattainable. Because most of the RCHCA lands at Lake Mathews were not exchanged and BLM did not assume management, the RCHCA is burdened with the unanticipated cost of management in order to maintain the state and federal SKR take permits.

However, BLM does manage its lands in the Steele Peak Reserve which is one of the seven core reserves and is owned primarily by the federal government. A portion of the remainder is owned by the RCHCA and managed consistent with the terms of the SKR HCP.

1.2 PURPOSE OF THE STEPHENS' KANGAROO RAT HABITAT MANAGEMENT PLAN

A part of the permit/authorization terms and conditions for the HCP is that "the RCHCA will ensure ongoing and appropriate management of conserved SKR habitat in the core reserves" (RCHCA 1996).

In addition, "the plan [HCP] provides a framework and funding for:

1. Coordinating management of conserved SKR habitat;
2. Increasing the amount and quality of SKR habitat in the reserve system; and
3. Monitoring the status of the SKR populations in the plan area" (RCHCA 1996).

1.3 OVERALL GOAL AND SCOPE OF THE STEPHENS' KANGAROO RAT HABITAT MANAGEMENT PLAN

The overall goal of the SKR Habitat Management Plan (HMP) is to provide the RCHCA with a plan for effective management of the SKR populations and habitat in the RCHCA-owned parcels in the Lake Mathews and Steele Peak Reserves (*Figure 1*) that can be implemented and monitored in a fashion consistent with the framework of the SKR HCP.

Figure 1 Regional Map

To achieve this overall goal, the following tasks were completed in preparation of the SKR HMP:

- Compiling the relevant information for developing the HMP, including baseline data for the Reserve areas that describe the biological context and setting of the HMP and scientific and unpublished literature regarding SKR ecology and habitat management methods;
- Consulting with other Reserve managers and agency personnel familiar with SKR management;
- Identifying critical uncertainties for managing SKR habitat and populations;
- Developing a simple conceptual management model to facilitate plan implementation;
- Developing the goals and objectives of the HMP;
- Identifying appropriate strategies for implementing management and associated monitoring;
- Integrating wildfire management into the HMP;
- Developing data quality assurance, data management, analysis, and reporting strategies;
- Estimating costs of the HMP; and
- Addressing public access and recreation, outreach, and education.

1.4 FIRE MANAGEMENT PLAN

An important element of the SKR HMP is a coordinated Fire Management Plan (FMP) for the RCHCA lands in the Lake Mathews and Steele Peak Reserves. The FMP, which is described in *Section 5.0*, establishes fire management goals and objectives that are consistent with and facilitate the overall goal of effectively managing the SKR populations and habitat on the Lake Mathews and Steele Peak Reserves. The FMP describes:

- The fire environment (e.g., climate, topography, vegetation/fuels, and their fire dynamics);
- Identified fire hazard situations on the Reserves;
- Fire models applicable to the Reserves;
- A fire management program;
- Emergency actions and contacts;
- Fire response actions;
- Long-term strategic fire protection;
- Prescribed fire; and
- Post-fire activities.

1.5 OVERVIEW OF BIOLOGICAL CONTEXT AND SETTING OF THE STEPHENS' KANGAROO RAT HABITAT CONSERVATION PLAN AREA

The 533,954-acre SKR HCP area is generally located in western Riverside County within the Riverside Lowlands Bioregion, which "characterizes areas east of the Santa Ana Mountains Bioregion, south of the Riverside/San Bernardino County line, west of Diamond Valley Lake, Lake Skinner, and Gilman Hot Springs, and north of the Riverside/San Diego County line. This Bioregion encompasses Estelle Mountain, Lake Mathews, Reche Canyon/Badlands, the San Jacinto Valley, Gavilan Hills, Lakeview Mountains, and French Valley. The Riverside Lowlands Bioregion generally occurs at elevations below 600 m (2,000 ft) and is characterized by Riversidian sage scrub and annual grasslands" (RCHCA 1996).

Based on the vegetation mapping (PSBS and KTU+A 1995) used for the SKR HCP, annual grasslands cover approximately 16 percent of the HCP area, and Riversidian sage scrub covers approximately 18 percent of the HCP area.

Annual grasslands in western Riverside County typically are comprised of non-native species that have evolved in the context of human agricultural practices, including several brome species such as foxtail chess (*Bromus madritensis*), ripgut grass (*B. diandrus*), soft chess (*B. hordaceous*), as well as wild oats (*Avena barbata* and *A. fatua*), ryegrass (*Lolium multiflorum* and *L. perrene*), barley (*Hordeum* spp.), rat-tail fescue (*Vulpia myuros*), and Mediterranean schismus (*Schismus barbatus*) (Jackson 1985; Sims and Risser 2000).

Riversidian sage scrub is an inland xeric form of coastal sage scrub that often occurs on drier west- and south-facing slopes and is the common form of sage scrub in the Riverside Lowlands Bioregion. The most common shrub species in Riversidian sage scrub are brittlebush (*Encelia farinosa*), California buckwheat (*Eriogonum fasciculatum*), and coastal sagebrush (*Artemisia californica*). Because of frequent fires and other disturbances, such as grazing and mechanical clearing, a substantial portion of Riversidian sage scrub in western Riverside County is now more often a mix of sage scrub and annual grassland than predominantly sage scrub.

2.0 EXISTING SETTING WITHIN THE MANAGEMENT AREAS

2.1 VEGETATION COMMUNITIES AND LAND COVERS

2.1.1 Lake Mathews Reserve

The RCHCA ownership within the Lake Mathews Reserve comprises approximately 4,543 acres, distributed among 11 discrete parcels that range from approximately 10 acres to 1,370 acres

(*Figure 2*). The vegetation communities present on RCHCA lands in the Lake Mathews Reserve (*Table 1* and *Figure 3*) include a variety of vegetation alliances (CNPS 2005). These alliances are organized under the general vegetation communities used for the Western Riverside County MSHCP (2002), including chaparrals (3 percent), coastal sage scrubs (61 percent), grasslands (7 percent), oak woodlands (1 percent), peninsular juniper woodland and scrub (<1 percent), riparian forest/woodland/scrub (2 percent), and disturbed (24 percent). Coastal sage scrub alliance/associations, which account for 61 percent of the vegetation communities in the Lake Mathews Reserve, provide important habitat for a number of listed and special-status species in addition to the SKR (which may occur in sparse stands of coastal sage scrub), such as the federally-listed threatened coastal California gnatcatcher (*Polioptila californica californica*), which often occupies the most dense areas of coastal sage scrub, and often on the steeper slopes. The SKR inhabits the more sparse or disturbed areas of coastal sage scrub on gentle slopes (also see *Section 2.6.1* for discussion of SKR ecology). It is notable that the largest RCHCA-owned parcel in the Lake Mathews Reserve supports the largest portion of the disturbed land cover, much of which is former citrus groves and possibly suitable for SKR habitat restoration. Under current conditions, most of this area probably should be mapped as annual grassland rather than disturbed land cover. In this HMP, disturbed land covers are treated as potential habitat for the SKR with regard to management recommendations (see *Section 4.3.1*).

2.1.2 Steele Peak Reserve

The RCHCA-owned portion of the Steele Peak Reserve (*Figure 4*) totals about 204 acres, of which about 110 acres are mapped as coastal sage scrub (85 acres of California buckwheat alliance, 17 acres of brittlebush-California buckwheat, 5 acres of California sagebrush – [California buckwheat] – annual grass-herb, and 3 acres of chamise-coastal sage scrub disturbance), 93 acres are mapped as annual grassland, and about 1 acre is mapped as Riparian Forest/Woodland/Scrub (*Table 1*). The coastal sage scrub and annual grassland is distributed across each of the three discrete parcels that comprise the RCHCA ownership in the Steele Peak Reserve. The sage scrub in the northern parcels primarily is on the southern part of parcels, with the grassland concentrated in the northern portions of the two parcels (*Figure 5*). The sage scrub in the southern parcel is in the central part of the parcel in the more rugged terrain and is bounded on the west and east in the more gentle terrain on the parcel that supports annual grassland (*Figure 5*).

Figure 2 RCHCA Lands in the Lake Mathews Reserve

Figure 3 Vegetation Communities/Land Covers on RCHCA Lands in the Lake Mathews Reserve

Figure 4 RCHCA Land in the Steele Peak Reserve

Figure 5 Vegetation Communities/Land Covers on RCHCA Land in the Steele Peak Reserve

TABLE 1
Vegetation Communities/Land Covers on RCHCA Lands in the Lake Mathews and Steele Peak Reserves

Vegetation Communities in Reserves	Lake Mathews	Steele Peak
Chaparrals		
Chamise - Hoaryleaf Ceanothus - Black Sage Association	117	
Chamise - Hoaryleaf Ceanothus - Sugar Bush Association	11	
Chamise Pure Association	10	
Sugar Bush Alliance	22	
Subtotal	**160**	
Coastal Sage Scrubs		
Brittlebush - California Buckwheat Mapping Unit	1,065	17
Brittlebush - California Sagebrush Association	78	
Brittlebush Alliance	27	
California Buckwheat - Brittlebush Association	14	
California Buckwheat Alliance	287	85
California Sagebrush - (California Buckwheat) - Annual Grass-Herb Mapping Unit	752	5
California Sagebrush - California Buckwheat Alliance	116	
California Sagebrush - Laurel Sumac Association	69	
California Sagebrush - White Sage Alliance	12	
Chamise - California Buckwheat Association	17	
Chamise - Coastal Sage Scrub Disturbance Mapping Unit	276	3
Laurel Sumac - (California Buckwheat - Black Sage - White Sage – California Sagebrush) Mapping Unit	61	
Subtotal	**2,774**	**110**
Grassland		
California Annual Grassland Alliance	316	93
Oak Woodland		
Coast Live Oak - Sycamore Riparian Mapping Unit	45	
Coast Live Oak / Annual Grass-Herb Association	6	
Coast Live Oak Alliance	4	
Subtotal	**55**	
Peninsular Juniper Woodland and Scrub		
California Juniper - California Buckwheat - California Sagebrush Association	13	
California Juniper - Coastal Sage Scrub Mapping Unit	5	
California Juniper / Annual Grass-Herb Association	4	
Subtotal	**22**	
Riparian Forest/Woodland/Scrub		
California Sycamore Alliance	28	
Mexican Elderberry - (Mulefat) Mapping Unit	15	0.4
Mixed Tree and Shrub Willow Super Alliance (More than 2 species of Salix spp. with varying heights)	5	
Mulefat Alliance	1	
Willow Mapping Unit	59	0.4
Subtotal	**108**	**1**
Disturbed		
Vacant (disturbed bare ground, <2% vegetative cover) Mapping Unit	1,108	
Total in Reserve	**4,543**	**204**

2.2 GEOLOGY, SOILS, AND TOPOGRAPHY

2.2.1 Lake Mathews Reserve

The Lake Mathews Reserve is underlain by several geological formations (*Figure 6*). The predominant geological formation in the southern parcels is Estelle Mountain volcanics (Herzig 1991) dating to the Cretaceous period and supporting a heterogeneous mix of extrusive and volcaniclastic rocks. The southernmost parcel also supports a substantial formation of the massive-textured tonalite of the Gavilan ring complex, also stemming from the Cretaceous period. This parcel also supports a small formation of very old axial channel deposits dating to middle to early Pleistocene. In the central portion of the Reserve, the formations include monzogranite of Cajalco pluton stemming from the Cretaceous period, with a small area of very old alluvial fan deposit from the middle to early Pleistocene. From the central to the northern portions of the Lake Mathews Reserve, formations include mesozoic metasedimentary rocks and the Lake Mathews Formation dating to the Miocene and made up of mudstone, minor conglomerate, and poorly bedded sandstone, with a large area of the monzogranite of the Cajalco pluton. A large area of the northern parcels also is underlain by intermixed Estelle Mountain volcanics and sedimentary rocks, possibly from the Cretaceous period. Within the intermixed Estelle Mountain volcanics is a small area of very old axial channel deposits.

Soils in the Lake Mathews Reserve also are relatively diverse, with 17 soil series mapped in the Reserve parcels (*Table 2* and *Figure 7*). Temescal rocky loam and Temescal loam account for about 44 percent of the soils and are the predominant soil series in the more rugged terrain in the southern parcels. The second-most common soil series is the Lodo series, which accounts for 23 percent of the soils, and is the predominant soil type in the western portion of the northern parcels. Cieneba rocky sandy loam (10 percent of soils) is also a significant component of the southern parcels. The co-dominant soil series in the eastern portion of the northern parcel is Porterville cobbly clay (7 percent of soils). Generally, the soils are more heterogeneous in the northern parcels, with significant areas of Cajalco fine sandy loam, Temescal loam, Las Posas loam, Bosanko clay, Escondido fine sandy loam, Buren fine sandy loam, and Yokohl loam. Terrace escarpments make up a significant portion of a central parcel.

Soil suitability for the SKR is discussed in more detail in *Section 2.6.1*.

Soil type also is an important factor for fire management for a number of reasons: **(1)** its properties enable specific plants and plant communities to establish; **(2)** its propensity for erosion; and **(3)** its potential for hydrophobicity following hot fires. These factors are considered in the designation of Fire Management Unit (FMU) Response Categories discussed in the FMP in *Section 5.11.2*.

Figure 6 Geological Formations on RCHCA Lands in the Lake Mathews Reserve

Figure 7 Soils on RCHCA Lands in the Lake Mathews Reserve

TABLE 2
Soils on RCHCA Lands in the Lake Mathews and Steele Peak Reserves

Lake Mathews Reserve	Acres	Suitable for SKR[1]
Bosanko clay, 8 to 15 percent slopes	22	Marginal
Buren fine sandy loam, 8 to 15 percent slopes, eroded	9	Yes
Buren loam, deep, 2 to 8 percent slopes, eroded	34	Yes
Cajalco fine sandy loam, 15 to 35 percent slopes, eroded	10	Yes
Cajalco fine sandy loam, 2 to 8 percent slopes, eroded	8	Yes
Cajalco fine sandy loam, 8 to 15 percent slopes, eroded	51	Yes
Cieneba rocky sandy loam, 15 to 50 percent slopes, eroded	462	Yes
Escondido fine sandy loam, 15 to 25 percent slopes, eroded	17	Yes
Escondido fine sandy loam, 2 to 8 percent slopes, eroded	10	Yes
Escondido rocky fine sandy loam, 8 to 50 percent slopes, eroded	9	Yes
Gullied land	27	No
Honcut loam, 2 to 8 percent slopes, eroded	3	Yes
Las Posas loam, 2 to 8 percent slopes	23	Yes
Las Posas stony loam, 8 to 15 percent slopes, eroded	60	Marginal
Lodo gravelly loam, 15 to 50 percent slopes, eroded	8	Marginal
Lodo rocky loam, 25 to 50 percent slopes, eroded	1,066	Marginal
Monserate sandy loam, 15 to 25 percent slopes, severely eroded	2	Yes
Monserate sandy loam, 5 to 8 percent slopes, eroded	7	Yes
Placentia fine sandy loam, 5 to 15 percent slopes	4	Yes
Porterville cobbly clay, 2 to 15 percent slopes	322	Marginal
San Timoteo loam, 8 to 25 percent slopes, eroded	6	Yes
Temescal loam, 15 to 50 percent slopes, eroded	64	Yes
Temescal rocky loam, 15 to 50 percent slopes, eroded	1,947	Marginal
Terrace escarpments	118	Marginal
Yokohl cobbly loam, 2 to 25 percent slopes, eroded	7	Marginal
Yokohl loam, 2 to 8 percent slopes	35	Yes
Yokohl loam, 8 to 15 percent slopes, eroded	72	Yes
Ysidora gravelly very fine sandy loam, 8 to 25 percent slopes, eroded	24	Yes
Ysidora very fine sandy loam, 2 to 15 percent slopes, eroded	116	Yes
Total	**4,543**	
Cieneba rocky sandy loam, 15 to 50 percent slopes, eroded	18	Yes
Cieneba sandy loam, 5 to 8 percent slopes	1	Yes
Cieneba sandy loam, 8 to 15 percent slopes, eroded	5	Yes
Escondido fine sandy loam, 8 to 15 percent slopes, eroded	10	Yes
Fallbrook sandy loam, 8 to 15 percent slopes, eroded	6	Yes
Friant fine sandy loam, 5 to 25 percent slopes, eroded	8	Yes
Hanford coarse sandy loam, 2 to 8 percent slopes	3	Yes
Lodo gravelly loam, 25-50 percent slopes, eroded	1	Marginal
Lodo rocky loam, 25 to 50 percent slopes, eroded	84	Marginal
Lodo rocky loam, 8 to 25 percent slopes, eroded	49	Marginal
Monserate sandy loam, 5 to 8 percent slopes, eroded	2	Yes
Vista coarse sandy loam, 2 to 8 percent slopes	17	Yes
Vista coarse sandy loam, 8 to 15 percent slopes, eroded	1	Yes
Total	**204[2]**	

TABLE 2 (*cont.*)

1 The determination of soils' suitability for the SKR is primarily from Price and Endo (1989) and O'Farrell and Uptain (1989) and the personal observations of Phil Behrends (a co-author of this document). Marginal soils have been observed to support the SKR but tend to support trace and low population densities because they constrain burrowing (e.g., clays and rocky, cobbly, or stony soils) or occur on steeper slopes (i.e., > 25%), thus limiting their value for management and enhancement purposes.

2 Acreage does not sum precisely to 204 acres due to rounding error.

The Lake Mathews Reserve is characterized by varied topography, consisting of some relatively flat areas in the northern parcels and steeper slopes and narrow canyons in the southern reaches of the Reserve (*Figure 8*). Elevations on RCHCA lands range from 960 feet near the bottom of Olsen Canyon to 2,706 feet near the top of Estelle Mountain. Numerous east-west trending canyons drain the Lake Mathews Reserve area toward Temescal Wash, including the larger Dawson and Olsen canyons. Topography of the Lake Mathews Reserve is discussed in more detail in *Section 5.7.2* in regard to defining FMUs in the FMP.

2.2.2 Steele Peak Reserve

The RCHCA land in the Steele Peak Reserve has two main geological formations (*Figure 9*). The northern parcels and the western portion of the southern parcel of the Reserve are underlain by schist from the Mesozoic period. The northern parcel also has a small area of Gabbro of Southern California batholith from the Cretaceous period. The eastern portion of the southern parcel of the Reserve is underlain by Val Verde tonalite of Val Verde pluton from the Cretaceous period, and also has a northwest-southeast trending strip of potassium feldspar-bearing tonalite of Val Verde pluton.

Despite its relatively small size, the RCHCA land in the Steele Peak Reserve supports a heterogeneous set of soils, including the Lodo series (134 acres), Cieneba series (24 acres) and Vista series (18 acres), with lesser areas of the Escondido, Fallbrook, Friant, Hanford, and Monserate series (*Table 2* and *Figure 10*).

The northern parcels and western portion of the southern parcel of the Steele Peak Reserve are characterized by hilly terrain, with flatter terrain on the east portion of the southern parcel. The southern parcel has an east-facing slope reaching gradients of 20 percent (*Figure 11*). Elevations range from 1,700 feet on the east portion of the southern parcel to 2,100 feet on the northern parcel.

Figure 8 Topography of RCHCA Lands in the Lake Mathews Reserve

Figure 9 Geological Formations on RCHCA Land in the Steele Peak Reserve

Figure 10 Soils on RCHCA Land in the Steele Peak Reserve

Figure 11 Topography of RCHCA Land in the Steele Peak Reserve

2.3 CLIMATE AND HYDROLOGY

The western Riverside County climate is Mediterranean, with hot, dry summers and cool winters. The majority of annual precipitation falls in the months of November through April in the region encompassing the Lake Mathews and Steele Peak Reserves, with average annual rainfall of about 13 inches, according to local Remote Automated Weather Stations (RAWS) data. However, average rainfalls vary greatly within western Riverside County due to weather patterns, topography, rain shadow effects, and the El Nino Southern Oscillation (ENSO), with some years having just a few inches of rain or less (La Nina events) and others having 20 inches of rain or more (El Nino events). Most rainfall events occur in January through May, and, consequently, the most stream flows throughout the Reserves (although most of the year there is no surface water) occur in those months as well. The Reserves are characterized by ephemeral drainages and stream courses.

Growth of herbaceous non-native annual grasslands and forbs during and following wet cycles, while producing important seeds for rodents, can negatively affect habitat quality where vegetative cover becomes dense and thatched and thus precludes SKR occupation. A more detailed climate description is presented in *Section 5.7.1* as part of the FMP.

2.4 FIRE HISTORY

The fire history for the Lake Mathews and Steele Peak Reserves is based on California Department of Forestry and Fire Protection (CDF) records (FRAP 2005). The CDF has maintained records of wildland fires since the beginning of the 20th century. These records describe significant fires and may not include some small, localized fires of a few acres or less. According to CDF data (FRAP 2005), the RCHCA lands in Lake Mathews and Steele Peak Reserves have a significant fire history.

2.4.1 Lake Mathews Reserve

As shown in *Table 3*, the RCHCA lands in the Lake Mathews Reserve have had 14 burn years from 1944 to 2004. *Figure 12* shows the fire frequency and areas of burn for this time period. Of the 14 burn years, 5 years are particularly significant: **(1)** 1957 with 43 percent of the Reserve area burned; **(2)** 1981 with 39 percent of the area burned; **(3)** 1995 with 32 percent of the area burned; **(4)** 1998 with 28 percent of the area burned; and **(5)** 2004 with 36 percent of the area burned. Of the 50 discrete burn areas, the median number of burns per area since 1944 is 3, the mean number of burns is 2.7, and the range in the number of burns in a given area is 0 to 6. Notably, the fire return intervals of the significant events show a trend of getting shorter, with 24 years (1957-1981), 14 years (1981-1995), and 9 years (1995-2004) between significant events.

Figure 12 Fire History for the RCHCA Lands in the Lake Mathews Reserve

TABLE 3
Fire History for RCHCA Lands in the Lake Mathews Reserve
(Area by Area and Total Acres Burned per Year)

No. Areas Burned	1944	1957	1977	1978	1980	1981	1982	1985	1988	1993	1995	1998	1999	2004
1	0.3	190.6	7.3	0.3	0.3	0.9	8.4	7.3	37.8	96.9	7.3	1,287.3	75.6	7.3
2	34.6	7.3	95.4	34.6	34.6	70.3	0.0	84.3	151.1		84.3			84.3
3	0.9	95.4	6.5	0.9	0.6	289.5		1.7			0.9			0.9
4	6.6	6.5		6.6		53.2		1.9			70.3			289.5
5	10.1	70.3		10.1		25.8					289.5			25.8
6		289.5		70.3		2.2					25.8			95.4
7		53.2		289.5		7.3					95.4			151.1
8		0.3		53.2		95.4					37.8			483.2
9		27.4		0.3		6.5					151.1			0.3
10		84.3		0.6		27.4					164.9			6.6
11		1.7		25.8		84.3					483.2			28.4
12		37.8		2.2		1.7					0.3			0.4
13		151.1		28.4		37.8					6.6			1.7
14		164.9		39.7		151.1					28.4			1.9
15		483.2				164.9					0.4			53.2
16		246.8				483.2								2.2
17		0.4				246.8								6.5
18		62.1				26.7								246.8
19						1.9								15.0
20						15.0								34.6
21														0.6
22														10.1
23														0.3
24														39.7
25														62.1
Total Area Burned (acres)	**52.5**	**1,972.8**	**109.2**	**562.3**	**35.4**	**1,791.9**	**8.4**	**95.2**	**188.9**	**96.9**	**1,446.1**	**1,287.3**	**75.6**	**1,647.8**

From 1944 to 2004, the average return interval for all areas that burned at least twice, including the most recent burn in 2004, was 16.1 years (range: 9-31 years); whereas, from 1977 to 2004, the average return interval for the same burn areas was 13.3 years (range: 8-28 years). The Reserve area did not burn between 1957 and the late 1970s. With the exception of 1981, there was little fire activity in the early 1980s.

From 1944 to 2004, the northern parcels of the Reserve have had a lower burn frequency than the central and southern parcels (*Figure 12*). The northwestern parcels burned once in 1998. Portions of the northeastern parcels burned once in 1993 and once in 1999. During this time, the southerly parcels typically had between three and five fires.

2.4.2 Steele Peak Reserve

Burn data are for the Steele Peak Reserve are limited and insufficient to assess burn trends. The majority of the Reserve has burned three times since 1950, with the south western portion of the Reserve having burned once. Small areas in the eastern portion of the Reserve have burned four times. Lands just to the west of the parcel burned three and four times during this time. Fire years include 1960, 1979, and 1982, although two fires burned in the area in 1960. There have been numerous small fires in the area since 1950, and fire remains an ongoing threat and management concern for the Steele Peak Reserve.

2.5 GRAZING HISTORY

Cattle and sheep grazing have been a significant component of the land use history in the Riverside Lowlands Bioregion since European settlement of the area. According to Minnich and Dezzani (1998), grazing was heaviest in the late 19th century, with winter sheep drives peaking about 1900. Grazing declined by the early 20th century.

Sheep grazing still occurs throughout western Riverside County in grasslands and alfalfa fields by contract shepherds. With proper management, sheep grazing can be an effective management tool for brushy fuel loads and non-native grasses and weeds that compete with native species for resources. Although no records are available regarding the time since the areas were last grazed or the frequency of grazing in the areas over the last several decades, it is probable that both the Lake Mathews and Steele Peak Reserve areas have been grazed by sheep or cattle in the past.

2.6 STEPHENS' KANGAROO RAT

2.6.1 Ecology and Life History

Habitat Associations: The SKR is found almost exclusively in open grasslands or sparse shrublands with cover of less than 50 percent during the summer (e.g., Bleich 1973; Bleich and Schwartz 1974; Grinnell 1933; Lackey 1967; O'Farrell 1990; Thomas 1973). According to O'Farrell (1990), the proportion of annual forbs and grasses is important because SKRs avoid dense grasses (e.g., non-native bromes [*Bromus* spp.]) and are more likely to inhabit areas where the annual forbs dry out and fall apart in the summer and leave more open areas. O'Farrell (1990) also noted a positive relationship between the presence of the annual forb red-stemmed filaree (*Erodium cicutarium*), grazing, and the SKR. O'Farrell and Uptain (1987) noted a decline in the abundance of SKR in the Warner Ranch area when the livestock was changed from mixed Hereford stock to Holstein dairy cattle, thus reducing grazing pressure and allowing for the proliferation of three-awn grasses (*Aristida* sp.). On the other hand, the SKR has been trapped in brittlebush (*Encelia farinosa*)-dominated coastal sage scrub with an estimated shrub cover of over 50 percent (USFWS 1997).

Although there are no confirmatory data, it has been assumed that the SKR historically occupied habitat dominated by native perennial grasses and forbs (e.g., Price and Endo 1989).

Soil type also is an important habitat factor for SKR occupation (O'Farrell and Uptain 1989; Price and Endo 1989). As a burrowing animal, the SKR typically is found in sandy and sandy loam soils with a low clay to gravel content, although there are exceptions where the SKR can utilize the burrows of Botta's pocket gopher (*Thomomys bottae*) and California ground squirrel (*Spermophilus beecheyi*). Price and Endo (1989) suggest that sandy soils may be necessary for sand bathing, which keeps oils from building up in the SKRs' fur. Sand bathing also may serve an important social communication function (Randall 1993). Kangaroo rats tend to avoid rocky soils (e.g., Brown and Harney 1993); SKRs may be found on rocky soils, but population densities generally are much lower. *Table 2* lists the soils found on the RCHCA lands in the Lake Mathews and Steele Peak Reserves and their general suitability for the SKR.

Slope is a factor in SKR occupation; the SKR tends to use flatter slopes (i.e., <30 percent), in general, the highest abundances of SKRs occur on slopes less than 15 percent and is found on steeper slopes only in trace densities (i.e., <1 individual per hectare). The SKR may use steeper slopes for foraging but not for burrows (Behrends, pers. obs.).

Because open ground is an important habitat factor, the distribution and quality of SKR habitat also is a function of periodic fires, range use by grazing animals (O'Farrell and Uptain 1987), year-to-year weather variations (Price and Endo 1989), and probably cycle length of dry and wet

periods. Although precipitation is positively related to primary production of food resources and breeding activities (McClenaghan and Taylor 1993; Price and Kelly 1994), several years of high rainfall can be detrimental. For example, dense matting of annual grasses, such as ripgut grass (*Bromus diandrus*), may exclude this species from certain areas after periods of high rainfall (USFWS 1997). O'Farrell (1997) noted distinct population changes in response to above-average precipitation and increased vegetative cover, with population densities inversely correlated with rainfall and cover. Over the short term, however, Goldingay and Price (1997) did not detect seasonal differences in habitat use by the SKR despite seasonal variation in the microhabitat.

The SKR is found at elevations ranging from approximately 180 feet above sea level on Camp Pendleton in San Diego County to 4,100 feet above sea level in the Anza Valley (USFWS 1997).

Genetics: The SKR is one of 19 species of kangaroo rat and is placed in the *heermanni* group of kangaroo rats (Patton and Rogers 1993a). It has a chromosome number of 70, which is shared only with the San Quintín kangaroo rat (*D. gravipes*) known from Baja California, Mexico (Patton and Rogers 1993a). Biochemical genetic studies using protein electrophoresis were conducted by McClenaghan and Truesdale (1991). Using samples from nine sites in Riverside County, they concluded that the SKR shows relatively little genetic variability within the planning region. In general, most heteromyid species (i.e., kangaroo rats, pocket mice, and kangaroo mice) show high degrees of genetic similarity based on electrophoresis (Patton and Rogers 1993b). Recent work using mitochondrial DNA (mtDNA) from hair follicles sampled from various populations, however, shows a much greater genetic variability (Metcalf et al. 2001). Based on topography, Metcalf et al. divided the species' range into three geographic regions: northern (Norco, Alessandro Heights, Sycamore Canyon, Lake Mathews, Steele Peak, and Potrero Creek); central (Motte-Rimrock Reserve, San Jacinto, Canyon Lake, Cottonwood Canyon, and Shipley Reserve); and southern (Lake Skinner, Lancaster Valley, Camp Pendleton, Fallbrook, and Guejito). They found that the species in different geographic regions differ genetically, with the central area having the greatest diversity of genetic lineages. These results indicate long-term demographic stability characterized by limited dispersal between regions and high local effective population size, which maintains the diversity within the regions. However, the southern region demonstrated very low genetic variability, which "was probably due to a local population bottleneck that occurred during recent range expansion into the southern region" (Metcalf et al. 2001, p. 1233).

The more refined mtDNA study by Metcalf *et al* (2001) indicates that regional conservation efforts for the SKR need to focus on preserving the geographical distribution of the species in order to preserve existing genetic variability. This study also indicates that any translocation programs will need to consider genetic impacts.

Diet and Foraging: As with other kangaroo rats and most heteromyids, the SKR primarily is a granivore (seed eater) that mostly feeds on the seeds of filaree (*Erodium* spp.) and annual brome grasses (*Bromus* spp) (e.g., Thomas 1975). The fact that the two main dietary components of the SKR are non-native taxa indicates that the species is relatively opportunistic and generalist in its diet. SKRs also collect and ingest herbaceous forbs when available. Food caches are established within or around burrows.

Daily Activities: Like other kangaroo rats, the SKR primarily is nocturnal. Individuals emerge from burrows around dusk to forage and carry out other surface activities. Most surface activity probably is concentrated in the early evening hours, but individuals may be active any time during the night, as indicated by live-trap captures occurring after midnight (Behrends, pers. obs.).

Reproduction: The SKR, like other kangaroo rats, exhibits relatively low fecundity, with litters averaging 2.7 young (Lackey 1967) and typically two litters produced per year (Price and Kelly 1994). The peak of the breeding season occurs in the winter and spring months. Reproductively active males have been found every month of the year, but female reproductive activity appears to be more temporally restricted (McClenaghan and Taylor 1993). Fecundity and population density is positively related to yearly rainfall, with the length of the breeding season longer, the average number of litters greater, and the proportion of first-year females breeding greater in a year of higher rainfall (McClenaghan and Taylor 1993; Price and Kelly 1994). In a good year, a female SKR can produce up to five litters, and females should be capable of breeding in their natal season (Price and Kelly 1994). Annual fecundity of the SKR may be somewhat higher than kangaroo rat species inhabiting more arid regions because of the more mesic conditions of the coastal region west of the peninsular mountain ranges.

Survival: Price and Kelly (1994) studied the survival of the SKR and generally found that adults persist longer than juveniles and that females persist longer than males. Overall, about 18 percent of adults persisted for 12 months after initial capture. McClenaghan and Taylor (1993) also observed a 12-month survival rate of about 14 percent but no difference in persistence between males and females. However, as is the case for most other studies of heteromyid rodents, dispersal and mortality are confounded in the survival estimates because there are no controls for animals moving to and from trapping grid sampling areas. Whether there is female-biased persistence is equivocal. Price and Kelly (1994) indicate that the observed lower persistence of adult males in their study may have been an artifact of their larger home ranges and fewer captures of individuals. On the other hand, if males are more active and range wider, particularly during the breeding season, they may be more susceptible to predation (Daly et al. 1990). Price and Kelly (1992) did not find precipitation- or density-dependency factors in survival.

Dispersal: Live-trapping studies by Price et al. (1994) on the Motte-Rimrock Reserve and the San Jacinto Wildlife Area demonstrated that SKRs are sedentary and philopatric, with juveniles moving distances similar to adults. Juveniles maintain a home range center within about 30 meters of their earliest record. Male juveniles tended to move farther than female juveniles, but the differences were not statistically significant. For example, average monthly maximum movements of juveniles ranged from about 10 meters for females on the Motte Reserve to about 21 meters for males at the San Jacinto site. Although it is clear that the SKR as a species is relatively sedentary, Price et al. (1994) indicate that their study underestimates the true frequency of long-distance movements by some individuals because of sampling error related to the size of the area sampled. Furthermore, three adult males were observed to move more than 400 meters, a highly unusual statistical event based on calculated movement regression equations (i.e., the expected distribution of movements by the population based on the observed movements of the sample group). These movements occurred between grids connected by dirt roads, which may facilitate movements not observed in more homogeneous habitats. Although long distance movements are rare, they may play an important role in genetic exchange between local populations and maintenance of genetic variability (Price and Kelly 1992; Metcalf et al. 2001). At present, there is insufficient information to determine whether the scale of observed movement is density-dependent or based on some specific habitat factors (Price and Kelly 1992).

Socio-Spatial Behavior: Radiotelemetry data indicate that adult SKRs are relatively sedentary and maintain stable home ranges and that no significant difference exists between sexes (Kelly and Price 1992; Price et al. 1994). Depending on the method used to estimate homes range (minimum convex polygon or harmonic mean), average home ranges at the Motte-Rimrock Reserve ranged from 0.15 hectare to 0.19 hectare for males and 0.10 hectare to 0.13 hectare for females. However, the range in the size of home ranges for individual males and females at the Motte Reserve was substantial: 0.29 hectare for males and 0.26 hectare for females. Female home ranges were reduced in the summer when they were lactating. Kelly and Price (1992) also report that male home ranges are more irregularly shaped, tend to overlap the ranges of several females and other males, and have more than one center of activity, whereas female ranges are more ovular or circular in shape.

As described above, individual SKRs are capable of moving long distances, with movements of more than 400 meters. Males tend to be more mobile than females, perhaps reflecting their larger home ranges (Price et al. 1994). In general, radiotelemetry data reveal much greater movement than live-trapping, indicating that individual animals are familiar with a much larger area than just the core area where they are captured (Price et al. 1994). Females tend to be less mobile when nursing litters.

Population densities in kangaroo rats vary greatly in relation to habitat conditions and seasonal and yearly fecundity. For example, Bleich (1973) reported population densities at two sites in

Fallbrook of 7.5 and 33.8 individuals per hectare. McClenaghan and Taylor (1993) reported densities varying from 7 individuals per hectare at the San Jacinto Wildlife Area to 52 individuals per hectare at Lake Mathews, with densities varying substantially with reproductive activity. Peaks in population densities occur in the spring and early summer when juveniles are present. Average densities, corrected for the effect of drawing animals from off the trapping grids, at the San Jacinto Wildlife Area, Motte-Rimrock Reserve, and Lake Mathews were 19.7, 26.2, and 36.1 individuals per hectare, respectively. McClenaghan and Taylor (1993) suggest that the density differences among their three study sites may partly be due to differences in habitat quality and structure. It is important to note, however, that localized scientific studies of the SKR probably will be biased in favor of sites with higher population densities; that is, sites with very few animals would not be selected for study. A more systematic survey of habitat and populations in a large part of the range of the SKR found that most habitats contained low or medium density populations, defined as 1 to 4 and 5 to 10 individuals per hectare, respectively (O'Farrell and Uptain 1989). The high densities reported by McClenaghan and Taylor (1993) probably are not typical for the SKR in much of its range.

Community Relationships: The community ecology of heteromyid rodents, including kangaroo rats (*Dipodomys* spp.), pocket mice (*Perognathus* and *Chaetodipus* spp.), and kangaroo mice (*Microdipodops* spp.) is among the most studied aspect of this family's biology. Brown and Harney (1993) provide a comprehensive overview and attempted synthesis of this complex subject. Some generalizations drawn from this large body of literature are described below.

Arid grassland and desert environments support a surprising diversity of coexisting rodent granivores. The diversity and number of coexisting species vary depending on local conditions and the requirements of the constituent species. For example, the range of the SKR overlaps with the ranges of three other kangaroo rats species and subspecies (*D. simulans, D. merriami parvus,* and *D. merriami collinus*), three pocket mice (*Chaetodipus fallax, Chaetodipus californicus,* and *Perognathus longimembris*), and at least five murids (*Peromyscus maniculatus*, *P. eremicus*, *Neotoma lepida*, *Reithrodontomys megalotis,* and *Onychomys torridus*). Any of these species may be a potential competitor of the SKR. Brown and Harney (1993, p. 646) conclude that "the composition of these assemblages is not random. Instead it is determined by interactions of the species with the physical environment, with other kinds of organisms, and with other rodent species." Generally, species that coexist tend to occupy and exploit different microhabitats or niches or differ in the seasonality of their resource exploitation. For example, a trapping program conducted along Wilson Creek east of Sage in Riverside County, California, recorded three species of kangaroo rats: *D. stephensi*, *D. merriami collinus,* and *D. simulans*. *D. stephensi* was trapped in sparse grassland and a dirt road away from the creek, *D. merriami* was trapped in coarse, sandy soils adjacent to the creek, and *D. simulans* was trapped in coastal sage scrub on the slopes above the creek (Dudek 1995). Other potential mechanisms of resource partitioning listed by Brown and Harney (1993) include independent adaptations, food partitioning and

variable foraging efficiency, seed distribution, resource variability, predator-mediated coexistence, and aggressive interference.

The geographic range of the SKR is overlapped by the range of the more common Dulzura kangaroo rat (DKR) (*Dipodomys simulans*). (Note: The DKR was recently distinguished from the Pacific kangaroo rat (*D. agilis*) by Sullivan and Best (1997), and the species occurring at lower elevations in western Riverside County is the DKR. For this discussion, the species *D. agilis* referred to in the literature will be treated as *D. simulans*.) However, congeneric species of similar size rarely occupy the same habitat niche. This general principle appears to hold for the SKR and the DKR (Goldingay and Price 1997; Price et al. 1991). The SKR and DKR are very similar in size, with average weights of about 62-65 g and 57-60 g, respectively (Price et al. 1991). Trapping studies indicate several habitat and resource factors that appear to segregate the two species. The SKR is trapped in more sparsely vegetated grassland habitat, while the DKR usually is trapped in shrubbier habitats, suggesting some spatial segregation between the two species (Goldingay and Price 1997; Price et al. 1991). However, the DKR appears to be more of a habitat generalist or opportunist with a broader habitat niche than the SKR. It is often trapped in grasslands and open habitats following fires (Price et al. 1991; Behrends, unpubl. data). In areas of San Diego County where the SKR does not occur, the DKR is often found in sparse grasslands and grazed pastures that would be considered ideal SKR habitat in western Riverside County (Behrends, pers. obs.). In a laboratory study of microhabitat use, the DKR avoided heavier substrates more than the SKR and, in response to light and artificial shrubs, the DKR foraged under shrubs and avoided light more than the SKR (Price et al. 1991). In the same study, the SKR consumed more commercial seed with high oil and protein content (Price et al. 1991). From these studies, Price et al. (1991) concluded that the two species may diverge on factors such as habitat use, predation risk (e.g., moonlight), water balance, and possible foraging efficiency. However, because there is some overlap in habitat use, with DKRs often occurring in SKR habitat, direct interspecific competition is suggested. A laboratory study of agonistic interactions between the two species indicated that the slightly heavier SKR is behaviorally dominant over the DKR (Bleich and Price 1995), but these results do not explain the absence of the SKR from scrub habitat (also see Goldingay and Price 1997). Bleich and Price (1995) indicate that a more complex set of factors is segregating the two species.

There is a correlational relationship between the population density of the SKR and other non-kangaroo rat rodent species. McClenaghan and Taylor (1993) noted that the density of SKR was negatively correlated with abundance of the deer mouse (*Peromyscus maniculatus*). Where SKRs were found in high abundance, other rodents were present only in low numbers. Other than the studies of the SKR and DKR described above, it is unknown whether there is interspecific competition between the SKR and other rodents or whether the observed correlational relationships reflect non-competitive habitat selection or some other resource partitioning mechanism.

Kangaroo rats and other heteromyid rodents also modify their environments (Brown and Harney 1993). They dig burrows, which moves the soils and provides habitat and refugia for other species, including other rodents, reptiles, amphibians, and invertebrates. Collection, storage, and consumption of seeds by kangaroo rats have profound effects on the vegetation structure of the habitats they occupy. For example, experiments by Brown and his colleagues (Brown and Heske 1990) in southeastern Arizona have demonstrated that kangaroo rats are a "keystone guild" where their removal from plots resulted in the habitat converting from desert shrub to grassland. In addition, resource use by kangaroo rats substantially overlaps with that of seed-eating birds and harvester ants. Where kangaroo rats have been excluded in experimental plots, ants have increased dramatically (Brown and Harney 1993). A recent study of the SKR by Brock and Kelt (2003) indicates that this species also has significant effects on the local plant community. Experimental exclusion of the SKR from areas resulted in significant increases in herb cover and filaree abundance and significant decreases in bare ground and seed predation.

It can be concluded from the coevolutionary results of these inter- and intraspecific community relationships and their relationship to plant communities that rodents are an important component of arid ecosystems. In addition to their direct impacts on plant communities, they are important prey for a variety of predators, and their presence also affects populations of other prey, such as small reptiles, lagomorphs, and some birds (Brown and Harney 1993).

Physiological Ecology: There are no specific studies of the physiological ecology of the SKR. However, some generalizations can be made based on studies of other species of kangaroo rats.

Kangaroo rats and most other heteromyid species live in arid environments characterized by hot summers, long, cold winters, unpredictable precipitation, and ephemeral primary productivity of food sources (French 1993). For example, *D. merriami* in the Great Basin Desert have been observed on the surface at temperatures of −19°C (Kenagy 1973). Living in such extreme environmental conditions has high metabolic and thermoregulatory costs. While most of the SKR's range is in the relatively mild coastal region, the Anza and Cahuilla valley populations at more than 4,000 feet are subject to environmental conditions similar to the Great Basin Desert.

Kangaroo rats are perhaps most famous for their water conservation capabilities. Schmidt-Nielsen (1964) and French (1993) summarized the behavioral and physiological means by which kangaroo rats conserve water: they occupy burrows during daylight hours to avoid high temperatures; their evaporative water loss is much lower than that of other mammals when corrected for body mass; they have relatively low metabolic rates (about 30 percent lower than average mammals); they produce low volumes of highly concentrated urine and low-moisture feces; and their water requirements can be satisfied by oxidative or metabolic water in conjunction with the seeds and herbaceous material they consume. Other species, such as *D. merriami*, may be even more adapted to conserving water than the SKR. The other coastal

southern California kangaroo rat species, the DKR, cannot survive without preformed water and does not thrive well on a seed-only diet (Forman and Phillips 1993; French 1993).

These physiological and behavioral characteristics allow kangaroo rats to inhabit a broad range of arid habitats in western North America and allow individuals to survive during long periods of adverse climatic conditions.

2.6.2 Stephens' Kangaroo Rat Distribution on RCHCA Lands in the Lake Mathews Reserve

Mapping of occupied SKR habitat in the RCHCA parcels in the Lake Mathews Reserve generally occurred in the early 1990s in relation to proposed development projects and habitat evaluations of areas proposed to be acquired or included in the Reserve. RECON generated a GIS SKR occupied habitat overlay in March 1994 that was used for the occupied estimates in the SKR HCP.[1] Most of the "occupied" habitat polygons were field-checked and assigned a population density at the time they were surveyed following the density categories used by O'Farrell and Uptain (1989, p. 3): trace = <1 individual per hectare; low = 1-5 per hectare; medium 5-10 per hectare; and high >10 per hectare. These estimates provide a relative quantification of habitat quality; actual population densities can vary substantially from year to year, but, for example, "trace" density habitat quality typically will be marginally suitable for SKR, and high densities in these areas even in productive years would not be expected. Some polygons were not field checked and appear in the GIS database as "potential" and "probable" occupied habitat.

Table 4 gives the densities of SKR-occupied area on RCHCA land in the Lake Mathews Reserve, and *Figure 13* shows the SKR densities of all RCHCA lands in the Lake Mathews Reserve. Of the approximately 4,543 acres of RCHCA lands in the Lake Mathews Reserve, approximately 1,133 acres (25 percent) are mapped as SKR occupied (97 percent of SKR habitat) and probable and potentially occupied (3 percent of SKR habitat). Low density habitat is the most common (33 percent), and low and medium density categories, including trace-low and medium-high categories, account for about 69 percent of the habitat. High density habitat, at only 1 acre, represents very little of the RCHCA Reserve area.

It should be noted that the "unoccupied" category depicted in *Figure 13* probably overestimates the actual amount of unoccupied habitat. The SKR habitat mapping conducted in the 1990s typically focused on areas most likely to support the SKR. It is likely that some "unoccupied" areas at least support scattered small patches of occupied habitat on ridgelines, hilltops, saddles, and terraces.

[1] The RECON 1994 coverage is the same as that compiled by the County of Riverside in 2000/2001.

Figure 13 Distribution of SKR Habitat on RCHCA Lands in the Lake Mathews Reserve

TABLE 4
Summary of SKR Habitat on RCHCA Lands
in the Lake Mathews and Steele Peak Reserves

	Lake Mathews Reserve		Steele Peak Reserve	
Habitat Designation/Density	**Acres**	**% of Total**	**Acres**	**% of Total**
High Density (>10 individuals/ha)	1	<1%	0	0%
Medium-High Density	75	6.6%	0	0%
Medium Density (5-10 individuals/ha)	150	13.2%	0	0%
Low-Medium Density	92	8.1%	0	0%
Low Density (1-5 individuals/ha)	373	32.9%	24	12.1%
Trace-Low Density	91	8.0%	5	2.5%
Trace Density (<1 individual/ha)	168	14.8%	168	84.8%
Occupied (no density rating)	153	13.5%	0	0%
Subtotal Occupied	**1,103**	**97.3%**	**197**	**99.4%**
Probable Occupied	28	2.5%	0	0%
Potential Occupied	2	<1%	1	0.5%
Grand Total	**1,133**	**100%**	**198**	**100%**

2.6.3 Stephens' Kangaroo Rat Distribution on RCHCA Land in the Steele Peak Reserve

Table 4 also gives the densities of SKR-occupied area on RCHCA land in the Steele Peak Reserve, and *Figure 14* shows the SKR densities on the RCHCA land in the Steele Peak Reserve. Of the 204 acres in the Steele Peak Reserve, approximately 198 acres (97 percent) are mapped as SKR occupied and potentially occupied, with more than 99 percent of this mapped as occupied. Trace density habitat is most common (88 percent of the total), with low density comprising about 12 percent of the habitat.

2.7 SPECIAL-STATUS SPECIES MANAGEMENT ISSUES

In addition to the SKR, a variety of other species covered under the Western Riverside County MSHCP (2002) (termed "Covered Species") occur in the Lake Mathews and/or Steele Peak Reserves that will require consideration in managing habitat for the SKR, particularly those species that rely on coastal sage scrub habitat. Foremost among these other species is the federally-listed threatened coastal California gnatcatcher. Other MSHCP Covered Species known to, or potentially, occur in the Lake Mathews and Steele Peak Reserves are listed in *Table 5*.

Figure 14 Distribution of SKR Habitat on RCHCA Land in the Steele Peak Reserve

TABLE 5
MSHCP Covered Species Known from or Potentially Occurring on the Lake Mathews and Steele Peak Reserves

MSHCP Covered Species	Lake Mathews Reserve	Steele Peak Reserve
Birds		
Bell's sage sparrow	•	•
Burrowing owl	•	•
Cactus wren	•	•
California horned lark	•	•
Coastal California gnatcatcher (FT)	•	•
Cooper's hawk	•	Forage Only?
Ferruginous hawk	•	Forage Only
Golden eagle	•	Forage Only
Grasshopper sparrow	•	•
Loggerhead shrike	•	•
Merlin	•	Forage Only
Northern harrier	•	Forage Only
Southern California rufous-crowned sparrow	•	•
Swainson's hawk (ST)	•	Forage Only
White-tailed kite (SP)	•	
Yellow warbler	•	
Yellow-breasted chat	•	
Reptiles		
Coastal western whiptail	•	•
Granite spiny lizard	•	•
Orange-throated whiptail	•	•
San Diego horned lizard	•	•
Western pond turtle	•	
Mammals		
Bobcat	•	•
Brush rabbit	•	
Coyote	•	•
Dulzura kangaroo rat	•	•
Long-tailed weasel	•	•
Mountain lion	•	
San Diego black-tailed jackrabbit	•	•
San Diego desert woodrat	•	•
Invertebrates		
Quino checkerspot butterfly (FE)	•	

Legend:

FE: Federally-listed Endangered
FT: Federally-listed Threatened
SP: State Fully Protected
ST: State-listed Threatened

There are two key management issues for these species in the context of managing habitat for the SKR: **(1)** ensuring that net habitat value for these species is not decreased by managing for the SKR (e.g., by reducing cover of sage scrub through prescribed burning); and **(2)** ensuring that these species are not directly harmed during management activities for the SKR (e.g., destruction of avian nests during habitat manipulations such as grazing or mowing).

2.8 OTHER SIGNIFICANT MANAGEMENT ISSUES

This section reviews ecological and anthropogenic management issues that will need to be addressed by the SKR HMP:

- Invasive species and air pollution
- Non-native predators
- Trespass/vandalism/trash dumping
- Off-highway vehicles
- Illegal shooting

These management issues have been identified both through a review of the literature, site visits, and discussions with managers of other SKR Reserves, including:

- Ron Baxter (Riverside County Regional Park and Open Space District)
- Ken Halama (Motte Reserve)
- Joseph Messin (Motte Reserve)
- Tom Paulek (CDFG – San Jacinto Wildlife Area)
- Christine Moen (Southwestern Riverside County Multi-Species Reserve)

2.8.1 Invasive Species and Air Pollution

Invasive annual grasslands and weeds, such as mustards (e.g., *Brassica nigra* and *Hirschfeldia incana*) and Russian-thistle (*Salsola* tragus) likely are part of the permanent habitat landscape of western Riverside County as a long-term result of various disturbances, including frequent fires, grazing, mechanical disturbances, and competitive exclusion (e.g., Minnich and Dezzani 1998). It is thought that the problem of invasive exotics in western Riverside County and elsewhere in California is exacerbated by air pollution that results in increased levels of nitrogen (N) deposition and increased productivity of weeds and non-native grasses (Allen 2004; Allen et al. 2000; Stylinski and Allen 1999; Weiss 1999).

While the conversion of native vegetation communities such as coastal sage scrub to non-native annual grasslands and forbs (e.g., filaree) is a serious management issue for many species dependent on coastal sage scrub, such as the California gnatcatcher (Minnich and Dezzani 1998),

annual grassland and non-native forbs, are not detrimental to the SKR, which is a grassland species that opportunistically forages on grass and forb seeds. However, the cover density of annual grassland and forbs is a crucial factor for the SKR, which, as discussed in *Section 2.6.1*, relies on sparsely vegetated grasslands with at least 50 percent bare ground for most of the year. Areas where grassland and forb cover exceeds 50 percent become marginal habitat for the SKR, and it often is precluded altogether in areas where grassland cover approaches 100 percent. In addition, areas with high density cover of grasslands may develop thick thatch that precludes the SKR even in non-growing seasons or years with poor grass productivity.

The SKR HMP cannot control air pollution levels in the Reserves, so management will need to focus on managing the effects of air pollution. Increased nitrogen levels resulting from air pollution have been implicated in fostering non-native and invasive plant species growth. Therefore, controlling of cover and density of non-native grasslands and forbs will be more problematic in the future and will need to be controlled to the extent feasible and practicable.

2.8.2 Non-native and Urban-related Predators

The problem of non-native and urban-related predators (primarily domestic cats and dogs along the boundaries of and within the Reserves) is an edge effect that occurs along the Reserve-urban interface, including low density rural areas. Although quantified studies of the impacts of non-native predators on the SKR have not been conducted, there is general agreement among the Reserve managers based on anecdotal observations that cats and dogs are a significant issue and the problem will worsen as areas adjacent to the Reserves become more urbanized. While cats tend to be limited to the edge of Reserve areas, dogs may and do form packs and wander throughout the Reserves.

The extent of the non-native and urban-related predator problem will in large part be a function of the amount of urban-reserve edge. At Steele Peak, there are residences along the eastern and southern boundaries of the southern parcel, as well as west of both the southern and northern parcels. Dogs have been observed on the southern parcel (Vergne, pers. obs. 2006). At Lake Mathews, there is substantial residential development along the eastern boundary of the Reserve in the Gavilan Hills area, but otherwise there are only scattered residences throughout the more southerly and mountainous portions of the Reserve. Although dogs may wander into the Reserve in these areas, cats are less likely to be a problem.

Another unintended urban-related factor that can result in increased predation on SKR and other native rodents is the creation of perches that can be used by owls (primarily barn owls [*Tyto alba*]) for hunting at night, including light standards, power poles and towers, ornamental trees, and other high structures.

2.8.3 Trespass, Vandalism, Trash Dumping

Trespass, vandalism, and trash dumping are related management issues that likely are common to all of the SKR Reserve habitats because of the proximity of the Reserves to urban development. The effects of trespass, vandalism and trash dumping range from being a generally benign eyesore to having potentially significant adverse effects on individual SKRs and long-term habitat value. Adverse effects include, but are not limited to, the following:

- Reduction of occupied habitat area, because of trash dumps and access roads;
- Introduction of non-native pests, such as old world rats and mice that are attracted to trash;
- Toxic materials from dumped items, including oil, paints, and other chemicals, and hazardous (e.g., electronic lead solder and other heavy metal waste) and industrial (e.g., asphalt) wastes;
- Increased fire risk; and
- Direct mortality of individuals from the public entering the Reserve at night when SKR are active.

While vandalism itself probably has minimal direct effects on habitat and individuals, cutting of fences, damage of gates, and creation of new roads and trails makes the Reserve more accessible to other trespassers that create the problems listed above. Addressing the impacts of trespassing, dumping, and vandalism consumes considerable Reserve management time and financial resources that could otherwise be directed toward sustaining and enhancing SKR populations and habitat quality.

Efforts to control access to the Reserve, such as erecting gates and fences, often inflames offenders, and, as a result, trespass, vandalism, and trash dumping will be a continuing management issue on the Reserves. Specific security methods to address these problems are discussed in *Section 3.4*.

2.8.4 Off-highway Vehicles

Related to trespass and vandalism is the problem of off-highway vehicles (OHVs) in the Reserve. While a limited number of trails and dirt roads can be beneficial to the SKR as dispersal corridors, OHV use has a net adverse impact, particularly in parking/staging areas and where practice race courses are established, because soil surfaces are either totally compacted (e.g., where vehicles park) or constantly churned up (e.g., on practice race courses or popular hill climb areas). Associated with heavy OHV use is littering, trash dumping, oil and gasoline spills,

erosion, and increased risk of fire. Erosion along off-road trails is especially serious in hilly terrain.

The management program will need to be tailored to control OHV use, focusing control efforts in the areas most vulnerable to damage from OHVs.

2.8.5 Illegal Shooting

Related to trespass and vandalism, as well as OHVs, is illegal shooting. Illegal shooting includes localized target practice, especially around trash dumps, and illegal hunting of wildlife throughout the Reserve. Illegal shooting around trash dumps results in an accumulation of expended pistol, rifle and shotgun shells, lead pollution from bullets and shot, broken glass, clay pigeon debris, additional trash and garbage dumping, increased OHV use, and increased fire risk, as well as direct risks to public safety. Nighttime illegal hunting can result in direct mortality of the SKR.

In the absence of an approved hunting program, hunting and other illegal shooting on the Reserve should be controlled. Because of serious consequences of hunting and illegal shooting on the Reserve, it will need to have a high management priority.

2.9 PUBLIC USES

The different SKR Reserves have different types of authorized public uses that have varying degrees of compatibility with management of SKR. Some Reserves allow no public access, while in others recreational public use is encouraged. The SKR is not particularly sensitive to daytime public uses that do not involve direct habitat disturbance, because they are primarily nocturnal and spend the day underground. For example, the San Jacinto Wildlife Area permits seasonal upland game hunting (approximately 5,000 hunter days per year) and other passive recreation uses, such as wildlife viewing (approximately 15,000 to 20,000 recreation days for the wetlands tour route) and equestrian uses on designated roads that are completely compatible with managing the SKR. Recreation is not allowed on the Motte-Rimrock Reserve, which is part of the UC Natural Reserve System, because it would interfere with the use of the Reserve for scientific research. The public use of the Motte-Rimrock Reserve is limited to guided classes. At the Lake Perris State Recreation Area, SKR are more likely subject to nighttime disturbances, such as noise and lighting, at campgrounds and the race track facilities at the south end of the Recreation Area.

In general, public uses, such as passive recreation, including but not limited to hiking, supervised group tours, mountain biking and horseback riding, are compatible uses as long as the public adhere to the guidelines outlined in *Section 7.0*. Walk-in seasonal daytime hunting also may be a

compatible use if an acceptable program proposed by CDFG, under their responsibility and liability, is adopted by the RCHCA.

3.0 OVERVIEW OF MANAGEMENT GOALS, OBJECTIVES, AND STRATEGIES

3.1 RCHCA RESERVE GOALS AND OBJECTIVES

According to the SKR HCP (RCHCA 1996, p. 161) habitat management goals and objectives for SKR Reserves are to:

1. Maintain viable populations of SKR within the reserve system and each of the core reserves sufficient to ensure the long-term persistence of the species in the HCP area;
2. Promote the maintenance and enhancement of the ecosystem upon which the SKR depends;
3. Develop and continually refine management practices which identify and adapt to changing conditions both within the reserves and on lands adjacent to them;
4. Establish a core wildlife reserve system that is managed to enhance the conservation of biological diversity in western Riverside County;
5. Assist in determining future priorities to add lands that have definable conservation and/or management value to the reserve system; and
6. Consistent with the primary goal of ensuring SKR persistence, establish programs which permit human access for activities deemed compatible with SKR habitat conservation.

Policies and procedures to guide management of the Reserve include (RCHCA 1996, p. 161):

1. Maintaining existing habitat values for SKR;
2. Enhancing habitat values for SKR where appropriate;
3. Maintaining or enhancing habitat values for other species where not in conflict with SKR management goals;
4. Minimizing the need for active management by allowing natural processes to occur where not in conflict with other management goals; and

5. Managing the reserve system adaptively by: a) integrating existing knowledge with the results of ongoing experimental management, and b) refining management techniques in response to changing conditions.

These goals, policies, and procedures shape the scope of this SKR HMP. This SKR HMP addresses goals 1, 2, 3, and 6. Establishing a core wildlife reserve system (goal 4) and assisting in determining future priorities to add lands to the Reserve System (goal 5) are not elements of this HMP because the reserve system has been deemed complete.

3.2 HABITAT MANAGEMENT STRATEGIES

The primary objective in maintaining and enhancing SKR habitat is to keep vegetation sparse enough to support the species, which prefers generally shrub-free and forb-dominated habitats (e.g., Kelt et al. 2005). In principle, areas with at least 50 percent bare ground during the non-growing season (e.g., June-December) are desired to provide high quality habitat for the SKR.

Based on a review of the literature and discussions with Reserve managers and Wildlife Agency staff, there are four primary habitat management strategies to maintain and enhance habitat for the SKR, while maintaining and enhancing habitat for other species and promoting overall biological diversity: **(1)** sheep grazing; **(2)** mowing; **(3)** herbicides; and **(4)** fire, including both management and control of unplanned wildfires and prescribed burns. Each strategy has advantages and disadvantages depending on local conditions. It is anticipated that the ultimate management approach will require integration of the different strategies in response to local conditions, implemented at the discretion of the Reserve Manager. Each of these management strategies is discussed generally here and in more detail in *Section 4.0*.

3.2.1 Sheep Grazing

Sheep grazing is the preferred grazing management strategy because of the logistics of implementing sheep grazing on a local basis and the existing practice of contract sheep grazing in western Riverside County. Timed, light to moderate cattle grazing is less likely to be a feasible alternative due to the labor and cost involved in transporting cattle.

Typically, sheep prefer broad-leaf herbs but also forage on grasses if the grazing coincides with the peak growing season for grasses and before grass awns (the bristle-like or barbed appendage around the seed) develop; sheep avoid the sharp awns, such as those on ripgut grass (*Bromus diandrus*).

Sheep grazing can have both beneficial and adverse effects on natural habitats, as discussed in more detail below. While it can be used for controlling invasive, non-native grasses and weeds

and for habitat management and fuel controls, uncontrolled or over-grazing can result in destruction of native species and vegetation communities and damage soils through compaction or encouraging erosion.

The utility of sheep grazing as a management tool for maintaining and enhancing SKR habitat was demonstrated by Kelt et al. (2005). This study compared grazing and mowing as alternative habitat management methods on the Southwestern Riverside County Multi-Species Reserve east of Temecula and south of Hemet. Sheep grazing was implemented on experimental plots (7x7 trapping grids with 10-meter intervals between traps). In the first treatment, about 1,500 sheep were left on each plot for about 4 hours, during which time all available forage was removed on the plot. In the second treatment, about 200 sheep were left on the plot for about 3 days to remove all available vegetation. Both treatments were conducted in June. On three plots, grazing was implemented the year after the same plots were mowed. The sites were live-trapped bimonthly for 4 years between November 1996 and October 2000, for a total of 24 trapping sessions, to assess SKR population densities. SKR populations increased over the 4 years on the plots receiving the grazing treatment, including the treatment that mixed mowing and grazing, whereas the control plots (no grazing or mowing) showed relatively constant population densities over the 4 years. It is important to note that the grazing/mowing treatment plots were inadvertently selected to have lower SKR densities than the control plots. After 4 years, the population densities on the treatment plots were statistically the same as the control plots; that is, the treatments increased the SKR densities to the same levels as those of the control plots. Kelt et al. (2005) concluded that sheep grazing was an effective management method for enhancing SKR habitat and that this effect occurred in less than 2 years. Kelt et al. (2005, p. 427) noted that "these treatments [including mowing] evidently served to revive sites that were becoming less suitable to SKR, and may not be capable of further improving sites with 'good' habitat for this species."

The utility of sheep grazing for maintaining and enhancing SKR habitat needs to be balanced against any other adverse effects, such as consumption and/or trampling of native vegetation, including special-status plant species. Ideally, sheep would be utilized and closely managed in areas where other sensitive resources are not present, or the timing of the grazing would avoid and minimize impacts to other resources.

Discussions with other Reserve managers and Wildlife Agency staff have raised other concerns about sheep grazing, including:

- Sheep as vectors for non-native seed dispersal;
- Direct impacts on SKR burrows; and
- Direct impacts on native shrubs.

Sheep may spread non-native grass and weed species either by their hooves or their feces. It may take 5 to 9 days for seeds to pass completely through their digestive system. However, if local sheep are used and because the SKR habitat on the Reserves already supports abundant non-native species, as noted by Kelt et al. (2005), this should not be a significant issue. Alternatively, sheep may be fed "sterile" feed for 5 to 9 days prior to grazing on the Reserves.

It is likely that sheep will step into and crush some SKR burrows. However, this temporary impact to burrow systems is not considered significant and will not affect the long-term viability of a local population. The long-term enhancement of habitat will outweigh these temporary impacts. Also, it is highly unlikely that individual kangaroo rats would be directly harmed even if burrow entrances are crushed, because the kangaroo rats are well below the ground during the day when sheep would be moving around.

The concern about impacts on native shrubs is significant. Sheep will browse on woody vegetation in the absence of grasses and forbs, but their preference is fresh, succulent vegetation. With proper sheep grazing management, it should be possible to protect native shrub vegetation.

The following recommendations for sheep grazing were compiled from the TNC Weed Control Methods Handbook and the Forest Service of British Columbia Extension Note EN16:[2,3]

- Because sheep do not graze uniformly, herding, fencing and/or salt licks should be used to concentrate the sheep in the desired location;
- Herds, as opposed to single sheep, are preferred because sheep need a period of adaptation to consume a new forage type and this adaptation period can be shortened if they can follow the behavior of other sheep;
- Sheep should be brought to a site when they most likely will be able to damage the target species (e.g., after grass has germinated and is growing, but before seed has set in the spring); and
- Grazing should be continuously monitored by experienced shepherds and well-trained dogs, and sheep should be promptly removed once the proper amount of control has been achieved.

As discussed in *Section 4.2*, sheep grazing may be used in conjunction with other management strategies depending on local conditions. For example, grazing may be appropriate in areas that are not accessible to tractors for mowing, such as steep or rocky terrain, whereas mowing or herbicides, for example, may be more appropriate elsewhere. Also, sheep may be more efficient

[2] <tnc.weeds.ucdavis.edu/products/handbook/04.grazing.pdf>
[3] <for.gov.bc.ca/rsi/research/cextnotes/extnot16.htm>

than herbicides for larger-scale management. (Note: If herbicides are approved for aerial spraying, they may be more efficient.)

3.2.2 Mowing

Mowing can be used to control invasive non-native grasses and weeds. It has the advantage of being highly controllable in terms of targeting specific areas. Invasive vegetation can be controlled with relatively little soil disturbance. For a grassland species such as the SKR, mowing can be a highly efficient management technique, particularly in relatively level, rock-free monocultures of annual grasses. If mowing is used repeatedly over time before grasses set seed in the spring, long-term control of annual grass production can be affected. A disadvantage of mowing is that it can result in thick thatch layers unless mowed grass is bagged, raked, or baled.

As discussed above, Kelt et al. (2005) also used mowing alone and in combination with grazing to enhance SKR habitat at the Southwestern Riverside County Multi-Species Reserve. Experimental plots were mowed with a tractor fitted with a mower deck attachment that was set to the lowest setting. As with grazing, after 2 consecutive years of mowing, SKR densities increased, and, after 4 years, densities on treatment plots were statistically the same as the control plots that initially had higher SKR densities. Kelt et al. (2005) concluded that mowing was an effective management method for enhancing SKR habitat and that this effect occurred in less than 2 years. As with grazing, Kelt et al. (2005, p. 427) noted that "these treatments evidently served to revive sites that were becoming less suitable to SKR, and may not be capable of further improving sites with 'good' habitat for this species." They concluded that grazing and mowing were equally successful for improving habitat for the SKR.

Mowing has also been used with success in SKR habitat management at the San Jacinto Wildlife Area (pers. comms., T. Paulek, CDFG, 2006, and M. Pavelka, USFWS, 2005), although quantitative results were not available at the time this document was prepared. It also was used on Metropolitan Water District (MWD) lands at the Lake Mathews Reserve over three spring seasons, although no quantitative monitoring data for the SKR were collected in conjunction with the mowing (Baxter, pers. comm. 2006).

There are several limitations on the utility of mowing:

- It can only feasibly be used in areas that are relatively level and rock free;
- There is some potential for soil disturbance and crushing of burrow systems in more friable soils;

- It has limited use during the avian breeding season (typically February through July) because of the potential to disturb nests of birds such as grasshopper sparrow and meadowlark;
- It can result in the buildup of thatch that itself can preclude SKR use;
- It can increase the risk of wildfire due to accidental sparks if mower blades strike rocks or contact of the engine with dry vegetation; and
- It may not be as efficient as herbicide application or grazing for smaller-scale targeted management areas.

3.2.3 Herbicides

The use of herbicides to improve habitat quality for the SKR has not been demonstrated directly, but experimental field studies by Allen and her colleagues at the Southwestern Riverside County Multi-Species Reserve indicate that herbicides could be used to control invasive grasses, at least on a small scale, and potentially on a large scale in the future. Allen (2005) reported on the results of a weed control program at the Reserve that used the grass-specific herbicide Fusilade, both in a Fusilade-alone treatment and a Fusilade and dethatching treatment (note: sheep grazing was also a treatment on separate plots). The dethatching treatment was applied to remove thatch buildup that potentially could reduce the effectiveness of Fusilade. Fusilade was applied to 1-hectare (2.47-acre) plots using hand-held applicators at the lowest level of the manufacturer's recommended dose in February/March in 1999 and 2000 (the peak of the growing season and before grasses set seed). Dethatching was conducted on plots in November 1999 using hand-held weed trimmers, followed by Fusilade treatment in February 2000. Percent cover data were collected in February/March and again in late April/early May of 1999 through 2005 to determine the long-term effect of the Fusilade treatment. There were some interactions of the results with precipitation amounts and timing, but generally grass cover was significantly reduced on the Fusilade-treated plots, and the result was immediate (sheep grazing, on the other hand, did not show reduction until the third year). The reduction of grasses persisted through 2003 and 2004, but this effect may have been partly due to the low precipitation in those years. Fusilade treatment also increased the production of native and non-native forbs, which are much more conducive to SKR occupation because the SKR both harvest the forb seeds and the forbs dry out and fall apart after the growing season and leave bare ground until the next growing season. While this study did not directly address the SKR's response to the treatments, Allen states that "the grass control treatments may be a benefit to those small mammals that do not thrive in tall stands of exotic grasses." (Allen 2005, p. 6).

3.2.4 Fire

Fire as a general habitat management tool has been broadly applied to natural landscapes to control non-native invasive species and to enhance the germination of native forbs and grasses. TNC in particular has applied fire for habitat management and has summarized its potential benefits, including stimulating the germination of some native plants and reducing the abundance of non-native invasive species, which would benefit the SKR. However, Keeley (2001) cautions against the use of prescribed fire for natural community restoration, because inappropriately applied prescribed fire can actually increase the abundance of non-native species, especially if fire intervals are shorter than the community would naturally experience.

The application of prescribed burns to SKR habitat management would focus on reducing the density of non-native grasses and the buildup of thatch and increasing the relative proportion of native and non-native forbs (e.g., filaree spp.) that both provide seeds for the SKR and also dry out and fall apart after the growing season, thus resulting in greater areas of bare ground preferred by the SKR. The utility of prescribed burns for managing SKR habitat has been investigated on several of the SKR Reserves, including the Southwestern Riverside County Multi-species Reserve (O'Farrell 1997), the Lake Mathews Reserve (to control thatch; R. Baxter, pers. comm. 2006), the Lake Perris State Recreation Area (Price et al. 1995), and on March Air Force Base (MAFB) (TNC 1996).

The goals of the TNC 1996 study using fire to manage SKR habitat were to:

- Reduce frequency and dominance of introduced annual grasses;
- Reduce the organic thatch layer, rendering nutrients available to the soil via ashes;
- Increase species diversity, with specific emphasis on annual native and exotic forbs;
- Improve structural aspects of grasslands to meet SKR habitat needs;
- Develop a prescribed fire site plan and burn unit protocol; and
- Develop a sustainable cooperative fire management program.

The goals of the O'Farrell (1997) study were to:

- Establish a monitoring program for habitat and population trends of the SKR;
- Evaluate methods of habitat manipulation for the purpose of enhancement; and
- Provide a management plan.

Price et al. (1995) applied burns to experimental plots at the Lake Perris Recreation Area and found increases in population size on burned plots compared to unburned controls between

August 1990 and March 1992. Furthermore, in March 1992, the burn plots had more bare ground and more filaree than controls. The abundance of SKR was positively correlated with the amount of bare ground in both August 1990 at the start of the study and in March 1992. Price et al. (1995) concluded that spring burns, after annual forbs have set seed and before annual grasses set seed, have no detrimental effects on SKR over the short term.

TNC implemented a prescribed burn program on MAFB that was initiated in spring 1991 and extended to spring 1993. Initially, there appeared to be a positive response to the burns, with increases in the SKR populations and decrease in non-native annual grass cover. However, interpretation of these data was limited by a lack of replicates to conduct statistical comparisons, as well as a lack of coordination between collection of the SKR population and vegetation data. Additional burns were conducted in spring and fall of 1994 and 1995 to investigate seasonal effects of the burns. Unfortunately, the TNC (1996) report does not provide a detailed analysis of the response of SKR populations to the prescribed burns due to a lack of SKR surveys in the burn units documenting pre-burn conditions.

O'Farrell (1997) found positive responses to burn treatments in the years following the 1991 prescribed burn and the extensive 1993 wildfire. Decreasing population trends were observed the second year after the burns (following wet winters), indicating that consecutive annual treatments may be required to maintain habitat quality, especially in high precipitation years following treatments. During drier years, intervals between fires to maintain habitat may be longer. Based on an analysis of burn and "disk and drag" treatments (an alternative management method that was concurrently being tested), as well as the effect of the 1993 wildfire, O'Farrell (1997, p. 23) found that, over several years, SKR densities "were more strongly influenced by annual changes in environmental variables [precipitation and vegetation density] than by treatments periodically applied to plots."

While these three studies clearly demonstrate an immediate positive response by the SKR to prescribed burning, the O'Farrell (1997) and TNC (1996) studies clearly show that fire-based management needs to be monitored annually and applied as needed in response to environmental conditions, particularly in years with above-normal precipitation.

It is important to note that fire does not appear to have an immediate direct negative effect on SKR individuals, which are insulated from the fire and smoke in their underground burrows. Within 2 weeks of the 1993 wildfire, O'Farrell found abundant fresh surface sign, particularly active trails. Likewise, Price et al. (1995) found no immediate effect of fire on SKR survival, based on live-trapping results.

Overall, studies have indicated a positive effect of burning on SKR population densities. However, the systematic studies of prescribed burns conducted by TNC and O'Farrell have

demonstrated the complexity and variability of the ecological systems and the difficulty of conducting controlled field studies of management strategies. O'Farrell's study was confounded by the extensive 1993 wildfire that burned almost all the experimental and control plots 2 years after the study was initiated, making straightforward statistical analyses and interpretation of the results impossible.

There is some disagreement about the best timing of prescribed burns as it relates to SKR habitat management. TNC (1996) indicates that spring burns are best for controlling non-native annual grasses, such as *Bromus mollis, B. diandrus, Hordeum leporinum, Avena barbata,* and *A. fatua*, while fall burns favor the establishment of the *Avena* species. Both fall and spring burns favor native and non-native forbs. Price et al. (1995) also concluded that spring burns have no adverse effect, at least in the short-term, on survival of the SKR. O'Farrell (1997), on the other hand, argued that fall burns better reflect a natural fire regime. Also, because of a concern about reducing the forb seed base that SKR depend on, especially during the peak breeding season, O'Farrell (1997) was concerned that spring burns may have a long-term negative impact on SKR populations. *Section 5.0* discusses the Fire Management Program and fire ecology in more detail.

In general, fire is beneficial to the SKR because it removes dense non-native grasses, thatch, and weeds that preclude or limit SKR occupation. Fire also is a very efficient way to treat large areas of habitat that cannot be mowed, such as rocky and steep areas. However, both prescribed and unplanned fire as a habitat management tool carries real or at least perceived inherent risks that may be unacceptable for many areas. Foremost is the potential risk to public safety and property. A "let it burn" management approach for unplanned wildfires on Reserves adjacent to urban development may not be acceptable because of the increased risk to people and their property, not only from the risk of burning but also from smoke and its impact on air quality.

Fire and its relationship to management of the Lake Mathews and Steele Peak Reserves is described in more detail in *Section 5.0*.

3.2.5 Summary of Habitat Management Strategies

Table 6 summarizes the four SKR habitat management strategies, including methods, results, and the advantages and disadvantages of each strategy. As shown in *Table 6*, each of the habitat management strategies can reduce non-native annual grasses and increase native and non-native annual forbs. Sheep grazing, mowing, and fire have all been demonstrated to result in at least short-term increases in SKR populations, and it is highly likely that herbicide treatments also would increase populations. The treatments for all strategies will need to be applied repeatedly over the long term. Due to the relatively short-term nature of the studies, the timing and frequency of the treatments for optimum effectiveness for the SKR still is not well understood. However, it is highly unlikely that a straightforward, fixed treatment schedule will ever be

feasible because of the strong inverse relationship between precipitation/vegetation cover and SKR population densities (e.g., O'Farrell 1997). While the studies conducted during drier years tended to show effectiveness of treatments lasting for 3 to 4 years (e.g., Kelt et al. 2005; Allen 2005), O'Farrell (1997) observed precipitous populations declines in SKR populations immediately following wet years. The Reserve Manager will have to closely monitor year-to-year changes to determine the most effective application of the treatments.

TABLE 6
Summary of Alternative Habitat Management Strategies

Treatment	Methods	Results	Pros	Cons
Sheep Grazing	• Run large herd of sheep for short period of time (a few hours), or • Run smaller herd for longer period of time • Control distribution with fencing or shepherds and dogs • Run sheep prior to grass seed set • Ensure that sheep are adapted to foraging on grass	• Reduced cover of non-native annual grasses and forbs • Lag time of about 3 years for measurable effect (Allen 2006) • Similar long-term effect (3-5 years) as herbicide • Increased SKR population density (Kelt et al. 2005) similar to mowing	• Extent of treatment is controllable • Effective for reducing non-native grasses and forbs • Can be used at relatively large scale • Can be used in rocky and steep terrain	• If not controlled properly, can have unintended adverse effects on native shrubs and soils • Can be vector for non-native species • Potential adverse impacts on water quality? • Sheep prefer forbs to grasses under normal circumstances • Requires highly experienced shepherds and well-trained dogs if not fenced • Grazing focus usually not for habitat management • Timing window for effective program is limited and dependent on precipitation patterns • Future of sheep grazing in western Riverside County is unknown
Mowing	• Tractor with mower deck set to lowest setting • Local areas hand-cleared with weed whackers	• Reduced cover of non-native annual grasses and forbs • Increased SKR population density (Kelt et al. 2005) similar to sheep grazing	• Extent of treatment is highly controllable • Effective for reducing non-native grasses and forbs • Can be used at relatively large scale • Flexibility in timing of application	• Limited to areas that are relatively level and without rocks • May result in inadvertent soil disturbance and mortality or injury to slow-moving species (e.g., rattlesnakes and rosy boas)

TABLE 6
Summary of Alternative Habitat Management Strategies

Treatment	Methods	Results	Pros	Cons
				• Potential Migratory Bird Treaty Act (MBTA) conflicts • Leaves thatch that could build up over time • Thatch buildup would increase fuel load and potential for a severe fire • Spark from mowing could start a fire
Herbicide	• Hand-application of grass-specific herbicide, such as Fusilade, at lowest manufacturer-recommended dose • Application generally during peak growing season before grasses set seed (e.g., February-March)	• Reduced cover of non-native annual grasses for 3-4 years • Increased cover of native and non-native annual forbs	• Extent of treatment is highly controllable • Effective for reducing non-native grasses • Increases native and non-native forbs, which should encourage SKR occupation • Flexibility in timing of application • May ultimately be most efficient control method if aerial application is approved	• At present, likely limited in scale of application to small areas • Unknown adverse environmental effects? • Negative public reaction?
Prescribed Fire	• Prescribed burns to predetermined areas conducted in coordination with CDF • Generally applied in spring before grasses set seed, but see text for discussion of appropriate timing	• Reduced cover of non-native annual grasses • Increased cover of native and non-native forbs and bare ground • Increased SKR population densities at least in periods immediately following burns	• Extent of treatment controllable if applied under appropriate conditions (e.g., calm conditions and higher humidity) • Can be applied at a relatively large scale over rugged and rocky terrain • Reduced cover of non-native annual grasses • Increased cover of native and non-native forbs and bare ground • Increased SKR population densities, at least in periods immediately following burns	• Can result in inadvertent damage to shrub habitats if not controlled properly • Increased risk to public safety and property • Short-term air quality impacts • May result in long-term increase in non-native weeds if not applied at proper intervals; necessary intervals may be shorter than natural fire regime • Logistically complex and expensive to implement; may not be cost-effective and practical as a long-term management strategy

TABLE 6
Summary of Alternative Habitat Management Strategies

Treatment	Methods	Results	Pros	Cons
Wildfire Management	• Allow unplanned wildfires to opportunistically burn designated areas according to Fire Management Plan	• Reduced cover of non-native annual grasses • Increased cover of native and non-native forbs and bare ground • Increased SKR population densities at least in periods immediately following burns	• Takes advantage of unplanned wildfires • Can be applied at a relatively large scale over rugged and rocky terrain • Reduced cover of non-native annual grasses • Increased cover of native and non-native forbs and bare ground • Increased SKR population densities at least in periods immediately following burns	• Can result in inadvertent damage to shrub habitats if not controlled properly • Increased risk to public safety and property • Short-term air quality impacts • May result in long-term increase in non-native weeds if fire intervals are too short

3.3 PUBLIC USE OPPORTUNITIES

Public uses of the RCHCA lands in the Lake Mathews Reserve and the Steele Peak Reserve are potential future uses that may be phased in as funding for such uses permits. **It is important to understand that the primary purpose of the Reserves is to conserve the SKR and other sensitive biological resources. Public uses are secondary to the conservation of biological resources.** Any public uses allowed on the Reserves will be monitored, and any activities found to permanently or temporarily jeopardize the conservation of biological resources, either through direct impacts or by impairing the ability to manage and monitor the biological function of the Reserves, are subject to temporary suspension or permanent termination by the RCHCA.

The RCHCA will consider the following potential future public uses:

- Access for daytime hiking on existing dirt roads originating at an entry kiosk, with information that includes a map of the authorized hiking areas and information about the function and purpose of the Reserve;
- Controlled group activities that have a low impact on biological resources and are led by authorized person(s); and
- Approved research studies.

In principle, these activities are considered to be compatible with the purpose and function of the Reserves. The SKR is not affected by low-impact daytime activities because of its nocturnal

behavior. Other diurnal species, particularly breeding birds and slow-moving reptiles, are more vulnerable to seasonal disturbances, but, in general, hiking and controlled group activities should not pose a significant risk to these species. These activities may pose greater risk to some species of breeding raptors (e.g., white-tailed kites or northern harriers) that are sensitive to human activities during the breeding season, or, alternatively the raptors may pose a risk to humans during the breeding season.
Other future public uses that may be considered include:

- Interpretive programs for the general public and school children;
- Eco-tourism;
- Horseback riding;
- Mountain biking; and
- Hunting, if an acceptable program proposed by the CDFG, under their responsibility and liability, is adopted by the RCHCA.

Because these types of public uses have relatively greater potential for impacts on the Reserves, they will need to be carefully evaluated by the RCHCA prior to approval. Horseback riding and mountain biking, for example, would be consistent with management of the Reserves for the SKR and other biological resources if activities are restricted to existing dirt roads. However, both activities also have the potential for significant habitat destruction if even a few users fail to remain on authorized dirt roads. A difficulty on the Lake Mathews Reserve, for example, is that there are many dirt roads and trails that have been created by unauthorized uses, such as OHVs, and should be closed to public uses. Ensuring that such roads and trails are not used by the public will be a major challenge.

3.4 RESERVE SECURITY

The general problem of Reserve security was discussed above in *Sections 2.8.3* through *2.8.5*. Trespass, vandalism, trash dumping, illegal shooting, and OHV use all contribute to a general degradation of habitat and consequent direct and indirect impacts on the SKR and other sensitive biological resources. These illegal activities can also threaten the integrity of habitat management areas, especially those subject to controlled studies, and the safety of field biologists and other personnel involved in Reserve management. It will be impossible to completely secure all Reserve areas due to the non-contiguous distribution of RCHCA Reserve lands and the rugged terrain of the parcels south of Dawson Canyon in the Lake Mathews Reserve. A more realistic goal is to improve security and minimize impacts from illegal activities. Security options include:

- Regular patrols by professional security services, at least in the short term;
- Strategically-placed cameras;
- Gating and fencing of key access points to inhibit trespass;
- Signage;
- Regular monitoring of gating, fencing, and signage to include repair of breaches and replacement of signs; and
- Future part- or full-time management that sets patrol as a high priority.

Although it is understood that these actions will not deter all trespassers, it is likely that the general "law abiding" public will respect the fencing, gates, and signage and that the level of unauthorized activities will significantly decline. Over the long term, these security measures will contribute to the goals of the HMP because management funds and other resources conserved by preventing such damage will be more effectively utilized to maintain and enhance SKR populations and habitat.

4.0 SKR HABITAT MANAGEMENT PROGRAM

4.1 DESCRIPTION OF THE MANAGEMENT APPROACH

The overall purpose and goal of the management program described here for the SKR is maintenance and enhancement of suitable habitat and populations of the SKR on RCHCA lands in the Lake Mathews and Steele Peak Reserves while at the same time providing for other special-status wildlife and plant species and their habitat and potential public activities within the Reserves.

4.1.1 Passive and Active Management

Management may take two basic forms: passive and active. *Passive management* does not involve direct or active manipulation of resources. If, through consistent monitoring, SKR habitat and/or populations are found to be self-sustaining without active manipulation or intervention, no management actions would, or need, be taken. Under *passive management*, habitats and populations would be allowed to vary within their natural bounds of resiliency in relation to stochastic environmental and demographic variables. *Active management* may be implemented under two conditions: **(1)** when monitoring reveals a significant decline in habitat quality (e.g., carrying capacity) or population levels such that the local population is at significant risk of extirpation (i.e., the habitat or population is being driven past its natural bounds of resiliency); and **(2)** a management decision is made to expand the existing population,

either by increasing occupied acreage or population densities or both, through habitat enhancement.

The key issue for the first condition that must be addressed is determining the threshold or trigger for active management. The long-term monitoring program should detect the early warning signs of an adverse trend so that the Reserve Manager can consider various strategies. The monitoring program should collect the appropriate information for distinguishing natural habitat/population oscillations (i.e., *intrinsic drivers*) from negative trends induced by environmental stressors (i.e., *extrinsic drivers*). At this time, the information needed to identify the management threshold is not available; for example, it is not known whether a two-fold or a ten-fold decline in a population warrants active management.[4]

Under the second condition above, active management may be implemented for the purpose of enhancing unsuitable/unoccupied or poor quality habitat and thereby increasing population densities (i.e., carrying capacity) and/or occupied acreage. For example, for the SKR, the openness and structure of the vegetation cover is a critical factor in habitat quality. SKRs typically occur in areas with at least 50 percent bare ground. A scenario in which habitat enhancement may be appropriate is where an existing population could be expanded by enhancing adjacent habitat through techniques that reduce vegetative cover, such as grazing, mowing, herbicides, or burning, as described below. SKRs, as a colonizing species, respond well to such habitat enhancements (e.g., Kelt et al. 2005; O'Farrell 1997; Price et al. 1995). Factors that must be considered when contemplating habitat enhancement include: **(1)** the long-term value of the enhanced habitat for the function of the SKR Reserve; **(2)** the current value of the habitat for other species; and **(3)** the long-term cost of maintaining the enhanced habitat; that is, some areas may require continuous maintenance to sustain the population such that the management is not cost effective over the long term. For example, thinning coastal sage scrub at the cost of reducing habitat value for the federally-listed threatened California gnatcatcher likely would not be acceptable. On the other hand, reducing vegetative cover in an overgrown annual grassland not only would improve its value for the SKR but also would improve habitat value for other native wildlife and plant species (e.g., many native forbs) that are precluded from dense annual grasslands. Habitat enhancement also would be appropriate in situations where a previous land use (e.g., citrus groves) has been discontinued and the area has high long-term potential value for the SKR.

[4] An example of this problem occurred at the UC Deep Canyon Reserve in Palm Desert in the 1980s where captures of the Merriam's kangaroo rat plummeted from a typical 20-30 individuals on a 1-hectare grid to just 4 one season preceded by drought conditions, followed by an explosion to more that 80 individuals on the same grid a year later following high precipitation (P. Behrends, pers. obs.). Kangaroo rats and other heteromyids are adapted to varying environmental conditions and can rebound quickly under suitable conditions despite their relatively modest reproductive capacity compared to many other rodent species. As noted above, in a good year, a female SKR can produce up to five litters, and females should be capable of breeding in their natal season (Price and Kelly 1994).

4.1.2 Routine and Experimental Active Management Approaches

There are management actions described in this program that may be considered routine because they are of such clear and obvious value to the management program that experimental testing of the management is unnecessary. For example, management of trespass (OHVs, trash dumping, and illegal shooting) is a clear management action.

Less clear is the appropriate application of habitat management methods designed to reduce vegetative cover and increase SKR populations. While several studies have clearly demonstrated the effectiveness of habitat manipulations in decreasing vegetation cover and increasing SKR populations, the optimum application of these management methods is unknown, such that the desired increase in SKR populations is achieved with the minimum amount of active management, given that continuous management can be an expensive and labor-intensive activity.

Additional investigation may be necessary to examine this critical uncertainty. For example, while grazing and mowing have been demonstrated to be effective management techniques for the SKR at the Southwestern Riverside County Multiple Species Reserve (Kelt et al. 2005), application of these techniques in the Lake Mathews and Steele Peak Reserves may require additional experimentation to determine the most effective regimes, such as frequency and intensity, for each of the areas.

Experimental management can be approach two ways:

1. *A priori* (pre-defined) management experiments; and

2. *Opportunistic* (after the fact) experimental management actions in response to some natural or human-caused disturbance event that provide an opportunity for applying different management treatments.

A priori management experiments are conducted in a manner to control relevant environmental variables to the extent possible. An example of an *a priori* management experiment would be comparing the effects of mowing and grazing on SKR occupancy on a selected number of sample plots with SKR occupancy on an unmanipulated control plot, as was done by Kelt et al. (2005). An *opportunistic* experimental management action may be implemented following a disturbance event such as an unplanned wildfire. The response could involve comparing effects of grazing or mowing in burn areas on habitat quality for the SKR. Similarly, if the wildfire burns areas were previously grazed, mowed, or unmanipulated, a comparison of the recovery of the area from the fire and its suitability for the SKR could be examined. The key for

opportunistic experimental management is to assess each situation and determine whether useful management information could be gained by different "after the fact" management treatments.

The distinction between routine management and experimental management is sometimes blurred. In some cases, a well-established, routine management action turns out to have more complex effects. For example, fire as a method to reduce vegetative cover would seem to be an obvious management technique. But, as reviewed in *Section 3.2.4*, use of fire as a management method is complicated by questions about the optimum timing of fire raised by TNC (1996), Price et al. (1995), and O'Farrell (1997).

Whatever form of management action is taken (i.e., routine or experimental), monitoring the results of the action is important to determine whether the action was effective and how, if necessary, it could be modified to make it more effective.

4.2 DESCRIPTION OF MONITORING PROGRAM

The purpose of the monitoring program is to collect reserve-specific information important for the long-term management of the Lake Mathews and Steele Peak Reserves. The overall monitoring program for the SKR includes the following key elements:

- Live-trapping of pre-selected plots for the first 3-5 years of the monitoring program
- Aerial photo mapping and walkover visual surveys to map occupied SKR habitat
- Vegetation assessments

The live-trapping program will collect data on SKR population abundances on the Reserves. In conjunction with the live-trapping program, burrow counts and vegetation information will be collected in the trapping areas to determine whether valid correlations can be drawn between population abundance, active burrow densities, and vegetation characteristics, such as percent vegetation cover or the ratio of forbs to annual grasses. Additional information, such as weather patterns, fire, and other anthropogenic disturbances in the Reserves that may directly affect SKR populations and/or habitat, will be collected. A number of management and monitoring questions can be addressed by collecting these kinds of monitoring data.

1. *What are the baseline fluctuations in SKR abundance on the Reserves that set the bounds for detecting adverse population trends?*

Understanding SKR population dynamics is fundamental to managing the Reserves. Natural fluctuations in populations in relation to environmental factors (also called "drivers") are to be expected. The key is to determine the point at which the population shows a significant decline

that requires management intervention. For example, SKR populations may naturally drop to very low levels in association with extended drought but would be expected to rebound naturally with increased precipitation (see footnote [4] above); the SKR is a relatively long-lived species whose life history is adapted to variable environmental conditions, However, if precipitation is adequate to support breeding activities, but a population decline is still occurring (as determined in relation to baseline conditions), a management action may be warranted.

2. *Can burrow counts be a valid and reliable index for estimating relative SKR population abundance?*

Burrow counts along transects within the trapping grids will be made to determine whether there is a valid and reliable relationship between the number of active burrows and population densities. The work to this point on burrow counts as an index of population density has been equivocal and, at best, may only be valid at a local scale and not across the SKR Reserve system (see Diffendorfer and Deutschman 2003). However, even if only at the local scale, if a relationship between burrow counts and SKR populations can be established, this method could be a very efficient monitoring tool. Because burrow counts can be done quickly over wide areas, they would be an invaluable method of measuring existing conditions in large areas of the Reserves and the response of populations to management.

3. *What is the relationship between SKR population abundance and percent cover of vegetation and bare ground?*

This is a fundamental question that has been addressed elsewhere (e.g., Kelt et al. 2005; O'Farrell 1997) but not in detail at the Lake Mathews and Steele Peak Reserves. There is a general understanding that the SKR prefers areas with substantial bare ground, but an optimum combination of bare ground and forb and grass seed supply has not been established. Measuring the dynamic relationship between vegetation and SKR population changes will help identify when management of vegetation cover may be needed.

4. *What is the relationship between SKR population abundance and vegetation composition, such as the forb/annual grass ratio or shrub cover?*

It has been suggested that the forb/grass ratio is an important factor for the SKR (O'Farrell 1997). Because annual forbs dry and fall apart after the growing season, they can both provide seeds for the SKR and help create open habitat in the non-growing season. Annual grasses, on the other hand, tend to build up thatch over time and preclude SKR occupation. Understanding the forb/grass ratio may be an important component of long-term management with regard to the type and timing of management, for example, in determining the optimum timing of grazing to maximally impact grasses while minimally impacting forbs.

5. *What is the temporal relationship between changes in vegetation cover/bare ground and SKR population densities (e.g., what is the lag time relationship between vegetation changes and SKR response)?*

Understanding the temporal relationships between changes in vegetation cover and bare ground and SKR population responses is important for knowing when to implement management. For example, if the lag time between increased vegetation cover and decreased SKR populations is short (e.g., a few months or less), immediate management may be needed once increases in vegetation are detected to prevent population declines. On the other hand, if the lag time is long (e.g., more than a year), management in an area could be deferred in favor of management resources being directed elsewhere. An additional factor that should be considered is the temporal relationship of precipitation to vegetation cover and SKR population changes. For example, if vegetation cover is increasing and SKR populations may be starting to decline, but a drier than normal year (e.g., a La Nina effect) is predicted, management may be deferred to take advantage of the naturally drier weather, On the other hand, if a wetter than normal year is predicted, vegetation management may be required that year to prevent a compounding increase in vegetation.

6. *What are the relative changes in SKR populations in different quality habitats (e.g., open grassland versus sparse sage scrub) in relationship to other environmental changes, such as percent vegetation cover, slope, and soil characteristics?*

Effective management of the Reserves will be enhanced by an understanding of SKR population dynamics in relationship to habitat quality. Some areas of the Reserves likely always support the SKR because of consistently suitable conditions. Other areas may exhibit more variability in relation to external environmental factors, such as precipitation and fire, and existing conditions, such as soils and slopes. When SKR populations are expanding, areas that typically do not support the SKR or are only marginal habitat supporting trace populations may be utilized to a greater extent. These areas also may serve important connectivity functions for long-term dispersal between high-quality habitat areas or be temporary refuge for dispersing juveniles. When populations are declining, SKR may temporarily disappear from these areas for variable periods of time. Identifying these marginal areas will help prioritize management actions such that resources are used most efficiently.

7. *What are the spatial and temporal dynamic relationships with the DKR in association with other environmental changes (e.g., do SKR abandon areas where DKR populations increase)?*

Related to the question above is the spatial and temporal relationship between the SKR and DKR, especially in areas where the two species overlap. For example, trapping grids that include

both open habitat on level ground and steeper terrain with shrubbier habitat likely support both species. An understanding of these overlap zones and how they relate to vegetation and other factors will help direct management actions. For example, areas with a large population of the DKR and only trace densities of the SKR may be a low priority for management because the long-term value of the area is higher for the DKR and management (e.g., vegetation control) may degrade the habitat for the DKR.

The aerial photo mapping and walkover visual surveys to map occupied SKR habitat through the Reserves are an important component of the long-term monitoring program. Initially, these surveys will help set the baseline conditions in the Reserves and, over the long-term, will help track any changes that may be important for maintaining habitat quality. The aerial photo mapping and walkover surveys will utilize the results of the live-trapping, burrow count and vegetation monitoring studies in the long term. In particular, if valid and reliable indicators of habitat quality and population densities can be established in the short-term studies, they can be used for long-term monitoring on a Reserve-wide basis. For example, burrow counts or vegetation transects could be used both to gauge populations and habitat quality and as indicators to trigger management. If specific vegetation cover percentages or forb/grass ratios predicting SKR declines are detected on the Reserves, management of these areas may be initiated.

The following sections describe the key components of the monitoring program. Specific monitoring programs for the Lake Mathews and Steele Peak Reserves are discussed in *Sections 4.3.1.3* and *4.3.2.3*, respectively.

4.2.1 Live-trapping of Pre-selected Plots

The live-trapping program directly monitors SKR populations on specific areas of the Lake Mathews and Steele Peak Reserves in order to assess systematic changes in population trends. This program, which was initiated in August 2006, is planned to occur over the next 3 to 5 years. While considerable biological information exists for the SKR, this 3 to 5 year monitoring program is intended to provide sufficient additional information specific to the Lake Mathews and Steele Peak Reserves so that future monitoring can be successfully achieved utilizing aerial photo mapping and visual walkover surveys. The live-trapping protocol will generally follow the recommendations of Diffendorfer and Deutschman (2003) for making point estimates of abundance and monitoring populations across space and time. The live-trapping protocol includes:

- 7x7 trap grid arrays, with 15-meter intervals between each trap station
- Four trapping sessions annually conducted in the periods of February/March, May/June, August/September, and November/December
- Three consecutive nights of trapping on each grid per session

- Passive Integrated Transmitter (PIT) tags to mark all captured SKR
- Census of active burrows on grid traplines
- Census of vegetation conditions on grids during each trapping session, including species composition, percent cover and bare ground, and forb/grass ratio
- 10 grids in the Lake Mathews Reserve and one grid in the Steele Peak Reserve

Appendix A provides a description of the live-trapping program.

The census of active burrows on the grid traplines at the time of live trapping is designed to investigate the relationship between the density of active burrows and the number of individuals on the grid. The purpose of this study is to determine whether burrow counts can be a reliable and valid surrogate for estimating population densities in future monitoring of the Reserves (see Diffendorfer and Deutschman [2003] for a detailed discussion of this issue).

The census of vegetation conditions on the grids at the time of live trapping is designed to investigate the relationship between the number of individuals on the grid and vegetative conditions. This study is particularly important for long-term management of the Reserves.

Selection of the trapping locations involved six steps:

1. Compiling existing information for the RCHCA-owned parcels in the Lake Mathews and Steele Peak Reserves, including vegetation communities, soils, and SKR-occupied habitat mapping;
2. Developing a Habitat Suitability Index (HSI) using the vegetation community and soils and slope data (described in *Appendix B*);
3. Conducting a preliminary field reconnaissance of RCHCA-owned parcels in the Reserves to determine the feasibility of access and to gain a general overview of habitat quality;
4. Delineating discrete areas of the Reserves based on access considerations and general habitat quality to target potential trapping grids for long-term monitoring;
5. Comprehensive field review of areas identified in Step 4 to locate trapping grids; and
6. Analysis of existing conditions of potential trapping grids to verify that locations provide adequate sampling of the habitat landscapes in the Reserves.

The 10 selected grid locations for the Lake Mathews Reserve and one location for the Steele Peak Reserve are shown in *Figures 15* and *16*, respectively. The trapping grid selection process and a detailed description of existing conditions on the grids are presented in *Section 4.3.1.3* for the Lake Mathews Reserve and in *Section 4.3.2.3* for the Steele Peak Reserve.

Figure 15 Trapping Grids on RCHCA Lands in the Lake Mathews Reserve

Figure 16 Trapping Grids on RCHCA Land in the Steele Peak Reserve

4.2.2 Aerial Photo Mapping and Visual Walkover Surveys

Aerial photo interpretation and visual walkover surveys for SKR-occupied habitat should be conducted, on average, about every 5 years throughout the RCHCA-owned parcels in the Lake Mathews and Steele Peak Reserves. Aerial photo mapping and walkover surveys are important because the trapping studies only sample a limited area of the Reserves and, because of the constraints of laying out the trapping grids, potential habitat areas, such as ridgelines bordered by steep slopes, are not suitable for trapping grids. Such areas predominate in the southern parcels of the Lake Mathews Reserve and are important for overall Reserve function, providing key habitat connectivity throughout the Reserve.

For aerial photo mapping, color or false-color (that clearly distinguished shrub from grassland) infrared aerial photography (digital orthophotos, 1-meter resolution) or a comparable high-resolution medium should be used to map potential SKR habitat. The key factor for remote interpretation is that grassland and shrubland vegetation communities can be reliably categorized in order to characterize the potential of the habitat for supporting the SKR. Based on the mapping of potential habitat, visual, on-the-ground surveys should be conducted to verify SKR occupation by personnel familiar with identifying SKR surface sign. The visual surveys should be quantified with regard to SKR surface sign and vegetation characteristics to the extent feasible and practicable. In areas without established trapping grids (i.e., the southern parcels of the Lake Mathews Reserve and northern parcels of the Steele Peak Reserve), active burrow counts along predesignated transects within occupied polygons would be ideal, but as with the trapping grids, there are limitations to setting up sample transects, especially in variable terrain where occupied habitat is patchy. O'Farrell (1992) and Baxter (2000), for example, used four parallel 135-meter transects spaced at 15-meter intervals for correlating burrow counts with population densities. However, an extensive statistical analysis by Diffendorfer and Deutschman (2003) of the burrow count and population density data collected by O'Farrell at various sites, by Baxter at Lake Mathews-Estelle Mountain, and at MAFB indicates that the relationship is extremely variable, including changes in the burrow count and density relationship at the same site over different years (see Figure 5 of Diffendorfer and Deutschman [2003]). As a result, they strongly caution against using burrow counts as a surrogate for population density at a specific point in time.

Although burrow counts may not be accurate for direct point estimates of abundance, they should be used as an adjunct to the live-trapping program. They can be used to monitor general trends in populations at a broader landscape level, in particular presence/absence and relative abundance, as long as they are applied in a consistent manner. For example, single designated transects along narrow ridgelines can be monitored periodically to determine the relative abundance of active burrows during different survey periods. Even if the O'Farrell (1992) transect method provided completely reliable and valid density estimates, ridgelines generally do not provide enough area to set out four parallel lines without some of the lines crossing

unsuitable habitat and thus biasing the density estimate. Although population densities cannot be precisely estimated, burrow counts can provide information about the general status of the species in the area, and comparisons with other surveys along the same transect in different years can be made.

Along with burrow counts, qualitative data should be collected as indicators of SKR occupation, including abundance of scat, runways, tail drags, tracks, and dust bowls. A biologist familiar with SKR surface sign typically can generate a reasonably accurate "gestalt" of habitat quality and relative abundance of individuals based on this information. A simple checklist of presence/absence and abundance of these kinds of surface sign for each sample transect should be adequate to generally and reliably characterize SKR activity in the area.

Selection of non-trapping grid sample transects should be completed during the first remapping of the Reserves, because the existing SKR habitat map is more than 10 years old. Also, because of the time period in which the mapping was conducted, delineations likely were directly onto U.S. Geological Survey maps and non-georeferenced aerial photos, and thus the physical accuracy of the maps probably is relatively poor compared to what could be done with current methods, materials and technology. At the time potential habitat polygons are field-checked, permanent sample transects should be established in areas that are representative of conditions within the area and logistically feasible to monitor. A possible method for selecting the transects is to first map the occupied habitat in the field, select general areas from the occupied habitat polygons that are feasible for long-term monitoring, and, by using a numbered grid overlaid on the polygons, randomly select a set number of transects from each area. Control points for transects can be established using a Global Positioning System.

4.2.3 Vegetation Assessments

A crucial element in monitoring and managing SKR habitat is maintaining suitable vegetation conditions. As described above, SKR prefer habitats with at least 50 percent bare ground. Habitat dominated by native and non-native forbs relative to annual grasslands is more suitable for the SKR because forbs both provide seeds for SKR and dry out and fall apart after the growing season, leaving more bare ground. Dense thatch can build up in areas dominated by annual grasses and effectively preclude SKR occupation over the long term.

As part of the live-trapping program, vegetation monitoring will occur on trapping grids concurrent with trapping. As recommended by Diffendorfer and Deutschman (2003), monitored variables will include percent vegetative cover, percent bare ground, diversity/cover of grasses, and forb/grass ratio. The vegetation monitoring protocol is described in more detail in *Appendix C*.

Similar vegetation monitoring also should be conducted on the pre-established walkover transects throughout the Reserves in order to correlate relative SKR abundance with vegetation conditions such as cover density and species composition.

4.3 LONG-TERM POPULATION AND HABITAT MANAGEMENT AND MONITORING

This section describes the long-term population and habitat monitoring program for the Lake Mathews and Steele Peak Reserves.

4.3.1 Lake Mathews Reserve

The RCHCA parcels in the Lake Mathews Reserve total approximately 4,543 acres, of which approximately 1,103 acres are occupied and approximately 30 acres are potentially or probably occupied by the SKR. Included in this acreage is a 160-acre BLM parcel for which the RCHCA intends to enter into a cooperative management agreement.

4.3.1.1 Goals, Objectives, and Strategies

The long-term goals of the SKR HMP are as follows:

1. To the extent feasible, maintain the baseline acreage of occupied SKR habitat and SKR population densities as described in *Section 2.6.2*.
2. To the extent feasible, attempt to increase the baseline acreage of occupied SKR habitat and to increase the SKR population densities of medium or higher.
3. To refine Goals, Objectives, and Strategies as more information becomes available.

Baseline data used for the SKR HCP (RCHCA 1996) indicate approximately 1,103 acres of occupied habitat and an additional 30 acres of probable/potential occupied habitat, for a total of 1,133 acres (*Table 4*). Using these baseline data, specific management objectives deriving from the above-stated goals are as follows:

Objective 1: To the extent feasible, maintain a minimum of 1,000 acres of occupied habitat on RCHCA lands in the Lake Mathews Reserve.

Objective 2: To the extent feasible, make best efforts to maintain a minimum of 280 acres of the occupied habitat at a population density of medium or higher. Based on the existing data, approximately 28 percent of the occupied habitat is designated as low-medium to high density (see *Table 4*).

Objective 3: As more information becomes available, to the extent feasible, make best efforts to increase the acreage of occupied SKR habitat and SKR population densities of medium or higher.

The strategies for achieving the Objectives above are:

- Conduct comprehensive SKR habitat mapping of the Reserve on average every five (5) years using color or false color infrared aerial photography (digital orthophotos, 1-meter resolution) or comparable resolution medium and field-truthing by qualified personnel to quantify the approximate amount of occupied SKR habitat.
- To the extent feasible, implement appropriate management measure(s), as described below, if total quantified occupied habitat falls below 1,000 acres and/or acreage of medium or higher density habitat falls below 280 acres.
- Relate long-term monitoring of sample trapping grids to variations in occupied habitat acreages to better understand population dynamics and population and habitat trends.
- To the extent feasible, implement appropriate management measure(s) in the Reserve that enhance and expand occupied habitat areas.

Implementation of the management strategies for achieving these objectives in the Lake Mathews Reserve is facilitated by subdividing the Reserve into discrete management units and then applying the appropriate management measure(s) in each unit. The following section describes this process.

4.3.1.2 Selection and Description of Habitat Management Units

The various RCHCA-owned parcels in the Lake Mathews Reserve are quite heterogeneous in regard to suitability for and occupation by the SKR, as well other listed and special-status species. In general, the more northerly parcels that occur in flatter and more open habitats support the majority of occupied SKR habitat, whereas the southerly parcels tend to be more mountainous and covered by coastal sage scrub and chaparral. The SKR in southerly parcels tend to be confined to ridgelines, hilltops, and saddles and are more likely to occur in trace and low population densities because of the rugged terrain and relatively poor suitability of the soils (typically Temescal rocky loam on 25-50 percent slopes). For these reasons, and because of logistical considerations, the trapping locations for monitoring populations were limited to the northerly parcels where the majority of the SKR population is located and where there are more opportunities for habitat enhancement.

This section discusses the selection of potential habitat management units based on the following criteria:

- Contribution to the overall viability of the Lake Mathews Reserve for the SKR;
- Suitable existing habitat conditions for managing existing SKR populations and enhancing habitat for expansion of the population without diminishing habitat value for other listed and special-status species based on:
    - Existing vegetation/land cover;
    - Soils suitability; and
    - Status of existing SKR populations.
- Likelihood that enhancement of currently unoccupied areas will be colonized by the SKR; and
- Logistic considerations (e.g., accessibility for management).

For example, a potential management unit may have a high priority for management because it is contiguous with already occupied habitat, it is primarily comprised of annual grassland or is mapped as vacant/disturbed (i.e., the former citrus groves), mostly supports sandy and/or loamy soils on gentle slopes (e.g., <25 percent), has been mapped as unoccupied in the past, and has good access for management activities (e.g., maintained roads). Such a location would be considered a strong candidate for enhancement designed to expand the existing SKR population. On the other hand, a potential management unit may be assigned a low priority or be rejected for SKR management (although it may be suitable for management for other species) because it is generally isolated from substantial SKR populations, is primarily shrubland (coastal sage scrub or chaparral), woodland, or riparian, supports generally unsuitable soils (e.g., clay, rocky, or cobbly soils), is in relatively steep terrain (i.e., >25 percent), or is logistically infeasible to manage.

Most potential management units have both positive and negative features for management. The goal of the selection exercise is to identify those management units that have the best potential for contributing to the SKR Reserve over the long-term.

The potential management units were delineated based primarily on field reconnaissance, interpretation of the vegetation maps, topography, accessibility, and the pre-existing RCHCA-owned parcel map. To the extent possible, boundaries of the management units were defined by existing dirt roads or topographic features, such as drainages, to facilitate identification of the units in the field. In cases where smaller parcels are isolated from other parcels, the entire parcel is the potential management unit. Larger parcels typically were subdivided into smaller management units based on the factors listed above (e.g., vegetation, topography).

As shown in *Figure 17*, the Lake Mathews Reserve was divided into 12 main units, identified as LM1 through LM12, based on the parcel information. The larger parcels were divided into subunits where appropriate (e.g., LM1-A, LM1-B). These subunits were used both for identifying trap locations and management units. A total of 26 potential management units was identified, varying in size from 9.7 acres (LM12) to 699.3 acres (LM11-B). *Table 7* summarizes the main features of each potential management unit and provides a management recommendation for each unit as follows:

1. ***Level 1***—SKR management is highly recommended because unit is known to support high-quality SKR habitat or has high potential for enhancement, based on existing vegetation/cover, soils, terrain, and contiguity with other occupied habitat that support potential source populations.

2. ***Level 2***—SKR management should be considered because unit is known to support the SKR and has good potential for enhancement based on existing vegetation/cover, soils, terrain, and contiguity with other occupied habitat that support potential source populations. Most Level 2 units, however, also may support other vegetation, such as coastal sage scrub or riparian, may have substantial areas of generally unsuitable soils that could limit the expansion and/or density of SKR populations, occur on more rugged terrain, or are more logistically challenging than Level 1 units.

3. ***Level 3***—SKR management is possible and has reasonable likelihood of success but is a lower priority because of other vegetation types on the unit or limiting factors such as unsuitable soils or rugged terrain.

4. ***SKR Management Not Recommended***—Management is not recommended for these units because the units are dominated by other vegetation, such as coastal sage scrub and chaparral, unsuitable soils, rugged terrain, and/or restricted, poor, or no access. It is important to note that most of these units contain occupied SKR habitat, but the occupied habitat usually is scattered throughout the unit on ridgelines, hilltops, and saddles between hilltops. Although these populations are important to the overall function of the Reserve for the SKR, because of their scattered and typically linear distribution and because they usually occur in a mosaic with sage scrubs and chaparrals on adjacent slopes, they are not considered suitable for landscape-level management activities. Furthermore, active management of these units may not be important because the local populations probably are less vulnerable to extirpation; predominant rocky, shallow soils in these areas are less susceptible to developing dense covers of non-native vegetation that preclude the SKR.

Figure 17 Habitat Management Units on RCHCA Lands in the Lake Mathews Reserve

TABLE 7
Summary of Habitat Management Units and Management Recommendations for RCHCA Lands in the Lake Mathews Reserve

Management Unit	Total Acres	Chaparral	Coastal Sage Scrubs	Annual Grasslands	Oak Woodlands	Peninsular Juniper Woodland and Scrubs	Riparian Forest and Woodland	Disturbed/ Vacant	Soils Suitable for SKR[1]	SKR Occupied Habitat	Unoccupied Habitat	Management Recommendation	Fire Management Unit & Response Category	Weed Abatement & Fuel Management	Public Access Control (see Figure 18)	Recreational Opportunities
LM1-A	170.1	0.0	0.4	0.5	0.0	0.0	0.0	169.1	22.8	0.0	168.8	Level 1 recommendation for management despite some marginal soils (31 acres of Temescal rocky loam, 108 acres of Porterville cobbly clay, and 8 acres of Los Posas stony loam) • Former citrus grove • Substantial enhancement opportunities • Adjacent to high-quality habitat in LM1-B • Easily accessed • Suitable for grazing and mowing depending on location of activity.	FMU 1 Reserved Response Category	Mowing would be effective due to relatively flat terrain on eastern portion of FMU.	Primary access control points from Cajalco Road via gates 5 and 6. Secondary access from Gate 7 to east, Gate 9 to the south and open access points to the west.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM1-B	109.4	0.0	12.0	93.0	0.0	0.0	4.3	0.1	34.4	107.7	1.7	Level 1 recommendation for management despite some marginal soils (57 acres of Porterville cobbly clay and 18 acres of Temescal rocky loam) • Existing occupied habitat • Dominated by annual grasslands • Easily accessed • Suitable for grazing and mowing depending on location of activity.	FMU 1 Reserved Response Category	Mowing would be effective due to relatively flat terrain on eastern portion of FMU.	Primary access control points from Cajalco Road via gates 5 and 6. Secondary access from Gate 7 to east, Gate 9 to south and open access points to the west.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM1-C	143.1	0.0	0.0	0.0	0.0	0.0	1.3	143.1	2.3	38.0	105.2	Level 1 recommendation for management despite some marginal soils (32 acres of Temescal rocky loam, 18 acres of Bosanko clay, and 91 acres of Porterville cobbly clay) • Former citrus grove • Existing occupied habitat • Easily accessed • Suitable for grazing.	FMU 1 Reserved Response Category	Mowing would be effective due to relatively flat terrain on eastern portion of FMU.	Primary access control points from Cajalco Road via Gates 5, 6 and 7. Secondary access from Gate 9 to the south and open access points to the west.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM1-D	70.5	0.0	18.7	3.6	0.0	0.0	1.6	46.6	32.6	14.0	52.3	Level 2 recommendation for management • Former citrus grove • Existing occupied habitat • Substantial areas of coastal sage scrub and riparian (total of 20 acres) • Substantial areas of Temescal rocky loam on 15-50% slopes (38 acres) • Easily accessed • Suitable for grazing with appropriate control.	FMU 1 Reserved Response Category	Sheep grazing likely effective on steeper areas.	Primary access points from Cajalco Road via Gate 5 and from open access points to the west. Secondary access from Gates 6 and 7 from the east and Gate 9 to the south.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM1-E	225.2	0.0	111.6	5.8	0.0	0.0	14.3	79.4	78.3	35.8	189.4	Level 2 recommendation for management • Portion former citrus grove • Existing occupied habitat • Substantial areas of coastal sage scrub and riparian (total of 126	FMU 1 Reserved Response Category	Sheep grazing likely effective on steeper areas.	Primary access points from Cajalco Road via Gate 5 and Gate 9 and from open access points to the west. Secondary access from Gates 6 and	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback

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												acres) • Substantial areas of Lodo rocky loam on 25-50% slopes (147 acres) • Easily accessed • Suitable for grazing with appropriate control.			7 from the east and Gate 9 to the south.	riding, mountain biking, and eco-tourism
LM1-F	47.5	0.0	27.0	15.9	0.0	0.0	3.0	1.6	0.0	0.0	47.5	Not recommended for management • Substantial area of coastal sage scrub and riparian (30 acres) • Poor access • Poor soil suitability • No mapped existing SKR habitat	FMU 1 Reserved Response Category	Sheep grazing likely effective on steeper areas.	Primary access from open access point on Cajalco Road and secondary access from open access to south.	• Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM1-G	224.4	0.0	0.6	0.2	0.0	0.0	9.7	213.9	53.5	45.9	178.5	Level 2 recommendation for management • Former citrus grove • Existing occupied habitat (36 acres of trace density) • Substantial areas of Porterville cobbly clay (57 acres), Temescal rocky loam (27 acres), Los Posas stony loam (52 acres), and Lodo rocky loam (24 acres) • Easily accessed • Suitable for grazing and mowing depending on location of activity • Subportions should be considered for management	FMU 1 Reserved Response Category	Mowing would be effective due to relatively flat terrain.	Primary access from Cajalco Road via Gates 5 and 6 and from south via Gate 9. Secondary access from open access points to the west and Gate 7 to east.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM1-H	135.2	0.0	0.4	0.0	0.0	0.4	0.0	134.3	22.4	0.0	135.1	Level 2 recommendation for management • Mostly disturbed/vacant land • 82 acres of Lodo rocky loam and 31 acres of Temescal rocky loam • Suitable for grazing	FMU 1 Reserved Response Category	Mowing would be effective due to relatively flat terrain on eastern portion of FMU. Sheep grazing likely effective on steeper areas.	Primary access from Cajalco Road via Gate 5 and secondary access from the east via Gates 6 and 7 and south via Gate 9 and from west at open access points 1-4.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM1-I	237.5	0.0	13.3	0.0	0.0	0.0	12.8	211.3	77.5	48.2	188.5	Level 2 recommendation for management • Existing occupied habitat (18 acres of low density and 27 acres of trace-low) • Soils are mostly Cieneba (7 acres), Lodo (77 acres) and Temescal (72 acres) rocky loams, and Bosanko clay (4 acres) • Suitable for grazing and mowing • Could be grazed in conjunction with management of LM1-A and LM1-H	FMU 1 Reserved Response Category	Sheep grazing likely effective on steeper areas.	Primary access from Cajalco Road via Gate 5 and secondary access from the east via Gates 6 and 7 south via Gate 9 and from west at open access points 1-4.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism

TABLE 7
Summary of Habitat Management Units and Management Recommendations for RCHCA Lands in the Lake Mathews Reserve

Management Unit	Total Acres	Chaparral	Coastal Sage Scrubs	Annual Grasslands	Oak Woodlands	Peninsular Juniper Woodland and Scrubs	Riparian Forest and Woodland	Disturbed/ Vacant	Soils Suitable for SKR[1]	SKR Occupied Habitat	Unoccupied Habitat	Management Recommendation	Fire Management Unit & Response Category	Weed Abatement & Fuel Management	Public Access Control (see Figure 18)	Recreational Opportunities
LM2-A	153.8	0.0	42.5	7.8	0.0	0.0	1.3	102.2	50.1	32.2	121.7	Level 3 recommendation for management because potential for expanding population limited by rocky soils on steep slopes • Large portion former citrus grove • Existing occupied habitat • Much of soil is Lodo rocky loam (104 acres) • Generally easy access • Suitable for grazing	FMU 2 Primarily Standard Response Category	Sheep grazing likely effective on steeper areas.	Primary access from south via Gate 9 and from north and west at open access points 1-4. Secondary access from Gate 5, 6 and 7.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM2-B	509.7	0.0	464.9	22.4	0.0	0.0	15.7	5.5	28.1	172.3	335.6	Not recommended for management • Substantial area of coastal sage scrub and riparian (481 acres) • Marginal soils with 438 acres of Lodo rocky loam • Generally rugged terrain	FMU 2 Primarily Assertive Response Category	Sheep grazing likely effective on steeper areas.	Primary access from south via Gate 9 and from north and west at open access points 1-4, and secondary access via Gates 5, 6 and 7.	• Daytime hiking • Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM3	54.2	0.0	11.7	42.6	0.0	0.0	0.0	0.0	38.9	51.8	2.4	Level 1 recommendation for management • Virtually all of parcel occupied – mapped at medium-high density • Dominated by annual grasslands • Easily accessed • Suitable for grazing and mowing with avoidance of sage scrub patches	FMU 3 Reserved Response Category	Mowing would likely be effective due to relatively flat terrain, patches of coastal sage scrub should be avoided but provided fuel modification on periphery by mowing of grasses.	Primary access from south via Gate 9 and secondary access from north, northwest, and east at open access points 1-4 and Gates, 5, 6 and 7.	• Controlled Group Activities
LM4	19.8	0.0	19.1	0.8	0.0	0.0	0.0	0.0	10.9	17.8	2.0	Level 2 recommendation for management (California Native Plant Society mapping of 19 acres of coastal sage scrub appears to be inaccurate based on site visit; much of parcel is grassland) • Most of parcel occupied – mapped at low density • Easily accessed • Suitable for grazing and mowing	FMU 4 Assertive Response Category	Mowing would be effective due to flat terrain.	Primary access from south via Gate 9 and secondary access from north, northwest, and east at open access points 1-4 and Gates, 5, 6 and 7.	• Controlled Group Activities
LM5	371.5	0.0	251.6	28.7	0.0	12.3	17.3	0.0	49.9	95.4	275.9	Not recommended for management • Substantial area of coastal sage scrub and riparian (270 acres) • Marginal soils with 154 acres of Temescal rocky loam, 100 acres of terrace escarpment, and 68 acres of Lodo rocky loam • Generally rugged terrain • No direct access	FMU 6 Mostly Assertive Response Category with Standard Response Category in Northwest Quadrat	No fuel reduction recommended unless prescribed burning at appropriate intervals can be implemented.	Primary access from south at open access point 11 in Dawson Canyon. Limited secondary access from Gates 5, 6, 7 and 9 to west and north.	• Controlled Group Activities • Potential for hunting, interpretive programs, horseback riding, mountain biking, and eco-tourism
LM6	186.2	0.0	130.6	42.5	9.0	0.0	4.3	0.0	0.0	39.4	146.8	Not recommended for management • Substantial areas of coastal sage scrub • Marginal soils with 107 acres of Temescal rocky loam and 79 acres of Lodo rocky loam	FMU 7 Assertive Response Category	No fuel reduction recommended unless prescribed burning at appropriate intervals can be implemented.	Primary access from west via open access points 10 in Dawson Canyon. Remote access from east and southeast via open access points 14 and 16.	Limited recreation opportunities due to ruggedness of terrain and lack of existing dirt roads or trails system.

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Management Unit	Total Acres	Chaparral	Coastal Sage Scrubs	Annual Grasslands	Oak Woodlands	Peninsular Juniper Woodland and Scrubs	Riparian Forest and Woodland	Disturbed/ Vacant	Soils Suitable for SKR[1]	SKR Occupied Habitat	Unoccupied Habitat	Management Recommendation	Fire Management Unit & Response Category	Weed Abatement & Fuel Management	Public Access Control (see Figure 18)	Recreational Opportunities
												• Generally rugged terrain • Limited access via private road				
LM7-A	55.3	0.0	53.6	1.7	0.0	0.0	0.0	0.0	0.0	14.9	40.3	Not recommended for management • Substantial areas of coastal sage scrub • Temescal rocky loam soils • Rugged terrain • Limited access via Southern California Edison easement	FMU 8 Assertive Response Category	No fuel reduction recommended in FMU.	Remote access via open access points 10 to the west, 14 to the east and 16 to the south.	Limited recreation opportunities due to lack of public access.
LM7-B	560.5	6.2	524.7	0.0	6.5	0.0	2.3	0.0	0.0	99.8	460.7	Not recommended for management • Substantial areas of coastal sage scrub • Marginal soils with 457 acres of Temescal rocky loam soils and 103 acres of Cieneba rocky sandy loam • Rugged terrain • Poor access	FMU 8 Assertive Response Category	No fuel reduction recommended in FMU.	Remote access via open access points 10 to the west, 14 to the east and 16 to the south.	Limited recreation opportunities due to lack of public access.
LM7-C	84.0	50.4	23.0	1.7	8.8	0.0	2.3	0.0	0.0	20.3	63.7	Not recommended for management • Substantial areas of coastal sage scrub and chaparral (total 73 acres) • Marginal soils with 7 acres of Temescal rocky loam soils and 77 acres of Cieneba rocky sandy loam • Rugged terrain • Access only via private road	FMU 8 Assertive Response Category	No fuel reduction recommended in FMU.	Remote access via open access points 10 to the west, 14 to the east and 16 to the south.	Limited recreation opportunities due to lack of public access.
LM9	38.9	0.0	38.4	0.0	0.0	0.0	0.9	0.0	0.0	11.5	1.7	Not recommended for management • Site virtually all coastal sage scrub • Soils all Temescal rocky loam • Rugged terrain • Poor access	FMU 9 Assertive Response Category	No fuel reduction recommended in FMU.	Primary access via open access points 14 to the north and remote access via open access point 10 to the west and 16 to the south.	Limited recreation opportunities due to lack of public access.
LM10-A	89.6	0.0	86.9	1.4	1.2	0.0	0.0	0.0	0.0	49.7	39.9	Not recommended for management • Site virtually all coastal sage scrub • Soils all Temescal rocky loam • Rugged terrain • Poor access – private road	FMU 10 Assertive Response Category	No fuel reduction recommended in FMU.	Access restricted at access points 12 (signage) and 13 (private gate).	Limited recreation opportunities due to lack of public access.
LM10-B	54.5	0.0	53.9	0.6	0.0	0.0	0.0	0.0	0.0	46.8	7.7	Not recommended for management • Site virtually all coastal sage scrub • Soils all Temescal rocky loam • Rugged terrain • Poor access	FMU 10 Assertive Response Category	No fuel reduction recommended in FMU.	Access restricted at access points 12 (signage) and 13 (private gate).	Limited recreation opportunities due to lack of public access.
LM10-C	58.6	0.0	55.2	3.5	0.0	0.0	0.0	0.0	0.0	45.4	13.3	Not recommended for management • Site virtually all coastal sage scrub • Soils all Temescal rocky loam • Rugged terrain • Poor access	FMU 10 Assertive Response Category	No fuel reduction recommended in FMU.	Access restricted at access points 12 (signage) and 13 (private gate).	Limited recreation opportunities due to lack of public access.
LM10-D	96.0	0.0	84.2	9.8	0.0	0.0	2.0	0.0	0.0	46.0	50.0	Not recommended for management • Site virtually all coastal sage scrub • Soils all Temescal rocky loam • Rugged terrain • Poor access	FMU 10 Assertive Response Category	No fuel reduction recommended in FMU.	Access restricted at access points 12 (signage) and 13 (private gate).	Limited recreation opportunities due to lack of public access.

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Summary of Habitat Management Units and Management Recommendations for RCHCA Lands in the Lake Mathews Reserve

Management Unit	Total Acres	Chaparral	Coastal Sage Scrubs	Annual Grasslands	Oak Woodlands	Peninsular Juniper Woodland and Scrubs	Riparian Forest and Woodland	Disturbed/ Vacant	Soils Suitable for SKR[1]	SKR Occupied Habitat	Unoccupied Habitat	Management Recommendation	Fire Management Unit & Response Category	Weed Abatement & Fuel Management	Public Access Control (see Figure 18)	Recreational Opportunities
LM11-A	138.6	50.0	66.3	0.0	10.5	0.0	0.0	0.0	0.0	1.3	105.5	Not recommended for management • Site virtually all coastal sage scrub and chaparral (total 116 acres) • Soils include 96 acres of Cieneba rocky sandy loam and 43 acres of Temescal rocky loam • Rugged terrain • Access from Lake St.	FMU 11 Assertive Response Category	No fuel reduction recommended in FMU.	Primary access via open access point 16 at south boundary.	Limited recreation opportunities due to ruggedness of terrain and lack of existing dirt roads or trails system.
LM11-B	699.3	53.3	609.1	0.0	16.9	0.0	4.4	0..0	0.0	89.5	599.1	Not recommended for management • Site virtually all coastal sage scrub and chaparral (total 662 acres) • Soils include 179 acres of Cieneba rocky sandy loam and 520 acres of Temescal rocky loam • Rugged terrain • Access from Lake St.	FMU 11 Assertive Response Category	No fuel reduction recommended in FMU.	Primary access via open access point 16 at south boundary.	Limited recreation opportunities due to ruggedness of terrain and lack of existing dirt roads or trails system.
LM12	9.7	0.0	0.0	0.0	0.0	9.7	0.0	0.0	8.9	9.7	0.0	Level 2 recommendation for management • Virtually all of parcel occupied – mapped at low and medium density • Easily accessed • Suitable for grazing and mowing?	FMU 5 Assertive Response Category	Mowing and grazing would be effective management tools for reducing fuels while maintaining habitat values.	Primary access via open access point 8.	No recreational opportunities due to isolated location.

[1] SKR may occur on soils generally not considered suitable, including rocky loams on 25-50% slopes. Typically trace to low population densities occur on these soils along relatively level ridgelines, hilltops, and in saddles between hilltops. Although these populations are important to the overall function of the Reserve for the SKR, because of their scattered and linear distribution and because they usually occur in a mosaic with sage scrubs and chaparrals on adjacent slopes, they are not considered suitable for landscape-level management activities. Furthermore, these populations probably are less vulnerable to local extirpation because rocky, shallow soils are less susceptible to developing dense covers of non-native vegetation that preclude the SKR.

As can be seen in *Figure 17*, all of the units recommended for Level 1 and 2 management are located in the northern portion of the Lake Mathews Reserve north of Dawson Canyon. This is almost entirely due to the natural physiography of the area; the open, level portions of the Reserve supporting the highest quality and potential SKR habitat is concentrated in this area, while the southern parcels are dominated by rugged terrain with scattered, patchy SKR populations. Fortuitously, public/quasi-public ownership patterns and access in the northern parcels facilitate management compared to the difficult access issues presented by private ownership patterns in the southern parcels. Furthermore, as noted above, habitat management will not be as important in the southern parcels because the dominant rocky and shallow soils resist invasion by exotics better than the deeper and more fertile soils in the northern parcels.

The units recommended for management summarized in *Table 7* provide opportunities for both managing the existing SKR population and significantly expanding the population. *Table 8* summarizes the Level 1 and Level 2 management units with regard to the amount of available manageable habitat (defined here as mapped annual grassland and vacant/disturbed), how much of the habitat in the unit currently is mapped as occupied (including probable and potentially occupied mapping units), and an estimate of the potential expansion of occupied habitat in the unit (i.e., the difference between the available manageable habitat and the amount already mapped as occupied). The estimate for potential expansion is conservative because it does not account for mapped occupied habitat that occurs in non-suitable vegetation, such as coastal sage scrub. It is important to note that the occupied habitat estimates are based on mapping conducted in the early 1990s and used in the 1996 SKR HCP (RCHCA 1996). Updating the SKR maps for these units certainly will change these acreages somewhat, but the overall evaluation presented here is not likely to significantly change.

TABLE 8: Summary of Level 1 and Level 2 Management Units

Management Unit	Grassland/Vacant/Disturbed	Mapped Occupied Habitat	Potential Expansion of Habitat
Level 1			
LM1-A	169.6	0.0	169.6
LM1-B	93.1	107.7	0.0
LM1-C	143.1	38.0	105.1
LM3	42.6	51.8	0.0
Level 1 Total	**448.4**	**197.5**	**274.7**
Level 2			
LM1-D	50.2	14.0	36.2
LM1-E	99.3	35.8	63.5
LM1-G	214.1	45.9	168.2
LM1-H	134.3	0.0	134.3
LM1-I	211.3	48.2	163,1
LM4	0.8[1]	17.8	0.0
LM12	9.7	9.7	0.0
Level 2 Total	**719.4**	**171.4**	**565.6**
Level 1 & 2 Total	**1,167.8**	**368.9**	**840.3**

[1] LM4 is mapped as having 19.1 acres of coastal sage scrub. Based on the reconnaissance of the site, this appears to be inaccurate; much of the site currently is annual grassland.

Based on the total amount of occupied habitat in the Level 1 and Level 2 management units, about 369 acres (33 percent) of the total 1,133 acres of mapped SKR habitat in the Lake Mathews Reserve are recommended for management. Based on existing information, it is estimated that the SKR habitat in these management units could be expanded by approximately 840 acres. Using this estimate, the RCHCA lands in the Lake Mathews Reserve could support at least 2,000 acres of occupied habitat, assuming that the unmanaged units do not change significantly in the amount of occupied habitat. With the goals of maintaining a minimum of 1,000 acres of occupied habitat on the Lake Mathews Reserve, of which 300 acres (30 percent) are to be medium or higher density, the expansion potential of the population in the Level 1 and Level 2 management units indicates that meeting these goals is very feasible.

4.3.1.3 Monitoring

As described in *Section 4.2*, monitoring will consist of live trapping of permanent grids (for at least 3-5 years), aerial photo mapping and walkover surveys on average every 5 years, and vegetation monitoring on both the trapping grids and transects established for walkover surveys. It is possible that the Reserve Manager also will conduct opportunistic monitoring of SKR population status and vegetation conditions in an adaptive fashion, for example, in response to high precipitation, extended drought, or unplanned wildfires. The need for live trapping beyond the planned 3-5 year program is not known. If reliable correlations between burrow counts and/or vegetation characteristics and population densities can be established in the 3-5 year trapping program on the Lake Mathews Reserve, additional periodic live trapping may not be necessary or could be greatly reduced in frequency. However, future trapping may be considered if unexpected population declines are documented, based on declining active burrow counts in relation to vegetation cover (e.g., where cover appears appropriate, but occupied burrows have declined), possibly indicating some other causative factor in the population decline such as disease, increased predation, or some other adverse urban-Reserve edge effect.

Ten permanent trapping grids have been established in the Lake Mathews Reserve, as shown in *Figure 15*. *Table 9* summarizes each of the grids with regard to size of the grid and existing conditions. The selected grid sites represent the gradient of the habitat in the Lake Mathews Reserve that supports the SKR, ranging from high-quality habitat on grids LM1-B and LM3 to marginally suitable habitat on grid LM1-I-3. This broad variability should allow for detectable trends in the populations and habitat quality. There is adequate representation of both high- and low-quality habitats, for example, to detect declines in populations on high-quality habitat and increased populations on low-quality or currently unoccupied habitat.

TABLE 9
Description of Lake Mathews Reserve Trapping Grids

Management Unit Trapping Grid	HSI Rank	Acres	Vegetation/Cover Type (CNPS 2005)	Acres	Mapped SKR Population Density	Acres	Soil Series	Acres
LM1-B	High	0.2	Grasslands	2.0	Low-Medium	2.0	Cajalco fine sandy loam, 8-15% slopes, eroded	0.2
	Medium	1.8					Temescal rocky loam 15-50% slopes	1.8
LM1-G	Low	2.0	Vacant/Disturbed	2.0	Low	1.2	Yokohl loam, 8-15% slopes, eroded	2.0
					Unoccupied	0.8		
LM1-E	High	1.2	Vacant/Disturbed	0.8	Unoccupied	2.0	Lodo rocky loam, 25-50% slopes, eroded	0.2
	Medium	0.6	Grasslands	1.2			Ysidora very fine sandy loam, 2-15% slopes, eroded	1.8
	Low	0.1						
	Very Low	0.1						
LM1-I-1	Very Low	2.0	Vacant/Disturbed	2.0	Low	1.5	Temescal rocky loam, 15-50% slopes, eroded	2.0
					Trace	0.5		
LM1-I-3	Very Low	2.0	Vacant/Disturbed	2.0	Low	0.8	Temescal rocky loam, 15-50% slopes, eroded	2.0
					Trace	0.3		
					Unoccupied	0.9		
LM2-A	Medium	0.9	Coastal Sage Scrub	0.9	Occupied	0.5	Lodo rocky loam, 25-50% slopes, eroded	2.0
	Very Low	1.1	Vacant/Disturbed	1.1	Trace	1.5		
LM2-B	Medium	2.0	Coastal Sage Scrub	2.0	Occupied	1.6	Lodo rocky loam, 25-50% slopes, eroded	2.0
					Unoccupied	0.4		
LM3	High	1.5	Coastal Sage Scrub	0.5	Medium-High	2.0	Buren fine sandy loam, 8-15% slopes, eroded	1.5
	Medium	0.5	Grasslands	1.5			Porterville cobbly clay, 2-15% slopes	0.5
LM4	High	2.0	Coastal Sage Scrub	2.0	Low	2.0	Yokohl loam 2-8% slopes	0.5
							Yokohl loam 8-15% slopes, eroded	1.5
LM12	High	2.0	Juniper Woodland and Scrub	2.0	Low	0.7	Monserate sandy loam, 15-25% slopes, severely eroded	0.5
					Medium	1.3	Monserate sandy loam, 5-8% slopes, eroded	1.5

Table 10 summarizes the existing conditions collapsed over all the grids. For example, for the HSI, 64 percent of the grids is composed of high and medium areas, while 36 percent is composed of low and very low areas. For vegetation/cover types, grassland and vacant/disturbed lands (former citrus groves), which would be expected to support the largest SKR populations in

the future, comprise 63 percent of the grids, while presumably lower-quality SKR habitat (coastal sage scrub and woodlands and scrub) comprise about 37 percent of the grids. Mapped occupied habitat also is variable among the grids, with medium to high densities mapped on 17 percent of the total grid area, trace to low-medium on 52 percent of the grid area, simply "occupied" on 11 percent of the grid area, and unoccupied on 20 percent of the grid area. It is important to note that SKR occupation was confirmed on a least a portion of all grids during the walkover reconnaissance and selection of trapping grids, so the 20 percent of "unoccupied" is overestimated. Finally, suitable soils (sandy and loamy soils) comprise 48 percent of the grid areas and generally unsuitable soils (rocky and cobbly soils on slopes >25 percent and clays) comprise 52 percent of the grids areas. The relatively high percentage of unsuitable soils is somewhat misleading because the grids were established in relatively level areas that may be mapped as having 25 to 50 percent slopes at a macro mapping level. Again, the walkover reconnaissance confirmed that grids with "unsuitable" soils do support the SKR. Also, as shown in *Table 2*, rocky and clay soils (Cieneba, Lodo, Porterville, and Temescal series) comprise the large majority of soils in the RCHCA lands in the Lake Mathews Reserve.

TABLE 10
Summary of Lake Mathews Trapping Grids Existing Conditions

Factor	Acres	% of Total
Habitat Suitability Index (HSI)		
High	6.9	35%
Medium	5.8	29%
Low	2.1	10%
Very Low	5.2	26%
Vegetation/Cover Type		
Grassland	4.7	24%
Vacant/Disturbed	7.9	39%
Coastal Sage Scrub	5.4	27%
Juniper Woodland & Scrub	2.0	10%
Mapped Population Density		
High	0.0	0%
Medium-High	2.0	10%
Medium	1.3	7%
Low-Medium	2.0	10%
Low	6.2	31%
Trace	2.3	11%
Occupied	2.1	11%
Unoccupied	4.1	20%
Soils		
Suitable	9.5	48%
Unsuitable	10.5	52%

4.3.1.4 Implementation of Habitat Management Strategies

Section 3.2 discussed the proposed habitat management strategies in detail. This section makes recommendations for implementing the different strategies.

All four of the alternative strategies—sheep grazing, mowing, herbicides, and fire—appear to be effective management methods for the SKR because all result in the reduction of annual grasses in favor of native and non-native forbs and creation of more open habitat and bare ground. The ultimate effectiveness of the different methods likely depends more on timing and frequency of the applications than the method itself. Assuming that all four methods would be acceptable from the perspective of managing SKR habitat, the selection of an alternative will depend on cost-effectiveness and practicability for the Lake Mathews Reserve. *Table 6* summarizes the advantages and disadvantages of each of the methods.

Sheep grazing and mowing are recommended as the primary management methods at this time, although fire would be the most natural treatment (see FMP and discussion of fire ecology in *Section 5.0*). Both have been shown to be effective in managing SKR habitat at the Southwestern Multi-Species Reserve (Kelt et al. 2005). Both are controllable with proper application and can be used at relatively large scales. Mowing is more limited in application where terrains are more rugged and/or rocky. Also, mowing has a greater potential for accidentally igniting fire, may result in greater buildup of thatch over time if not combined with removal, may cause inadvertent soil disturbances, and may directly affect some species, such as slow-moving snakes. Sheep grazing has more flexibility because terrain and rockiness are not limiting factors. However, grazing requires proper controls (e.g., experienced shepherds, fencing, well-trained dogs) to avoid over-grazing and impacting non-target vegetation communities such as coastal sage scrub. Timing also is more critical with sheep grazing because sheep prefer forbs to grasses and will not eat grass that has developed sharp awns. Also, without proper controls, sheep can be a vector for non-native species.

Grass-specific herbicide treatment (e.g., Fusilade) has been shown to be an effective control on non-native annual grasses and results in increased forb cover (Allen 2006). Herbicides also appear to have a more immediate effect than grazing or mowing. Although herbicide treatment has not been directly demonstrated to enhance SKR populations, the main effect of the treatment is entirely consistent with increased habitat quality for the SKR and other small native rodent species. At this time, large-scale use of herbicides is not recommended as a primary management method. If feasible and practicable, it is recommended that grass-specific herbicide treatment be investigated on a small-scale (e.g., 1-hectare or 2.47-acre experimental plots) to determine its effectiveness in increasing SKR populations and its long-term safety for use in the Reserve. If herbicide treatment is shown to be effective and safe, it could be the most efficient and cost-effective form of landscape-level management.

Prescribed burning is an effective management technique, as demonstrated by Price et al. (1995) and O'Farrell (1997). However, for the Lake Mathews Reserve, prescribed burning may not be practical because of concerns about its controllability, air quality, and public health and safety. It is unlikely that residents in the vicinity of the Reserve would support prescribing burning. For this reason, although prescribed burning is a management option, it may not be feasible at this time.

Wildfire management will also be a key factor in maintaining and enhancing habitat quality and must be considered in the overall management program. Wildfires will occur in the Lake Mathews Reserve, and fire frequencies are expected to increase with increasing urbanization in areas adjacent to the Reserve. The FMP is discussed in detail in *Section 5.0*. Long-term management will have to integrate active SKR-specific management methods, such as grazing and mowing, with fire management. If a portion of the Reserve that had been targeted for grazing or mowing experiences an unplanned burn because of the buildup of non-native grasses, this area may be allowed to burn under the FMP if existing conditions are appropriate to do so, such as if there is a buildup of non-native grass and/or thatch, and the area can be allowed to burn without risk to public safety and property. Following the burn, the Reserve Manager will need to monitor the recovery response of the area to the fire and determine when the area should again be treated with grazing or mowing. The timing and type of recovery will depend on several factors, such as precipitation, timing of the burn, and vegetative conditions at the time of the burn. Coordination with CDF and post-fire monitoring will be crucial for properly planning future management. If, for example, the fire is followed by several years of drought, the area may not require management for a prolonged period. However, if the fire is followed by wet years, non-native grasses and weeds may proliferate and require extensive management over a short period of time.

Table 11 summarizes the recommendations for the application of sheep grazing and mowing, the two primary management methods, to the 14 Level 1 and Level 2 management units. Generally, where the terrain allows, mowing would be effective. Where the terrain tends to be more rugged and/or rocky, sheep grazing is recommended.

As described in *Section 3.2*, the application of management treatments requires proper timing for effectiveness. In general, both mowing and grazing should be applied during the peak annual grass-growing season (typically winter-early spring) to maximize effectiveness of controlling annual grasses and having the least impact on native and non-native forbs. The need for and precise timing of these applications will be the Reserve Manager's decision based on a general monitoring of habitat conditions. In general, it is understood that above average precipitation results in increased vegetation cover, so in wet years the Reserve Manager should monitor vegetative conditions closely. Although there is no set formula for how much vegetative cover would trigger management actions, O'Farrell (1997) suggests a general grass to forb (G/F) ratio

greater than 1.5 is a reasonable threshold for implementing habitat management. This recommendation needs to be examined during the live-trapping program that will correlate population densities with vegetative conditions. It is recommended that the Reserve Manager monitor vegetation conditions along transects within the 10 trapping grids and elsewhere at the Manager's discretion during the peak growing season to determine if management is needed.

TABLE 11
Summary of Grazing and Mowing Recommendations
for Lake Mathews Level 1 and 2 Management Units

Management Unit	Sheep Grazing	Mowing	Comment
Level 1 Units			
LM1-A	•	•	Mowing likely would be effective due to relatively flat terrain
LM1-B	•	•	Mowing likely would be effective due to relatively flat terrain
LM1-C	•	•	Mowing likely would be effective due to relatively flat terrain
LM1-H	•	•	Mowing likely would be effective due to relatively flat terrain, but some rocky areas would need to be avoided
LM3	•	•	Mowing likely would be effective due to relatively flat terrain, but patches of coastal sage scrub should be avoided
Level 2 Units			
LM1-D	•		Grazing recommended because of steeper terrains
LM1-E	•		Grazing recommended because of steeper terrains
LM1-G	•	•	Mowing likely would be effective in flatter areas
LM1-I	•	•	Mowing likely would be effective due to relatively flat terrain
LM1-J	•	•	Mowing likely would be effective due to relatively flat terrain
LM1-K	•		Grazing recommended because of steeper terrains
LM1-L	•	•	Grazing primarily recommended because of steeper terrains, but flatter areas could be mowed
LM4	•	•	Mowing likely would be effective due to relatively flat terrain
LM12	•	•	Mowing likely would be effective due to relatively flat terrain

At this time, information on demographic processes is insufficient to precisely direct management decisions; for example, determining percent vegetative cover at which management should be initiated. The purpose of the live-trapping studies on the 7x7 grids across the SKR Reserve System is to better understand the relationship between demography and environmental conditions, such as precipitation patterns and vegetative conditions across space and time. It is expected that, over the next several years, information from the trapping studies will be useful in helping direct long-term management of the Reserves. Until the trapping studies provide more detailed information, it is recommended that the Reserve Manager consult regularly with qualified biologists, if necessary, in making these management decisions. Biologists familiar with the SKR can fairly accurately determine general habitat suitability.

4.3.1.5 Security/Access Controls

The general security issues for the Reserve are discussed in *Sections 2.8.3* through *2.8.5*. Three objectives for improving security are:

- Patrols;
- Gating and fencing of key access points to inhibit trespass; and
- Signage.

In the Lake Mathews Reserve, there are several access points for trespassers (see numbered locations on *Figure 18*). Open access points are locations where there are no gates, fencing, or signs to restrict or limit public access. The 16 open and gated access points and potential security issues for the management units in the Lake Mathews Reserve are described as follows.

- **Access Points 1, 2, and 3:** Open access point 1 allows unrestricted access by 4-wheel drive vehicles and OHVs from Cajalco Road to the Lake Mathews Reserve north of Dawson Canyon via access areas 2 to LM2 and 3 to LM1. Access point 1 feeds into an intensive OHV use area located to the west of LM2 at access area 2. Access area 2 at LM2 may be difficult to control with fencing because of the numerous access points along the boundary depicted in *Figure 18*. This location is a popular OHV area. To close off direct access at the intersection corner of LM2-A and LM2-B would require at least 2,000 linear feet of fencing. However, because this area allows access to all the parcels north of Dawson Canyon via numerous dirt roads and OHV trails, fencing this area may be warranted. Determining the feasibility and effectiveness of fencing access area 2 will need to consider the potential access north (along LM2-A) and west (along LM2-B) of the fence lines. If these areas are accessible to motorcycles, fencing this area may only expand the damage to this area. Open access point 3 is a single road leading into the southern portion of LM1. Fencing, boulders, or k-rails may be feasible for controlling access at this point, depending on the accessibility of adjacent terrain to OHVs; that is, creating new trails around the edge of the fence. This access point likely allows access to all the parcels in the Lake Mathews Reserve north of Dawson Canyon.

- **Access Point 4:** Open access point 4 on Cajalco Road is easily accessed from Cajalco Road and allows direct access to all the parcels via LM1-F in the Lake Mathews Reserve north of Dawson Canyon. It currently is used for illegal dumping and for access by OHVs. Because of the steep terrain bordering this location, this access point probably could be effectively controlled with a heavy pipe gate (if permanent access is needed) and/or adjacent k-rails or large boulders to block the road.

Figure 18 Potential Trespass Access Points to RCHCA Lands in the Lake Mathews Reserve

- **Access Point 5:** This is one of the main authorized gated access points to the Lake Mathews Reserve off Silverton Court/Farley Drive. This location is gated and fenced and provides good security. Other than maintenance of this location, as needed, no additional security measures are recommended.
- **Access Point 6:** This location provides access to MWD lands within the Lake Mathews Reserve directly from Cajalco Road and is secured with a pipe gate and large boulders adjacent to the gate and by 4-strand barbed wire fence posted with signs that parallels Cajalco Road. This gate and fencing also provide direct security for LM1.
- **Access Point 7:** This gated access point is off Hollis Lane and High Reservoir Way just east of the MWD Lake Mathews Reserve Headquarters on Cajalco Road. This location provides direct access from Cajalco Road to the Lake Mathews parcels north of Dawson Canyon via easily traveled dirt roads. The fence and gate at this location are broken and need to be replaced to improve security.
- **Access Point 8**: This open access point to LM12 is located at Emilita Street. Because of the small area of the Reserve and the adjacent residences, security at this site is not a priority.
- **Access Point 9:** This gated access point is located along the northern boundary of the El Sobrante Landfill. It is secured with a pipe gate and provides adequate security at this point. (Note: Other potential access points from east of the landfill were not field-checked and will require additional study to determine if other security measures are needed.)
- **Access Point 10:** This open access point is from Dawson Canyon Road and is indicated as Skyline Road on the Thomas Guide. This location provides direct access to the SCE powerline road and parcels LM6, LM7, and LM11 and indirect access to LM9 and LM10 via other dirt roads. This road is well maintained but appears to be remote enough that it is not heavily used by the general public or by casual users. There is little evidence of trash dumping at least up to and in the vicinity of LM6. There is some evidence of OHV trails off the main road, but much of the terrain along the road is too steep and rugged even for OHVs. Because of the extensive network of roads in the area, especially on the eastern portion of the powerline road in the vicinity of LM7, LM 9, LM 10, and LM 11, specific security measures other than patrolling likely are not feasible or practicable. With the little evidence of vandalism and OHV use, security of this area is not a primary concern for day-to-day management of the Reserve. The main management issue in this area is fire, with the powerline road providing access for arsonists, as well as increasing the chance of accidental ignitions (see FMP in *Section 5.0*).
- **Access Point 11:** This open access point is from Dawson Canyon and directly accesses LM5 from the south. It is indicated as Rim Canyon Road on the Thomas Guide. This access road appears to dead end on the southern portion of LM5 and does not provide

access to most of the parcel. The access point is not a primary security concern except for the potential of intentional and accidental fire ignitions.

- **Access Points 12 and 13:** Access point 12 to LM10 is a private dirt road off of El Hermano. It is posted No Trespassing near the western end of the road but is not gated at this point. At approximately location 13, the road is privately gated with security cameras. Given the existing posting and gating of the road and the generally rugged terrain in this area, security is not a primary concern.
- **Access Point 14:** This open access point is via Gavilan Springs Ranch Road from Lake Mathews Drive. This well-maintained public dirt road provides local access for residents, direct access to parcels LM9 and LM7, and indirect access via other roads to LM10 and LM11, including the main SCE powerline road. Because of the extensive network of dirt roads in the area, restricting access to the Reserve parcels would be difficult. However, access is difficult in some areas because of the steep and rocky terrain, necessitating 4-wheel drive and limiting access by 2-wheel drive vehicles. Access by local residents using OHVs is probably common.
- **Access Point 15:** This potential access point to LM11 from the north along Estelle Mountain Road is restricted by a locked gate. Security from this direction is not a concern.
- **Access Point 16:** This open access point to LM11 from the south via Lake Street is a significant problem. This access road connects with the SCE powerline road and is easily and frequently accessed by the public, as evidenced by extensive dumping, target shooting, and general vandalism in the riparian area at the southeast corner of parcel LM11. Security in this area needs to be addressed because of the high level of illegal trespass and the access it provides to LM11 and other parcels to the north via the network of roads in the area. The feasibility of patrolling, gating, and fencing this area should be examined. The possibility of improving security in this area should be discussed with SCE.

Generally, actions that would improve overall security in the Reserve include the following:

- Irregular or unpredictable patrols in security hotspot areas such as the Lake Street access point 16.
- Labeling and signage of key roads in the Reserve to facilitate patrols and coordination with the Riverside County Sheriff and CDF (see FMP in *Section 5.0*).
- Signage indicating No Trespassing at key access points. Signs should be fairly generic, with identification of the area as an ecological Reserve printed in small letters at the bottom of the sign. No icons of wildlife should be used.

- Pipe gates that protect locks, chain link fence, 4-strand barbed wire fencing, k-rails, or large boulders at appropriate areas.
- Coordination with SCE and the El Sobrante Landfill regarding public access related to their facilities.
- Coordination with adjacent private landowners to gain a better understanding of public access across or adjacent to their properties, particularly in the areas of Gavilan Springs Ranch Road and Estelle Mountain Ranch Road east of LM7 and north of LM11.
- Clearing of existing trash dumps as soon as feasible and practicable and at least annual maintenance of magnet areas, such as the Lake Street dump site.
- Coordination and/or contract with a law enforcement entity for the purpose of responding to more serious Reserve management issues, such as trespass, illegal OHV use, dumping, stolen cars, drug labs, and use of firearms.
- Coordination with CDF regarding access for fire fighting and management (see *Section 5.0* FMP).

4.3.2 Steele Peak Reserve

The RCHCA parcel in the Steele Peak Reserve is 204 acres, of which approximately 197 acres are occupied by the SKR and 1 acre is potentially occupied. The same general management and monitoring approach recommended for the Lake Mathews Reserve (*Section 4.3.1*) is recommended for the Steele Peak Reserve.

4.3.2.1 Goals, Objectives, and Strategies

The long-term goals of the SKR HMP are as follows:

1. To the extent feasible, maintain the baseline acreage of occupied SKR habitat and SKR population densities as described in *Section 2.6.2*.
2. To the extent feasible, attempt to increase the SKR population densities of medium or higher.
3. To refine Goals, Objectives, and Strategies as more information becomes available.

Available data for the Steele Peak Reserve indicate approximately 197 acres of SKR-occupied habitat and 1 acre of probable/potential SKR-occupied habitat, for a total of 198 acres (*Table 4*). Of the SKR-occupied habitat, 168 acres are mapped as trace density, 24 acres as low density, and 5 acres as trace-low density. Based on these data, specific management objectives are as follows:

Objective 1: To the extent feasible, maintain a minimum of 197 acres of occupied habitat on RCHCA land in the Steele Peak Reserve.

Objective 2: To the extent feasible, make best efforts to maintain a minimum of 24 acres of occupied habitat at a population density of low (see *Table 4*).

Objective 3: As more information becomes available, to the extent feasible, make best efforts to increase the acreage of occupied SKR habitat and SKR population densities of low or higher.

The strategies for achieving Objectives above are:

- Conduct comprehensive SKR habitat mapping of the Reserve on average every 5 years using color or false-color infrared aerial photography (digital orthophotos, 1-meter resolution) or comparable resolution medium and field-truthing by qualified personnel to quantify the approximate amount of occupied SKR habitat.
- Implement appropriate management measure(s), as described below, if total quantified occupied habitat falls below 197 acres.
- Implement management measures to increase low or higher density habitat.
- Relate long-term monitoring of the sample trapping grid to variations in occupied habitat acreages to better understand population dynamics and population and habitat trends.

4.3.2.2 Description of Habitat Management Unit

Because of the relatively small size of the RCHCA land in the Steele Peak Reserve, the entire parcel is the habitat management unit. Site conditions are summarized in *Table 12* for vegetation communities, soils, and SKR habitat. About 54 percent of the site is mapped as supporting coastal sage scrub (110 acres), with 85 acres of this dominated by California buckwheat. Annual grassland comprises about 45 percent of the site (93 acres). About 70 acres of the site support moderately to highly suitable soils for the SKR, with the remaining 134 acres (the Lodo series) considered marginal for the SKR (*Table 2*). However, as shown in *Table 12*, the large majority of the site is already occupied by the SKR, with 168 acres (85 percent) mapped as trace density. The trace density is consistent with the dominance of marginal soils. Also, much of the site mapped as trace density supports coastal sage scrub. Management of the site thus will focus on maintaining existing habitat suitability for the SKR because relatively little can be done to increase population densities due to soil limitations and existence of coastal sage scrub. However, to achieve Objective 2, active management of the eastern portion of the site where annual grassland predominates and soils are more suitable for the SKR (see *Figures 5* and *10*, respectively) is recommended to increase the amount of low or higher density habitat.

TABLE 12
Summary of Habitat Management Unit and Management Recommendations for RCHCA Land in the Steele Peak Reserve

Management Unit	Total Acres	Coastal Sage Scrubs	Annual Grasslands	Riparian Forest and Woodland	Soils Suitable for SKR[1]	SKR Occupied Habitat[2]	Unoccupied Habitat	Management Recommendation	Fire Management Unit & Response Category	Weed Abatement & Fuel Management	Public Access Control (see Figure 19)	Recreational Opportunities
Steele Peak	204	110	93	1	204	198	6	Level 2 recommendation for management • Enhancement opportunities on eastern portion of site supporting annual grasslands • Majority of site supports trace density with little enhancement potential due to dominance of marginal soils and existing coastal sage scrub • Easily access to eastern portion of site via Forrest Drive • Suitable for grazing and herbicide treatment • Limited suitability for mowing in eastern portion of site.	FMU 12 Assertive Response Category	Grazing and limited mowing are possible along access roads. Minimize fire spread during wildfire as part of habitat enhancement. Timed prescribed fire could be used on a long-term basis, but not until wildfire frequency is substantially reduced.	Primary access control points from Mountain Lane via Reserve gate 5 and open access points 6, 7, 8, and 9. Primary access point from Forrest Drive via Reserve gate 12. Secondary access from west via private gates 1 and 2 and open access points 3 and 4. Secondary access from south via private gate 11 and open access point 10.	Recreation on RCHCA land in the Steele Peak Reserve is not recommended due to limited size and recreational opportunities of Reserve and the general need to protect the area from encroachment by the public.

[1] Of the 204 acres onsite, approximately 70 acres are highly suitable and 134 acres are considered marginal although they are occupied (see Table 2).

[2] Includes 1 acre of potential occupied.

4.3.2.3 Monitoring

As described in *Section 4.2*, monitoring will consist of live-trapping of permanent grids (for at least 3-5 years), aerial photo mapping and walkover surveys on average every 5 years, and vegetation monitoring on both the trapping grid and transects established for walkover surveys. It is possible that the Reserve Manager also will conduct opportunistic monitoring of SKR population status and vegetation conditions in an adaptive fashion, for example, in response to high precipitation, extended drought, or unplanned wildfires. Because of the small size of the RCHCA portion of the Steele Peak Reserve, one permanent trapping grid has been established in the Reserve, as shown in *Figure 16*.

Existing conditions on the 7x7 grid include:

- 2.0 acres of HSI High habitat quality;
- 1.0 acre of coastal sage scrub and 1.0 acre of grassland;
- 2.0 acres of trace density; and
- Soils including:
    - 0.4 acre of Vista coarse sandy loam on 2-8 percent slopes
    - 1.6 acres of Fallbrook sandy loam on 8-15 percent slopes

4.3.2.4 Implementation of Habitat Management Strategies

Management of the Steele Peak Reserve, as summarized in *Table 12*, should focus on maintaining and enhancing high-quality habitat for the SKR in areas mapped as annual grassland in the eastern portion of the site and where soils are highly suitable for the SKR (*Figures 5* and *10*, respectively). There is a small patch of annual grassland associated with Friant sandy loam (approximately 8 acres) in the northwest parcels (*Figures 5* and *10*) that may be considered for management as well. With 93 acres of mapped annual grassland on the site, enhancement of existing population densities should be feasible. A site visit in July 2006 confirmed that open areas in the eastern portion of the southern parcel (e.g., along the roads) support fairly abundant SKR surface sign, including burrows, scat, and runways, with sign being more scarce where annual grasses are thicker.

The setting of the Steele Peak Reserve, generally bounded by rural residential development, indicates that prescribed fire is an unlikely management option for this area due to concerns about public safety and property. Given the general rockiness and drainages on the majority of the site, mowing also is not the most efficient management option for the entire site, although

there may be some areas that could be mowed; for example, the eastern edge of the site had been mowed apparently for a firebreak. Sheep grazing and herbicides are two viable options, with sheep grazing the preferred option. The issues and concerns about sheep grazing as a management tool discussed above for the Lake Mathews Reserve also apply to the Steele Peak Reserve. In particular, the grazing would need to be implemented in a highly controlled manner to protect the coastal sage scrub onsite.

4.3.2.5 Security

Access issues related to the Steele Peak Reserve are outlined below and depicted on *Figure 19*. In general, the Reserve area is well fenced, with trespasser-caused breaches occurring sporadically along Mountain Lane, which borders the western boundary of the southern parcel and bisects the northern parcels, where it dead ends at its northern terminus. These access problems can be easily fixed by re-fencing the area; however, a significant security patrol presence will likely be needed initially to discourage further damage to fences. As a general rule, three- and 4-strand barbed wire instead of chain-link fencing is recommended to allow coyotes and possibly bobcats to move through the Reserve more easily. It is understood that chain link may be required in vulnerable areas to prevent unauthorized access to the Reserve. The following describes each of the access points in more detail.

- **Access Points 1 and 2:** Private access points 1 and 2 are currently blocked by private gates which are locked and posted with "No Trespassing" signs. Both points are located off of Sawgo Road, northwest of the Reserve. Unauthorized access to the Reserve from these locations is not a primary issue.

- **Access Point 3:** Open access point 3 is situated west of the Reserve along Post Road. This location provides alternative access to areas blocked by access points 1 and 2 and the Reserve via a dirt road. Stolen and abandoned vehicles, trash dumping, and equestrian and OHV use are apparent along the dirt road. Due to local uses it is likely that this area would be difficult to control and unauthorized access would be better controlled at the Reserve boundary adjacent to access point 4.

- **Access Point 4:** Open access point 4 is situated at the northwestern boundary of the Reserve at the western terminus of Mountain Lane. It appears that a gate was torn down along the northern fenceline and should be replaced to control access from the west as noted above. A 3- and 4-strand barbed wire fence runs along both sides of Mountain Lane throughout and adjacent to the Reserve.

Figure 19 Potential Trespass Access Points to RCHCA Land in the Steele Peak Reserve

- **Access Point 5:** Reserve gate access point 5 is situated along the western fenceline along Mountain Lane. Fencing breaches occur sporadically along this fenceline. Approximately 50 linear feet of fencing needs to be replaced.

- **Access Point 6:** Open access point 6 allows unrestricted access by OHVs from Mountain Lane into the northern parcels. Abundant trash is also present. This breach should be repaired.

- **Access Point 7:** Open access point 7 is situated at the junction of the northern and southern parcels. While access does not appear to directly lead into the Reserve at this point, it likely allows unauthorized access to the southern parcel. The fence and gate at this location should be repaired and this area is a good candidate for boulder or k-rail placement to improve security.

- **Access Point 8:** Open access point 8 consists of a 40-foot long segment of fence and gate that have been damaged along the eastern fenceline paralleling Mountain Lane. Abundant trash dumping and OHV use occur at this point. The fence and gate should be replaced.

- **Access Point 9:** Open access point 9 consists of a cut segment of fence approximately 20 feet long. This parallels the eastern fenceline along Mountain Lane. This segment should be replaced.

- **Access Point 10:** Open access point 10 is situated at the junction of Mountain Lane and San Jacinto Avenue. Both are local dirt access roads. This location would likely be difficult to control due to local access rights; however this dirt road appears to only service the Reserve and ends at the Reserve boundary in the north. If feasible, a sturdy gate should be installed at this location.

- **Access Point 11:** Private access point 11 blocks east-bound traffic along San Jacinto Avenue via a private gate. This appears to block unauthorized southern access to the Reserve, however private inholdings south of the Reserve may have access.

- **Access Point 12:** Reserve access point 12 is a heavily fortified combination of heavy-duty gate and outboard barbed wire-topped chainlink fencing along Forrest Drive. The fencing continues along most of the southern, eastern, and a portion of the northern limits of the Reserve. Access generally is well controlled here, although the fence next to the gate had been cut in July 2006 and subsequently repaired. Because of easy public access, this area will likely require ongoing maintenance.

Generally, actions that would improve overall security in the Reserve include the following:

- Irregular or unpredictable patrols in security hotspot areas such as along Mountain Lane.
- Labeling and signage of key roads in the Reserve to facilitate patrols and coordination with the Riverside County Sheriff and CDF (see FMP in *Section 5.0*).
- Signage indicating No Trespassing at key access points. Signs should be fairly generic, with identification of the area as an ecological Reserve printed in small letters at the bottom of the sign. No icons of wildlife should be used.
- Pipe gates that protect locks, chain link fence, 3- and 4-strand barbed wire fencing, k-rails, or large boulders at appropriate areas.
- Coordination with adjacent private landowners to gain a better understanding of public access across or adjacent to their properties, particularly along Mountain Lane.
- Clearing of existing trash dumps as soon as feasible and practicable and at least annual maintenance.
- Coordination and/or contract with a law enforcement entity for the purpose of responding to more serious Reserve management issues, such as trespass, illegal OHV use, dumping, stolen cars, drug labs, and use of firearms.
- Coordination with CDF regarding access for fire fighting and management (see *Section 5.0* FMP).

In an earlier reconnaissance of the southern parcel in March, dogs were observed on the site and may be a management issue (Vergne, pers. obs. 2006). Because of the proximity to residences, pet cats also may be a problem, although coyotes likely control the cat population. Coordination with local property owners and trapping of dogs and cats may be needed to control these potential problems.

5.0 FIRE MANAGEMENT PLAN

5.1 INTRODUCTION

Wildland fires are a common natural hazard in Southern California, with a long and extensive history. Southern California open space areas include vast tracts of shrublands and native and non-native grasslands. Wildfire in Mediterranean-type ecosystems, as found in the Lake Mathews and Steele Peak Reserves, ultimately affects the structure and function of vegetation communities (Keeley and Keeley 1984). Large wildfires have had and will continue to have a substantial and recurring role in native California landscapes (Keeley and Fotheringham 2003),

in part because **(1)** native landscapes, from forest to grasslands, become highly flammable each fall and **(2)** the climate in the region has been characterized by fire climatologists as the worst fire climate in the United States (Keeley 2004) with high winds (Santa Ana) occurring during autumn after a 6-month drought period each year.

Wildfire suppression efforts over the last several decades may have aided the accumulation of fuels in natural communities (Minnich 1983; Minnich and Chou 1997), and creating mosaics of vegetation ages by prescribed burning may reduce wildfire spread (Minnich 1998). However, large fires, such as the 2003 fires in San Diego County, are only minimally constrained by varying fuel loads (Moritz et al. 2004) during extreme fire weather inherent to the region. Additionally, human influences account for most of the burned acreage in southern California (Keeley 1984) and on the Lake Mathews and Steele Peak Reserves. Based on this research, the growing human population and ignition sources in the Reserve vicinities, and the fire history of the areas, it is expected that large wildfires will occur again.

Open space reserves provide benefits to sensitive species and society, but, as urbanization continues expansion adjacent to and intermixed with reserves, the potential for increased fire and detrimental impacts from fire intensifies. The SKR Reserve has historically been subject to naturally occurring wildfires that would burn out when fuels were exhausted or when weather changed. The Reserve has since become an "island" amongst a growing sea of development. Fires are no longer desirable from a human impact perspective but occur at much higher rates than they did historically. The areas where urban development abuts these vast tracts of open space and associated fuels will require special attention and planning efforts and in some cases may include significant fuel treatments within Reserve areas.

This FMP specifically addresses the RCHCA-owned lands at Lake Mathews and Steele Peak. The following plans, which were prepared for the Reserve areas of western Riverside County, were reviewed during the preparation of this FMP:

- Lake Mathews – Estelle Mountain Reserve Fire Management Program (Wills et al. 2000)
- Lake Mathews Fire Management Plan – Volumes I – III (Metropolitan Water District of Southern California et al. 1994)
- Motte-Rimrock Reserve Fire Suppression Plan (California Department of Forestry and Fire Protection, No date)
- Southwest Riverside County Multiple Species Reserve Fire Management Plan (County of Riverside 2002)
- California Department of Forestry and Fire Protection, Riverside Unit Fire Management Plan (California Department of Forestry and Fire Protection 2005)

This FMP corresponds most closely with the Lake Mathews-Estelle Mountain Reserve Fire Management Program (Wills et al. 2000) prepared by The Nature Conservancy (TNC) and Center for Natural Lands Management (CNLM). That plan addresses fire management on Reserve lands that overlap with a portion of the RCHCA lands included in this FMP. This FMP describes a plan for CDF response to fires on RCHCA lands in a way that integrates beneficial management of fire for SKR and other sensitive species within the Lake Mathews and Steele Peak Reserves while also meeting public safety requirements. Many of the management, monitoring, research, and experimental concepts described in Lake Mathews – Estelle Mountain Reserve Fire Management Program (Wills et al. 2000) are applicable to the RCHCA lands, and, to that end, those sections are incorporated or referred to in this FMP.

5.2 FIRE MANAGEMENT PLAN AREA

The RCHCA authorized the preparation of the SKR FMP for the Lake Mathews and Steele Peak Reserves in western Riverside County, as described in *Section 2.0* and shown in *Figure 1*.

5.3 BACKGROUND

This FMP has been prepared to be consistent with existing plans for adjacent, non-RCHCA owned lands in the larger Lake Mathews and Steele Peak Reserve areas. This FMP presents topics in a similar way as other Reserve FMPs because firefighting personnel are familiar with this presentation of Reserve management priorities. However, this FMP adds information important for CDF response and omits information not essential to CDF's use of this FMP. It also provides a Response Map Book template that is recommended for wider implementation in updating existing FMPs and for preparation of new FMPs in areas under the jurisdiction of CDF in Riverside County. One important goal of this Reserve FMP is to standardize response information for CDF so that emergency decision making is guided by easy-to-read, graphically-based management directives.

Despite the fact that this FMP focuses on RCHCA owned Reserve lands, wildfire does not adhere to ownership boundaries. As such, it is recommended that cooperation and coordination between the various landowners within the SKR Reserve be as seamless as possible. The Response Map Book provided with this FMP will be utilized under varying conditions but primarily by Reserve staff and CDF firefighting personnel under stressful and potentially threatening circumstances. Its design, therefore, must be intuitive and quickly understood by CDF personnel and by firefighting personnel from neighboring jurisdictions who may not have knowledge of the Reserve. An effective FMP will minimize the otherwise negative impacts of fire management techniques on Reserve management goals.

5.4 PURPOSE AND NEED

This FMP is a strategic plan that defines a program to manage wildland fires based on an area's land management plan. FMPs must address a full range of fire management activities that support ecosystem sustainability, values to be protected, protection of firefighters and public safety, public health and environmental issues, and consistency with resource management objectives and activities of the area. The intent of this FMP is to provide CDF with information and recommendations for emergency fire response within and immediately adjacent to RCHCA Reserve boundaries and identify necessary weed abatement/fuel management procedures that can be implemented as preventative measures. This FMP provides a planning framework for prevention, suppression, and post-suppression fire control activities within and adjacent to the RCHCA lands in the Lake Mathews and Steele Peak Reserves.

5.5 FIRE MANAGEMENT GOALS AND OBJECTIVES

5.5.1 Fire Management Goals

Fire is a natural component of many of the vegetation types present within the Lake Mathews and Steele Peak Reserves. However, increasing human populations in the areas around the Reserves have resulted in increasing anthropogenic-induced fires, altering the natural fire regime and affecting the Reserves and their natural resources, including SKR and other sensitive species' habitats (also see *Section 2.4* and *Table 3* for discussion of fire history). In any FMP, the highest priority must be given to public safety, whose threat escalates in proportion to population increases. For these reasons, planning must occur to create and adopt management strategies consistent with those used in the HMP for Lake Mathews and Steele Peak Reserves. The goals for this FMP include:

- Transfer of critical Reserve information to, and absorption by, CDF's Riverside unit firefighting personnel responsible for incident response.
- Avoidance of Reserve-wide, catastrophic wildfires that negate the Reserves' ultimate goal of protecting and increasing the populations of SKR.
- Restoring or enhancing the quality of degraded vegetation communities and habitat types in a manner consistent with overall conservation goals for species and natural communities.
- Minimizing loss of current mature coastal sage scrub.
- Enhancing currently degraded shrublands.
- Maintaining native grassland.

- Removing non-native annual grassland in favor of low-growing annual forbs and native grasses.
- Developing fuel-loading reduction methods that are consistent with overall Reserve management goals.
- Providing for public safety through response plans and prevention activities.
- Providing for adaptive fire management.

5.5.2 Fire Management Objectives

To achieve long-term fire management goals for the RCHCA lands in the Lake Mathews and Steele Peak Reserves, the following objectives have been formulated to achieve SKR habitat targets, as well as desired levels for public safety and protection of valuable assets:

- Utilize available fuel-reduction techniques, such as grazing, mowing, herbicides, and prescribed fire, consistent with Reserve goals for habitat preservation, enhancement, and restoration.
- Develop Response Scenarios for CDF (and other responding jurisdictions) that effectively guide responders to appropriate options for incident resolution.
- Establish fuel modification areas (FMAs) typically associated with high-value resources, such as residential structures, but also including high-value habitats, cultural resources, and critical ingress/egress routes.
- Establish long-term, ongoing maintenance of FMAs that serve as buffers between urban and wildland areas with a dual role of preventing wildfire from impacting urban areas, as well as protecting the Reserves from fire originating in urban areas.
- Educate firefighting personnel on the Lake Mathews and Steele Peak Reserves' sensitive resources and overall management considerations through graphically-based, easy-to-use response maps and engagement in ongoing fire prevention activities.
- Provide maps of sensitive biological and cultural resources to be avoided to the maximum extent feasible.
- Provide maps of the Reserves' high-value assets.
- Delineate FMUs for the Lake Mathews and Steele Peak Reserves based on modeled wildland fire behavior, existing information on locations of species, habitats, and other priority features.
- Prepare a key map indicating boundaries, topography, vegetation types, and other major features, including roads and structures.

- Prepare a GIS Fire Response Map Book that is concise, easy-to-use, and widely distributed among nearby fire jurisdictions. The Fire Response Map Book will include critical information required by on-site firefighting personnel in graphical format so that time-sensitive decisions can be quickly determined through maps and associated spreadsheets.
- Prepare fire management guidelines for each FMU including discussion of prevention, suppression, and post-suppression activities.
- Provide basic recommendations for minimizing impacts to biological resources when fighting fire on the Lake Mathews and Steele Peak Reserve. Guidance provided by this FMP and its associated tools would include preferred access routes and natural resource priorities within FMUs.
- Provide appropriate contact information to responding fire personnel in the event fire management activities may affect priority resources.

5.6 FIRE MANAGEMENT PLAN AREA – DESCRIPTION OF RCHCA LAKE MATHEWS AND STEEL PEAK RESERVES

The physical property descriptions of the Lake Mathews and Steele Peak Reserves are provided in *Section 2.0.* The following brief descriptions are provided for their relationship to wildfire management and response. The Lake Mathews and Steel Peak Reserves include many shared landscape features and are briefly described in the following sections.

5.7 FIRE ENVIRONMENT

Fire environments are dynamic systems and include many types of environmental factors. Fires can occur in any environment where conditions are conducive to ignition and fire movement. Natural open space reserves like the Lake Mathews and Steele Peak Reserves are typically comprised of conditions favorable to wildfire spread. The three major components of fire environment are climate, topography and vegetation/fuels. The current state of each of these components and their interaction with each other determine the potential characteristics and behavior of a fire at any given moment. Understanding these existing conditions is necessary to understand the potential for fire within and around the RCHCA Reserve lands.

5.7.1 Climate

As with most of Southern California, the Lake Mathews and Steele Peak Reserves are influenced by the Pacific Ocean and are frequently under the influence of a seasonal, migratory subtropical high pressure cell known as the Pacific High. Wetter winters and dry summers, with mild seasonal changes, generally characterize the Southern California climate. This climatological

pattern is occasionally interrupted by extreme periods of hot weather, winter storms, or dry, easterly Santa Ana winds.

There is some local variance to the typical Southern California climate. For example, the Lake Mathews and Steele Peak Reserves inland locations affect the degree of influence of the Pacific Ocean, resulting in less-regulated temperatures. The average high temperature for this area is approximately 90°F, with high temperatures in the summer and early fall (July through October) reaching 106°F. The average precipitation for the area is 13 inches per year, with the majority of rainfall concentrated in the months of December (2.1 in.), January (2.4 in.), February (2.7 in.), and March (2.1 in.).

The prevailing wind pattern is from the west, but the presence of the Pacific Ocean causes a diurnal wind pattern known as the land/sea breeze system. During the day, winds are from the west-southwest (sea), and, at night, winds are from the northeast (land). Wind speeds average 6 miles per hour (mph). During the summer season, the diurnal winds may, on average, be slightly stronger than the winds during the winter season, reaching speeds of 21 mph, due to greater pressure gradient forces. Surface winds can also be influenced locally by topography and slope variations. On the Lake Mathews and Steele Peak Reserves, the varied topography may affect wind velocity and patterns. The highest wind velocities are typically associated with downslope, canyon, and Santa Ana winds.

The fire season typically starts in June as vegetation begins to dry out after winter and spring rains. The fire season typically ends in September, although fire weather may be present year round (Schroeder and Buck 1970). Typically, the highest fire danger coincides with the Santa Ana winds. The Santa Ana wind conditions are a reversal of the prevailing southwesterly winds that usually occur on a region-wide basis during late summer and early fall. They are dry, warm winds that flow from the higher desert elevations in the north through the mountain passes and canyons. As they converge through the canyons, their velocities increase. Consequently, peak velocities are highest at the mouths of canyons and dissipate as they spread across valley floors. Wind speeds in the area can reach up to 54 mph (RAWS 2006).

Weather data for the Lake Mathews and Steele Peak Reserves were derived from two separate RAWS, including the Corona RAWS (Latitude: 33.8750, Longitude: -117.5492, Elevation: 620') and the Clark RAWS (Latitude: 33.8767, Longitude: -117.3089, Elevation: 1720'). Summer (June-August) and fall (September-November) weather data were retrieved for each of these sites for periods covering 3 years. These data were then combined to determine weather averages for the Lake Mathews and Steele Peak Reserve areas during fire season. The results of the weather data analysis are presented in *Table 13*.

TABLE 13
Average Weather Conditions for the Lake Mathews and Steele Peak Reserves by RAWS Station and Season

Weather Station Location	Wind			Air Temp.**			Fuel Temp.			Humidity			Precip.
	Avg. (mph)	Dir. (deg.)	Max. (mph)	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	(inches)
Summer													
Clark RAWS Station	5.6	268	21	73	90	57	82	110	55	65	93	37	0.00
Corona RAWS Station	2.3	309	17	75	89	62	79	103	61	66	93	40	0.00
Fall													
Clark RAWS Station	4.8	228	18	63	82	51	66	94	47	62	90	35	0.01
Corona RAWS Station	1.6	231	14	67	82	55	68	94	56	63	87	37	0.03

* *Data derived from available RAWS Station data for three years (averaged) during the period of 2000 to 2005.*

** *Temperatures in degrees Fahrenheit.*

5.7.2 Topography

The general topography of the Lake Mathews and Steele Peak Reserves is described in Section 2.2. This section describes specific topography of each of the 12 FMUs. FMUs 1 to 11 relate to the Lake Mathews Reserve (*Figure 8*) and FMU 12 (*Figure 11*) relates to the Steele Peak Reserve. *Figure 20* shows the entire set of FMUs for the Lake Mathews and Steele Peak Reserves overlaid on an aerial base that depicts the general terrain of the FMUs.

FMU 1: Elevation ranges from 1,080 feet to 1,540 feet with relatively flat terrain in the eastern portion of the FMU. The western portion of the FMU drops westward toward Cajalco Road and Temescal Wash and is characterized by numerous small canyons and draws. Slope gradients range from 2 to 25 percent.

FMU 2: Elevation ranges from 960 feet in the west to 1,590 feet atop a small peak in the central portion of the FMU. Olsen Canyon runs through the southern portion of the FMU and is characterized by steep canyon walls with slopes exceeding 40 percent. Aspect is varied throughout the FMU based on numerous canyons, draws, and peaks.

FMU 3: Elevation is relatively constant across this small FMU at 1,480 feet. Slope values range between 0 and 4 percent.

Figure 20 Fire Management Units on RCHCA Lands in the Lake Mathews and Steele Peak Reserves

FMU 4: Elevation within this FMU ranges between 1,440 feet and 1,600 feet, with a southeast-facing slope reaching 16 percent.

FMU 5: Elevation is relatively constant in this small FMU at 1,520 feet. Slope values range from 0 to 4 percent.

FMU 6: Ridge tops characterize this FMU, with elevations ranging from 1,200 to 1,807 feet atop the highest peak. Slopes drop from these peaks in all directions and reach 35 percent. The southeast corner of this FMU extends to the bottom of Dawson Canyon.

FMU 7: This unit is located south of Dawson Canyon and is bisected by a tributary stream flowing through the unit in a northwest direction. Elevation ranges between 1,160 and 1,732 feet, and slopes reach 35 percent.

FMU 8: This relatively large parcel contains portions of Dawson Canyon and two other major canyons draining from the top of Estelle Peak, located just south of the FMU boundary. Elevation ranges between 1,360 feet at canyon bottoms to 2,477 feet at the highest peak in the FMU. Slopes in the canyons characterizing this unit often exceed 35 percent.

FMU 9: A small parcel east of FMU 8 contains the upper reaches of a tributary to Dawson Canyon, with elevations ranging from 2,160 to 2,520 feet. Canyon walls in this FMU face north and south, with slopes reaching 25 percent.

FMU 10: This FMU contains a portion of the peak of Estelle Mountain and the topography drops significantly westward toward Temescal Wash. Elevation ranges between 1,560 and 2,706 feet, with slopes reaching 40 percent.

FMU 11: The southernmost FMU is characterized by several peaks and canyons draining south toward Temescal Wash. Elevation ranges from 1,400 feet at canyon bottoms to 2,337 feet atop the highest peak. Slopes are steep along drainage walls and reach 30 percent.

FMU 12: **(Steele Peak Reserve)**: this unit is characterized by a ridgeline with two peaks oriented in a north-south direction. East-facing slopes reach gradients in excess of 35 percent, while west-facing slopes are more gradual, measuring up to 25 percent. Elevation in this FMU ranges from 1,700 in the east to 2,160 feet in the northern portion of the FMU.

5.7.3 Vegetation/Fuels

The vegetation composition on the Lake Mathews and Steele Peak Reserves and adjacent lands varies based on topography, fire history, and proximity to development. Vegetative cover consists primarily of grasslands (native and non-native) and coastal sage scrub habitats (Riversidian sage scrub[5]) with smaller patches of chaparral and riparian cover types. Non-native vegetation consists primarily of annual grasslands and exotic-dominated communities located on disturbed land and/or agricultural land recently left fallow. A summary of vegetative cover per individual FMU is presented in *Table 14*.

TABLE 14
Vegetation Coverage in the Lake Mathews and Steele Peak Reserves by Fire Management Unit

Fire Mgmt. Unit	Vegetation Coverage (acres)							
	Chaparral	Coastal Sage Scrub	Developed/ Disturbed	Grasslands	Riparian	Water	Woodland/ Forest	*Total*
(Fuel Model)	*4*	*18*	*0*	*1*	*8*	*98*	*9*	
1	0.0	184.0	0.1	1,132.7	46.1	0.0	0.0	*1,362.8*
2	0.0	508.8	0.1	138.1	17.0	0.0	0.0	*664.0*
3	0.0	11.6	0.0	42.6	0.0	0.0	0.0	*54.2*
4	0.0	19.0	0.0	0.8	0.0	0.0	0.0	*19.8*
5	0.0	0.0	0.0	9.7	0.0	0.0	0.0	*9.7*
6	0.0	313.0	0.0	28.7	17.3	0.0	12.3	*371.3*
7	0.0	130.5	0.0	42.5	4.2	0.0	9.0	*186.2*
8	73.8	584.3	0.1	13.6	12.6	0.0	15.5	*699.9*
9	0.0	38.4	0.0	0.0	0.6	0.0	0.0	*39.0*
10	0.0	280.2	0.0	15.3	2.0	0.0	1.2	*298.7*
11	103.2	687.2	0.0	9.5	8.6	0.4	29.0	*837.9*
12	0.0	109.1	0.4	93.4	0.7	0.0	0.0	*203.6*
Total	**177.0**	**2,866.1**	**0.7**	**1,526.9**	**109.1**	**0.4**	**67.0**	***4,747.2***

**Vegetation cover types derived from Vegetation Alliances of Western Riverside County (August 2005 CDFG, CNPS, and AIS) database and edited by Dudek in May 2006.*

With regard to fire management, certain vegetation types present increased hazard based on plant physiology (resin content), biological function (flowering, retention of dead plant material), and/or physical structure (leaf size, branching patterns). For example, native shrub species found in portions of the Lake Mathews and Steele Peak Reserves are considered to exhibit higher potential hazard based on such criteria, including coastal sagebrush (*Artemisia californica*),

[5] Riversidian sage scrub is discussed specifically as the dominant inland form of coastal sage scrub for the FMP because of specific fuel model analyses. In previous sections, Riversidian sage scrub was referred to more generically as coastal sage scrub.

chamise (*Adenostoma fasciculatum*), California buckwheat (*Eriogonum fasciculatum*), and black sage (*Salvia mellifera*). Non-native invasive species presenting similar attributes include: mustard (*Brassica* spp.), thistle, tobacco (*Nicotiana* spp.), and juniper (*Juniperus* spp.). These vegetation types present additional hazard when located adjacent to neighboring structures or within defensible space zones.

Vegetation distribution throughout the Lake Mathews and Steele Peak Reserves varies by location and topography. Riparian trees and scrub are concentrated in canyon bottoms and low, flatter areas, while upland areas typically support shrub cover (either Riversidian sage scrub or chaparral) or grass cover. Riversidian sage scrub is the dominant vegetation type throughout the Lake Mathews and Steele Peak Reserves area, covering nearly 61 percent of the total RCHCA ownership. Grasslands (covering approximately 32 percent of the RCHCA ownership) exist in scattered patches typically surrounded by sage scrub vegetation. The importance of vegetative cover on fire suppression efforts is its role in affecting fire behavior. For example, while fires burning in grasslands may exhibit lower flame lengths than those burning in chaparral or sage scrub, fire spread rates in grasslands are often much more rapid than those in other vegetation types. The distribution of vegetative fuel within the Lake Mathews and Steele Peak Reserves and surrounding area is depicted in *Figures 21* and *22*, respectively. Images of vegetative fuels are presented in *Figures 23* and *24*. See *Section 5.10.3* for a discussion of fuel model numbers.

5.7.4 Vegetation Dynamics

Vegetation plays a significant role in fire behavior and is an important component of the fire behavior models discussed in this FMP. A critical factor to consider is the dynamic nature of vegetation communities. Fire presence and absence at varying cycles or regimes affect plant community succession. Succession of plant communities, most notably the gradual conversion of shrublands to grasslands with high frequency fires and grasslands to shrublands with fire exclusion, is highly dependent on the fire regime.

Biomass and associated fuel loading will increase over time, assuming that disturbance or fuel reduction efforts are not realized. Depending on the success of fire exclusion activities and any prescribed burn plan ultimately designed for the Lake Mathews and Steele Peak Reserves and the remainder of the SKR Reserve, as described in existing FMPs (e.g., the Lake Mathews-Estelle Mountain Reserve Fire Management Program), the current vegetation composition and density will continue to change through either increased volume and the establishment of exotic species or the continued degradation of shrublands and persistence of annual grasses.

Wildfire disturbances can also have dramatic impacts on individual plants and plant composition. Heat shock, accumulation of post-fire charite, and change in photoperiods due to removal of shrub canopies may all stimulate seed germination (Keeley and Keeley 1984). The post-fire response for most species is vegetative reproduction and stimulation of flowering and fruiting.

Figure 21 Fuel Distribution on RCHCA Lands in the Lake Mathews Reserve

Figure 22 Fuel Distribution on RCHCA Land in the Steele Peak Reserve

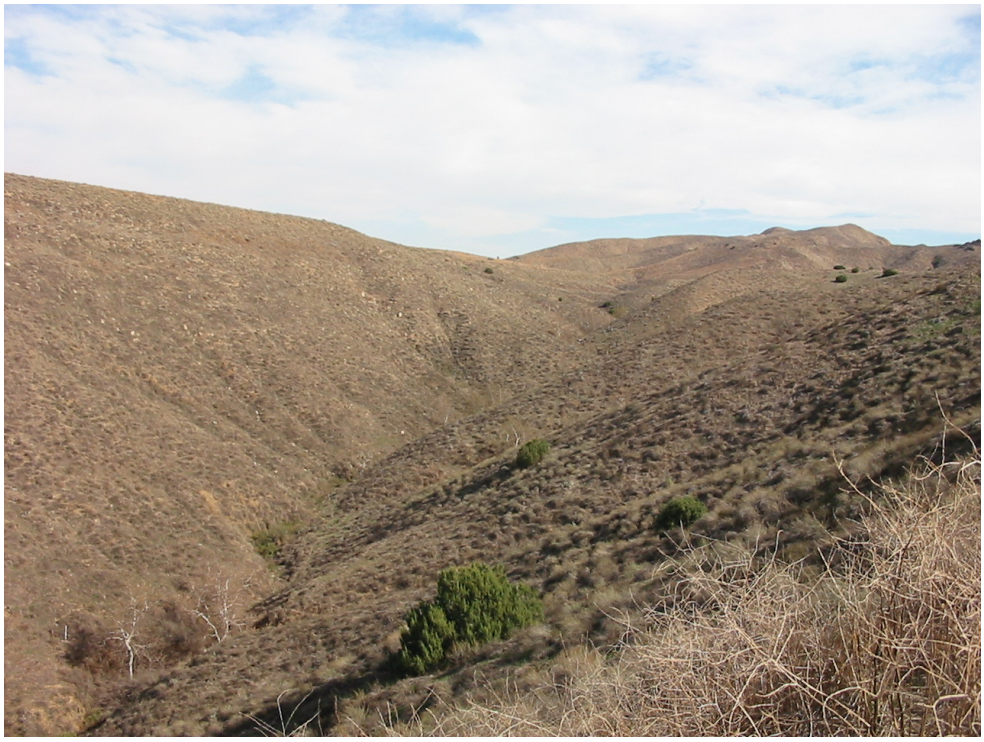

Figure 23. East-west trending canyon in FMU 6 dominated by disturbed sage scrub cover.

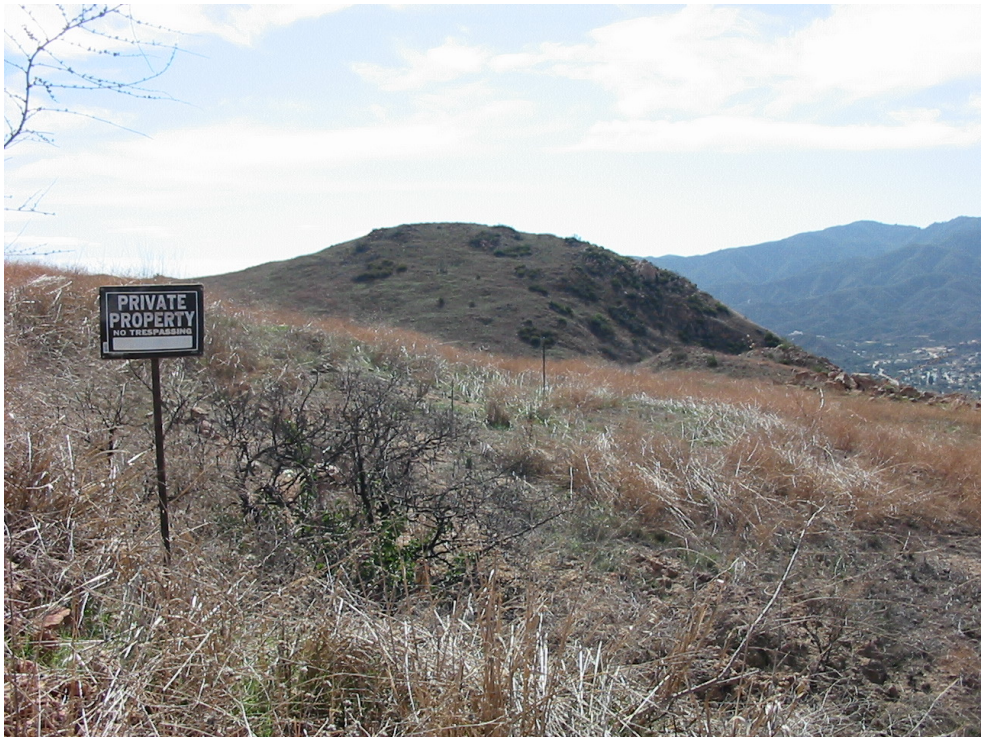

Figure 24. Grassland-sage scrub ecotone located in FMU 1.

The combustion of aboveground biomass alters seedbeds and temporarily eliminates competition for moisture, nutrients, heat, and light (Wright and Heinselman 1973). Species that can rapidly take advantage of the available resources will flourish. It is possible to alter successional pathways for varying plant communities through varying the frequency and intensity of fire. This concept is a key component of this FMP.

The predominant plant communities on the Lake Mathews and Steele Peak Reserves are Riversidian sage scrub and annual grasslands. The primary responses to fire for each of these communities are discussed briefly in the following sections.

5.7.5 Grassland Fire Effects

There are numerous native and non-native grass species on the Lake Mathews and Steele Peak Reserves. They are distributed in large blocks of grasslands and interspersed amongst degraded sage scrub plants. There are nearly as many annual grassland responses to fire as there are species. An extensive review and analysis of the response to burning and grazing of California grasslands indicates that prescribed burning temporarily reduces exotic annual grasses but also results in increased exotic forbs and native forbs (Rice 2005; Bainbridge and D'Antonio 2003; D'Antonio et al. 2003). These study results are consistent with SKR habitat goals (also see Price et al. 1995; O'Farrell 1997; TNC 1996). These studies indicate that single prescribed burns often decrease exotic annual grasses, but they recover by the third year in the absence of additional disturbance. Grazing or follow-up burns hinder the recovery of exotic annual grasses and maintains forb cover, which would be beneficial to the SKR.

A study conducted on the Lake Mathews-Estelle Mountain Reserve for plant community response to varying duration of successive years of spring or fall burning of annual grassland had contrary results. The study indicates that spring burns reduce abundance of exotic grasses and some native forbs while increasing biomass of native perennial grass (Rice 2005). Rice (2005) reports that pre-fire condition of the Reserve included stands with significant native perennial grass cover, which realized increased benefits from burning. Furthermore, short fire return intervals reduced the annual grass cover and thatch build-up but may also have contributed to native forb decline. Fall burns resulted in similar effects as winter burns, but with increasing exotic grass biomass. Considering this increase in exotics, coupled with the higher fire hazard during the fall, it is not recommended that fall burns be conducted on the Lake Mathews and Steele Peak Reserves.

As mentioned, fire has varying effects on grassland communities. One effect that appears to be fairly common among exotic grasses is that lower-intensity grassland fires rarely damage seeds on or near the soil surface (Daubenmire 1968). One study included a May burn (following seed dispersal) to remove annual grasses from a severely degraded coastal sage scrub site in

California (Cione et al. 2002). The investigators noted that there were many exotic annual grass seeds lying on the soil surface after the controlled burn. The logical conclusion is that non-native grassland burns must be timed appropriately so that the seeds are consumed, resulting in decreased re-establishment of non-natives and reduced competition for annual forbs.

5.7.6 Riversidian Sage Scrub Fire Effects

Riversidian sage scrub on the Lake Mathews and Steele Peak Reserves varies in quality from degraded to fair condition. There is very little traditional, high-quality Riversidian sage scrub on either Reserve. Degraded areas have been subject to frequent fire and are converting from Riversidian sage scrub to annual grassland. Coastal sage scrub communities located within the coastal influence areas are quicker to recover post-fire due primarily to the prolific sprouting of the shrub species. Inland sage scrub (Riversidian sage scrub) shrub species do not sprout significantly, and therefore seedling recruitment from the native seedbank and, less notably, from wind- or animal-disseminated seed is relied upon for most regeneration (Wills 2005). As such, it is easier for type conversion, which is occurring on portions of the Lake Mathews and Steele Peak Reserves. It should be noted that despite the reduction of shrub vegetation caused by repeated fires, the overall fuel loading may increase with the proliferation of grass cover. Non-native annual grasses can increase the fire frequency and result in nearly annual burning (Keeley 2005), although typically they would be lower-intensity fires. On the contrary, long-term fire suppression in Riversidian sage scrub plant communities can result in higher potential fire hazard with the accumulation of plant biomass over time.

Following fire, the typical succession includes predominance of annual herbs during the first year. They tend to decline in subsequent years without fire or other disturbances, as shrubs establish and attain greater cover. Perennial herb understory species, which may grow from re-sprouts, show low recruitment from the soil seed bank. Unlike herbaceous annuals, the overall diversity of perennial understory herbs remains constant the first few years following fire. New species continue to become established in recovering sage scrub, reaching a peak at 5 to 10 years after a fire. After the peak in species diversity, there is a general decline in perennial understory herb species, possibly attributable to shading effects from dominant shrubs (Wills 2000; Keeley and Keeley 1984).

Lack of fire, due to prevention efforts, will allow shrub cover to return to burn areas over time. Shrub cover, although less likely to burn in the first 20 years during typical weather conditions, will burn under extreme fire events (Moritz 2003). Once established, the shrub cover will increase in volume, and, following approximately 20 years, the hazard will increase corresponding with fuel age (Keeley 2005). Changes in land use will also affect the vegetation distribution pattern. For example, the encroachment of non-native plants into open-space areas is likely based on the proximity of ornamental landscaping to undeveloped or Reserve land.

5.8 FIRE HISTORY

Fire history can provide clues for predicting the likelihood that a fire will be ignited, its rate of spread, and its intensity. The Lake Mathews and Steele Peak Reserve areas are subject to wildland fires due to large expanses of open space, numerous ignition sources, steep terrain, highly flammable vegetation within preserved open-space areas, and high winds that correspond with seasonal dry periods. The CDF maintains records of wildland fires dating back to the beginning of the 20th century. Current research indicates that large conflagrations driven by extreme weather are normal occurrences in Southern California and that fuel age may not be an important factor in fire risk (Keeley 2005; Moritz 2003). However, under normal weather conditions, fires hazard is correlated with vegetation age, which, if not burned regularly, begins to accumulate dead material that is more easily ignited and spreads fire faster than newer vegetative growth (Keeley 2005; Moritz 2003).

According to CDF data (FRAP 2005), the RCHCA lands in the Lake Mathews and Steele Peak Reserves have a significant fire history. A map depicting the fire history of the area is presented in *Figure 12*. *Section 2.4* discusses the fire history for the RCHCA lands in the Lake Mathews and Steele Peak Reserves.

5.9 FIRE HAZARD SITUATIONS AT LAKE MATHEWS AND STEELE PEAK RESERVES

This section presents a discussion of fire hazard situations observed during field assessments of the Lake Mathews and Steele Peak Reserves and surrounding areas. This information was collected during initial site analysis and reviews of high-resolution aerial images and was integrated into the preparation of this document and the related fire hazard exhibits and recommendations.

1. Based on topography, vegetation, and fire history, wildfire will likely enter the Lake Mathews Reserve from the I-15 corridor to the west during typical on-shore wind pattern or from open-space areas to the north and east of the RCHCA lands in the Reserve during Santa Ana wind conditions.

2. There is currently not a significant Wildland-Urban Interface (WUI) threat associated with the Reserves. However, FMU numbers 1, 2, 5, 8, 10 and 12 include at least one residence or other structure adjacent. FMU 12 includes the highest level of interface with rural development areas to the east, south and west. FMU numbers, 1,2, 5, 8 and 10 include fewer structures adjacent, typically in the form of scattered rural development. FMU 5 is near a major ignition source (Cajalco Road). It is anticipated that developable land outside the Reserves will continue to convert to urbanized areas with an increasing WUI that may be more intermix than an interface.

3. Wildfires may move rapidly, fueled by Santa Ana winds across the Lake Mathews and Steele Peak Reserves. Grasslands and mixed grass/sage cover dominate the site. Steep slopes with even steeper walled drainages typify the topography of the southern portion of the Lake Mathews Reserve. Fires in the grasslands will be fast-moving ground fires, and, where sage scrub exists in suitable densities, canopy fire may result.

4. A fire originating in a structure in the sphere of influence of the Lake Mathews and Steele Peak Reserves could spread to Reserve areas. Presently urban influence on these areas is mostly from travel corridors, such as I-15, Cajalco Road and tertiary roads.

5. Firefighting may be difficult in all FMUs with the difficulty increasing as one moves away from Cajalco Road as access is limited or unavailable. Aircraft attack will be an important component but may not be available or usable, depending on the extent of the fire event and/or the time of day and weather conditions.

6. The Lake Mathews and Steele Peak Reserves' catastrophic wildfire threat is extreme when severe fire weather occurs. Severe weather is defined as air temperature greater than 80°F, off-shore wind greater than 20 mph, and relative humidity at or below 20 percent.

5.10 FIRE MODELS AND RESPONSE

Fire behavior modeling includes a high level of analysis and information detail to arrive at reasonably accurate representations of how wildfire would move through available fuels in high-fire hazard areas. Fire behavior calculations are based on site-specific fuel characteristics supported by fire science research that analyzes heat transfer related to specific fire behavior. Current and accepted fire research data from several programs that specialize in the study of wildland fire were utilized for the completion of this analysis. Among these are the CDF, the International Fire Code Institute, the Federal Emergency Management Agency, and the U.S. Forest Service Intermountain Forest and Range Experiment Station located in Missoula, Montana. To objectively predict flame lengths and intensities, the FlamMap 3.0 fire behavior fuel modeling system was applied using predominant fuel characteristics from representative fuel models observed within the Lake Mathews and Steele Peak Reserves. In addition to fuels data, topographic and weather data were utilized in developing fire behavior models for two separate weather conditions: summer (on-shore flow) and fall (off-shore flow). *Figures 21* and *22* present a map indicating the locations of the different fuel models used in this analysis, while *Figures 25* through *28* present maps depicting fire behavior model outputs.

Valuable response scenario input was provided by CDF resulting in a greater understanding of the local complexity of the issue. Additionally, CDF provided details for available resources, such as fire stations, engines, personnel, and equipment described in *Appendix G*.

Figure 25 Fire Behavior Analysis (Flame Length, Summer Weather) on RCHCA Lands in the Lake Mathews and Steele Peak Reserves

Figure 26 Fire Behavior Analysis (Flame Length, Fall Weather) on RCHCA Lands in the Lake Mathews and Steele Peak Reserves

Figure 27 Fire Behavior Analysis (Spread Rate, Summer Weather) on RCHCA Lands in the Lake Mathews and Steele Peak Reserves

Figure 28 Fire Behavior Analysis (Spread Rate, Fall Weather) on RCHCA Lands in the Lake Mathews and Steele Peak Reserves

5.10.1 Wildland Fire Behavior Prediction

Predicting wildland fire behavior is not an exact science. As such, the minute-by-minute movement of a fire will probably never be predictable, especially when considering the variable state of weather and the fact that weather conditions are typically estimated from forecasts made many hours before a fire. Nevertheless, field-tested and experienced judgment in assessing the fire environment, coupled with a systematic method of calculating fire behavior, yields accurate results (Rothermel 1983).

The FlamMap (version 3.0) software package is a GIS-driven computer program that incorporates fuels, weather, and topography data in generating static fire behavior outputs, including values associated with flame length and spread rate. It is a flexible system that can be adapted to a variety of specific wildland fire planning and management needs.

FlamMap is ideally suited for real-time predictions of the behavior of wildfires. The predictions that come from FlamMap are based on BehavePlus Fire Modeling System mathematical models and result in geographically distinct values for fire behavior characteristics. FlamMap model outputs allow wildland resource managers to predict rate of spread, fireline intensity, and flame length, which provide important insights about the characteristics of wildfire spread within and adjacent to high-value areas, such as preserved sage scrub.

The basic assumptions and limitations of FlamMap are.

- The fire model output describes fire behavior only in the flaming front. The primary driving force in the predictive calculations are the dead fuels less than 0.25 inch in diameter. These are the fine fuels that carry fire. Fuels greater than 1 inch have little effect, and fuels greater than 3 inches have no effect.
- The model bases calculations and descriptions on a wildfire spreading through surface fuels that are within 6 feet of the ground and contiguous to the ground. Surface fuels are often classified as grass, brush, litter, or slash.
- The software assumes that weather is uniform. However, because wildfires almost always burn under non-uniform conditions, length of projection period and choice of fuel must be carefully considered to obtain useful predictions.
- The FlamMap fire behavior computer modeling system was not intended for determining sufficient fuel modification zone widths. However, it does provide the average length of the flames, which is a key element for determining defensible space distances for minimizing structure ignition.

Unknowns are inherent in any modeling effort that attempts to describe the complex and dynamic nature of fire behavior. Each of the input variables used in FlamMap remain constant at each location, meaning that the input variables are applied consistently to each grid cell and the fire behavior at one grid cell does not impact that at a neighboring grid cell. Essentially, the model presents a "snapshot" in time and does not account for temporal changes in fire behavior or the movement of fire across the landscape. As such, the results of the models contained herein should be utilized as valuable information sources and tools to prioritize fuel treatment options rather than an exact representation of how a fire would behave on the Lake Mathews and Steele Peak Reserves. Although FlamMap has some limitations, the fire modeling software provides valuable fire behavior predictions. These predictions can be used with a reasonable degree of certainty as an aid to the decision-making process.

5.10.2 Fuels Classification

Reliable estimates of fire behavior must consider the relationship of fuels to the fire environment and the variations in these fuels. Natural fuels are made up of the various components of vegetation, both live and dead, that occur on a site. The type and quantity will depend upon the soil, climate, geographic features, and the fire history of the site. The major fuel groups of grass, shrub, trees, and slash are defined by their constituent types and quantities of litter and duff layers, dead woody material, grasses and forbs, shrubs, regeneration, and trees. Fire behavior can be predicted largely by analyzing the characteristics of these fuels. Fire behavior is affected by seven principal fuel characteristics: fuel loading, size and shape, compactness, horizontal continuity, vertical arrangement, moisture content, and chemical properties.

All vegetation is considered fuel. All vegetation will burn; however, some species require more heat in order to ignite and propagate flame. The moisture content of vegetation is an important component; dry vegetation will ignite more rapidly, whereas green vegetation must lose its moisture before it will ignite. Consequently, shrubland vegetation with high oil content (above 6 percent) will burn more quickly and hotter than vegetation with high leaf moisture levels and low oil content levels. More than 90 percent of the flaming front of a wildfire is composed of fuel less than 0.5 inch in diameter and is consumed in minutes. Fuels larger than 1 inch in diameter are termed "residual" fuel and may require several hours to burn out. This larger fuel does not contribute to the forward rate of spread of the fire.

Fuel loading is defined as the oven dry weight of fuels in a given area, usually expressed in tons per acre. Natural fuel loading varies greatly by vegetative or fuel types in addition to the different size classes of fuel particles. Vegetation types can be rated as light, moderate, or heavy. Each rating is an estimate of the dead or live surface fuels that are less than 3 inches in diameter. Although specific measurements were not taken, based on the vegetation types identified in the

cursory survey of the Lake Mathews and Steele Peak Reserves, the different sites can generally be assigned a moderate to high rating.

Measuring the intensity, force, and destructive potential of wildfire is accomplished by observing flame lengths produced by burning vegetation. A direct relationship exists between the amount of energy released during burning (per second) and the length of flame generated. The standard for measuring energy release in the United States is the British Thermal Unit (BTU). One BTU is defined as the amount of energy required to increase the temperature of 1 pound of water 1°F (a standard kitchen match or candle flame is approximately one BTU).

Size and shape affect the surface area to volume ratio of fuels. Small fuels have a greater surface area to volume ratio than larger fuels. Dead fuels are separated into four size classes: **(1)** grasses, litter, or duff less than 0.25 inch diameter; **(2)** twigs and small stems 0.25 inch to 1 inch diameter; **(3)** branches 1 inch to 3 inches diameter; and **(4)** large stems and branches greater than 3 inches diameter. The fine fuels less than 0.25 inch in diameter are most important for fire behavior analysis because their ignition time is less, and their fuel moisture content changes rapidly. This characteristic is typical for the grasses that were identified within and adjacent to the Lake Mathews and Steele Peak Reserves.

The arrangement, size, and surface area of vegetative fuels plays an important role in fire behavior and spread potential. Dense, concentrated biomass may burn evenly; however, when overall size decreases and surface area increases (as seen in native shrub stands), burning patterns change, resulting in faster ignition and spread. Live shrubland and grassland vegetation generally exhibit high surface to volume ratios. Standing grass, coastal sage scrub, and chaparral have high surface area to volume ratios, whereas forest litter and chipped or cut biomass exhibit very low surface to volume ratios.

Compactness, or spacing between fuel particles, affects the rate of combustion. For example, fuel particles that are closely compacted have less surface area exposed and less air circulation between particles and thus are slower to combust. The thick duff layer found underneath a mixed forest is an example of a tightly compacted fuel, whereas the open, dead branches on coastal sagebrush are considered a loosely compacted fuel. The fuels within and adjacent to the Lake Mathews and Steele Peak Reserves are loosely spaced with adequate air circulation required to carry a fire.

Horizontal continuity is the extent of horizontal distribution of fuels at various levels or planes. The vegetative types within various portions of the Lake Mathews and Steele Peak Reserves were analyzed for horizontal continuity and vertical arrangement. Fuels are either rated as uniform or patchy. Uniform fuels are evenly distributed and occur in a continuous, non-interrupted cover across the landscape. Patchy fuels are not continuous.

Vertical arrangement is defined as the relative heights of fuels above the ground, as well as their vertical continuity. Both of these vegetation characteristics influence the ability of fire to reach various fuel levels or strata. Vegetation of various heights that can transport fire from the low-level brush to tree canopies is called a fuel ladder and may create what is called a "crown fire." When tall grasses and shrubs grow around trees with low hanging branches, the result is a fuel ladder. When a ground fire climbs the fuel ladder into the crowns of trees, it can spread canopy to canopy, creating higher fire intensity and firebrands.

Fuel moisture content is defined as the amount of water in fuels. The moisture content of plant materials plays a major role in the ignition, development, and spread of fires. Fuel moisture controls the current flammability of fuels both living and dead. During the most active growing periods of spring, the moisture content of plant foliage may be quite high. As the season progresses, a plant's moisture content declines until late summer or early fall when the plant becomes dormant or completely dies. Fine fuels, less than 0.25 inch thick, are most responsible for the spread of fire and have highly variable fuel moisture contents depending on the relative humidity of the air. Live fuel moisture content during the peak fire season (October through December) is estimated to be 60 to 80 percent in the drier open areas. This can potentially drop to less than 60 percent under extreme, dry wildfire conditions (County of Los Angeles Fire Department, Forestry Division, Vegetation Management Program).

There are two types of fuel moisture values to consider: **(1)** dead fuel moisture, with measurements of 1-hour time-lag, 10-hour time-lag, 100-hour time-lag, and 1,000-hour time-lag; and **(2)** live fuel moisture.

Dead fuel moisture percentages are determined by temperature, aspect, time of day, relative humidity, and month of the year. One-hour time-lag fuel is less than 0.5 inch thick, 10 hour time-lag fuel is between 0.5 inch and 1 inch thick, 100-hour time-lag fuel is between 1 and 3 inches thick, and 1,000-hour time-lag fuel is greater than 3 inches thick. One hour time-lag fuel can reach equilibrium with the surrounding atmosphere in 1 hour, or within minutes when air temperature exceeds 80°F and relative humidity is below 25 percent. One hour time-lag fuel moisture may be calculated using a set of tables that reference time of day, month, aspect, slope, temperature, and relative humidity. Ten-hour, 100-hour, and 1,000-hour time-lag fuel can take up to 10 hours, 100 hours, or 1,000 hours to reach equilibrium with the surrounding atmosphere, respectively. In Southern California, 1-hour, 10-hour, and 100-hour time-lag fuels are usually given equal value. One thousand hour time-lag fuel, which occurs in more heavily wooded environments (i.e., timber), is generally used in measuring drought effects. Forests are considered "critical" when 1,000-hour fuel measurements are less than 15 percent (as a frame of references, kiln-dried wood moisture averages 22 percent).

Despite variations in the topography and disturbance history of the Lake Mathews and Steele Peak Reserves, vegetative cover is classified into two main types: grass and coastal sage scrub. Frequent fires have created low-volume fuel beds throughout much of the Reserves. In areas where fire and grazing have been excluded, fuel loads have reached higher levels. A variety of fuel classes are represented on the Reserves. Although most fuels occur in the 1-hour size class, pockets of 10- and 100-hour fuels can be found in the Reserve interiors.

Live fuel moisture is described as the moisture in leaves and woody portions of a shrub. Field measurements of live fuel moistures are calculated by cutting small branches (less than 3 inches in diameter), weighing the branch, placing it in a low- temperature oven for 12 hours, removing the branch, and weighing it again. The difference in weight is the loss of moisture in the leaves and woody portion of the branch. Consequently, live fuel moisture may exceed 100 percent of the dry weight of the plant. Live fuel moisture is the highest in the spring and early summer, and the lowest in late summer, fall, and early winter. This measurement is a valuable tool in predicting wildfire potential for a general area.

Chaparral and coastal sage scrub are common Southern California vegetation types found in many upland locations and generally have reduced fuel moisture levels. Conversely, riparian vegetation, including California sycamore (*Platanus racemosa*), coast live oak (*Quercus agrifolia*), and mulefat (*Baccharis salicifolia*), has higher leaf moisture values than vegetation growing in drier, more xeric sites. The importance of fuel moisture in examining fire hazard is that higher moisture levels ultimately require higher BTU output to ignite or sustain ignition. Consequently, fuel arrangement, along with fuel chemical/moisture content, plays an important role in wildfire combustion, spread, and heat output. Fuel moisture is a significant component, as vegetation requires external heat and energy to reduce moisture levels before it will ignite. High winds, low relative humidity, and/or high temperatures begin the process of removing fuel moisture, thus allowing vegetation to ignite and burn more rapidly. Consequently, lower fuel moisture values, including both dead and live fuel moistures, result in increased fire intensity. Moisture-laden fuels inhibit complete combustion while simultaneously producing excessive smoke output.

Fuel chemical properties include the presence of volatile substances such as oils, resins, wax, and pitch. These also affect the rate of combustion. Chaparral fuels, especially the sages, have rather high amounts of these volatile substances that contribute to rapid rates of spread and high fire intensities.

Oil and moisture contents vary between fuels and fluctuate depending on the time of year. For example, black sage may have an oil content approaching 20 percent of its weight in dry summer or autumn months, but, in the spring, when sufficient groundwater is available, moisture content values can exceed 300 percent. When stressed during extreme dry weather conditions, numerous

chaparral and coastal sage scrub species may react explosively when moisture falls below 60 percent, whereas larger shrubs may require higher energy to sustain ignition.

5.10.3 Fuel Models

All seven principal fuels characteristics are descriptors that help define the 13 standard fire behavior fuel models (Anderson 1982) and the more recent custom fuel models developed for Southern California. Five fuel models (models 1, 4, 8, 9, and SCAL 18) were used in the FlamMap analysis for this FMP. The fuel models are required input in the mathematical fire spread model. Descriptions of the five fuel models used in the analysis conducted for Lake Mathews and Steele Peak Reserves:

Fuel Model 1*: Fire spread is governed by the fine herbaceous fuels that have cured or are nearly cured. Fires move rapidly through cured grass and associated material. Very little shrub or timber is present, generally less than one-third of the area. Grasslands and savanna are represented, along with stubble, grass tundra, and grass-shrub combinations that meet the above area constraint. Annual and perennial grasses are included in this fuel model.

Fuel Model 4*: Fire intensity and fast-spreading fires involve the foliage and live and dead fine woody material in the crowns of a nearly continuous secondary overstory. Stands of mature shrubs, 6 or more feet tall, such as California mixed chaparral, the high pocosins along the east coast, the pine barren of New Jersey, or the closed jack pine stands of the North Central States are typical candidates. Besides flammable foliage, there is dead woody material in the stand that significantly contributes to the fire intensity. Height of stands qualifying for this model depends on local conditions. There may also be a deep litter layer that confounds suppression efforts.

Fuel Model 8*: Slow-burning fire with low flame lengths are generally the case, although the fire may encounter an occasional heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Closed canopy stands of short-needle conifers or hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and occasionally twigs because little undergrowth is present in the stand. Representative conifer types are white pine and lodgepole pine, spruce, fir, and larch.

Fuel Model 9*: Fires run through the surface litter faster than model 8 and have longer flame height. Both long-needle conifer stands and hardwood stands, especially oak-hickory types, are typical. Fall fires in hardwoods are predictable, but high winds will actually cause higher rates of spread than predicted because of spotting caused by rolling and blowing leaves. Closed stands of long-needled pine like ponderosa, Jeffrey, and red pines, or southern pine plantations are grouped in this model. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting, and crowning.

Fuel Model SCAL 18: This fuel model represents typical coastal sagebrush- and buckwheat-dominated coastal sage scrub vegetation communities. Fire spread is primarily through the fine herbaceous fuels, either cured or dead. Fuel possesses a high ether extractive content (oil) and will provide containment problems when fuel moisture is at 120 percent. Fire will burn explosively when fuel moisture is below 100 percent.

***Note:** descriptions from: "Aids to Determining Fuel Models for Estimating Fore Behavior" by Hal E. Anderson (1982).*

5.10.4 Wildland Fire Behavior Calculations

A fire behavior calculation was computed for five fuel model types observed on the Lake Mathews and Steele Peak Reserves. Live fuel moisture inputs are from the Los Angeles County Fire Department and are estimated to be at least 5 percent higher than Riverside County. However, live fuel moisture readings below 60 percent are essentially equal, as little moisture remains present in the fuel.

The FlamMap output data were employed to assess wildfire risk and provide an indication of how vegetative fuels will burn under specific fuel, weather, and topographical conditions. Presentation of FlamMap outputs is included in *Figures 25* through *28*.

Fuel models used in the FlamMap analysis are classified into four groups based upon fuel loading (tons/acre), fuel height, and surface to volume ratio. Fuel model classifications were made during field analysis and in conjunction with available vegetation maps of the Reserve. The following list of fuel types describes the classification of fuel models based on vegetation type:

- Grasses Fuel, Models 1 through 3. These models represent the fast moving, light, flashy fuels found in grassland landscapes.

- Brush Fuel, Models 4 through 7, SCAL 14 through 18. These models are designed to represent the higher-intensity sage scrub dominated landscapes.
- Timber Fuel, Models 8 through 10. Timber models are selected to represent the riparian woodland or ornamental forested landscapes.
- Logging Slash, Fuel Models 11 through 13. These models are used to represent slash; none were utilized on the SKR Reserve fire behavior modeling.

To improve accuracy for southern California vegetation types, 40 additional fuel models and 5 southern California-specific models were introduced in 2004 with BehavePlus 3.0.

5.10.4.1 FlamMap Fuel Model Inputs

FlamMap software requires a minimum of 5 input files that represent field conditions in the study area, including elevation, slope, aspect, fuel model, and canopy cover. Each of these files was created as a raster GIS file in Arc View 9.1 software, exported as an ASCII grid file, then utilized in creating a Farsite Landscape file that served as the base for the FlamMap runs. The resolution of each grid file and associated ASCII file that was used in the models described herein is 10 meters, based on available digital elevation models (DEMs). In addition to the Landscape file, wind and weather data are incorporated into the model inputs. The output files chosen for each of the modeling runs included flame length (feet) and rate of spread (feet/minute). *Figures 25* through *28* depict the results of each of the four modeling runs and exhibit each of these output variables.

A description of the input and output variables used in processing the FlamMap models follows. In addition, data sources are cited and any assumptions made during the modeling process are described.

a. Elevation

Elevation data were derived from a DEM file that was acquired from the USGS. The resolution of the DEM was 10 meters. These data were utilized to create an elevation grid file, using units of meters above sea level. The elevation data are a necessary input file for FlamMap runs and are necessary for adiabatic (i.e., a process that happens without loss or gain of heat) adjustment of temperature and humidity and for conversion of fire spread between horizontal and slope distances (FlamMap 2005).

b. Slope

Using GIS tools, a slope grid file was generated from the elevation grid file described above. Slope measurements utilized values in percent of inclination from horizontal. The slope input file is necessary for computing slope effects on fire spread and solar radiance (FlamMap 2005).

c. Aspect

Using GIS tools, an aspect grid file was generated from the elevation grid file described above. The aspect values utilized were azimuth degrees. Aspect values are important in determining the solar exposure of grid cells.

5.10.4.2 Fuel Model

Vegetation coverage data in the form of a GIS shapefile were used in this analysis to create a fuel model file. Derived from the Vegetation Alliances of Western Riverside County (August 2005: CDFG, CNPS, and AIS) database, the vegetation data were edited to accommodate the more recent conversion of agriculture land to grassland in FMU 1. Vegetation types were classified according to existing National Forest Fire Laboratory (NFFL) and BehavePlus fuel models, and the data file was converted to a grid file for inclusion in FlamMap modeling. *Table 15* outlines the fuel model values applied to the different vegetation types found in the Lake Mathews and Steele Peak Reserves area.

TABLE 15
Fuel Model Descriptions and Canopy Cover Classifications

Fuel Model	Description	Canopy Cover Value
1	Light grass	0
4	Chaparral	0
8	Riparian vegetation	2
9	Forest/Woodland	2
SCAL18	Riversidian sage scrub	0

a. Canopy Cover

Canopy cover is a required raster file for FlamMap operations. It is necessary for computing shading and wind reduction factors for all fuel models. Canopy cover is the horizontal percentage of the ground surface that is covered by tree crowns. Canopy cover is measured as the horizontal fraction of the ground that is covered directly overhead by tree canopy. Crown closure refers to the ecological condition of relative tree crown density. Stands can be said to be "closed"

to recruitment of canopy trees but still only have 40 or 50 percent canopy cover (FlamMap 2005). Coverage units can be categories (0-4) or percentage values (0-100). *Table 15* presents canopy cover values assigned by fuel model.

b. Weather

Wind and weather data were obtained through RAWS, where temperature, wind speed, and wind direction were downloaded for the Clark and Corona sites for a period of 3 years. This information was analyzed and incorporated into the Initial Fuel Moisture file used as an input in FlamMap. In addition, wind direction and wind speed values for the different FlamMap runs were manually entered during the data input phase. All other weather data were held constant for each of the FlamMap runs. *Table 16* summarizes weather and fuel moisture data inputs used for both summer and fall weather conditions.

TABLE 16
Weather Inputs

Input Values	Summer Fire Conditions	Fall Fire Conditions
1-h Moisture	2%	2%
10-h Moisture	3%	3%
100-h Moisture	5%	5%
Live Herbaceous Moisture	60%	30%
Live Woody Moisture	80%	60%
20-ft Wind Speed	20 mph	50 mph
Air Temperature	100 0 F	95 0 F
Wind Direction	45°	190°

5.10.4.3 FlamMap Fuel Model Outputs

Two output grid files were generated for each of the two FlamMap runs, and include representations of flame length (feet) and rate of spread (feet/minute), as shown in *Figures 25* through *28*. The fire behavior analysis results for the Lake Mathews and Steele Peak Reserves vary depending on fuel type. It should be noted that the modeling results depict values based on inputs to the FlamMap system. Variations in weather or pockets of different fuel types are not accounted for in this analysis. Additionally, the coarse scale of analysis (10 square meters) limits fine-scale analysis and interpretation. Model results should be used as a basis for planning only, as actual fire behavior for a given location will be affected by many factors, including unique weather patterns, small-scale topographic variations, or changing vegetation patterns that could not be obtained for this analysis.

5.11 FIRE MANAGEMENT PROGRAM

Below is the synopsis of the Fire Management Program. For specific information provided by California Department of Forestry, please see *Appendix G*.

5.11.1 Short-term Tactical Fire Suppression Plan

A tactical fire suppression plan has been developed for the RCHCA lands in the Lake Mathews and Steele Peak Reserves. The tactical fire suppression plan includes individual response plans for each FMU identified in the following section. In addition to FMU-specific response plans, the tactical fire suppression plan includes discussion of primary contacts, CDF response levels, access roads, and potential response staging areas.

5.11.2 Fire Management Units

The FMUs for RCHCA lands on the Lake Mathews and Steele Peak Reserves correspond with individual parcel boundaries. The intent is to guide CDF's on-the-ground tactical operations during fire events while considering the management objectives aimed at maintaining wildlife habitat. Consistent with individual parcels, there are 12 FMUs designated throughout the Lake Mathews and Steele Peak Reserves, as described in *Section 5.7.2* and shown in *Figure 20*.

Similar to the Lake Mathews-Estelle Mountain Reserve Fire Management Program (Wills et al. 2000), this FMP utilizes a color-coded response system, as presented in *Table 17*. One important difference between this FMP Response Category color code and others is a reversal of colors for the "Assertive" and "Reserved" Response Categories. This change is consistent with the focus of the Response Map Book for CDF use. For most people, red indicates stop and green indicates go. As such, the **"RED"** Response Category is associated with the Reserved Response FMUs and the **"GREEN"** Response Category is associated with the Assertive Response FMUs.

Response Category **GREEN** FMUs include the high-value response areas requiring assertive intervention. This Response Category indicates that, in these areas, management goals focus on reducing the fire return interval for habitat enhancement or that increased allocation of tactical resources as a rapid intervention method to minimize losses to high-value assets and resources is required. Response Category "**YELLOW"** FMUs include standard tactical response areas. **YELLOW** FMUs are managed for fire containment but with consideration for the least impact possible for control. Fires in **YELLOW** FMUs will not typically be allowed to self-extinguish. Response Category **RED** includes FMUs where current management goals include fire and where fire will be allowed to burn but will be "guided" toward existing site features, such as roads, rock outcrops, and bare ground, or other control lines to encourage the fire to self-extinguish (as long as conditions allow a high probability of successful containment). *Table 17*

discusses of Response Categories, and *Table 18* provides the Response Category classifications by FMU.

TABLE 17
Fire Management Unit Response Categories

Response Category	Response Level	Description	Fire Management Unit Objectives
GREEN	**Assertive**	Fire Management Units assigned "GREEN" status are managed for minimal fire losses. As such, incident response in "GREEN" FMUs is aggressive.	1. Rapid fire containment 2. Fire spread minimization 3 All available tactical firefighting resources and methods may be utilized
YELLOW	**Standard***	Fire Management Units assigned "Yellow" status are managed for fire containment with minimal biological damage created by the suppression operation.	1. Fire containment and control 2. Minimize destruction of habitat 3. Utilize lowest biologically impacting fire suppression equipment and methods possible*
RED	**Reserved***	Fire Management Units assigned "RED" status are managed for minimal biological impacts. As such, fire suppression efforts focus on the least soil, plant, and wildlife impacting methods.	1. Containment within FMU 2. No or minimal destruction or disturbance of habitat 3. Utilize only non-impacting fire suppression methods*

* *When conditions dictate use of equipment or techniques that may result in biological disturbances within "Yellow" or "RED" FMUs to control or extinguish a fire, priority is given to public safety and avoidance of Reserve-wide, catastrophic fire conflagration. Under such conditions, "impacting" fire suppression methods should be considered valid by CDF.*

NOTE: Under "Red Flag" conditions, severe fire weather subjects all FMUs to Response Category level elevation. Ultimately, implementation of the FMU recommendations will depend on site-specific fire environment conditions. It is anticipated that variations in the type of tactical response occurring on any given FMU during wildfire events will occur and will be addressed with post-fire monitoring and management.

TABLE 18
Individual Fire Management Units
Response Category Classification*

FMU	Acreage	Elevation Range (ft.)	Maximum Slope (%)	Access	Structures Adjacent	Response Category**
1	1,386.9	1,080-1,540'	25	Cajalco Rd. at Silverton Ct.	Yes	Reserved
2	673.6	960-1,590'	40+	Cajalco Rd. at Silverton Ct.	Yes	Standard / Assertive
3	54.2	1,480'	4	Cajalco Rd. at Silverton Ct.	No	Reserved
4	19.8	1,440-1,600'	16	Cajalco Rd. at Hollis Ln.	No	Assertive
5	9.7	1,520'	4	Cajalco Rd. at Archer Rd.	Yes	Assertive
6	375.1	1,200-1,807'	35	Dawson Canyon Rd.	No	Standard / Assertive
7	186.2	1,160-1,732'	35	Dawson Canyon Rd. at Skyline Rd.	No	Assertive
8	719.4	1,360-2,477'	35	Dawson Canyon Rd.	Yes	Assertive
9	39.0	2,160-2,520'	25	Dawson Canyon Rd.	No	Assertive
10	299.1	1,560-2,706'	40	El Hermano Rd.	Yes	Assertive
11	842.5	1,400-2,337'	30	Cates Rd. (north) or Lake St. (south)	No	Assertive
12	203.8	1,700-1,920'	20	Forrest Dr. at San Jacinto Ave.	Yes	Assertive

* *When conditions dictate use of equipment or techniques that may result in biological disturbances within **"YELLOW"** or "**RED**" FMUs to control or extinguish a fire, priority is given to public safety and avoidance of Reserve-wide, catastrophic fire conflagration. Under such conditions, "impacting" fire suppression methods should be considered valid by CDF.*

** *The categories assigned to each FMU should be evaluated by the Reserve Manager each year and may be subject to change based on recent fire activity, changes in vegetative cover, or observations of sensitive species.*

5.12 PRIMARY ACTIONS AND CONTACTS FOR WILDFIRE EMERGENCY

When a fire has been spotted on the Reserve(s), the following information should be collected and provided to the CDF response team. Because there is currently no full time-site manager, the information provided to CDF may not include all of the details recommended herein. However, the more information that is provided, the higher the likelihood that involved FMUs will be provided the type of response prescribed according to their Response Category and that ground disturbance will be minimized.

1. Grid Number (Utilizing CDF's Response Grid)
2. Response Category
3. Fire Management Unit number
4. Response Map Book page number
5. Most direct access route
6. Type of fuels
7. Sensitive resources

The following "Key Decision Maker" contact information is provided in a prominent location in the GIS Response Map Book:

California Department of Forestry and Fire Protection
Contact: 911 – provide initial Response Map Book information, if known

RCHCA
Carolyn Syms Luna

Lake Mathews Reserve Manager

Steele Peak Reserve Manager

Others
Neighboring Land Owners
CDFG
BLM
MWD
Waste Management

5.13 FIRE RESPONSE

CDF's present response schedule represents an excellent utilization of available fire resources. The CDF Riverside Unit shows exceptional initial attack success for grass and brush fires, with a 96 percent and 91 percent success rate, respectively, within its direct protection area (DPA) (2005 Riverside Unit Fire Management Plan - Ignitions Workload Analysis 2005). Fire Suppression Air Support will be a key component of responses to all FMUs and in particular the more remote FMUs (3,4, 6-10), especially under conditions that would accelerate wildfire spread. Under extreme conditions, or at night, air support may not be available, and in these situations, response categories may become secondary to public safety. Fires occurring within open space areas have the demonstrated potential to move into other Response Category FMUs or into urban areas, consequently overwhelming available fire resources.

When considering a potential wildfire occurrence on the Lake Mathews and Steele Peak Reserves, the majority of the RCHCA land can be reached by CDF within a 10 to 15 minute time period from dispatch. Certain portions of the open space areas can be reached more quickly than others due simply to the available access roads.

Air support is available from Hemet Ryan Air Base, in Hemet, and the entire Lake Mathews and Steele Peak Reserves can be reached within a reasonably fast period of time, less than 30 minutes, weather permitting and includes both fixed wing and helicopter support.

This FMP stresses the need for fire response to minimize impacts to natural resources, when possible, by using pre-planned fire suppression tactics and actions within the boundary of the Lake Mathews and Steele Peak Reserves. Drivable roads and trails within portions of the RCHCA Reserves are wide-ranging. In these areas, additional fire breaks are not planned, and the need for ground-disturbing activities can be carefully considered based on the location of roads and other valuable resources. Other parcels are more remote and will limit accessibility to CDF engines. Response to these areas will also utilize pre-planned FMU information to minimize impacts to the Reserve and may, for example, include immediate response with helicopter or fixed-wing air support and hand crews providing on-site "mop-up" to protect Riversidian sage scrub with minimal ground disturbance.

Response to the Reserves for fire suppression should include existing road access for firefighting personnel, type I engines, type III engines, fire crews, air attack, helicopters, and air tankers. Fire suppression actions may include one or more of the following: direct attack with engines, fire crews, helicopters, and firing operations within the FMUs, according to the pre-planned management guidelines. Line construction activities within the Reserve would be best carried out by hand crews. Dozers/road graders may be activated but should not be put into operation on the

Reserve itself unless necessary for improving existing roads for engine access or constructing line or secondary line for preservation of high-value resources.

5.13.1 Roads/Access

Roads are extensive throughout the Lake Mathews and Steele Peak Reserves, although maintenance and road surface condition varies by location. FMUs 1 through 5 have relatively good access via dirt roads established for former agricultural operations or based on their proximity to developed areas. FMUs 6 through 11 are more remote with limited access available, primarily by steep dirt roads or powerline access roads. FMU 12 (Steele Peak) has good access via paved roads on the east. Primary access roads to each FMU are provided on the response maps attached to this report.

5.13.2 Staging Areas

Staging areas are important for incident command to organize, plan, and implement firefighting strategies. Their placement on the Lake Mathews and Steele Peak Reserves is also important because staging areas will likely realize higher ground disturbance from personnel, vehicles, and equipment in a confined area. There are few key staging areas on the Lake Mathews and Steele Peak Reserves. Staging areas are primarily associated with FMU number 1, along Cajalco Road. Staging areas on FMU number 12 may be possible, but only as necessary in the absence of alternative sites. FMU number 1's potential staging area(s) are identified in the Response Map Book. RCHCA owned Reserve lands generally do not include staging sites due to their remote and difficult to access locations relative to the remainder of the Reserve areas and potentially dangerous terrain. General descriptions of the FMUs and their potential for staging areas are provided in *Table 19*.

TABLE 19
Fire Management Unit Staging Areas for Firefighting Operations

Fire Management Unit	Staging Area	Description
1	Multiple possible locations for staging areas.	Primary staging area for apparatus and personnel entering the Reserve. Parking along road and in disturbed areas. Location for a helicopter landing.
2	No Staging Area	Staging for this area would likely be located off of I-15 or in FMU number 1.
3	No Staging Area	Not likely for staging area due to small size and terrain.
4	No Staging Area	Not a likely staging site due to small size and terrain.
5	No Staging Area	Not a likely staging site due to size and location.
6	No Staging Area	Not a likely staging area due to steep terrain, difficult access and remote location.
7	No Staging Area	Not a likely staging area due to remote location and terrain constraints.
8	No Staging Area	Not a likely staging area due to remote location.
9	No Staging Area	Not a likely staging area due to terrain and remote location.
10	No Staging Area	Terrain makes most of this FMU difficult for establishing as a staging area
11	No Staging Area	Terrain, including steep canyons, results in FMU 11's low priority as a staging area.
12	Possible Staging Area	If necessary, a staging area could be established but would result in disturbance/impacts. A better staging area would be located on an existing non-Reserve parcel near access roads.

5.14 LONG-TERM STRATEGIC FIRE PROTECTION PLAN

The long-term strategic fire protection plan considers strategic fire prevention activities, fire suppression with regard to fire effects on habitat, and post-fire monitoring and rehabilitation.

The long-term strategic fire protection plan for the Lake Mathews and Steele Peak Reserves must accomplish public safety while also meeting the goals of Reserve management. Due to the continued human population growth in urban areas near the Reserves, public safety requirements will require increasing fuel reduction activities at the interface and intermix areas. Fuel reduction in the interface and intermix areas will be most successfully accomplished by a combination of maintenance on private property that may include experienced fuel reduction contractors and more robust, ecologically-based management and maintenance on Reserve areas. A key component of the long-term strategic fire protection plan will be public education. Prevention activities are more successful when coupled with active education programs.

5.14.1 Fire Prevention/Fuel Reduction

Successful fire management requires pre-planning and utilization of fire prevention techniques and strategies. High-value resource areas must be identified, and then appropriate wildfire hazard/fuel reduction practices must be implemented and maintained. With those concepts in mind, high-value resource areas of the RCHCA Reserve lands were identified and appropriate methods for reducing potential hazard are provided. *Table 20* provides a summary of the high-value resource areas acknowledged for the Lake Mathews and Steele Peak Reserves and the associated fire prevention strategy recommended for achieving long-term management goals.

TABLE 20
Fire Prevention/Fuel Reduction Prescriptions for Lake Mathews and Steele Peak Reserves FMU High-value Resource Areas

FMU NUMBER	HIGH VALUE RESOURCE	FIRE PREVENTION PRACTICE
1	Annual Grassland	Annual mowing and grazing would provide the most feasible form of fuel reduction, and can be focused adjacent and along Cajalco Road and highly used dirt access roads.
2	Riversidian Sage Scrub	Reduction of fires through strategic mowing along ignition source areas, especially access roads, and rapid response for extinguishing wildfire, especially in the western portion of this FMU
3	Annual Grassland	Annual or semi-annual grazing would be the most likely form of fuel reduction for FMU 3 due to its slopes and location.
4	Riversidian Sage Scrub	This very small FMU would be difficult to efficiently treat unless it is part of a larger treatment. Reduction of fires through strategic mowing along ignition source areas, especially access roads, and rapid response for extinguishing wildfire
5	Annual Grassland	Annual Mowing is feasible in FMU 5 and could be focused along the access road that bisects the FMU..

TABLE 20
Fire Prevention/Fuel Reduction Prescriptions for Lake Mathews and Steele Peak Reserves FMU High-value Resource Areas

FMU NUMBER	HIGH VALUE RESOURCE	FIRE PREVENTION PRACTICE
6	Riversidian Sage Scrub	The southern and eastern portion of this FMU could be lightly grazed according to habitat requirements and mowing conducted along dirt roads.
7	Riversidian Sage Scrub	Steep terrain in this FMU limits the amount of mowing that would be possible. Grazing is possible, but may be difficult to manage. Minimizing fire spread during wildfire will be a key component to habitat enhancement in this FMU. Timed prescribed fire could be used on a long-term basis, but not until wildfire frequency is reduced substantially.
8	Riversidian Sage Scrub	Steep terrain in this FMU limits the amount of mowing that would be possible. Grazing is possible, but may be difficult to manage. Minimizing fire spread during wildfire will be a key component to habitat enhancement in this FMU. Timed prescribed fire could be used on a long-term basis, but not until wildfire frequency is reduced substantially.
9	Riversidian Sage Scrub	Steep terrain in this FMU limits the amount of mowing that would be possible. Grazing is possible, but may be difficult to manage. Minimizing fire spread during wildfire will be a key component to habitat enhancement in this FMU. Timed prescribed fire could be used on a long-term basis, but not until wildfire frequency is reduced substantially.
10	Riversidian Sage Scrub	Steep terrain in this FMU limits the amount of mowing that would be possible. Grazing is possible, but may be difficult to manage. Minimizing fire spread during wildfire will be a key component to habitat enhancement in this FMU. Timed prescribed fire could be used on a long-term basis, but not until wildfire frequency is reduced substantially.
11	Riversidian Sage Scrub	Steep terrain in this FMU limits the amount of mowing that would be possible. Grazing is possible, but may be difficult to manage. Minimizing fire spread during wildfire will be a key component to habitat enhancement in this FMU. Timed prescribed fire could be used on a long-term basis, but not until wildfire frequency is reduced substantially.
12	Riversidian Sage Scrub	Grazing and limited mowing are possible, especially along access roads. Minimizing fire spread during wildfire will be a key component to habitat enhancement in this FMU. Timed prescribed fire could be used on a long-term basis, but not until wildfire frequency is reduced substantially.

In summary, each of the FMUs include high-value habitat resources that may be treated for fuel reduction practices, potentially including sheep grazing, annual mowing, herbicides, and prescribed burning. The high value resource areas include urbanization or intermix/interface or are nearby occupied habitat, access routes, or staging areas. In total, it is estimated that about 2,400 acres are suitable for timed, annual fuel reduction efforts, at least along ignition sources and the remainder of the approximately 4,500 acres would be suitable for treatment on longer timeframes, except possibly along access roads, where annual mowing is recommended.

Potential fire prevention and fuel reduction practices include:

- Sheep grazing – timing, avoid introduction of exotics;
- Mowing – timing to avoid wet soils and potential for ignition;

- Herbicides – timing to maximize effect on non-native grasses;
- Prescribed fire – timing, spring preferred, some winter burning possible;
- Hand tools/thinning – especially on private properties that are and will continue to push into the interface/intermix areas of the Reserve; and
- Fuel or fire breaks – augment existing roads, bare ground, rock outcrops with fuel reduction and maintenance; create new only as indicated in FMU map book.

Considering the RCHCA lands in the Lake Mathews and Steele Peak Reserves, the following uses of fire prevention and fuel reduction practices are recommended:

Sheep Grazing: Grazing is a valid fuel reduction method and is compatible with SKR management goals.

Mowing: Mowing is one of the most common and successful methods for reducing fuel loads and is compatible with SKR management goals; it may be of limited use in rocky and rugged terrain.

Prescribed Fire: Prescribed fire can be the least expensive but overall least feasible form of fuel reduction. The advantages of prescribed fire must be weighed against difficulties in getting burns implemented, potential for escape, public opposition, and propensity to result in non-native grass and weed reestablishment if implemented too frequently.

Water Storage: Water storage at various Reserve locations can increase the ability of CDF to successfully limit wildfire size and effects.

Gate and Access Road Signage: Gates and signs with access road names and road quality will benefit CDF responders and complement Response Map Books, resulting in reduced possibility for delayed response.

Thinning: Thinning can reduce fuel continuity and loading by selective removal of dead and dying, overly dense horizontal and vertical bunches, and exotics. Most useful in the intermix areas around high-value resources, such as residences.

Fuel Breaks: Fuel breaks provide areas of removed fuels that play an important role in helping CDF contain fire. The sites currently include numerous fire/fuel breaks (roads, outcrops, and other flame slowing features) from which fire fighting personnel could conduct operations. Based on the locations of RCHCA lands within the Reserve, it is not recommended that additional breaks be created. There may be opportunities for fuel breaks on non-RCHCA lands that would be beneficial for containing fire spread. However, fuel breaks should not be located

near areas that are to be managed for restoration of Riversidian sage scrub or native grasslands because newly cut fuel breaks can support non-native plants, providing a safe site with reduced temperatures and proliferation in disturbed areas following fire. In effect, they become major sources of non-native seed on very receptive burn areas after fires (Keeley 2005).

Roadside Buffers: The I-15 corridor, along with other secondary roads such as Cajalco Road, has been identified as a high-priority ignition source. According to CDF (2005), steps have been taken to address this issue by enhancing the size and quality of fuel modification zones or buffers along the roadways. These areas, along with all well-used roads in the vicinity of the Reserves, will require diligent annual maintenance in order to reduce the encroachment of wildfire onto Reserve lands.

Illegal Access: Off-highway vehicles and shooting are other potential sources for fire that must be managed through restricting access (fence, gates), more frequent patrols, and higher profile presence of Reserve staff.

Public Education: Private property owners in intermix (located within or surrounded by open space areas) and interface areas can be encouraged to play an active role in reducing the potential hazard on properties within or adjacent to the Reserves. It will also be beneficial if the public understands the management actions occurring on the Reserve, such as grazing, mowing, herbicides, and prescribed fire. As such, this FMP recommends a concerted effort to reach property owners who are situated in locations that may be affected by wildfire on the Reserve or who may serve as ignition points to Reserve fires. Educational material can be customized for these homeowners to include discussion of the importance of the SKR Reserve lands. Standard measures for implementing a 100-foot fuel modification zone can be provided from materials available through the Fire Safe Council (http://www.fire safecouncil.org/). As part of the public education program, private property owners should be encouraged to participate as "eyes on the Reserve" to help curb illegal access and report potential problems.

5.14.2 Annual Grass Dominated FMUs (FMUs 1, 3, and 5)

As illustrated on the vegetation distribution maps (*Figures 3* and *5*), several areas of the Lake Mathews and Steele Peak Reserves are dominated by non-native annual grasslands. Generally, the grasslands are concentrated in FMUs 1, 3, and 5, although smaller patches of grassland cover exist in the remaining FMUs. The long-term goals for these non-native grasslands are to provide an optimal disturbance pattern using the management tools described above and cost-effective restoration planting following fire that are consistent with creation of low-growing annual forbs and non-native grassland, where appropriate. This process has a long time horizon and will require experimentation, research, and monitoring, as described in *Section 5.16.2* of this FMP. In the interim, it will be the goal to maintain, enhance, or create open grasslands and forb lands

through periodic disturbance, potentially including sheep grazing, mowing, herbicides, and fire. The ideal open/bare areas would have grass and forb cover of 50 percent or less and some open scrub land at transition areas. Annual forbs are preferred over annual grasses with *Bromus* spp. being undesirable because over time it forms thick thatch, restricting occupation and movement of SKR (Wills et al. 2000).

5.14.2.1 Habitat Quality Enhancement/Fire Hazard Reduction Methods

Although the optimal disturbance regime will be determined through on-the-ground experimentation, based on available research, it is anticipated that a disturbance return of approximately every 5 years or less will be necessary to avoid degradation of SKR habitat quality. A 5-year disturbance return can be accomplished through various methods, including grazing, mowing, herbicides, and prescribed fire.

Mowing is a safe, acceptable method of fuel reduction and cover reduction per a USFWS letter to Riverside County Fire Department in 1998 and is an effective treatment for managing SKR habitat (Kelt et al. 2005). Mowing has not been determined to be a significant factor for fire starts (CDF 2005). Mowing is anticipated to be most effective in areas of high-value resources and as an alternative between wildfire or prescribed burns. Examples include along primary access roads as buffers, on the periphery of Riversidian sage scrub dominated areas where management includes fire exclusion, as fuel modification areas around or on the exposed portions of private residences, or around known cultural resources sites. Mowing techniques should seek to replicate grazing, with similar mow heights and patterns. Site terrain will be a limiting factor for the extents of mowing, as will soil conditions. Mowing is not recommended when soil moisture levels are such that the weight of the mowing equipment cannot be supported, and soil compaction and potential impacts on occupied burrows may result. Mowing equipment with wide rubber tires for high distribution of weight is preferred.

Sheep grazing can be a low-impact alternative to fire and mowing. Grazing is an effective fuel reduction method that performs a dual function of reducing cover in heavily thatched grasslands. It also has been shown to be an effective management method of SKR habitat enhancement (Kelt et al. 2005). Managed grazing for habitat quality improvement and fuel reduction will require the preparation of a range plan considering timing, pre-grazing preparations, grazing units, and optimal grazing, intensity, duration, and rotation. Currently, there is limited sheep grazing in Riverside County, which may affect the reliability of grazing as an alternative. It may be prudent for the County to begin research into the availability of suitable herds and/or the feasibility of acquiring a small herd that can be used throughout the SKR Reserve.

Prescribed fire is a useful tool that is cost effective and, in some landscapes, is the favored form of disturbance for SKR. Prescribed fire is discussed in more detail in the following section. In

brief, where managed fire is feasible and desirable in the Lake Mathews and Steele Peak Reserves annual grasslands, spring burning is recommended. Prescribed fire during late spring climatic and plant phenological conditions seems to provide the most significant improvements in community composition and structure (Wills et al. 2000). Consistent with ongoing fire research on the SKR Reserve, initial fire return intervals are anticipated to be approximately 3 years or less during what can be considered the restoration phase. As habitat improvement targets are approached, the fire regime may more closely resemble the historic pattern (approximately every 10 years), or it may be completely independent of the historic pattern due to the presence of the non-native grasses that will continue to opportunistically establish and have potentially changed the optimal fire return from historic frequency (Keeley 2005).

5.14.3 Riversidian Sage Scrub Dominated FMUs (FMU Nos. 2, 4, 6-12)

As illustrated on the vegetation distribution maps, (*Figures 3* and *5*), the majority of the Lake Mathews and Steele Peak Reserves consist of Riversidian sage scrub cover. Generally, the Riversidian sage scrub is concentrated in the southern and eastern portions of the Lake Mathews Reserve, although isolated patches do exist in FMUs 1 and 3. About 45 acres of the 70-acre Steele Peak Reserve are sage scrub. The long-term goal for these Riversidian sage scrub areas is to minimize disturbance, except as appropriate for the reduction of non-native species. The majority of the Riversidian sage scrub within the noted FMUs is degraded from too frequent fire return intervals. Long-term restoration of this Riversidian sage scrub to higher-quality habitat supports the Reserves' goal of conserving the California gnatcatcher and other MSHCP Covered Species. It may, however, simultaneously increase the potential for higher-intensity fire and elevated risk for public safety. Active management of the Riversidian sage scrub on the Lake Mathews and Steele Peak Reserves provides an opportunity to focus (and minimize) the use of fire during the initial restoration period and optimize long-term fire frequency and intensity in a manner that results in the potential to lower risk to intermix (residences intermixed with natural vegetation as opposed to interface where only one side of residences are exposed to natural vegetation communities) structures while enhancing the long-term conservation of natural habitats.

Public safety and Reserve goals, however, may be in conflict because the establishment of high-quality Riversidian sage scrub may result in increased potential for high intensity fire. However, fire is a necessary process within Riversidian sage scrub, and managed fire, combined with fire prevention priorities described in this FMP, would result in a manageable hazard, especially given CDF's Riverside Unit's success rate for shrub wildfire response. The highest risk would be associated with older construction in extreme fire weather.

The degraded Riversidian sage scrub habitats will need reduction of non-native annual grasses, which can be accomplished through a combination of mowing, grazing, herbicide treatment, and

limited use of fire. Too frequent disturbance levels have resulted in the establishment and flourishing of these non-native grasses. It is important to note that without fire exclusion and lengthening of the fire return interval, establishment of non-native annual grasslands will not be reduced but rather will be enhanced. The presence of intermixed non-native grasses in Riversidian sage scrub increases the likelihood of burning and a shift of the typical crown fire (shrubs) to a surface fire. This type of fire favors increases in the survivorship of non-native seed banks due to the lower intensity and temperatures associated with light, flashy fuel fires (Keeley et al. 2006; Keeley 2005). Increased fire frequency lowers the threshold beyond which native shrub cover cannot recover (Jacobson et al. 2004). Therefore, the restoration of Riversidian sage scrub on the Lake Mathews and Steele Peak Reserves requires enhanced efforts at fire prevention, fire suppression, and avoidance of prescribed burning (Keeley 2005).

5.14.3.1 Habitat Quality Enhancement/Fire Hazard Reduction Methods

Pre-fire prevention activities (fuels reduction, ignition management, habitat health improvements), along with aggressive fire suppression tactics to minimize fire size and escape, are primary practices recommended for Riversidian sage scrub areas. Methods available for reducing fire effects in these Riversidian sage scrub-dominated areas include mowing, grazing, herbicides, and targeted and minimal use of prescribed fire. However, the primary methods center on the reduction of ignitions and the increase in response success. CDF's initial attack success is high, but even incremental increases in success through implementation of concepts provided in this FMP will help limit impacts to Reserve habitat. Increasing response success is an important component of this FMP and its tactical response plan.

Ignition Reduction: It is well documented that the ignition corridor along I-15 is compressing the fire return interval and resulting in shrubland conversion to largely non-native annual grassland. As mentioned, CDF is working with Caltrans and others to improve roadside buffers along I-15. It is recommended that fuel modification buffers be provided for all primary and secondary roads that may affect the Lake Mathews and Steele Peak Reserves. In addition, site access must be managed through the use of gates and locks, fencing and signage, and trespass and unauthorized recreational activities must be curtailed through a higher presence of patrols.

Fire Suppression: Fire suppression, in combination with other management methods in targeted SKR habitat management areas, is the priority for Reserve lands, particularly Riversidian sage scrub, riparian, and woodland areas. Lengthening the fire return cycle to an optimal frequency will require fuel reduction experiments, research, monitoring, and analysis as part of the overall management approach. The optimal fire frequency in sage scrub may be from 10 to 60 years or more. It may be difficult to achieve the longer fire return intervals given the current and projected ignition sources that may affect the Reserve. However, results of site data analysis will

more firmly establish the optimal return intervals to meet habitat goals, or if additional steps need to be implemented, to lengthen the return of fire for a given FMU.

5.15 PRESCRIBED FIRE PROGRAM

Prescribed fire has been considered an important tool for maintaining or enhancing SKR habitat quality. Although there may be benefits from prescribed fire, this FMP favors other methods of disturbance due to the long-term likelihood that prescribed fire will not be feasible on the Lake Mathews and Steele Peak Reserves due to the many constraints associated with managed burns. The Lake Mathews and Steele Peak Reserves exhibit various levels of effects from wildfire, but the greater Lake Mathews Reserve is generally considered to have experienced high disturbance levels while the RCHCA land in the Steele Peak Reserve are considered to exhibit lower disturbance levels. The high disturbance areas are experiencing a fairly dramatic reduction of Riversidian sage scrub and an equally dramatic increase in areas dominated by exotic grasses. SKR, tolerant of open exotic grasslands, have managed to persist throughout these disturbed habitats, but their populations are known to decline as grass density increases (Wills et al. 2000), which will occur over time without periodic disturbance. Prescribed fire is one option for providing disturbance needed to create a more open, preferred habitat for SKR.

Many questions remain about the long-term use of prescribed burning to enhance SKR habitat quality. The Center for Natural Lands Management is undertaking a multi-year prescribed burning experiment to evaluate timing and frequency of burns (Wills et al. 2000). Results of this experiment are expected to help focus further research and refine management prescriptions, as well as offer suggestions to other SKR Reserve managers. It is recommended that this information be applied to the Lake Mathews and Steele Peak Reserves areas as part of the Reserve-wide management for SKR.

Prescribed burning is considered one of the more economically feasible treatments, but there are increasing constraints on its widespread use because of the hazards on populated landscapes (Keeley 2005). As human populations in the sphere of influence of the Reserve areas increase, it will likely become more difficult to implement prescribed burns. Another constraint on effective implementation of prescribed fire is concern for air quality (McPherson 1995). Air quality concerns are not limited to effects on human populations but also on wildlife. For example, spring burning, which on the Lake Mathews and Steele Peak Reserves has initially proven to be the most successful period for burning, is prohibited on many wildlife refuges because of impacts on nesting birds.

In addition to the difficulties in permitting prescribed burns, the effects of prescribed burning on non-native species are diverse and not thoroughly understood. Except for a few cases, prescribed burning generally promotes persistence of non-natives (Keeley 2005).

Because native and non-native grass species may respond very differently to fire based on timing, intensity, and frequency, precise knowledge of plant morphology, phenology, and life history is required to select a successful burn prescription (Pyke et al. 2003). Life history determines the direct susceptibility of plants to fire. Optimizing longer-term control of invasives and establishment of desired natives would include a burning regime that promotes desirable plants, as well as negatively affecting target weedy plants (Rice 2005). Burning annual grass seeds before they shatter and disseminate is a goal of restoration managers (Allen 1995; Kan and Pollak 2000; Menke 1992). This is facilitated by the tendency for higher burn temperatures in a fine fuel (grass) canopy than at the soil surface. The key is to complete the burn prior to curing of the seed for maximal seed susceptibility to heating (Rice 2005; Brooks 2001). Methods to increase the duration or intensity of seed heating include backing fires, deferred grazing, and fuel additions (hay) across the burn area (Rice 2005). D'Antonio et al. (2003) state:

> "Fire intensity can be manipulated to some extent by season of burn and pre-treatments that influence fuel load (including intensive grazing to reduce fuel or rest from grazing to increase fuel**)**, and by ignition strategies (i.e.*,* using a headfire [driven by wind] versus a backing fire [burning into the wind]). Intensity is also influenced by factors that cannot be controlled, such as slope, soil texture, and humidity and temperature (Daubenmire 1968). Controlled burns tend to be less intense than wildfires, and small fires less intense than large fires."

Therefore, prescribed burning should be considered as one alternative for habitat enhancement and fuel reduction on the Lake Mathews and Steele Peak Reserves. Grazing, mowing, and herbicides should be utilized as the first options for habitat disturbance and prescribed fire only where appropriate, such as in conjunction with burning on neighboring SKR grasslands. Prescribed fire is not recommended in interface/intermix areas due to potential hazards associated with burn operations. It should only be considered for areas where large expanses of grassland are available for burning, with minimal risk to public safety and property. Within the larger areas, smaller blocks should be selected to enable wildlife use of unburned areas immediately following fire and loss of habitat.

Despite the potential complications associated with prescribed fire, as discussed previously, fire provides benefits that cannot be mimicked by grazing, mowing, or herbicides. However, it is anticipated that wildfire will continue to occur in the Reserves due to the numerous and increasing ignition sources and may fulfill some of the beneficial fire effects that are lacking from alternative management methods.

Prescribed fire occurs in two forms: **(1)** natural fire occurring primarily through lightning strikes; and **(2)** intentional, managed fires. Natural fire caused by lightening is very uncommon on the Lake Mathews and Steele Peak Reserves but does occur (CDF 2005). If natural fire occurs on the

Reserve lands under a pre-established prescription on FMUs that have a suitable prescription and the fire poses no threat to life or high-value resources, the fire may be allowed to burn. If unsafe conditions exist and without suppression, it has a high likelihood of burning into areas of fire exclusion or threatening valuable resources, then assertive suppression should be pursued. Intentional managed fires are planned ignitions for purposes of reducing fuels primarily for public safety or habitat improvement, require a Vegetation Management Program (VMP), and are regulated by all applicable laws.

Where prescribed burning is feasible, such as in FMUs 1 and portions of 2 and 6, certain protocols must be followed prior to burns being conducted. There is already an active prescribed burn plan under preparation for the greater Reserve. According to the Riverside CDF Unit, a VMP is underway that includes prescribed burning plans for areas in their DPA. Early indications are that this program has been hampered by lawsuits. Regardless, all burns on the RCHCA lands would be completed with the aid of California's VMP. CDF would provide resources for each planned burn.

Winter burns, which typically include weather allowing prescribed burns to take place, will usually result in non-native dominance (Keeley 2005). Avoidance of winter burns is recommended, with spring burns being the preferred period, although experimental winter burns may provide insight into the vegetative response on this site. It is recommended that a trained and experienced fire ecologist be involved to help determine the optimal timing of burns to favor annual forbs and open, bare ground patches.

In addition to prescribed burns in annual grasslands, portions of FMUs 2 and 6, and possibly 4 could be managed for an open scrub habitat, which would provide a level of diversity for SKR in transition areas from grasslands to scrub lands. This would only be considered an option if there is a very high probability of burn control and where it is acceptable to cut fuel breaks between "Assertive" Response Category Riversidian sage scrub lands and transitional scrub lands. The FMU's are relatively small and would need to include neighboring Reserve area agreement for prescribed burning.

5.16 POST-FIRE ACTIVITIES

5.16.1 Erosion Control

One of the first concerns following wildfire is stabilization of soils in the burn area, especially if sloped areas are included in a burn. A goal should be to have erosion control Best Management Practices (BMPs) in place as soon as possible and prior to the onset of the winter rainy season. There are various erosion control practices available for slowing the rate of erosion. Recent research indicates that mechanical rehabilitation treatments, including straw mulch, hay bales,

and jute rolls are more predictable for reducing soil erosion and post-fire hydrological problems than seeding or other treatments (Robichard et al. 2000). Mulching may introduce exotics (Kruse et al. 2004), so erosion potential should be high before the decision to place these erosion-mitigating features in the Reserve is finalized.

5.16.2 Research and Monitoring

Because this FMP is based on strategies that are commonly utilized for fire management and for habitat enhancement but are untested on this site and may require additional experimentation, pre- and post-fire research and monitoring are strongly recommended. The monitoring program outlined in the Lake Mathews-Estelle Mountain Reserve FMP (Wills et al. 2000) provides description of on-going study of pre- and post- fire response of plant and animals on portions of the Reserve. To augment that research and add to the growing database, similar efforts can be duplicated on RCHCA lands, subject to available funding.

The following list identifies primary areas for potential research, experimentation, and monitoring, some of which are already being implemented on portions of the Reserve (Wills et al. 2004):

On-Going Fire Management

- Identify areas in particular need for disturbances and which are in need of re-burning to maintain SKR habitat;

- Experimentally determine the optimal disturbance frequency;
  - Experiment with 4-, 5-, and 7-year mowing, grazing, and burning of FMUs;
  - Examine the efficacy of "guided or controlled" wildfires to provide the benefits associated with prescribed burning
  - Examine mowing and grazing effects on annual grasslands;
  - Consider low-cost native grass re-establishment;

- Maintain fire frequency between 4 and 8 years to control non-native grasses;

- Two permanent plant transects in each FMU completed and analyzed each year; and

- Study protocol to be adjusted or terminated after determining that fire frequencies are detrimental or are suitable.

Long-Term Monitoring

- Plant Community Response
  - Follow Reserve protocols
  - Qualitative and quantitative data
  - Prior to and following burn annually

- Animal Community Response
  - Follow Reserve protocols
  - Mammals using live-trapping techniques
  - Avian using transects of point counts
  - Herpetile and ground invertebrate using pit-fall traps.

It will be the responsibility of Lake Mathews and Steele Peak Reserves staff and RCHCA to review the monitoring results and adapt the FMP's implementation.

5.16.3 Data Management

Data management is an important aspect for fire management on the RCHCA lands. Assuming research and monitoring information is collected as recommended in this and other Reserve plans, it will be necessary to house that information within a secure database in a format that is compatible with statistical and trend analysis software applications (see *Section 6.2*) Data analysis results will, over time, become the basis for FMP adaptations to more closely match Lake Mathews and Steele Peak Reserves management goals should current recommendations prove inadequate. Data collected prior to, during, and following disturbance events should be made available to other Reserves with similar habitat management goals so that larger data sets can be evaluated. Optimal disturbance return intervals may vary by site, and comparisons among Reserve land data will be important for long-term Reserve fire and habitat management.

6.0 ADMINISTRATION, DATA COLLECTION AND REPORTING, AND FUNDING

6.1 ADMINISTRATION

The RCHCA will be the responsible party for management of the RCHCA lands in the Lake Mathews and Steele Peak Reserves. At this time, a specific Reserve Manager has not been named. However, for the purpose of defining the administrative duties of the Reserve Manager, no extensive biological experience is assumed. Where specific biological expertise is required, the Reserve Manager may rely on the input of outside expertise as needed, including other SKR

Reserve Managers, Wildlife Agency staff (USFWS and CDFG), university researchers, and private consulting biologists.

Duties of the Reserve Manager may include, but are not limited to:

- Manage the RCHCA lands in the Lake Mathews and Steele Peak Reserves consistent with this SKR HMP and the SKR HCP (RCHCA 1996).
- Prepare annual management plan updates as part of the annual reporting of management activities, including future management recommendations;
- Meet with the RCHCA and participate in determining high-priority management actions, as well as other pertinent Reserve activities, within the RCHCA lands.
- Coordinate and consult with other SKR and MSHCP Reserve Managers and managing entities via the Reserve Managers Coordinating Committee, attend Lake Mathews Reserve Manager Committee (RMC) meetings at the direction of RCHCA administrative staff, and perform other coordination and consultation tasks at the direction of RCHCA administrative staff.
- Control access and oversee activities of outside biologists, as needed, including Wildlife Agency staff, university researchers, and private consulting biologists.
- Oversee management contractors, such as shepherds, mowers, and herbicide applicators.
- Oversee security operations, including patrols, gating, fencing, and signage.
- Contract for and oversee cleanup operations at existing and future trash dumps, removal of abandoned cars, etc.
- Coordinate with CDF regarding fire management activities.
- Keep apprised of new technical reports and scientific literature pertinent to management of the Reserves.
- Compile management and monitoring information from the Reserves on an annual basis, interpret such information, in coordination with technical experts if needed, and prepare annual reports for submittal to the RCHCA.
- Prepare and implement public access plan, including educational information, brochures, and construction of trailhead kiosk(s).
- Prepare and implement any future approved public access policies/plans, including various forms of passive recreation (hiking, supervised group tours, mountain biking, and horseback riding) and share information with Lake Mathews RMC .

6.2 DATA COLLECTION AND REPORTING

6.2.1 Data Collection, Storage, and Analysis

The Reserve Manager, in coordination with the RCHCA, will be responsible for overseeing and carrying out the management and monitoring data collection, storage, and analysis. These functions are fundamental components of the HMP and the associated FMP, where feedback from prior management and monitoring actions are essential to management. Without reliable and valid methods for collecting, storing, and analyzing data, the management and monitoring efforts will be wasted. Although collection, storage, and analysis methods and technologies most certainly will evolve over time, it is imperative that new methods are consistent with prior methods so that data sets are comparable and compatible for conducting statistical tests and trend analyses and drawing inferences. The following subsections provide guidance for the collection, storage, and analysis of data that meet these goals (the reader is referred to Chapter 6 of Elzinga et al. 2001 for a more general treatment of data collection and management). All data collected on RCHCA lands will be submitted to the Reserve Manager and to the RCHCA main office.

6.2.1.1 Data Collection

Field data collection should be automated as much as possible. Currently, the most efficient method for field data collection is the use of data loggers, field computers, and/or GPS units, depending on the type of data being collected (e.g., population counts, species composition, spatial information). Although loggers, field computers, and GPS units are initially expensive, they more than compensate for their initial cost over the long term in terms of quality control and assurance and reliability of the data. Data loggers and computers, for example, provide standardized or predesigned data formats and have the advantage of being directly downloadable to compatible software for conducting analyses without the need for manual transcription, which prevents data transcription and input errors. GPS units are invaluable for collection of spatial information that can be input directly into GIS applications for mapping and spatial analyses. Software included with GPS units allows for creation of data dictionaries, which, in turn, allow for standardization of data element definitions and database schemes. The use of data dictionaries can eliminate or minimize personal biases or transcription mistakes in the data set being recorded. The specific hardware and software that will be used, in part, will depend on the available funding for equipment purchases versus labor costs. Because data management, analysis, and reporting can be a substantial portion of the overall budget of a monitoring and management program, careful selection of field equipment is paramount for a cost-efficient program. A wise initial expenditure of funds for field equipment can provide long-term savings for the program.

6.2.1.2 Data Storage and Management

Data storage and management should be standardized to maintain a high level of quality assurance. This includes specific protocols for naming directories, subdirectories, and files; for example, keeping raw data files separate from summary and analysis files. All data files should be accompanied by metadata that describe in detail the data set. A backup system (e.g., CD-ROM or tape drive) should be incorporated to minimize the risk of lost data; backup data should be stored off site. In addition, data should be stored and managed so that it can be shared, as appropriate and feasible, with other SKR Reserve Managers/Entities. Consequently, the data management should be compatible with the data management methods used by the state and federal agencies. As noted in *Designing Monitoring Programs in an Adaptive Management Context for Regional Multiple Species Conservation Plans* (USGS 2004, p. 39):

> The state of California is developing a multi-taxa, multi-level integrated data management system for monitoring data collected throughout the state that will allow powerful queries by species, study type, habitat or geography. With increasing sophistication in technology, it is possible for data collection entities to maintain a copy of the database and mirror those data in near real-time to a state database while maintaining local control over data entry and corrections.

Currently, for example, the CDFG uses a database system known as the Biogeographic Information and Observation System (BIOS).

6.2.1.3 Data Analysis

Data analyses will be tailored to the goals and objectives of the SKR HMP. It is anticipated that much of the field data will be analyzed using a standard statistical package such as SAS or SPSS, but specialized software to address specific monitoring issues will be utilized as needed. For example, for long-term population trend analyses software programs, TRENDS (Gibbs et al. 1998) and MONITOR (Gerrodette 1987), are available. Likewise, the program CAPTURE can be used to estimate populations using short-term capture/recapture data (although Diffendorfer and Deustchman [2003] discuss the limitations of CAPTURE when sample sizes are too small). The Reserve Manager will be responsible for identifying the analytic software that is appropriate for the management and monitoring data.

As noted above, data are intended to be shared with other SKR Reserve Managers/Entities, as appropriate, as part of the Annual Reports. However, it will not be the responsibility of the Reserve Manager or the RCHCA to analyze shared data for uses beyond the scope of implementing the SKR HMP.

6.2.2 Program Implementation Tracking, Reporting, and Analysis

Overall tracking of implementation of the SKR HMP is a critical component of the plan that provides the information about whether the HMP is meeting its goals and objectives and helps complete the feedback loop between the Reserve Manager and decision-makers. Tracking of the HMP will be the primary responsibility of the Reserve Manager, in coordination with the RCHCA. Tracking of the HMP will include the following tasks:

- Preparation and ongoing revision of goals and objectives for Lake Mathews and Steele Peak Reserves;
- Annual reports prepared by the Reserve Manager to be submitted to the RCHCA (suggest early-mid fall submittal to allow for time to plan and implement spring management activities);
- RCHCA review/feedback of the annual reports prepared by Reserve Manager; and
- Record keeping, public noticing, and annual report preparation on behalf of the RCHCA (a general requirement of the SKR HCP).

The annual reports will provide, at minimum, the following information:

- Identification of management and monitoring priorities for that year;
- Updates to the conceptual models for the managed resources;
- The sampling sites and data collected in terms of investigator, frequency, timing, and duration;
- A description of the data analysis and results;
- Synthesis/integration of the year's management and monitoring results with previous years as applicable (e.g., analyzing apparent trends);
- An evaluation of the year's work plan in relation to achieving or progressing toward the management and monitoring goals established in this HMP;
- Identification of significant problems or successes with the program that may alter the management and monitoring program approach, such as:
    - Whether the field protocols or analytic methods are satisfactorily addressing the management/monitoring goals and objectives (e.g., are the measurement methods sensitive enough?) and whether sampling or analysis methods need revision,
    - Whether the data, based on the "working management thresholds," indicate that the SKR or its habitat is declining at a rate that an immediate, possibly unanticipated action is required, and

- Whether the data indicate an earlier than expected positive response of the SKR or its habitat to an active management action such that continued testing is unnecessary or becomes a lower priority.

- Suggested changes/revisions to the HMP based on the points listed above.

6.3 FUNDING

This program will be funded through the RCHCA at the direction of the RCHCA Board. The estimated costs for initiating the program, personnel, office and equipment, security, habitat management, public services, data analysis and reporting, and administration and supporting calculations are included as *Appendix D*. Many variables affect this cost estimate and it should be considered very preliminary. The following sections provide a conceptual description of the necessary elements of administration and implementation of the program.

6.3.1 Staffing Requirements

Basic staffing includes a Reserve Manager and assistant. It is anticipated that the Reserve Manager will have biological and/or land management expertise. Estimated staffing costs include payroll taxes, health insurance, workman's compensation, sick leave, vacations and holidays. The Reserve Manager may have to engage outside expertise, such as other SKR Reserve Managers, consulting biologists, Wildlife Agency staff (USFWS, CDFG), range managers, and/or university researchers. These potential additional costs have not been estimated.

6.3.2 Equipment

Depending how much field time will be expended by the Reserve Manager and what field tasks will be carried out, the necessary "in-house" field equipment that needs to be purchased upfront and maintained over the long-term will be quite variable. Assuming that most field work will be conducted by the Reserve Manager and assistant, significant basic field and office equipment includes a field vehicle, radio units, GPS, digital camera, miscellaneous field tools, computer hardware/software, and printer/copier/fax/scanner. Estimated purchase and maintenance costs are provided in *Appendix D*.

6.3.3 Habitat Management Options

Four options have been identified for SKR habitat management; sheep grazing, mowing, herbicides, and prescribed burning.

Costs per acre have been estimated for mowing and herbicides. Sheep grazing costs can be quite variable depending on stocking levels, the type of arrangement with the sheep contractor, the number of grazing days, the amount of onsite management, whether fencing is needed, etc. Recognizing that these costs will vary over time and circumstance, the current estimates are listed in *Appendix D*.

6.3.4 Security

The cost of providing security will vary depending on the level of patrol services and the amount of gating and fencing that will be required to reasonably secure the Reserves.

For security patrols, it is recommended that the RCHCA contact potential patrol services to provide cost estimates based on different levels of service; e.g., daily patrols, including nighttime patrols, 2-3 times per week, or focused patrols on weekends when trespass activity likely would be highest. It is recommended that a minimum level of patrol be utilized initially (e.g., weekends or 2-3 times a week on a random schedule) to evaluate the effectiveness of patrols. Prior to initiating patrols, it is recommended that problem dumping areas and other trespass points (see *Figures 18* and *19*) either be cleaned up and/or photo-documented to assess the effectiveness of the security patrols in controlling trespassers; i.e., a before-and-after evaluation.

A pilot gating, fencing, and signage program that erects gates, fencing, and signs in certain key locations to determine their effectiveness, or lack thereof, may be warranted before a large-scale gating and fencing program is implemented.

It should be noted that for signage prohibiting trespassing to hold up in a criminal prosecution of trespassing, under California Penal Code, signage would be required at specified minimum intervals (e.g., a least one sign per mile). If not already known, it is recommended that the RCHCA consult with legal counsel as to what the appropriate interval is for the Reserve lands.

6.3.5 Public Services

Public services that may require funding through the program include volunteer coordination and community outreach (see *Section 7* below).

6.3.6 Data Collection and Reporting

Data collection and reporting was described above in *Section 6.2*. Funding will be required to support database management, mapping (GIS/CAD), preparation of the annual work plan, annual reporting, and updating of the management plan.

6.3.7 Administration

Administration costs include RCHCA oversight and management of the program.

7.0 PUBLIC ACCESS, OUTREACH, AND EDUCATION

Public use opportunities of the Lake Mathews and Steele Peak Reserves were discussed in *Section 3.3*. As noted above, the primary purpose of the Reserves is to conserve the SKR and other sensitive biological resources, and such public uses are secondary to the conservation of biological resources. Certain types of passive recreational and educational activities could be allowed on the Reserves without harm to the SKR or disruption of management activities. Such compatible activities could include:

- Access for daytime hiking on existing dirt roads, potentially with an entry kiosk with brochures that include a map of the authorized hiking areas and information about the function and purpose of the Reserve; and
- Controlled group activities led by authorized person(s) that have low impact on biological resources.
- Approved research studies.

Other public uses that may be considered in the future, but which will need to be carefully considered prior to their allowance include:

- Interpretive programs for the general public and school children;
- Eco-tourism;
- Horseback riding;
- Mountain biking; and
- Hunting, if an acceptable program proposed by CDFG, under their responsibility and liability, is adopted by the RCHCA.

Because the Reserves include other sensitive biological resources, such as habitat for other special-status species (see *Table 5*), permitted public uses need to be carefully considered. See Public Access Policy in *Appendix F*.

Under the assumption that some level of public use of the Reserves may be authorized in the future, activities that could harm the SKR and/or other biological resources should be prohibited. The following rules should apply:

- No collection or removal of any native plant, animal or microorganism, unless authorized for monitoring or research, or for other authorized purposes;
- No deliberate introduction of any non-native plant or wildlife species or microorganism;
- No collection of rocks, soils, or fallen trees unless conducted under an authorized survey, salvage, or research program;
- No activities that are incompatible with or may disturb or disrupt ongoing management activities;
- No use of firearms or weapons, hunting, or trapping (unless carried out pursuant to the Reserve HMP or a RCHCA adopted hunting program as defined above) and fireworks;
- No cigarette, cigar, pipe, or other smoking;
- No Alcoholic beverage possession;
- No motorized or non-motorized vehicle operations off designated roads except for infrastructure operation/maintenance or Reserve management, such as fence repairs;
- No hiking, mountain biking, or equestrian activities off designated trails;
- No swimming and/or wading in lakes, ponds, or creeks, unless conducted as part of authorized activities (e.g., monitoring or research of aquatic species);
- No dogs, cats, domestic, or other pets will be allowed; and
- No Dumping of ashes, trash, garbage, or other unsightly, offensive, or toxic material or the storage or use of biocides and agricultural chemicals except as such biocides and/or chemicals may be necessary to implement the SKR HMP.

The Reserve Manager and/or contracted security patrols will have the authority to enforce Reserve regulations and an individual(s) engaging in such activities will be escorted from the Reserve. In the case of more serious infractions such as use of firearms or dumping, the Reserve Manager and/or contracted security patrol will contact the Riverside County Sheriff for enforcement action. Enforcement will be subject to applicable California Civil Codes and Riverside County Ordinances as desired and appropriate.

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APPENDIX A

Live-Trapping Monitoring Study

APPENDIX A
Live-Trapping Monitoring Study

INTRODUCTION

An important element of the Stephens' Kangaroo Rat Habitat Management Plan (SKR HMP) is a 3-5 year live-trapping across the SKR Reserve System to monitor the spatiotemporal variation in populations. Prior methods of estimating population densities such as burrow counts based on estimates of populations densities at a single point in time do not provide a reliable surrogate for estimating population because of the high amount of spatiotemporal variation, although there is a correlation between burrow counts and SKR abundance (Diffendorfer and Deutschman 2003).

The purpose of the 3-5 year live-trapping program is to begin to assess the dynamic patterns of SKR populations across space and time and in relation to natural and anthropogenic environmental factors that appear to be important determinants of SKR population densities and distribution, such as precipitation patterns, vegetation changes, wildfires, etc. The results of the 3-5 program will help inform the monitoring program for the long-term, or as Diffendorfer and Deustchman (2003) state, "we must 'monitor to understand how to monitor' for the next 3-5 years."

The live-trapping protocol described here is based on the recommendations of Diffendorfer and Deutschman as quoted here.

> *We strongly recommend a coordinated trapping effort, implemented immediately, across all reserves. In all cases, trapping should take place at least 2 but no more than 4 time per year, simultaneously at all locations (a 1-2 month "window" of trapping should be adequate), using 7x7 trapping grids or larger, trapped for 2 or 3 days. Within each reserve, if funds are available, 10-20 sites should be sampled. At each site, SKR should be individually marked and a burrow count assessment done using at least 3 assessment lines. The effort should last for at least 3 years.* (p. 44)

These recommendations are based on a power analysis of trapping methods conducted by Diffendorfer and Deutschman that examined the relationship between variables such as grid size and shape and the number of trapping nights. The goal of the power analysis was to identify a trapping program that would provide statistically reliable and valid data to assess SKR population densities; e.g., what happens with reduced or increased trapping efforts such as a 7x7 trapped 2 days versus 3 days, etc.?

Based on the Diffendorfer and Deustchman recommendations, and as described in more detail below, the live-trapping monitoring program included the following:

- 10 7x7 trapping grids on the Lake Mathews Reserve and 1 7x7 grid on the Steele Peak Reserve.

- Trapping conducted 4 times per year for 3 consecutive nights on each Reserve.

- Burrow counts in conjunction with trapping on each gird

- Vegetation monitoring in conjunction with trapping on each grid (see Appendix C)

METHODS

Trapping Grid Selection and Establishment

A total of 10 7x7 trapping grids with 15-meter (m) intervals between trap stations was established on the Lake Mathews Reserve and one 7x7 grid was established on the Steele Peak Reserve. Ideally grids would have been selected on a random or stratified random basis to avoid any bias in locating the grids. However, because of the existing spatial distribution of the RCHCA lands in the Reserves, the distribution suitable habitat, the distribution of existing SKR populations, and the accessibility of sites for long-term trapping, the selection of trapping grids could not be randomized. Nonetheless, the selection of the trapping grid locations attempted to distribute the grids in a way that provides a broad sample of the Reserves' landscape and thus should provide a representative sample of the Reserve lands. Selection of grid locations considered the following factors:

- The potential grid location had a high probability of supporting the SKR based on a visual survey for diagnostic surface sign (burrows, scat, runways, etc.).

- Representative locations in the Reserves tied to the distribution of RCHCA lands and accessibility factors (e.g., lands that required access via private property or were remote from access roads were given a lower priority).

- Representative locations with regard to the Habitat Suitability Index (HSI) rating for the area, which reflects vegetation, soil and slope conditions.

- Representative locations with regard to SKR occupied status such that areas with trace through medium-high population abundances were sampled.

- Locations where a 7x7 trapping grid could be practically laid out and sample suitable SKR habitat (i.e., the grid would need to cover generally level and open vegetation and avoid steep and/or densely vegetated areas that do not support the SKR).

- The individual trapping grids were far enough apart that at least within each 2-month trapping period it was unlikely that individual SKR would be trapped on more than one grid (the two closest trapping grids, LM1-K and LM2-A, are about 600 feet apart).

The actual selection of grid locations in the Lake Mathews Reserve was based on field site visits in April 2006 by Dudek biologists Phil Behrends and Brock Ortega and the contracted trapping consultants Karen Kirtland and Philippe Vergne. The selected trapping grids for the Lake Mathews Reserve are shown in *Figure 13* of the SKR HMP. Using the criteria stated above, all of the trapping grids in the Lake Mathews Reserve were located north of Dawson Canyon. The RCHCA lands south of Dawson Canyon were unsuitable for establishing long-term trapping grids for two main reasons: (1) poor accessibility due to remoteness and/or the need to cross private lands; and (2) poor suitability for establishing the trapping grids due to extremely rugged terrain and generally poor soils. The SKR is scattered throughout these southern parcels, but generally is confined to ridgelines, hilltops and other relatively level and sparsely vegetation areas patchily distributed on these lands.

Trapping Protocol

The trapping protocol follows well-established standard small mammal trapping/census practices and the conditions and requirements of the federal permit and state Memorandum of Understanding help by the trapping contractors (Kirtland and Vergne).

Four separate trapping sessions are conducted annually generally in the periods of February/March, May/June, August/September and November/December. To the extent possible, all trapping for each session is conducted within these 2-month periods. However, due to inclement conditions due to winter storms or some other foreseen circumstance, trapping in the November/December and February/March periods may occasionally be disrupted, and if extended inclement conditions or other factors occur, trapping may extend several days or up to two weeks beyond the designated period. As long as every attempt is made to conduct all trapping within the designated period, overruns beyond the period are not considered a significant problem for analyzing and interpreting the census data.

Three consecutive nights of trapping are conducted on each trap grid per session. Sherman live-traps suitable for capture of kangaroo rats (i.e., of sufficient length or modified to prevent tail lacerations by the trap door) are set at dusk and baited with mixed bird seed. The traps are left

open for at least 4 hours, checked and then closed for the night. All captured animals are processed and the following data are collected: species, sex, weight (to nearest gram), age-class (adult or juvenile) and reproductive condition (lactating, estrous, testicular), if observable. All captured SKR are scanned with Passive Integrated Transmitter (PIT) tag reader. If the SKR was not previously PIT-tagged, a new PIT tag is injected under the animal's skin just lateral to the dorsal midline. All SKR and other captured animals are released immediately at the point of capture following processing. Typically an animal is held no longer than 5 minutes once it is removed from the trap.

Trapping is not conducted during inclement weather conditions such rain or otherwise wet/foggy and muddy conditions, high winds, or cold temperatures (approximately 40 degrees Fahrenheit) to minimize the risk or injuring or killing animals.

Burrow Counts

During each trapping session a count of active kangaroo rat burrows is conducted on each trapping grid. Burrow count transects are conducted between each of the seven traplines on a north/south alignment and starting from west to east. Each transect is a 6-meter wide belt 90 meters long. The centerline of the belt transect (i.e., 3 meter on each side) is slowly walked and all active kangaroo rat burrows within the belt transect are recorded. Active burrows are distinguished from inactive burrows by evidence of recent kangaroo rat activity, including relatively unobstructed openings (i.e., lack of cobwebs, debris, crushing), fresh digging and maintenance of the burrow apron (the flattened area the burrow entrance), scat (fecal pellets), tracks, and tail drags.

APPENDIX B

Habitat Suitability Index

APPENDIX B
Habitat Suitability Index

INTRODUCTION

Preparation of the Stephens' kangaroo rat Habitat Management Plan (SKR HMP) included identifying long-term live-trapping grids and habitat management units. As part of the database development to facilitate this process, a simple Habitat Suitability Index (HSI) model was created. The HSI combines habitat suitability factors that should be helpful in predicting occupied habitat or creating occupiable areas with appropriate management. The HSI model is not meant to be definitive of suitable habitat, but rather provides a tool for the relative ranking of areas within the Lake Mathews and Steele Peak Reserves for the purpose of establishing trapping grids and management units that capture the environmental gradient within the Reserves used by the SKR.

HABITAT SUITABILITY FACTORS

Based on well established habitat affinities for the SKR, three main habitat suitability factors were used in the HSI model:

1. Vegetation communities
2. Soils
3. Slope

As described *Section 2.6* of the SKR HMP, the SKR is found almost exclusively in open grasslands or sparse shrublands with vegetative cover of less than 50 percent during the summer (*e.g.*, Bleich 1973; Bleich and Schwartz 1974; Grinnell 1933; Lackey 1967; O'Farrell 1990; Thomas 1973). Generally, the SKR prefers habitats dominated by annual native and non-native forbs (e.g., *Erodium* spp.) that disarticulate after the growing season and leave substantial areas of bare ground for much of the year. The SKR and all kangaroo rats (genus *Dipodomys*) are bipedal and adapted to moving quickly through sparse habitats that are characteristic of deserts and semi-deserts. Dense cover of grasses (native and non-native) and shrubs inhibits the ability of kangaroo rats to locomote metabolically efficiently (i.e., bipedally vs. quadrapedally); dense covers and/or shrub habitats are more suitable for quadripeds. Also, in dense grasslands, thick thatch may build up over time, further precluding kangaroo rats even in the non-growing season.

Soil type also is an important habitat factor for the SKR (O'Farrell and Uptain 1989; Price and Endo 1989). As a fossorial (burrowing) animal, the SKR typically is found in sandy and sandy loam soils with a low clay or gravel content, although there are exceptions where they can utilize the already excavated burrows of Botta's pocket gopher (*Thomomys bottae*) and California ground squirrel (*Spermophilus beecheyi*). Also, Price and Endo (1989) suggest that sandy soils may be necessary for sand bathing, which keeps oils from building up in their fur. Sand bathing

also may serve an important social communication function in kangaroo rats (Randall 1993). As noted by others (*e.g.,* Brown and Harney 1993), kangaroo rats tend to avoid rocky soils. SKRs may be found on rocky soils, but population densities generally are much lower and probably are limited by soil conditions that inhibit burrowing. *Section 4.3.1.2* of the SKR HMP notes that while the SKR occurs throughout the Lake Mathews Reserve in less suitable soils (e.g., Lodo and Temescal rocky loams, which account for the majority of the soils in the Reserve), the population densities that can be achieved even in highly productive years in the less suitable soils probably is limited. For this reason, management of populations on less suitable soils is a lower management priority. On the other hand, such areas probably do not require as much management because the shallow, rocky soils are less vulnerable to invasions by annual grasses. Temescal rocky loam, which is the dominant soil in the Lake Mathews Reserve (1,947 acres), particularly in the southern parcels. developed predominantly from latite-porphyry or gabbro and has low natural fertility. Minnich and Dezzani (1998) suggest that coastal sage scrub on gabbro basalts is less susceptible to invasion by annual grasses. Lodo rocky loam, which at 1,066 acres, is the second most common soil in the Lake Mathews Reserve has very low natural fertility. The Lodo series is also the dominant soil type on the Steele Peak Reserve.

Slope also is a factor in SKR occupation; the SKR tends to use flatter slopes (*i.e.*, < 30 percent), but, as with less suitable soils, may be found on steeper slopes in low or trace densities (*i.e.*, < 5 individual per hectare). Furthermore, the SKR may use steeper slopes for foraging, but not for burrows (Behrends, pers. obs.). In general, the highest abundances of SKRs occur on gentle slopes less than 15 percent, and for the purposes of rating habitat quality, slopes < 15 percent are rated higher.

CREATION OF HSI MODEL

The three factors discussed above – soils, slope, and vegetation communities - occurring in the Lake Mathews and Steele Peak reserves were ranked for their suitability as SKR habitat in the HSI model on the following scale of 1 through 4:

1	=	Very Low Suitability
2	=	Low Suitability
3	=	Medium Suitability
4	=	High Suitability

Soils and slope are based the existing soils maps for the Lake Mathews and Steele Peak reserves show in *Figures 7* and *9*, respectively of the SKR HMP (source: USDA NRCS SSURGO). Soils series are described in terms of soils type (e.g., loam, clay, etc.) and slope (e.g., 25-50 percent slopes). Assigning the soils and slopes to the different categories is based on O'Farrell and

Uptain (1989), Price and Endo (1989) and the field experience of one of the authors of the SKR HMP (Phil Behrends) based on many years of field experience with the SKR. The CNPS (2005) vegetation community map was used for ranking vegetation communities, which includes both the vegetation alliance/community attribute, but also a density attribute.

Soils and vegetation communities ranked as "Very Low Suitability" almost always do not support the SKR, although there are rare exceptions. Soils and vegetation communities ranked as "Low Suitability" typically do not support the SKR, but occasionally the species may occur, but usually only in trace densities (< 1 SKR/hectare). Soils and vegetation communities ranked as "Medium Suitability" more commonly support the SKR, but occupancy and populations densities may vary from season-to-season or year-to-year in relation to stochastic events (e.g., precipitation cycles, vegetation succession, wildfire, and other disturbances) and/or demographic factors. Soils and vegetation communities ranked as "High Suitability" typically support the SKR on the most consistent basis and at the highest population densities. Absence of the SKR from these areas only would be expected where local populations have been extirpated due to some other environmental pressure; e.g., a small isolated habitat patch subject to high predation levels, or high precipitation and increased vegetation cover density has displaced animals.

As described above, the SKR typically uses friable soils on relatively level terrain; i.e., sandy and sandy loam soils with little clay and gravel content on slopes less than 30 percent (although exceptions to both criteria do occur). *Table 1* shows the Habitat Suitability rankings for soils. Clays and Gullied Land were assigned Very Low Suitability. Generally rocky or cobbly soils and/or soils on steeper, eroded slopes (> 25 percent) and Terrace Escarpments (typically 30-70 percent slopes) were assigned Low Suitability. Loamy soils and sandy loam soils on somewhat steep slopes (e.g., 15-35 percent) were assigned Medium Suitability. Sandy soils and sandy loams on gentle slopes (< 15 percent) were assigned High Suitability.

TABLE 1
Habitat Suitability Rankings of Soils Occurring in the Lake Mathews and Steele Peak Reserves

Soil Code	Soil Series[1]	Habitat Suitability Rank
BfD	Bosanko clay, 8 to 15 percent slopes	1
BuD2	Buren fine sandy loam, 8 to 15 percent slopes, eroded	4
BxC2	Buren loam, deep, 2 to 8 percent slopes, eroded	3
CaC2	Cajalco fine sandy loam, 2 to 8 percent slopes, eroded	4
CaD2	Cajalco fine sandy loam, 8 to 15 percent slopes, eroded	4
CaF2	Cajalco fine sandy loam, 15 to 35 percent slopes, eroded	3

APPENDIX B
Habitat Suitability Index

TABLE 1
Habitat Suitability Rankings of Soils Occurring in the Lake Mathews and Steele Peak Reserves

Soil Code	Soil Series[1]	Habitat Suitability Rank
ChC	Cieneba sandy loam, 5 to 8 percent slopes	4
ChD2	Cieneba sandy loam, 8 to 15 percent slopes, eroded	4
CkF2	Cieneba rocky sandy loam, 15 to 50 percent slopes, eroded	2
EcC2	Escondido fine sandy loam, 2 to 8 percent slopes, eroded	4
EcD2	Escondido fine sandy loam, 8 to 15 percent slopes, eroded	4
EcE2	Escondido fine sandy loam, 15 to 25 percent slopes, eroded	3
EfF2	Escondido rocky fine sandy loam, 8 to 50 percent slopes, eroded	2
FaD2	Fallbrook sandy loam, 8 to 15 percent slopes, eroded	4
GzG	Gullied land	1
HcC	Hanford coarse sandy loam, 2 to 8 percent slopes	4
HuC2	Honcut loam, 2 to 8 percent slopes, eroded	3
LaC	Las Posas loam, 2 to 8 percent slopes	3
LcD2	Las Posas stony loam, 8 to 15 percent slopes, eroded	2
LoF2	Lodo gravelly loam, 15 to 50 percent slopes, eroded	3
LpF2	Lodo rocky loam, 25 to 50 percent slopes, eroded	2
MmC2	Monserate sandy loam, 5 to 8 percent slopes, eroded	4
MmE3	Monserate sandy loam, 15 to 25 percent slopes, severely eroded	3
PlD	Placentia fine sandy loam, 5 to 15 percent slopes	4
PrD	Porterville cobbly clay, 2 to 15 percent slopes	1
SmE2	San Timoteo loam, 8 to 25 percent slopes, eroded	3
TaF2	Temescal loam, 15 to 50 percent slopes, eroded	2
TbF2	Temescal rocky loam, 15 to 50 percent slopes, eroded	2
TeG	Terrace escarpments	2
VsC	Vista coarse sandy loam, 2 to 8 percent slopes	4
VsD2	Vista coarse sandy loam, 8 to 15 percent slopes, eroded	4
YbC	Yokohl loam, 2 to 8 percent slopes	3
YbD2	Yokohl loam, 8 to 15 percent slopes, eroded	3
YkE2	Yokohl cobbly loam, 2 to 25 percent slopes, eroded	2
YrD2	Ysidora very fine sandy loam, 2 to 15 percent slopes, eroded	4
YsE2	Ysidora gravelly very fine sandy loam, 8 to 25 percent slopes, eroded	3

Source: USDA NRCS SSURGO

APPENDIX B
Habitat Suitability Index

Table 2 shows the Habitat Suitability rankings for vegetation communities. The Habitat Suitability ranking is based on a combination of the vegetation community type and the density rating for the particular mapping unit. The "N" under SKR Suitability indicates that the vegetation community typically does not support the SKR, such as riparian and sycamore and coast live oak woodland communities. Although the SKR is considered to be a grassland species, all shrubland communities were assigned "P" for potential habitat because where there are openings or disturbances within shrubland patches, or the community is sparsely distributed (such as after wildfire or extended drought), SKR occupation may occur, often in a dynamic fashion related to successional factors in the community (e.g., in relation to wildfire, grazing or other disturbances of vegetation, and precipitation cycles). For potential habitat, the HSI ranking was then related to the following density values assigned to the community by CNPS (2005):

1	=	Greater than 60%
2	=	40-60%
3	=	25-40%
4	=	10-25%
5	=	2-10%

As noted above the SKR typically occupies habitat with less than 50 percent vegetation cover, although it may be found in areas with more than 50 percent cover, especially grasslands and forblands during the spring growing season, but also in some shrublands (USFWS 1997). Typically coastal sage scrub communities are more likely to support SKR than chaparral communities because, in the absence of direct disturbance, they tend to be more open. Generally chaparral communities with densities of "1" or "2" were assigned Low Suitability and densities with "3" or higher were assigned Medium Suitability. Coastal sage scrub-chaparral communities with densities of "1" were assigned Low Suitability and densities of "2-5" were assigned Medium Suitability. Coastal sage scrub communities with densities of "1" were assigned Low Suitability, densities of "2-3" were assigned Medium Suitability, and densities of "4-5" were assigned High Suitability. Annual grassland communities were assigned High Suitability regardless of density because of seasonal and year-to-year variation in densities. Refinement of what grasslands are likely or unlikely to be highly suitable habitat for the SKR over the long-term would require more detailed field surveys to verify site conditions because some annual grassland areas remain too densely vegetated over the seasons and years to reliably support the SKR without active management.

APPENDIX B
Habitat Suitability Index

TABLE 2
Habitat Rankings of Vegetation Communities in Reserves

Vegetation Community Alliance Mapping Unit Name[1]	Habitat Suitability Rank	SKR Suitability	Cover Density
Coast Live Oak – Sycamore Riparian	1	N	1
Coast Live Oak – Sycamore Riparian	2	N	2
California Juniper - Coastal Sage Scrub	3	P	4
California Juniper - Coastal Sage Scrub	3	P	5
Willow	1	N	1
Willow	2	N	2
Willow	2	N	3
Willow	2	N	4
Chamise - Coastal Sage Scrub Disturbance	2	P	1
Chamise - Coastal Sage Scrub Disturbance	3	P	2
Chamise - Coastal Sage Scrub Disturbance	3	P	3
Chamise - Coastal Sage Scrub Disturbance	3	P	4
Chamise - Coastal Sage Scrub Disturbance	3	P	5
Laurel Sumac - California Buckwheat – Black Sage - White Sage - California Sagebrush	3	P	4
Mexican Elderberry – Mulefat	2	N	4
Mexican Elderberry – Mulefat	2	N	5
California Sagebrush - California Buckwheat - Annual Grass-Herb	3	P	2
California Sagebrush - California Buckwheat - Annual Grass-Herb	3	P	3
California Sagebrush - California Buckwheat - Annual Grass-Herb	4	P	4
California Sagebrush - California Buckwheat - Annual Grass-Herb	4	P	5
Brittlebush - California Buckwheat	3	P	3
Brittlebush - California Buckwheat	4	P	4
Brittlebush - California Buckwheat	4	P	5
Coast Live Oak	2	N	2
Coast Live Oak / Annual Grass-Herb Association	2	N	3
Coast Live Oak / Annual Grass-Herb Association	2	N	5
California Juniper / Annual Grass-Herb Association	4	P	5
California Juniper - California Buckwheat - California Sagebrush Association	4	P	4
California Juniper - California Buckwheat - California Sagebrush Association	4	P	5
Mixed Tree and Shrub Willow Super Alliance	1	N	1
Red Willow	1	N	1
California Sycamore	1	N	1
California Sycamore	2	N	2
California Sycamore	2	N	3
California Sycamore	2	N	4
Sugar Bush Alliance	4	P	4
Chamise Pure Association	2	P	1
Chamise - California Buckwheat Association	2	P	2

TABLE 2
Habitat Rankings of Vegetation Communities in Reserves

Vegetation Community Alliance Mapping Unit Name[1]	Habitat Suitability Rank	SKR Suitability	Cover Density
Chamise - Hoaryleaf Ceanothus - Black Sage Association	2	P	1
Chamise - Hoaryleaf Ceanothus - Black Sage Association	2	P	2
Chamise - Hoaryleaf Ceanothus - Black Sage Association	2	P	3
Chamise - Hoaryleaf Ceanothus - Black Sage Association	2	P	3
Chamise - Hoaryleaf Ceanothus - Black Sage Association	3	P	4
Chamise - Hoaryleaf Ceanothus - Sugar Bush Association	2	P	1
Mulefat	2	P	3
Mulefat	2	P	4
California Sagebrush - California Buckwheat	3	P	2
California Sagebrush - California Buckwheat	3	P	3
California Buckwheat	4	P	4
California Buckwheat	4	P	5
Brittlebush Alliance	4	P	4
California Sagebrush - White Sage	3	P	2
Brittlebush - California Sagebrush Association	3	P	2
Brittlebush - California Sagebrush Association	3	P	3
Brittlebush - California Sagebrush Association	4	P	4
Brittlebush - California Sagebrush Association	4	P	5
California Buckwheat - Brittlebush Association	3	P	3
California Buckwheat - Brittlebush Association	4	P	4
California Buckwheat - Brittlebush Association	4	P	5
California Sagebrush - Laurel Sumac Association	3	P	2
California Sagebrush - Laurel Sumac Association	3	P	3
California Sagebrush - Laurel Sumac Association	4	P	4
California Annual Grassland	4	P	1
California Annual Grassland	4	P	2

[1] CNPS. 2005. Vegetation Alliances of Western Riverside County, California.

The Habitat Suitability rankings for the soils and vegetation communities were then summed to generate an HSI score for the vegetation/soils polygon combinations as follows:

Score	Ranking
2	Very Low Suitability
3-4	Low Suitability
5-6	Medium Suitability
7-8	High Suitability

It is important to understand that the rankings provided in *Tables 1* and *2* are only general and are only intended to identify habitat management units and a potential set of trapping grids. Because the SKR is an opportunistic, colonizing species, it is possible, and even likely, that it occurs in areas ranked as having Very Low or Low Suitability, such as where SKR use ground squirrel or gopher burrows in clayey soils, on steeper slopes (especially in areas adjacent High Suitability areas), and in areas where the vegetation communities have been mapped as having a dense cover, but at any given time are suitable for the SKR due to changing field conditions due to disturbances such as wildfire, grazing, extended drought and mechanical clearing.

RESULTS

The results of the HSI modeling for the Lake Mathews and Steele Peak Reserves are shown in *Figure A-1* and summarized in *Table 3*.

TABLE 3
Habitat Suitability Index Summary

	Lake Mathews		Steele Peak	
HSI Rank	**Acres**	**Percent**	**Acres**	**Percent**
High	197.1	4%	51.8	62%
Medium	2932.0	64%	150.8	38%
Low	499.4	11%	1.1	<1%
Very Low	918.7	20%	0.0	0%
Total	**4,547.2**		**203.7**	

The large majority of both the Lake Mathews and Steele Peak Reserve is ranked as having Medium Suitability.

The southerly parcels of the Lake Mathews Reserve (LM6-11) are comprised of Medium or Low Suitability, with Low areas typically associated with riparian areas, steep ravines and chaparral vegetation. The SKR likely is distributed throughout these parcels, but primarily in more level terrain such as ridgelines, hilltops and saddles and along dirt roads. The northern parcels (LM1-5) support all rankings, with Medium and Very Low rankings accounting for the majority of the area. The Very Low ranking accounts for almost 919 acres, and reflects the CNPS mapping of the old citrus groves as agricultural land. With the clearing of these areas, the vegetation now is primarily annual grassland and the ranking probably should be at least Low or Medium, depending on soils and slopes. The SKR HMP treats some of these areas as having good

management potential, although other areas such as unit LM1-J are dominated by Porterville cobbly clay soils, which are considered marginal for the SKR.

For the Steele Peak Reserve, much of the hillier terrain in the northern parcel and the western portion of the southern parcel are comprised on Medium Suitability, with the areas of grassland underlain by annual grassland on more gentle slopes is mapped as High Suitability. These mapped areas correspond well with the occupied habitat distribution, with Medium Suitability areas being mostly trace density and the High Suitability areas as low density.

APPENDIX C

SKR HMP Vegetation Assessment Protocol

APPENDIX C
SKR HMP Vegetation Assessment Protocol

Introduction

A component of the SKR monitoring and management program is maintaining suitable vegetation conditions. SKR prefer habitats with at least 50 percent bare ground. Habitat dominated by native and non-native forbs relative to annual grasslands is more suitable for the SKR because forbs both provide seeds for SKR and dry out and fall apart after the growing season, leaving more bare ground. Dense thatch can build up in areas dominated by annual grasses and effectively preclude SKR occupation over the long term.

As part of the live-trapping program, vegetation monitoring will occur on trapping grids concurrent with trapping. As recommended by Diffendorfer and Deutschman (2003), monitored variables will include percent vegetative cover, percent bare ground, diversity/cover of grasses, and forb/grass ratio. The vegetation monitoring protocol is described here.

Survey Methods

Generally, vegetation information will be collected for quadrats placed along line transects situated between traplines on all trapping grids. The following field methods will be used.

- All transect surveys will be conducted by teams of at least two surveyors.
- A total of six transects are established in a north-south direction between traplines, perpendicular to the southern edge of the trapping grid. Three quadrats are placed along each transect for a total of 18 quadrats per trapping grid.
- A random number generating function of Microsoft Excel program is used to select a number between 1 and 15 to indicate how many meters to walk east of the south-west oriented line of traps to start the transect line. This number is entered as "transect meter" on the transect data sheet (described below).
- A 0.5-meter quadrat is initially placed at a random point along the transect using a random number generating function of Microsoft Excel program. This random number must fall between 1 and 30. This random number is entered as "1st Quad Meter."
- The second and thirds quadrats along the transect are placed at a distance of 30 meters and 60 meters, respectively, from the first quadrat. This spacing is to maximize the likelihood of independence between the measurements along the transect.
- Each transect is walked with a measuring wheel. When the surveyor arrives at the randomly chosen point for the first quadrat of that transect, the quadrat is placed and

oriented with its south-west corner on the point. The quadrat is 1 meter by 0.5 meter constructed of PVC pipe.

- All quadrats are labeled 1 to 3 from south to north. One surveyor sets up all quadrats, leaving pin flags to mark where the quadrats should be, and the second surveyor follows along to collect the quadrat data.
- Within each quadrat, surveyors collect the following data:
    - Estimated total vegetation cover
    - Estimated total litter cover. Litter is defined as the detritus of fallen vegetation that is dead, which is distinguished from the standing dead vegetation that is from this year's growing season and has already desiccated.
    - Estimated total cover of rock.
    - Estimated total bare ground.
    - Thatch layer, measured by a narrow measuring device or small ruler that is marked in centimeter increments. Five measurements are taken in each quadrat. They are standardized along the west edge of the quadrat at intervals marked on the quadrat frame and entered on the data sheet as measurements number 1 – 5.
    - Vegetation categories, defined as one of the following three: shrub (all woody vegetation), tall herbaceous (>10 cm), and short herbaceous (< 10 cm).
    - Dominant species within each vegetation category, recorded as the three dominant species for tall and short herbaceous and the two dominant species for the shrub layer, their percent cover, and phenology (flowering, green but not flowering, seed-set, or desiccated).
    - Other relevant miscellaneous notes about the grid.

Site-specific information for each grid will be collected on a single data cover sheet (see attached) to reduce the amount of redundant information that needs to be entered on each data sheet. The data cover sheet includes the names of the surveyors, the unique identifier for the grid (Grid ID), the Grid Name (general name for the grid; e.g., Lake Mathews Reserve), Coordinates (in UTM NAD 83), Source of Coordinates, and the Date. A separate data sheet will be used to cover each transect (see attached data sheet).

Site ID:_____ Observer Initials: _____ Date: _____
Transect #:_____ Transect Meter: :_____ 1st Quad Meter: :_____

SKR Vegetation Quadrat 1

Total Veg Cover:	Total Litter Cover:			Notes
Total Rock:	Total Bare Ground:			
Thatch Layer(mm): 1._____ 2._____ 3._____ 4._____ 5._____				
	Species	% Cover	Phenology	
Shrub (total)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
Grass/Herb(Height: >10cm)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
species 3			grn-n/flr flr seed desicc.	
Grass/Herb(Height: <10cm)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
species 3			grn-n/flr flr seed desicc.	

SKR Vegetation Quadrat 2

Total Veg Cover:	Total Litter Cover:			Notes
Total Rock:	Total Bare Ground:			
Thatch Layer(mm): 1._____ 2._____ 3._____ 4._____ 5._____				
	Species	% Cover	Phenology	
Shrub (total)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
Grass/Herb(Height: >10cm)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
species 3			grn-n/flr flr seed desicc.	
Grass/Herb(Height: <10cm)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
species 3			grn-n/flr flr seed desicc.	

SKR Vegetation Quadrat 3

Total Veg Cover:	Total Litter Cover:			Notes
Total Rock:	Total Bare Ground:			
Thatch Layer(mm): 1._____ 2._____ 3._____ 4._____ 5._____				
	Species	% Cover	Phenology	
Shrub (total)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
Grass/Herb(Height: >10cm)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
species 3			grn-n/flr flr seed desicc.	
Grass/Herb(Height: <10cm)			grn-n/flr flr seed desicc.	
species 1			grn-n/flr flr seed desicc.	
species 2			grn-n/flr flr seed desicc.	
species 3			grn-n/flr flr seed desicc.	

APPENDIX D

RCHCA SKR HMP – Cost Estimate for SKR Reserve Management

APPENDIX D: RCHCA SKR HMP - Cost Estimate for SKR Reserve Management							
Task List	**Specification**	**Unit**	**Number of Units**	**Cost/ Unit**	**Annual Cost**	**Divide Years**	**Total Costs**
INITIATION COSTS							
Headquarters	New building	sq ft.	2000	$150.00	$300,000.00	30	$10,000.00
4x4 Pick-up truck	Toyota Tacoma access cab	Unit	2	$22,500.00	$45,000.00	8	$5,625.00
Tools	Misc. Tools	Item	1	$500.00	$500.00	5	$100.00
Chemical sprayer	5 gallon, gas powered	Item	2	$500.00	$1,000.00	5	$200.00
Radio, mobile unit	Radio, SP-50 UHF	Item	2	$500.00	$1,000.00	8	$125.00
GPS	Trimble GeoXT system	Unit	2	$4,295.00	$8,590.00	5	$1,718.00
Data Logger	Juniper Allego Field PC	Unit	1	$2,900.00	$2,900.00	5	$580.00
Digital Camera	Olympus digital	Unit	2	$300.00	$600.00	5	$120.00
Memory Card	1 GB memory card	Unit	2	$80.00	$160.00	5	$32.00
Notebook Computer	Toshiba - wireless, dvd burner…	Unit	2	$1,200.00	$2,400.00	5	$480.00
Software	Microsoft package	Unit	2	$250.00	$500.00	5	$100.00
Flashlight	Maglite	Unit	2	$100.00	$200.00	3	$66.67
Supplies	pens, files, paper, misc.	Item	1	$600.00	$600.00	5	$120.00
Furniture	desks, book cases, file cabs…	Item	1	$5,000.00	$5,000.00	10	$500.00
Printer/Copier/Fax/Scanner	HP Color LaserJet 2840	Unit	1	$900.00	$900.00	3	$300.00
Printer Server	D-Link Airplus wireless	Unit	1	$100.00	$100.00	3	$33.33
subtotal							*$20,100.00*
PERSONNEL							
Reserve Manager	Supervise/Conduct work	Unit	1	$70,000.00	$70,000.00	1	$70,000.00
Assistant	Site Worker/Crew Leader	Unit	1	$50,000.00	$50,000.00	1	$50,000.00
Payroll tax	Payroll tax	Unit	2	$8,700.00	$17,400.00	1	$17,400.00
Health Insurance	Health Insurance benefit	Unit	2	$7,000.00	$14,000.00	1	$14,000.00
Workers Compensation	Workers Compensation coverage	Unit	2	$627.00	$1,254.00	1	$1,254.00
Sick Leave	Sick leave benefit	Unit	2	$2,600.00	$5,200.00	1	$5,200.00
Vacation	Vacation benefit	Unit	2	$5,400.00	$10,800.00	1	$10,800.00
Holiday	Holiday benefit	Unit	2	$2,100.00	$4,200.00	1	$4,200.00
subtotal							*$172,854.00*
OFFICE AND EQUIPMENT MAINTENANCE							
Headquarters	Site maintenance	sq ft.	2000	$1.00	$2,000.00	1	$2,000.00
4x4 Pick-up truck	Toyota Tacoma access cab	Unit	2	$2,000.00	$4,000.00	1	$4,000.00
Cell phone	Standard Cell Phone	Unit	2	$200.00	$400.00	1	$400.00
Fuel	regular fuel	Gal.	1032	$2.60	$2,683.20	1	$2,683.20
Vehicle Insurance	Insurance	Year	1	$1,100.00	$1,100.00	1	$1,100.00
Cell Phone Contract	Cell contract	Month	12	$120.00	$1,440.00	1	$1,440.00
Utilities	Water, phone, electricity, gas	Month	12	$500.00	$6,000.00	1	$6,000.00
GPS	Trimble GeoXT system	Unit	2	$100.00	$200.00	1	$200.00
Data Logger	Juniper Allego Field PC	Unit	1	$100.00	$100.00	1	$100.00
Notebook Computer	Toshiba - wireless, dvd burner…	Unit	2	$100.00	$200.00	1	$200.00
Printer/Copier/Fax/Scanner	HP Color LaserJet 2840	Unit	1	$100.00	$100.00	1	$100.00
Printer cartriges	HP cartriges	Unit	12	$100.00	$1,200.00	1	$1,200.00
Paper	Printer paper	Unit	12	$100.00	$1,200.00	1	$1,200.00
Supplies	pens, files, misc.	Entire	12	$200.00	$2,400.00	1	$2,400.00
Batteries	AA and D size batteries	Unit	12	$50.00	$600.00	1	$600.00
subtotal							*$23,623.20*
RESERVE SECURITY							
Heavy duty gate	Bow Pipe Gate	Unit	7	$1,200.00	$8,400.00	30	$280.00
Gate Installation	Installation	L. Hours	21	$15.00	$315.00	30	$10.50
Fence - Installed	4 strand barbed wire	Lin. Ft.	3600	$3.00	$10,800.00	35	$308.57
Locks	High Quality Padlock	Unit	7	$20.00	$140.00	2	$70.00
Vehicle Barrier	K-rail Median barrier	Lin. Ft.	500	$45.00	$22,500.00	45	$500.00
Patrol	Daily Patrol	L. Hours	2920	$15.00	$43,800.00	1	$43,800.00
Signage - tresspass	Aluminum 11" x 11", 25 words	Item	50	$1.50	$75.00	5	$15.00
Signage - Guidepost	Aluminum 11" x 11", 25 words	Item	20	$1.50	$30.00	5	$6.00
subtotal							*$44,990.07*
HABITAT MANAGEMENT							
Sheep Grazing Management[1]							
Grass Control	Managed Sheep Grazing	Acre	100	$400.00	$40,000.00	1	$40,000.00
subtotal							*$40,000.00*
Herbicide Management[2]							
Grass Control	Fusilade and application	Acre	50	$271.00	$13,550.00	1	$13,550.00
subtotal							*$13,550.00*
Mowing Management[3]							
Grass Control	Mowing grass	Acre	100	80	$8,000.00	1	$8,000.00
Grass Control	Dethatch	Acre	50	80	$4,000.00	1	$4,000.00
subtotal							*$12,000.00*
Other Management							

APPENDIX D: RCHCA SKR HMP - Cost Estimate for SKR Reserve Management							
Task List	**Specification**	**Unit**	**Number of Units**	**Cost/ Unit**	**Annual Cost**	**Divide Years**	**Total Costs**
Non-organic Debris Removal	Dump fee	Unit	1	$465.00	$465.00	1	$465.00
Non-organic Debris Removal	Equipment Trash Collection	Hourly	10	$75.00	$750.00	1	$750.00
Refuse Collection	Hand Trash Collection	L.Hours	480	$24.00	$11,520.00	1	$11,520.00
Feral Animal Control	Trap	Item	5	$53.00	$265.00	5	$53.00
Feral Animal Control	Trapping, Labor	L.Hours	40	$35.00	$1,400.00	1	$1,400.00
Adaptive Management	Discretionary Fund	Item	1	$10,000.00	$10,000.00	1	$10,000.00
subtotal							*$24,188.00*
MONITORING							
Short Term	current contract plan	unit	1	$240,682.00	$240,682.00	1	$240,682.00
Long term - To Be Determined							
PUBLIC SERVICES							
Volunteer Coordinating	Meetings	L. Hours	80	$35.00	$2,800.00	1	$2,800.00
Community Outreach	Meetings	L. Hours	80	$35.00	$2,800.00	1	$2,800.00
subtotal							*$5,600.00*
REPORTING							
Database Management	Data Input	L. Hours	40	$35.00	$1,400.00	1	$1,400.00
GIS/CAD Management	Data Management	L. Hours	20	$35.00	$700.00	1	$700.00
Annual Work Plan	Plan and PAR Budget	L. Hours	40	$45.00	$1,800.00	1	$1,800.00
Agency Report	Annual Report	L. Hours	40	$40.00	$1,600.00	1	$1,600.00
Monitoring Reports	Monitoring Documentation	L. Hours	52	$40.00	$2,080.00	1	$2,080.00
Management Plan	HMP Updates	L. Hours	40	$45.00	$1,800.00	5	$360.00
subtotal							*$7,940.00*
SUBTOTAL COSTS							*$364,845.27*
CONTINGENCY & ADMINISTRATION							
Contingency	10%						$36,484.53
Adminstration	22%						$80,265.96
							$116,750.49
TOTAL ANNUAL COSTS							**$481,595.76**
PER ACRE COSTS							**$101.45**

[1] Sheep grazing costs can be quite variable depending on stocking levels, the type of arrangement with the sheep contractor, the number of grazing days, the amount of onsite management, whether fencing is needed, etc. The provided estimate is based on _____.

Total does not include short-term monitoring cost

[2] The cost estimate for hand-application of herbicide treatment is estimated using the manufacturer's recommended concentration for Fusilade. Fusilade is sold in quarts for about $92.00 retail (June 2006 price; M. Girard, Habitat Restoration Sciences, Inc.). One acre of hand application at the minimum concentration requires 16 oz. (0.5 quart). Labor to apply the herbicide on one acre is approximately $225, plus the $46 for the herbicide, resulting in a total cost of approximately $271 per acre. Ultimately this cost could be significantly reduced with large-scale application. With a spray rig (truck or tractor with boom), costs could be reduced to about $105 per acre.

[3] Mowing can be provided by outside contractors or by Reserve Staff. The Riverside County Fire Department maintains a list of weed abatement contractors on its website (www.rvcfire.org). A June 2006 list is provided in Appendix 2. According to R. Baxter (pers. comm. 2006), mowing costs were about $80/acre on Lake Mathews for a private contractor, but this cost is expected to be variable. Also, if raking or baling of the thatch is included, costs could be substantially higher because of the additional labor required.

APPENDIX E

Weed Abatement Contractors

Name	Contact	Address	City	Zip	Phone	Cell
Ace Weed Abatement		15860 Oro Glen	Moreno Valley	92551	951-243-9809	
Anderson, Greg		P.O. Box 144	Perris	92572	951-928-1268	
Bill's Tractor & Backhoe	Bill Baldwin	24865 Jefferson Ave.	Murrieta	92562	951-677-5295	
C & M					760-240-1663	
Carlson, Dave		3750 Quartz Canyon Dr.	Glen Avon	92509	951-685-1784	
Coronado, Ilene & Tony		23805 Gunther Rd.	Romoland	92585	951-928-0210	
Daniel Tractor Service					951-928-3112	
DeGuire, James J.		20895 Warren Rd.	Perris	92570	951-943-8827	951-741-4790
East Brothers		112 E. Aviator	Fallbrook	92028	760-731-2013	
FD & R Coleman		40455 Carrigan	Murrieta	92562	951-698-9312	
Firescape Weed Abatement	Chuck Morton				866-468-1355	909-378-6825
Garcia's Tractor		25310 Kuffel	Sun City	92585	951-943-1261	
Goad Farm		40494 Dutton St.	Cherry Valley	92223	951-845-8094	
Hunt, Billy		40265 Aranda St.	Temecula	92592	951-233-9492	
Ingold Tractor	Harley Ingold	26580 Sherman	Sun City	92585	951-679-7512	951-265-8256
Inland Empire Property Service Inc.		15860 Oro Glen	Moreno Valley	92551	951-924-6905	
J. Gallo Mobile Tree Grinding	Joseph Gallo				951-943-6318	909-634-4342
J.M. Tractor Works					951-519-2918	
Karl's Tractor Service		P.O. Box 1121	Hemet	92546	951-658-2328	
KDI West	Tim Lockhart				888-474-6337	
Laan's Tree Service	John Laan	P.O. Box 892800	Temecula	92589-28	951-699-6053	951-926-2159
Moore, Albert Sr.		22640 Ellis Ave.	Perris	92570	951-943-4301	
Pacific Coast Construction	Glen Thomas	1058 Encanto Dr.	San Jacinto	92582	951-295-3666	
Peltzer Farms	Charlie	40275 Calle Contento	Temecula	92591	951-695-3513	
Pest Master Services	Luis Soria	P.O. Box 891480	Temecula	92589	951-693-1555	
Pirkey Tractor Service		P.O. Box 302	Norco	91760	909-735-0248	
Rheingans, Gene		28395 Vista Del Valle	Hemet	92544	951-658-3784	
Savala, Nick		33287 Vino Way	Temecula	92591	951-676-9671	
Schryer, Marc		27751 Cold Spring Rd.	Quail Valley	92587	951-244-8533	909-233-3933
Scott Tractor Service		P.O. Box 478	Bloomington	92316	1-800-352-5333	
Scroggins, Daniel		26580 Sherman Rd.	Sun City	92585	951-679-7512	
Sepulveda, Roy		21841 Ellis Ave.	Perris	92570	951-943-1090	
Smith, Gregory		P.O. Box 527	Wildomar	92595	951-674-9419	
Sunshine Grove Care		P.O. Box 1205	Corona	92878	951-371-5983	
Temecula Valley Erosion Control	Dan Williams	41851 Kalmia St.	Murrieta	92562	951-461-8900	
Tom's Discing & Weed Abatement	Will	P.O. Box 331	Cabazon	92230	951-922-2685	909-288-9666

True Blue Service Corp.	Josh Stephens	P.O. Box 891656	Temecula	92589	951-302-6886	
United Pacific Services		1740 North Hills Dr.	La Habra	90631	909-629-5857	
Utter, Dave		34165 Ave. I	Yucaipa	92399	951-795-8669	
Valeriano, Macias		635 Apache Rd.	Perris	92570	951-943-5690	
Warren Brothers		7731 Grandview	Corona	91719	951-737-2227	
Washburn Grove Mgmt.		43790 Citrus View Dr.	Hemet	92544	951-927-2052	909-322-4690
Weeds B Gone	Marc	6000 Garden Grove Blvd., #242	Westminster	92683		951-233-3933
Zeiders & Sons		27900 Garboni	Menifee	92584	951-679-1411	
Doug Reed Weed Abatement	Doug Reed	3668 Rossmuir St.	Riverside	92504	951-351-0278	951-202-2338
Doug Reed Weed Abatement	Doug Reed Jr.	20876 Warren Rd.	Perris	92570	951-657-1050	

APPENDIX F

Reserve Public Use Policy & Implementation Guidelines

APPENDIX F
Reserve Public Use Policy and Implementation Guidelines

1. Policy

This public use policy is directed at requests from the general public to utilize RCHCA owned reserve lands. Requests for access to areas outside the RCHCA lands but within the Lake Mathews Reserve will need to go to the Lake Mathews Reserve Management Committee for consideration.
Evaluation of proposals will be based on:

a. Potential to provide opportunities for the public to learn from and enjoy the Reserve provided that it is done in a manner consistent with good management, public safety, and consistency with the Reserve mandate to protect native species and their habitats; and
b. Potential for adverse environmental (ecological and/or biological) effects.

Decisions on public access will balance the benefits to the public against the potential impacts to Reserve resources. The potential for public access to generate funds for the management of the Reserve may be a consideration.

2. Implementation Guidelines

Individuals requesting access to the Reserve (proponent) will be provided with the "RCHCA Public Use Proposal Checklist". The proposal will address the information required on the checklist.

The proposal will be sent to the Reserve Manager who will conduct a pre-review of the proposal and contact the proponent if further information and/or clarification is necessary. The Reserve Manager will provide the proposal, along with her/his recommendations, to the RCHCA administrative staff for review. The recommendations provided by the Reserve Manager will include, but not be limited to:

a. A description of the proposed public use;
b. A brief discussion of how the proposed use will be managed. Such a discussion will identify potential conflicts with other public uses, ongoing research programs, management activities, and the level of oversight that will be necessary by Reserve staff;
c. A description of potential environmental impacts; and
d. An analysis of potential income generated by the proposed use.

The Reserve Manager will discuss the proposal with RCHCA administrative staff. The evaluation will be based on the following considerations (see details in Number 4):

- Ecological/biological benefits and impacts;
- Management issues and conflicts;
- Interpretation and recreation benefits and/or conflicts;
- Cultural resources issues and/or concerns; and
- Potential fees.

A proposal may be approved as presented or with specific terms and conditions as determined by the Reserve Manager and RCHCA administrative staff. It may be deemed necessary to take a proposal to the RCHCA Board.

3. Provisions for Summary Approval of Activities

The implementation guidelines described above apply to all proposed uses of the Reserve, except that, once a general trail and public access plan has been approved and implemented, public uses that are generally consistent with that trail and public access plan may be considered without the formal process outlined above. For example, a request for a special event such as a "group hike" or a one-time "walk-a-thon" may be considered without implementing the process outlined above. Such activities may be summarily approved, provided that all three of the following criteria are met:

1. The proposed public use is consistent with the approved trails and general public access plan;
2. The proposed public use will not have significant impacts, impacts greater than those anticipated in the general trails plan and/or public access plan; and
3. Approval of the proposed public use does not set a precedent which would lead to other activities which might have impacts significantly greater than those anticipated in the general trails and public access plan.

If the Reserve Manager receives a proposal which may fall into this category, s/he will forward the proposal to RCHCA administrative staff for concurrence.

4. Evaluation Considerations

4.1 Potential Ecological/Biological Impacts

The evaluation of the potential for significant impacts will include consideration of the duration of an activity, the duration of the impact, and the capacity of the resource to adapt to the impact. To evaluate the potential for a proposed public use to have significant ecological or biological impacts, RCHCA administrative staff may utilize available information and data as well as the expertise of biological staff and/or consultants.

Criteria 1: Nature of the activity

A number of factors will be considered in evaluating the nature of an activity:

a. Geographic extent of the activity (by habitat, by location, total area covered);

b. Duration of the activity (daily, seasonal, annual, one-time only);

c. The timing of the activity (early morning, all day, evening, etc.);

d. Disturbance potential of the activity (noise, physical impacts on habitat); and

e. Potential for introduction of exotic species.

The evaluation of ecological impacts will be judged on the basis of the combination of these factors, taking into account, for example, that a wide-spread activity with short duration and low-levels of participation may have an impact equivalent to a highly confined activity that involves daily impacts of many people. The evaluation will reflect the potential for one of the above factors to offset another.

In addition to a purely technical evaluation, the evaluation may also consider whether allowing a particular activity or level of use sets a precedent which would require similar activities to be considered in the future. In short, the evaluation must consider fairness to others with similar interests or proposals.

Criteria 2. Biological Resource Sensitivity

An evaluation of biological/ecological sensitivity will take into account:

- Seasonal variations in species/community sensitivity;

- The status of species affected (endangered, threatened, or other levels of official legal protection);
- The specific sensitivity of the suite of species affected to the type of disturbance the activity will involve (i.e., whether the species affected are likely to be tolerant of the activity; and
- The scope of the impact, whether the impact will be to individuals, sub-populations, habitat units, populations, or whole communities.

No public activity which has a significant impact on a species listed as protected under California or Federal regulations including, but not limited to, ESA, CESA, NCCP, MBTA, and CEQA. Further, impacts to any of the species covered under this MSHCP will also be carefully considered.

4.2 Management Issues and Conflicts

The ability to manage an activity will necessarily enhance the ability to ensure its compatibility with Reserve objectives. In evaluating this factor, the following may be considered:

a. The historic record of management attempts (have other people been successful at managing similar activities); and

b. The inherent manageability of the activity (do we have the resources needed to manage effectively or can it be self-managed?)

In general, a proposed activity will not be approved if it has a history of being non-controllable or if resources are not available to provide management of the activity. The evaluation will take into consideration a group's ability and willingness to self-manage their proposed activity, thereby not placing a burden on Reserve resources (human or mechanical).

Criteria 3: Public Safety

Public safety is an overriding concern. Prior to making a decision, the Reserve Manager and/or RCHCA administrative staff will consult appropriate agency staff to determine the public safety and liability risks involved in approval of an activity. There are several different safety issues: the documented potential for problems (in general and on the Reserve), the potential for injury if there is a problem, and the potential for safety problems associated with the activity. In considering this criterion, the evaluation will address:

a. The demonstrated safety record of the activity;

b. Conditions on the Reserve which may affect the safety of the activity for the general public, researchers, Reserve staff, and Reserve neighbors;

c. The level of activity which may be allowed consistent with public safety; and

d. Management, such as signs, patrols, and special regulations, required to provide for public safety, consistent with the wilderness nature of the Reserve.

4.3 Interpretation and Recreation Benefits of the Proposal

Criteria 5: Purpose of the Activity: Nature Study, Interpretation, or Recreation

In accordance with the Reserve MSHCP, public uses which have a nature study and/or interpretive component will be given higher priority than uses which do not have such a component. The following should be considered:

a. The extent to which the proposed activity is generally educational;

b. The extent to which the proposed activity increases the public's appreciation of the goals and objectives of the Reserve; and

c. The extent to which the recreation experience provided can be supplemented by an educational or interpretive program.

Criteria 6: General Public Benefits

The Reserve is a public trust, and general public uses will be given priority over specialized uses, if there is a conflict. In evaluating this issue, the evaluation will generally consider levels of use, whether a proposed use would restrict other uses, and duration of the restriction. As a guideline, the priorities are, in generally descending order:

a. General public use;

b. Special events open to a broad spectrum of the general public; and

c. Other special events/activities which do not conflict with general public use.

Special events or activities which involve a limited conflict with general public use may be approved if the evaluation concludes that such activities will not significantly affect a general public use, or affect general public health and safety of visitors to and neighbors of the Reserve.

Finally, the evaluation will consider whether a special activity requires an exemption from rules which govern other general public uses, and whether granting an exemption for a use may set precedents which may lead to general revisions to management or public use rules.

For purposes of evaluation, "general public use" is defined as "use which is available to a broad spectrum of the public, including different age groups, which does not require special training, equipment, or permits." As an example, hiking would be considered a general public use whereas hang-gliding would not. "Specialized uses" are defined as all uses which are not general public uses.

Criteria 7: Existing Regional Opportunities for the Activity

If there are many locations where the activity proposed is available, then the incremental benefit of the activity on the Reserve would be considered to be lower than if the Reserve was one of only a few areas where the activity was available. This criterion is not applicable to the general trails uses specified in the Reserve MSHCP. For other activities, the evaluation will consider:

a. The extent to which there are other opportunities/venues for the activity in the region and the immediate vicinity of the Reserve;

b. The potential for the Reserve to provide a higher quality opportunity for the activity than at other locations in the region and the immediate vicinity of the Reserve; and

c. The extent to which the activity requires open space, or can be conducted elsewhere.

Criteria 8: Demand

Demand will be evaluated in terms of the number of people who will likely participate in the proposed activity and the probability that demand will change in the future. Frequent changes in permitted activities or levels of use can confuse people and lead to frustration. The evaluation will consider the potential long-term demand for an activity with the understanding that any activity may be cancelled if it proves harmful to the Reserve.

4.4 Cultural Resources Impacts

Compliance with Federal and State laws and regulations regarding the protection of cultural resources is required. University of California Riverside is the repository for information on cultural resources.

Criteria 9: Cultural Impacts

The following factors will be considered in evaluation of cultural resources:

a. Importance of affected resource;

b. Nature of the impact;

c. Potential for permanent loss or damage to the resource;

d. Cost of mitigation; and

e. The desires of the Native American Community.

In general, higher priority will be given to activities affecting low-importance resources, with low impact, low potential for permanent loss, low mitigation costs, and low concern of the Native American Community.

4.5 Potential Fees

A fee and/or deposit may be required.

RCHCA Public Use Proposal Checklist

Mail proposal at least three months prior to the requested event date to:

Reserve Manager

_____

_____

This form is for activities that are not associated with already approved Reserve trail use. In addition, this form is not for research proposals. If you need a research proposal application, or if you have any questions, please contact the Reserve Manager at _____.

Please use this checklist to be sure you include all relevant information in your proposal. Please be aware that the following are not allowed: overnight events, off-road vehicle use, off-road bicycle use, or open fires of any kind:

1. Current date
2. Date(s) and time(s) of requested event
3. Applicant name, mailing address, telephone number, email address
4. Description of the proposed activity
    a. What kind of activity are you proposing?
    b. How many people would be participating?
    c. How long will the event last?
    d. How many vehicles will need to be in the Reserve?
    e. Will there be a need to travel off road?
5. Describe or map the area where you would like the event to take place. (Please contact the Reserve Manager for a map.)
6. The Reserve may charge a deposit and/or fee for public use. Please be prepared to discuss the fee for your activity with the Reserve Manager.
7. Please list all anticipated impacts to the Reserve from your activity:
    a. Damage to habitat
    b. Noise
    c. Dust
8. Will you need to collect any plants or animals?
9. Be sure to carefully review and sign the rules and regulations below. If the application is approved, the user must comply with all applicable reserve regulations.

RESERVE REGULATIONS

1. The person who is identified as the applicant in the proposal will accept all responsibility for the actions of the group and agrees to apprise the group of all Reserve rules and regulations.

2. Firearms are prohibited on the reserve unless specifically authorized.

3. Smoking and/or other incendiary devices is/are prohibited within Reserve boundaries.

4. Alcohol is prohibited within Reserve boundaries.

5. Gates will be kept locked at all times.

6. The speed limit on the reserve is a maximum of 15 m.p.h.

7. All elements of your visit (trash, equipment, etc.) must be removed at the end of your stay.

8. Cultural resources may not be disturbed or removed.

9. Do not disturb the wildlife. Any wildlife encountered shall be avoided.

10. The applicant listed on this proposal **will notify the Reserve Manager** by phone (_____) and/or email (_____) at least 24 hours prior to visiting the reserve.

11. Failure to comply with the reserve regulations, any special limitations, or unnecessary damage to roads or other Reserve resources may result in the revocation of privileges or access.

I have read and agree to comply with the regulations listed above and any specific terms and conditions appended to this application and I am aware that it is my responsibility to disseminate this information to all members of my party.

_____ _____

Applicant's Signature Date

APPENDIX G

California Department of Forestry
Fire Management Plan Input

Appendix G
CDF Strategic Plan

California Department of Forestry (CDF) utilizes three levels of dispatch and response based upon weather conditions and time of year. The three levels are:

- Low – includes two engines with three personnel each
- Medium – includes three engines with three personnel each, one Battalion Chief, One mid-sized bulldozer, one type III Helicopter, and one 16 person handcrew

High – includes five engines with three personnel each, one Battalion Chief, two medium bulldozers, one AA, two Air Tankers, and one Type III Helicopter

Dispatch levels are based on weather conditions. Low dispatch occurs during the winter months from November through May. Medium and High dispatch occur during the normally declared fire season, June through October. There is some variation in the timing of the dispatch levels, based entirely on weather.

Fire response to the fire management units delineated in this FMP varies by FMU (described in detail in the next section). FMUs 1 through 4 would be addressed by Cajalco Station 4, El Cerritto Station 15 and Station 82, Lake Hills, all in 7 to 10 minute time frame. FMUs 6 through 10 would be addressed by Station 15, El Cerritto and Elsinore Fire Sations in 10 to 15 minutes. FMU 11 would be addressed by Station 61 in Wildomar in 7 to 10 minutes and Station 10 in Elsinore in 10 to 12 minutes. FMU 12 would be addressed by Station 9, Goodmeadow in 7 to 10 minutes and Station 4, Cajalco in 10 to 12 minutes.

There is no automatic aid in place but mutual aid could be requested that would bring in other agency resources from the surrounding jurisdictions such as City of Riverside, Murrieta, Corona and if necessary, from throughout the state.