ADAMS BROADWELL JOSEPH & CARDOZO
A PROFESSIONAL CORPORATION

DANIEL L. CARDOZO
THOMAS A. ENSLOW
TANYA A. GULESSERIAN
JASON W. HOLDER
MARC D. JOSEPH
ELIZABETH KLEBANER
RACHAEL E. KOSS
LOULENA A. MILES
ROBYN C. PURCHIA

FELLOW
AARON G. EZROJ

OF COUNSEL
THOMAS R. ADAMS
ANN BROADWELL
GLORIA D. SMITH

ATTORNEYS AT LAW
601 GATEWAY BOULEVARD, SUITE 1000
SOUTH SAN FRANCISCO, CA 94080-7037

TEL: (650) 589-1660
FAX: (650) 589-5062
rkoss@adamsbroadwell.com

SACRAMENTO OFFICE
520 CAPITOL MALL, SUITE 350
SACRAMENTO, CA 95814-4721
TEL: (916) 444-6201
FAX: (916) 444-6209

July 9, 2010

DOCKET
09-AFC-8
DATE JUL 09 2010
RECD. JUL 09 2010

California Energy Commission
Attn Docket No. 09-AFC-8
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512

Re: Genesis Solar Energy Project; 09-AFC-8

Dear Docket Clerk:

Enclosed are an original of

(1) Second Revised Califronia Unions for Reliable Energy Sequential Exhibit List
(2) Second Revised California Unions for Reliable Energy Topic Exhibit List
(3) Additional exhibits
  a. 542
  b. 543
  c. 544
  d. 545
  e. 546
  f. 547

Please docket the original, conform the copy of this letter and return the copy of this letter in the envelope provided.

Thank you for your assistance.

Sincerely,

Rachael E. Koss

Rachael E. Koss

REK:bh
Enclosures
2364-102a

STATE OF CALIFORNIA

Energy Resources Conservation and Development Commission

In the Matter of: The Application for Certification for the GENESIS SOLAR ENERGY PROJECT	Docket No. 09-AFC-8

<u>SECOND REVISED</u> CALIFORNIA UNIONS FOR RELIABLE ENERGY SEQUENTIAL EXHIBIT LIST

July 9, 2010

Rachael E. Koss
Tanya A. Gulesserian
Marc D. Joseph
Adams Broadwell Joseph & Cardozo
601 Gateway Boulevard, Suite 1000
South San Francisco, CA 94080
(650) 589-1660 Voice
(650) 589-5062 Facsimile
rkoss@adamsbroadwell.com
tgulesserian@admsbroadwell.com

2364-101a

EXHIBIT	WITNESS	DESCRIPTION	CATEGORY
500	Scott Cashen	Testimony of Scott Cashen on Behalf of the California Unions for Reliable Energy on Biological Resources for the Genesis Solar Energy Project	Biological Resources
501	Scott Cashen	Cashen Declaration	Biological Resources
502	Scott Cashen	Cashen C.V.	Biological Resources
503	Scott Cashen	Documented occurrences of Gila woodpeckers (map)	Biological Resources
504	Scott Cashen	CalPIF monitoring sites, breeding status, and current range for the Gila Woodpecker in California (map)	Biological Resources
505	Scott Cashen	Memo to Craig Hoffman from Heather Blair (2/5/10) Re Abengoa Mojave Solar Project – time-sensitive issues and informational needs	Biological Resources
506	Scott Cashen	J. E. Pagel, D.M. Whittington, G.T. Allen, US Fish and Wildlife Service, Interim Golden Eagle Inventory and Monitoring Protocols; and Other Recommendations (2/2010)	Biological Resources
507	Scott Cashen	Rebuttal Testimony of Scott Cashen on Behalf of the California Unions for Reliable Energy on Biological Resources for the Genesis Solar Project	Biological Resources
508	Scott Cashen	Cashen Declaration	Biological Resources
509	Greg Okin	Testimony of Greg Okin on Behalf of the California Unions for Reliable Energy on Soil and Water Resources and Biological Resources for the Genesis Solar Energy Project	Soil/Water Biological Resources
510	Greg Okin	Okin Declaration	Soil/Water Biological Resources
511	Greg Okin	Okin C.V.	Soil/Water Biological Resources
512	David Whitley	Rebuttal Testimony of David S. Whitley on Behalf of the California Unions for Reliable Energy on Cultural Resources for the Genesis Solar Energy Project	Cultural Resources
513	David Whitley	Whitley Declaration	Cultural Resources
514	David Whitley	Whitley C.V.	Cultural Resources
515		Programmatic Agreement Among The Bureau of Land Management-California, The California Energy Commission, Next Era Genesis Solar LLC, And The California State Historic Preservation Officer, Regarding the Next Era Genesis Ford Dry Lake Solar Project, Riverside County, California	Cultural Resources
516		Hearing Transcript 10-CRD-1 re Consolidated Hearing on Issues Concerning BLM Cultural Resources Data (6/19/10)	Cultural Resources
517	Matthew F.	Testimony of Matthew F. Hagemann on Behalf of the California Unions for	Hazardous Materials

	Hagemann	Reliable Energy on Hazardous Materials and Waste Management of the Genesis Solar Energy Project	Waste Management
518	Matthew F. Hagemann	Hagemann Declaration	Hazardous Materials Waste Management
519	Matthew F. Hagemann	Hagemann C.V.	Hazardous Materials Waste Management
520	Matthew F. Hagemann	Spill Reports at SEGS (5/99 and 7/07)	Hazardous Materials Waste Management
521	Matthew F. Hagemann	Desert Training Center/California Maneuver Area map, identifying the Project within an area identified as a "gunnery range"	Hazardous Materials Waste Management
522	Matthew F. Hagemann	WW-II era map of the CAMA	Hazardous Materials Waste Management
523	Eric D. Hendrix	Testimony of Eric D. Hendrix on Behalf of the California Unions for Reliable Energy on Soil and Water Resources of the Genesis Solar Energy Project	Soil/Water
524	Eric D. Hendrix	Hendrix Declaration	Soil/Water
525	Eric D. Hendrix	Hendrix C.V.	Soil/Water
526	Eric D. Hendrix	Rebuttal Testimony of Eric D. Hendrix on Behalf of the California Unions for Reliable Energy on Soil and Water Resources of the Genesis Solar Energy Project	Soil/Water
527	Eric D. Hendrix	Hendrix Declaration	Soil/Water
528	David Marcus	Testimony of David Marcus on Behalf of the California Unions for Reliable Energy on Soil and Water Resources for the Genesis Solar Energy Project	Soil/Water
529	David Marcus	Marcus Declaration	Soil/Water
530	David Marcus	Marcus C.V.	Soil/Water
531	David Marcus	Dry cooling versus applicant-proposed technology chart	Soil/Water
532		MWD Comment letter to the CEC and BLM re DEIS/SA for the NextEra Energy Resources Genesis Project and Possible California Desert Conservation Area Plan Amendment (6/15/2010)	Soil/Water
533		CEC Decision and Scoping Order for the Genesis Solar Energy Project (2/2/10)	Soil/Water
534		State Water Resources Control Board letter to Melissa Jones, CEC, re State Policies for Water Quality Control and their applicability to Power Plant Licensing (1/20/10)	Soil/Water
535		Steven C. Hvinden, U.S. Dept. of the Interior, memo to Holly Roberts, Bureau of Land Management re Federal Register Notice Dated November 23, 2009, Entitled Notice of Intent to Prepare Two Environmental Impact Statements/Staff Assessments for the Proposed Chevron Energy Solutions/Solar Millennium Palen and Blythe Solar Power Plants, Riverside County, CA and Possible Land Use Plan	Soil/Water

		Amendments (12/21/09)	
536		Gerald R. Zimmerman, Colorado River Board letter to Alan H. Solomon, CEC, (3/22/10) requiring a Section 5 BCPA contractual entitlement	Soil/Water
537	Janet Laurain	Gerald R. Zimmerman, Colorado River Board letter to Janet Laurian, responding to Public Records Act request for the Blythe Solar Power Project (2/22/10)	Soil/Water
538	Janet Laurain	Solar Millennium LLC/Chevron Energy Solutions Blythe and Palen Solar Power Projects Presentation (1/6/10)	Soil/Water
539	Janet Laurain	Laurain Declaration [Re Ex. 537 and 538]	Soil/Water
540		Boulder Canyon Project Agreement Requesting Apportionment of California's Share of the Waters of the Colorado River Among the Applicants in the State (8/18/31)	Soil/Water
541		U.S. Geological Survey Update of the Accounting Surface Along the Lower Colorado River Scientific Investigations Report 2009-5113	Soil/Water
542	Scott Cashen	Persistence and local extinctions of endangered lizard *Uma inornata* on isolated habitat patches, Cameron W. Barrows, Michael F. Allen	Biological Resources
543	Scott Cashen	Final Report, Mojave Fringe-toed Lizard Surveys at the Marine Corps Air Ground Combat Center, Twentynine Palms, California, & Nearby lands administered by the Bureau of Land Management	Biological Resources
544	Scott Cashen	The Natural History of the Mojave Fringe-Toed Lizard, Uma Scoparia: The Northern Lineage, Amargosa River, CA prepared by Jeffery M. Jarvis	Biological Resources
545	Scott Cashen	Amphibian and Reptile Species of Special Concern in California, California Department of Fish & Game, pp. 138-144	Biological Resources
546		Comment Letter (7/2/10) from Gerald R. Zimmerman, Colorado River Board of California, to Mike Monasmith, CEC, re a Section 5 BCPA contractual entitlement	Soil/Water
547		State of California Public Utilities Commission Draft Resolution E-4343	Soil/Water

STATE OF CALIFORNIA

Energy Resources Conservation and Development Commission

In the Matter of: The Application for Certification for the GENESIS SOLAR ENERGY PROJECT	Docket No. 09-AFC-8

SECOND REVISED CALIFORNIA UNIONS FOR RELIABLE ENERGY TOPIC EXHIBIT LIST

July 9, 2010

Rachael E. Koss
Tanya A. Gulesserian
Marc D. Joseph
Adams Broadwell Joseph & Cardozo
601 Gateway Boulevard, Suite 1000
South San Francisco, CA 94080
(650) 589-1660 Voice
(650) 589-5062 Facsimile
rkoss@adamsbroadwell.com
tgulesserian@admsbroadwell.com

2364-103a

BIOLOGICAL RESOURCES		
500	Scott Cashen	Testimony of Scott Cashen on Behalf of the California Unions for Reliable Energy on biological Resources for the Genesis Solar Energy Project
501	Scott Cashen	Cashen Declaration
502	Scott Cashen	Cashen C.V.
503	Scott Cashen	Documented occurrences of Gila woodpeckers (map)
504	Scott Cashen	CalPIF monitoring sites, breeding status, and current range for the Gila Woodpecker in California (map)
505	Scott Cashen	Memo to Craig Hoffman from Heather Blair (2/5/10) Re Abengoa Mojave Solar Project – time-sensitive issues and informational needs
506	Scott Cashen	J. E. Pagel, D.M. Whittington, G.T. Allen, US Fish and Wildlife Service, Interim Golden Eagle Inventory and Monitoring Protocols; and Other Recommendations (2/2010)
507	Scott Cashen	Rebuttal Testimony of Scott Cashen on Behalf of the California Unions for Reliable Energy on Biological Resources for the Genesis Solar Project
508	Scott Cashen	Cashen Declaration
509	Greg Okin	Testimony of Greg Okin on Behalf of the California Unions for Reliable Energy on Soil and Water Resources and Biological Resources for the Genesis Solar Energy Project
510	Greg Okin	Okin Declaration
511	Greg Okin	Okin C.V.
542	Scott Cashen	Persistence and local extinctions of endangered lizard *Uma inornata* on isolated habitat patches, Cameron W. Barrow,s Michael F. Allen
543	Scott Cashen	Final Report, Mojave Fringe-toed Lizard Surveys at the marine Corps Air Ground Combat Center, Twentynine Palms, California & Nearby lands administered by the Bureau of Land Management
544	Scott Cashen	The Natural History of the Mojave Fringe-Toed Lizard, Uma Scoparia: The Northern Lineage, Amagosa River, CA prepared by Jeffery M. Jarvis
545	Scott Cashen	Amphibian and Reptile Species of Special Concern in California, California Department of Fish & Game, pp. 138-144
CULTURAL RESOURCES		
512	David Whitley	Rebuttal Testimony of David S. Whitley on Behalf of the California Unions for Reliable Energy on Cultural Resources for the Genesis Solar Energy Project
513	David Whitley	Whitley Declaration
514	David Whitley	Whitley C.V.
515		Programmatic Agreement Among The Bureau of Land Management-California, The California Energy Commission, Next Era Genesis Solar LLC, And The California State Historic Preservation Officer, Regarding the Next Era Genesis Ford Dry Lake Solar Project, Riverside County, California

516		Hearing Transcript 10-CRD-1 re Consolidated Hearing on Issues Concerning BLM Cultural Resources Data (6/19/10)
HAZARDOUS MATERIALS		
517	Matthew F. Hagemann	Testimony of Matthew F. Hagemann on Behalf of California Unions for Reliable Energy on Hazardous Materials and Waste Management of the Genesis Solar Energy Project
518	Matthew F. Hagemann	Hagemann Declaration
519	Matthew F. Hagemann	Hagemann C.V.
520	Matthew F. Hagemann	Spill Reports at SEGS (5/99 and 7/07)
521	Matthew F. Hagemann	Desert Training Center/California Maneuver Area map, identifying the Project within an area identified as a "gunnery range"
522	Matthew F. Hagemann	WW-II era map of the CAMA
SOIL/WATER		
509	Greg Okin	Testimony of Greg Okin on Behalf of the California Unions for Reliable Energy on Soil and Water Resources and Biological Resources for the Genesis Solar Energy Project
510	Greg Okin	Okin Declaration
511	Greg Okin	Okin C.V.
523	Eric D. Hendrix	Testimony of Eric D. Hendrix on Behalf of the California Unions for Reliable Energy on Soil and Water Resources of the Genesis Solar Energy Project
524	Eric D. Hendrix	Hendrix Declaration
525	Eric D. Hendrix	Hendrix C.V.
526	Eric D. Hendrix	Rebuttal Testimony of Eric D. Hendrix on Behalf of the California Unions for Reliable Energy on Soil and Water Resources of the Genesis Solar Energy Project
527	Eric D. Hendrix	Hendrix Declaration
528	David Marcus	Testimony of David Marcus on Behalf of the California Unions for Reliable Energy on soil and Water Resources for the Genesis Solar Energy Project
529	David Marcus	Marcus Declaration
530	David Marcus	Marcus C.V.
531	David Marcus	Dry cooling versus applicant-proposed technology chart
532		MWD Comment letter to the CEC and BLM re DEIS/SA for the NextEra Energy Resources Genesis Project and Possible California Desert Conservation Area Plan Amendment (6/15/2010)
533		CEC Decision and Scoping Order for the Genesis Solar Energy Project (2/2/10)
534		State Water Resources Control Board letter to Melissa Jones, CEC, re State Policies for Water Quality Control and their applicability to Power Plant Licensing (1/20/10)
535		Steven C. Hvinden, U.S. Dept. of the Interior, memo to Holly Roberts, Bureau of Land Management re Federal Register Notice Dated November 23, 2009, Entitled Notice of Intent to Prepare Two Environmental Impact Statements/Staff Assessments for the Proposed Chevron Energy Solutions/Solar Millennium Palen and Blythe Solar Power Plants, Riverside County, CA and Possible Land Use Plan Amendments

		(12/21/09)
536		Gerald R. Zimmerman, Colorado River Board letter to Alan H. Solomon, CEC, (3/22/10) requiring a Section 5 BCPA contractual entitlement
537	Janet Laurain	Gerald R. Zimmerman, Colorado River Board letter to Janet Laurian, responding to Public Records Act request for the Blythe Solar Power Project (2/22/10)
538	Janet Laurain	Solar Millennium LLC/Chevron Energy Solutions Blythe and Palen Solar Power Projects Presentation (1/6/10)
539	Janet Laurain	Laurain Declaration [Re Ex. 537 and 538]
540		Boulder Canyon Project Agreement Requesting Apportionment of California's share of the Waters of the Colorado River Among the Applicants in the State (8/18/31)
541		U.S. Geological Survey ,Update of the Accounting Surface Along the Lower Colorado River, Scientific Investigations Report 2009-5113
546		Comment Letter (7/2/10) from Gerald R. Zimmerman, Colorado River Board of California, to Mike Monasmith, CEC, re a Section 5 BCPA contractual entitlement
547		State of California Public Utilities Commission Draft Resolution E-4343
WASTE MANAGEMENT		
517	Matthew F. Hagemann	Testimony of Matthew F. Hagemann on Behalf of the California Unions for Reliable Energy on Hazardous Materials and Waste Management of the Genesis Solar Energy Project
518	Matthew F. Hagemann	Hagemann Declaration
519	Matthew F. Hagemann	Hagemann C.V.
520	Matthew F. Hagemann	Spill Reports at SEGS (5/99 and 7/07)
521	Matthew F. Hagemann	Desert Training Center/California Maneuver Area map, identifying the Project within an area identified as a "gunnery range"
522	Matthew F. Hagemann	WW-II era map of the CAMA

EXHIBIT 542

Vol. 3: 61–68 | ENDANGERED SPECIES RESEARCH
Endang Species Res | Published May 30

Persistence and local extinctions of endangered lizard *Uma inornata* on isolated habitat patches

Cameron W. Barrows*, Michael F. Allen

Center for Conservation Biology, University of California Riverside, Riverside, California 92521-0334, USA

ABSTRACT: Occupancy and persistence in naturally isolated habitat patches were analyzed to evaluate patterns of local extinction of an endangered species, the Coachella Valley fringe-toed lizard *Uma inornata*. We examined 4 parameters: (1) habitat quality, (2) patch size, (3) patch connectivity, and (4) drought. The Coachella Valley in southern California's Colorado Desert has a strong west–east gradient, with drier and more persistent drought conditions in the east. The distribution of habitats along this gradient was the best single factor explaining patch occupancy over 14 yr. Drought and patch size provided the best multivariate model. When the westernmost habitat patches were analyzed alone, patch size was the only statistically significant variable. Our results show how conservation planning criteria for species of concern can differ within a species' range. In this instance, patches located in the eastern part of the valley may need to be much larger than those in the more mesic west. Applying one minimum habitat size criteria for conservation efforts throughout the lizards' range could result in either not protecting viable populations (e.g. in the west) or spending limited conservation funds on protecting non-sustainable populations in the east (if the minimum size was too small). Identifying gradients that may impact population persistence and extinction across landscapes is an important step in effective conservation planning.

KEY WORDS: Patch size · Persistence · Extinction · Drought · *Uma inornata* · Conservation

INTRODUCTION

An important goal for conservation biology is to provide a scientific basis for informed conservation planning. This background includes identifying habitat loss and extinction thresholds. Some of the variables that may impact population occurrence and persistence on habitat fragments include patch size and the distance between additional habitat patches (Simberloff 1997), the number of habitat patches and the porosity of the inter-patch matrix (Hanski 1991), habitat quality (Thomas 1994, Scott et al. 2006), and various stochastic processes such as drought or fire (Gilpin & Soulé 1986, Wiens 1997). Rather than a single explanatory factor, extinctions are likely the result of some synergistic combination of these variables. The challenge with respect to protecting biodiversity is to identify those variable combinations.

To evaluate variables which alone or in concert contribute to extinctions on habitat fragments, patch size, distance between patches, as well as a range of factors generally lumped as habitat quality, need to be clearly defined. Oceanic islands are often used as models for evaluating extinctions in terrestrial species; the distinction between habitat patches (the island) and the surrounding matrix (water) can be clearly defined. In mainland terrestrial systems the distinctions between habitat and matrix are often less distinct. Our study system includes well-defined patch-matrix distinctions consisting of aeolian sand habitat patches captured in uplifted alluvial hills. The fine aeolian sand sharply contrasts with the alluvial rock and gravel matrix and so can be readily delineated. This separation is biotic as well as physical. Isolated sand dunes form unique insular habitats (Britton & Rust 1996) that are inhabited by aeolian sand-obligate plants (Pavlick 1985, 1989), mammals (Brown 1973), arthropods (Seely 1978, Rust 1986, Britton & Rust 1996, Barrows 2000), and reptiles, particularly members of the saurian genus *Uma* in North America (Norris 1958, Trépanier & Murphy

*Email: cbarrows@ucr.edu

2001). In the present study we focused on patterns of persistence and extinction for one of the sand dune obligate reptiles, the Coachella Valley fringe-toed lizard *Uma inornata*, which was listed in 1980 as threatened (US federal) and endangered (State of California).

Aeolian sand habitats once stretched across much of the floor of the Coachella Valley of southern California's Colorado Desert (Beheiry 1964, Proctor 1968), providing a nearly contiguous habitat for a diverse community of aeolian sand-adapted species. Over the past 3 decades, increases in human population and suburban development have resulted in the loss of as much as 95% of this habitat and have severely fragmented what remains (Barrows 1996, 2006). However, not all that fragmentation was the result of anthropogenic actions. The numerous sand-etched rocks or ventifacts indicate that an aeolian sand sheet spread over the western Indio Hills forming the northern margin of the Coachella Valley's dune field (Beheiry 1964, Proctor 1968, Lundstrom 2001). Besides ventifacts, current evidence for a sand sheet includes the occurrence of aeolian sand patches on the leeward side of steep ridges (falling dunes, sensu Lancaster 1995) and in isolated valleys. Although there were likely earlier events, the most recent movement of sand across the Indio Hills followed heavy rains, flooding and fluvial sediment movement in 1937–8 (Griffiths et al. 2002), with subsequent aeolian sand movement in the months and years following that flood. Aerial images taken in 1953 clearly show each of the sand patches in its present location and size. The matrix separating these sand patches consists of steep slopes of uplifted alluvial gravel and rock (Proctor 1968). The temporal and spatial patterns of patch occupancy exhibited by these fringe-toed lizards on these sand patches provide an opportunity to evaluate variables that lead to local extinctions in arid environments.

We tested 4 hypotheses to explain observed lizard extinction patterns on naturally fragmented habitat patches. These hypotheses were: (1) patch size and distance between patches, with an expectation that larger patch size and smaller inter-patch distances would support higher occupancy rates; (2) the number of habitat patches with potential connectivity, with an expected positive correlation with higher patch occupancy; (3) differences in habitat quality to the extent that some sites were unsuitable for occupancy; and (4) differential environmental stochasticity (drought), resulting in temporal and spatial variation in patch suitability. To test these hypotheses we compared observed patterns to predicted patterns for each hypothesis. Habitat quality for Coachella Valley fringe-toed lizards has been defined based on sand grain size (Stebbins 1944, Norris 1958, Pough 1970, Turner et al. 1984) and sand compaction (Turner et al. 1984, Barrows 1997). Departures from established thresholds for fringe-toed lizard habitat suitability should correlate with occupancy if habitat quality were a key driver in the observed patterns. Within our study area in the Coachella Valley of southern California, there is a steep precipitation west–east gradient, along the same axis as the distribution of our habitat patches (Barrows & Allen 2007). Coachella Valley fringe-toed lizard population dynamics are driven to a large extent by annual rainfall fluctuations (Barrows 2006). Variation in annual precipitation increases with decreases in mean annual rainfall (Noy-Meir 1973, Bell 1979, MacMahon 1979), so in the more arid eastern valley the lizard populations are more likely to be stressed by stochastic drought events. If the stochastic process hypothesis provides the best model, there should be a strong west–east correlation with persistence and local extinctions.

MATERIALS AND METHODS

Study area. The Indio Hills extend roughly 35 km from the northwest to the southeast, forming a northern boundary to the Coachella Valley, Riverside County, California. The Coachella Valley is situated in the northwestern portion of the Sonoran Desert and is one of the driest and hottest portions of that desert. Annual precipitation varies with a west–east mean annual rainfall gradient of 125 to 79 mm (most recent 60 yr means, Western Regional Climate Center, Palm Springs and Indio reporting stations). The lowest rainfall year occurred in 2002, with from 7 to 4 mm of rainfall recorded across the valley floor. In contrast, in 2005, 326 to 210 mm of rainfall was measured, the largest annual rainfall total recorded in the past 50 yr for some Coachella Valley locations. Temperatures show similar extremes, ranging from a low approaching 0°C in the winter to highs exceeding 45°C commonly recorded during July and August.

Clusters of aeolian sand patches occur throughout the Indio Hills, although most predominantly in the western third, closest to the sand sources (Fig. 1). The sand patches occurred as falling dunes on leeward, east-facing slopes as well as in protected valleys within the Indio Hills. Four discrete sand patch clusters were identified based on potential connectivity within clusters and the lack of likely connectivity between clusters. Barriers to connectivity were identified as locations when the nearest sand patches were separated by rock and coarse alluvium, and when there were no obvious corridors, such as sandy washes or trails, connecting these patches. The closest distance between patch clusters was 1.5 km of rocky substrate. While

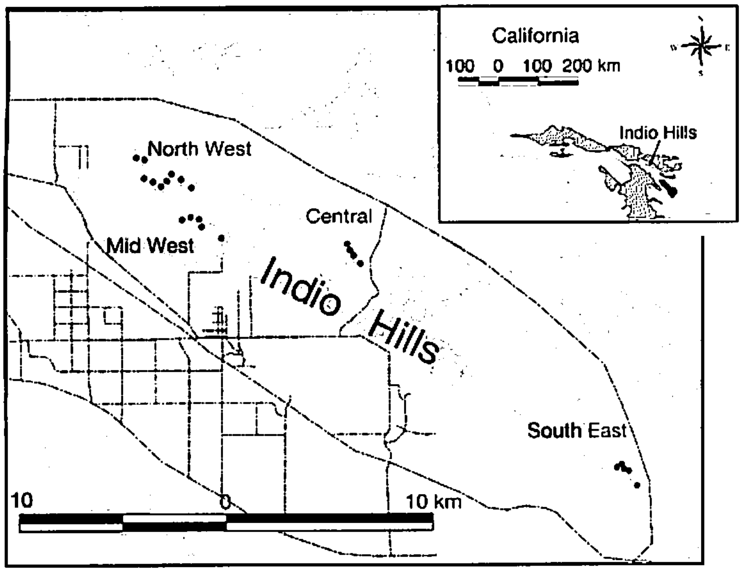


Fig. 1. Distribution of the aeolian sand patches included in the present study. The Indio Hills form a northern border to the Coachella Valley and are located within the northwestern edge of the Sonoran desert in California. Mountain areas are shaded, major roads are shown as lines. Inset shows position of our study area with respect to southern California, USA. North West, Mid West, Central and South East: habitat patches tested

barriers within patch clusters were exclusively the result of geological features, separation of the central and south east sand patch clusters from other clusters was exacerbated by roads, gravel mining, agriculture and suburban development. Centroids for the 4 habitat clusters ranged from 33° 53' N, 116° 24' W for the North West cluster, 33° 52' N, 116° 22' W for the Mid West cluster, 33° 50' N, 116° 18' W for the Central cluster, and 33° 45' N, 116° 10' W for the South East cluster.

Surveys. Each aeolian sand habitat patch was surveyed 1 to 3 times during April and May in 1993, 2004, 2005, and 2006. Surveys were conducted during the active period for the fringe-toed lizards, when temperatures ranged from ≥35° ≥43°C, measured 1 cm above the sand in full sun, and involved 1 to 2 people repeatedly traversing the habitat patch attempting to flush lizards and identify their diagnostic tracks (Barrows et al. 2006). The steep terrain and fine sand substrate limited the number of sympatric lizard species. The tracks of those lizards that did co-occur with the fringe-toed lizards, such as western whiptails *Aspidoscelis tigris*, and side-blotched lizards *Uta stansburiana*, were distinctive (relative foot size, foot-fall pattern, tail drag or not) and enabled unambiguous identifications. If no fringe-toed lizards or their tracks were located, a patch was re-visited on separate days up to 3 times in a given year. The identification of the lizards' diagnostic tracks enabled surveyors to readily identify lizard occupancy or absence despite the otherwise cryptic and evasive behaviors used by the lizards. Sighting lizards was always accompanied by observations of numerous diagnostic tracks. Lizards were never found on patches where the tracks were not observed.

Variables. The area and distance between sand patches was measured using ARCVIEW 3.2 software. Sand patch perimeters were digitized from an IKONOS 4 m multi-spectral satellite image taken in 2002. Variables calculated included: the easternmost Universal Transverse Mercator (UTM) (NAD83) coordinate for the center of each sand patch was used to describe the east–west position for each patch; the Distance from each patch to the closest location or patch where there was continuous fringe-toed lizard occupancy during the study duration. Rather than a direct linear distance, the most likely corridor between patches was measured, which often included following sandy washes rather than rocky ridges; Patch Number was the total number of sand patches that appeared to be inter-connected within a patch cluster; and Patch Size was calculated from the digitized perimeter of the sand patch.

Sand compaction has been described as a key habitat variable for Coachella Valley fringe-toed lizards *Uma inornata* (Barrows 1997). For a reference from which to evaluate habitat suitability for fringe-toed lizards on the isolated sand patches, we measured sand compaction and Coachella Valley fringe-toed lizard abundance on 159 belt transects distributed in a stratified random configuration across the aeolian sands of the valley floor (Barrows & Allen 2007). Measures of lizard abundance were based on mean counts of 6 surveys yr^{-1} using diagnostic tracks left in the sand within 100 × 10 m belts. Sand compaction was measured at 25 points, approximately 4 m apart, along the transect midline, using a hand-held pocket penetrometer with an adapter foot for loose soils (Ben Meadows Company). Due to multiple year measurements at most of these transects, a total of 405 mean sand compaction values were used for the reference data set. Mean sand compaction on sand patches was based on 10+ measurements sand $patch^{-1}$, collected at points approx. 4 m apart along a randomly located transect across the patch. Sand compaction data were recorded as the force (kg cm^{-2}) required to get the penetrometer 'foot' beneath the sand surface.

Analyses. Logistic regressions were used to evaluate models for explaining the occupancy pattern of lizards on sand patches. The discrete dependent variable was occupancy, where patches with an occupancy rate of >50% = 1, and those where the occupancy rate was ≤50% = 0. The best models, i.e. those with the lowest AIC (Akaike's Information Criterion) were selected; model ratings were considered distinct when the difference between AIC values was >2.

RESULTS

Occupancy patterns of fringe-toed lizards occurring on the Indio Hills sand patches varied between year and between patch clusters (Table 1). In 1993, 76% of the 26 habitat patches surveyed were occupied by this lizard. Periodic surveys of selected sand patches in each of the 4 patch clusters revealed no changes in occupancy patterns through 1998; however, when the next comprehensive survey of all sites occurred in 2004, occupancy was just 28%. This followed a severe drought in 2002. That year, and for each subsequent year, fringe-toed lizard populations within the Central and South East patch clusters were not detected on any patch and were presumed extinct. The Mid West cluster appears to have stabilized after 2004 with 60% of the patches occupied, and with no re-colonization of either patch G or H. These 2 patches lacked direct connectivity via either sandy washes or trails. The North West cluster maintained the highest occupancy rates throughout the years surveyed, except for 2004 when 44% of the patches were occupied. In each other year when surveys were conducted, 90% of the patches were occupied, although the location of the unoccupied patches varied from year to year.

As an index of habitat suitability for fringe-toed lizards, mean sand compaction for each sand patch was compared throughout their occupied habitat on the valley floor (Fig. 2). Each sand patch considered here had mean compaction values comparable to sites where the lizard populations reach their highest abundances elsewhere (mean sand compaction = 0.08 kg cm^{-2}, SE = 0.009).

Table 1. *Uma inornata*. Patterns of occurrence for Coachella fringe-toed lizards. +: occupancy was confirmed; 0: presumed absence. Patch area was calculated from digitized patch perimeters drawn from satellite imagery. Patch distance was the distance to the closest occupied patch (for the lizards). The measurement did not account for topographic barriers and so was likely an underestimate of the true distance a lizard would need to travel between patches

Habitat patches	Patch size (ha)	Patch distance (m)	*Uma* occupancy 1993	2004	2005	2006
North West						
J	2.73	620	+	+	+	+
K	13.46	620	+	+	+	+
L	1.02	656	+	0	+	+
M	0.41	1484	+	0	+	0
N	4.11	1312	+	0	+	+
O	2.81	514	+	+	+	+
P	0.46	356	+	0	+	+
Q	2.35	514	+	+	+	+
R	0.57	581			+	+
S	0.21	1544	0	0	0	+
Mid West						
A	0.73	624	+	+	+	+
B	1.01	624	+	+	+	+
C	0.42	378	+	+	+	+
G	0.57	589	+	0	0	0
H	0.27	1424	+	0	0	0
Central						
A	1.75	6500	+	0	0	0
B	0.72	6800	0	0	0	0
C	0.06	6900	0	0	0	0
D	0.05	6950	0	0	0	0
E	0.02	6975	0	0	0	0
South East						
A	2.25	15000	+	0	0	0
B	0.39	15000	+	0	0	0
C	0.1	15000	+	0	0	0
G	0.1	15000	+	0	0	0
E	0.1	15000	0	0	0	0
F	0.01	15000	+	0	0	0

Logistic regression analyses were undertaken using variables or variable combinations from Table 1. With just 25 sand patches in the total sample, multivariate analyses were limited to 2 variables to reduce model over-fitting. Although each single and paired variable model provided a statistically significant explanation for the observed occupancy patterns, the low AIC values for both the east–west position of the sand patch (UTM) and the distance to the closest continuously occupied sand patch (Distance) indicated that these 2 variables provided the best single variate models (Table 2). UTM and Distance were correlated with each other (r = 0.937, Pearson pairwise correlation) and are therefore not separate models. The best model for explaining the observed occupancy patterns was a combination of the UTM and Patch Size variables.

At the scale of the entire Indio Hills study area the influence of the east–west gradient dominated the results. To exclude that influence, the logistic regression was repeated for just the western 2 clusters of sand

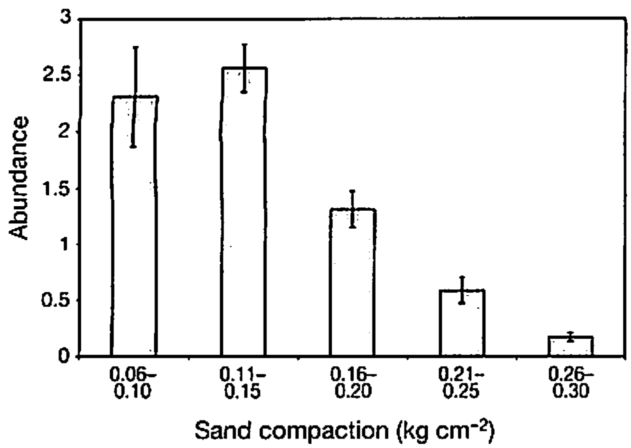


Fig. 2. *Uma inornata*. Patterns of Coachella Valley fringe-toed lizard abundance (mean number of lizards detected on 100 × 1 m belt transects) compared with sand compaction. Error bars indicate 1 SD. Mean sand compaction on the Indio Hills sand patches was 0.08 kg cm^{-2}

Table 2. Results of logistic regression analyses using patch occupancy as the dependent variable (occupancy > 50% = 1, ≤50% = 0)

	AIC	Likelihood (χ^2 probability)
ALL SITES		
Single Variables		
UTM	20.74	<0.0001
Distance	22.68	0.0001
Patch #	26.92	0.0011
Patch Size	27.48	0.0014
Paired Variables		
UTM+Patch Size	16.32	<0.0001
Distance+Patch Size	19.74	<0.0001
Distance+Patch #	23.07	0.0002
WESTERN SITES		
Variable(s)		
Patch Size	11.46	0.0023
Patch #	20.26	0.4854
Distance	20.74	0.9308

patches (Table 2). At this more local scale, sand patch size provided the only statistically significant model.

DISCUSSION

A first step in evaluating processes that influence occupancy of isolated habitat patches is to determine the suitability of the habitat within those patches. While for most species this is a difficult task, the primary habitat correlates for Coachella Valley fringe-toed lizards have been previously defined and described based on sand grain size (Stebbins 1944, Norris 1958, Pough 1970, Turner et al. 1984) and sand compaction (Turner et al. 1984, Barrows 1997). All of the sand patches included in our analyses are aeolian deposits and thus comprise the appropriate sand grain size. Sand compaction measurements confirmed that each site provided habitat characteristics consistent with those sites with high fringe-toed lizard abundance elsewhere on the Coachella Valley floor. High lizard occupancy rates measured in 1993 confirmed that the sand patches provided suitable habitat.

The west–east gradient provided the best single variate logistic model explaining the patterns of fringe-toed lizard occurrence on the sand patches in the Indio Hills; combining that variable with patch size provided the best overall model. Vulnerability to stochastic perturbations, such as drought, increases with small population size; the coupling of these 2 factors therefore fits within existing theory (Wiens 1997). This result is consistent with the hypothesis that stochastic processes, in this case a more severe and prolonged drought in the eastern valley, resulted in patch extinctions.

However, the observed extinction of the central patch cluster had an additional stochastic stressor. The one occupied sand patch there was an actively moving dune. The leading edge moved into an adjacent native California fan palm (*Washingtonia filifera*) oasis, which was hosting a number of predators. American kestrels *Falco sparverius* and loggerhead shrikes *Lanius ludovicianus* used the palm trees as perches to launch their hunting sorties; coupled with the drought effects, the lizards were extirpated at this patch within 1 yr. The same bird species were identified as a leading cause of a 100 to 150 m edge effect, eliminating another lizard species, the flat-tailed horned lizard *Phrynosoma mcallii*, from the boundaries of larger habitat areas on the valley floor (Barrows et al. 2006). Hawlena & Bouskila (2006) found a similar increase in predation on desert lizards and changes in the lizard assemblage resulting from increases in avian predators hunting from planted trees.

To eliminate the influence of the west–east precipitation gradient we conducted a second analysis using only the 2 westernmost sand patch clusters. The results indicated that without that moisture gradient, patch size provided the only statistically significant model to explain patterns of patch occupancy. The importance of patch size in explaining the observed occupancy patterns is an expected result; larger patches should provide habitat for larger lizard populations, which should be more resilient to stochastic processes. However, the sand patches with 100% occupancy were surprisingly small (mean = 3.5 ha, range 13.46 to 0.42 ha).

Chen et al. (2006) estimated that the minimum habitat patch size for sustaining a Coachella Valley fringe-toed *lizard population*, if isolated from other populations, was 100 to 200 ha. Only 2 of the 26 sand patches tracked through the duration of our study were sufficiently large to yield a non-negative result when patch area was inserted into their regression model. The area of patches K and N, both occurring in the North West patch cluster, yielded estimated extinction times of 25.5 and 5.7 yr, respectively. Even if we assumed continuous movement between habitat patches within the North West patch cluster, and so combined all patches, the total area was 28.13 ha, yielding an estimated extinction time of 37.9 yr. Exact ages for the isolation of the sand patches were not available; however, given that the most recent aeolian sand movement event into the Indio Hills was in the years immediately following 1937–8 (Griffiths et al. 2002) we assumed a minimum age for all patches of 60 to 70 yr. Aerial photos from 1953 confirm the location and size of each patch conforming to its current configuration over 50 yr ago. Combining the habitat patches within each of the other 3 patch clusters still did not provide sufficient total areas to yield non-negative values. With each sand patch likely having its current level of isolation for over 50 yr, either the Chen et al. (2006) model needs to be reconsidered, or these habitat patches are not truly isolated.

The data used to develop the Chen et al. (2006) model were collected from valley floor sites in the eastern Coachella Valley along with the one occupied sand patch in the Central patch cluster. As our data indicate, stochastic drought has a strong influence on sand patch occupancy in these regions, but a weaker influence in the more mesic western sand patches. Anthropogenically isolated aeolian sand areas on the eastern valley floor have also experienced extinctions, providing support for Chen et al. (2006); however, those in the western valley have not. In addition to the habitat patches included in our analysis we identified 2 additional naturally isolated aeolian sand patches, not in the Indio Hills but in the western valley, with areas less than 13 ha. Both of these sites continue to be occupied with relatively dense fringe-toed lizard populations, yet no similarly sized patches remain occupied in the eastern valley (C. W. Barrows, pers. obs.). The applicability of the Chen et al. (2006) model thus may be limited to truly isolated habitat patches in the eastern Coachella Valley where stochastic processes, especially drought, appear to be the primary drivers of *Uma* population dynamics.

Our data prompt the question as to why, after 60–70 or more years of isolation, the Central and South Eastern sand patch clusters became extinct during our study. In part, the answer may be related to the recent degree of anthropogenic landscape fragmentation that surrounds the Indio Hills. While not necessarily contributing to the extinctions within the clusters, these barriers have permanently restricted the ability for the lizards to recolonize those sites from the remaining *Uma inornata* populations on the valley floor. Another factor explaining the timing of the extinctions is related to the extreme aridity of the central-eastern valley. Variation in annual precipitation increases with decreases in mean annual rainfall (Noy-Meir 1973, Bell 1979, MacMahon 1979). Annual rainfall is a primary driver of Coachella Valley fringe-toed lizard population dynamics (Barrows 2006). The driest year on record for the Coachella Valley was 2002; less than 4 mm fell in the eastern valley that year, and this was preceded and followed by years (1999 through 2004) with below average rainfall. Over the past 75 yr there has been no other continuous 6 yr sequence of below average rainfall (Western Regional Climate Center, Palm Springs and Indio reporting stations). In the eastern valley, 4 of those 6 yr (1999, 2000, 2002, and 2003) experienced rainfall totals less than the 50 mm threshold for positive population growth for Coachella Valley fringe-toed lizards (Barrows 2006). In the western valley conditions were dry as well, but in 2001, 2003 and 2004 rainfall totals all exceeded 50 mm (86 to 117 mm). Predictions of global climate change include both increasing temperatures and a likelihood of decreasing precipitation for this region (Hayhoe et al. 2004). Determining whether the observed precipitation patterns and local extinctions recorded during our study represent the effect and early casualties of global climate change will be a matter for future retrospective analyses.

Our analyses did not provide support for number of patches or distance to more permanently occupied patches as explanations of our observed pattern of patch occupancy. These variables should have demonstrated some influence if periodic inter-patch movements (an essential component of metapopulation processes) were important there. Despite the lack of statistical support, direct observations of lizards in potential corridors (C. W. Barrows, pers. obs.) indicated that inter-patch connectivity may have a role in structuring the observed occupancy patterns. Those patches that had high occupancy rates on the western patch clusters all had some level of habitat connectivity (dry washes or sandy trails). On the Mid West patch cluster the 2 fringe-toed lizard populations that did become extinct after 1993 (G and H) were not connected to the other 3 occupied patches by sand corridors. Similarly, on the North West patch cluster, patch M had a relatively low occupancy rate and had poor connectivity to the other patches. Although our analyses failed to identify metapopulation dynamics-related variables as an important patch persistence-extinction process, these direct observations are consistent with a metapopulation hypothesis. Perhaps the stronger influences of drought and patch size overshadowed a weaker metapopulation process, or our variable selection and definition failed to capture the role of connectivity in patch occupancy.

From the perspective of conservation planning, our results indicate that criteria to sustain Coachella Valley fringe-toed lizard populations may differ along the valley's west–east precipitation gradient. In the drier eastern valley larger habitat areas, perhaps as large as Chen et al.'s (2006) 100 to 200 ha estimate, may be required to provide long-term protection for this species. In the western valley, although patch size is important, much smaller minimum areas may be required. Applying the same conservation planning criteria throughout the Coachella Valley could result in not including otherwise sustainable habitats in the western valley, or spending finite conservation funds on non-sustainable lizard populations in the eastern valley.

While these results are specific to a particular site and species, they provide a cautionary tale that has broader implications. Scientists providing guidance to conservation planners need to take care to provide conservation criteria within relevant geographic or situational bounds. Landscapes targeted for conservation are invariably more complex than they first appear. Even in the superficially similar sand dunes of the Coachella Valley, at least 4 distinct communities have been identified, each with unique species associations and population dynamics (Barrows & Allen 2007). Identifying gradients across landscapes and their potential influence on processes that drive persistence and extinction is a critical step in understanding the implications of that complexity to conservation planning.

Acknowledgements. Funding was provided by the Center for Conservation Biology at UC Riverside.

LITERATURE CITED

Barrows CW (1996) An ecological model for the protection of a dune ecosystem. Conserv Biol 10:888–891

Barrows CW (1997) Habitat relationships of the Coachella Valley fringe-toed lizard (*Uma inornata*). Southwest Nat 42(2):218–223

Barrows CW (2000) Tenebrionid species richness and distribution in the Coachella Valley sand dunes (Coleoptera: Tenebrionidae). Southwest Nat 45(3):306–312

Barrows CW (2006) Population dynamics of a threatened dune lizard. Southwest Nat 51:514–523

Barrows CW, Allen MF (2007) Community complexity: stratifying monitoring schemes within a desert sand dune landscape. J Arid Environ 69:315–330

Barrows CW, Allen MF, Rotenberry JT (2006) Boundary processes between a desert sand dune community and an encroaching suburban landscape. Biol Conserv 131: 486–494

Beheiry SA (1967) Sand forms of the Coachella Valley, Southern California. Ann Assoc Am Geogr 57:25–48

Bell FC (1979) Precipitation. In: Goodall DW, Perry RA, Howes KMW (eds) Arid-land ecosystems: structure, functioning and management. Cambridge University Press, Cambridge, p 373–392

Britten HB, Rust RW (1996) Population structure of a sand dune-obligate beetle, *Eusattus muricatus*, and its implications for dune management. Conserv Biol 10:647–652

Brown JH (1973) Species diversity of seed-eating rodents in sand dune habitats. Ecology 54:775–787

Chen X, Barrows CW, Li B (2006) Is the Coachella Valley fringe-toed Lizard (*Uma inornata*) on the edge of extinction at Thousand Palms Preserve? Southwest Nat 51:28–34

Gilpin ME, Soulé ME (1986) Minimum viable populations: the process of species extinctions. In: Soulé ME (ed) Conservation biology: the science of scarcity and diversity. Sinauer Associates, Sunderland, MA, p 13–34

Griffiths PG, Webb RH, Lancaster N, Kaehler CA, Lundstrom SC (2002) Long-term sand supply to Coachella Valley fringe-toed lizard (*Uma inornata*) habitat in the northern Coachella Valley, California. U.S.G.S. Water Resources Investigations Report 02-4013, Tucson, AZ

Hanski I (1991) Single-species metapopulation dynamics. In: Gilpin M, Hanski I (eds) Metapopulation dynamics. Academic Press, London, p 17–38

Hawlena D, Bouskila A (2006) Land management practices for combating desertification cause species replacement of desert lizards. J Appl Ecol 43:701–709

Hayhoe K, Cayan D, Field CB, Frumhoff PC, Mauer EP and 14 others (2004) Emission pathway, climate change, and impacts on California. PNAS 101:12422–12427

Lancaster N (1995) Geomorphology of desert dunes. Routledge, London

Lundstrom SC (2001) Tertiary geologic mapping in the Desert Hot Springs area, Riverside County, California: data to address societal needs and geoscience issues. Geol Soc Am Bull 33:76

MacMahon JA (1997) North American deserts: their floral and faunal components. In: Goodall DW, Perry RA, Howes KMW (eds) Arid-land ecosystems: structure, functioning and management. Cambridge University Press, Cambridge p 21–82

Norris K (1958) The evolution and systematics of the iguanid genus *Uma* and its relation to the evolution of other North American desert reptiles. Bull Am Mus Nat Hist 114: 251–326

Noy-Meir I (1973) Desert ecosystems: environment and producers. Annu Rev Ecol Syst 4:25–51

Pavlick BM (1985) Sand dune flora of the Great Basin and Mojave deserts of California, Nevada and Oregon. Madroño 32:197–213

Pavlick BM (1989) Phytogeography of sand dunes in the Great Basin and Mojave deserts. J Biogeogr 16:227–238

Pough FH (1970) The burrowing ecology of the sand lizard, *Uma notata*. Copeia 1970:145–157

Proctor RJ (1968) Geology of the Desert Hot Springs—upper Coachella Valley area, California. California Division of Mines and Geology, Special report 94

Rust RW (1986) Seasonal distribution, trophic structure and origin of sand obligate insect communities in the Great Basin. Pan-Pac Entomol 62:44–52

Scott DM, Brown D, Mahood S, Denton B, Silburn A, Rakoton-

draparany F (2006) The impacts of forest clearance on lizard, small mammal and bird communities in the spiny forest, southern Madagascar. Biol Conserv 127:72-87
Seely MK (1978) The Namib dune desert: an unusual ecosystem. J Arid Environ 1:117-128
Simberloff D (1997) Biotic approaches and the new conservation biology. In: Pickett STA, Ostfeld RS, Shachak M, Likens GE (eds) The ecological basis of conservation. Chapman & Hall, New York, p 274-284
Stebbins RC (1944) Some aspects of the ecology of the iguanid genus *Uma*. Ecol Monogr 14:311-332
Thomas CD (1994) Extinction, colonization and metapopulations: environmental tracking by rare species. Conserv Biol 8:373-378
Trépanier TL, Murphy RW (2001) The Coachella Valley fringe-toed lizard (*Uma inornata*): genetic diversity and phylogenetic relationships of an endangered species. Mol Phylogenet Evol:18:327-334
Turner FB, Weaver DC, Rorabaugh JC (1984) Effects of reduction in windblown sand on the abundance of the fringe-toed lizard (*Uma inornata*) in the Coachella Valley, California. Copeia 1984:370-378
Wiens JA (1997) The emerging role of patchiness in conservation biology. In: Pickett STA, Ostfeld RS, Shachak M, Likens GE (eds) The ecological basis of conservation. Chapman & Hall, New York, p 93-107

Editorial responsibility: Luca Luiselli, Rome, Italy

Submitted: February 5, 2007; Accepted: April 4, 2007
Proofs received from author(s): May 17, 2007

EXHIBIT 543

Final Report

Mojave Fringe-toed Lizard Surveys

at the

Marine Corps Air Ground Combat Center, Twentynine Palms, California

&

Nearby lands administered by the Bureau of Land Management

Project funded by:
Natural Resources and Environmental Affairs Division
United States Marine Corps
Marine Air Ground Task Force Training Command
Twentynine Palms, California

Contract # M67399-00-C-0005

Submitted by

Dr. Mary E. Cablk
Desert Research Institute
2215 Raggio Parkway
Reno, NV 89512
(775) 673-7371
mcablk@dri.edu

&

Dr. Jill S. Heaton
University of Redlands, Redlands Institute
1200 E. Colton Ave
Redlands, CA 92374
(909) 335-5384
jill_heaton@redlands.edu

Recommended Citation:

Cablk, M.E. and J.S. Heaton. 2002 Nov. Mojave Fringe-Toed Lizard surveys at the Marine Corps Air Ground Combat Center at Twentynine Palms, California and nearby lands administered by the Bureau of Land Management. California: Marine Corps Air Ground Combat Center. Report M67399-00-C-0005. 115 p.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Mojave Fringe-toed lizard, *Uma scoparia*, is a California Department of Fish and Game "species of special concern" and a Bureau of Land Management (BLM)-designated "sensitive species." *U. scoparia* habitat includes sand dunes, sand sheets, and wind dominated transitional sand-vegetation areas in the California Mojave Desert. The United States Marine Corps, Natural Resources and Environmental Affairs Division funded a multi-season project to assess population density, distribution and habitat use by *U. scoparia* on lands managed by the Marine Corps as well as nearby lands administered by the BLM. The primary purpose of this study was to begin the collection of data which would conceivably be utilized in any future discussions of Endangered Species Act listing and/or Critical Habitat designations.

Within this geographic region the Marine Corps Air Ground Combat Center (MCAGCC) at Twentynine Palms, adjacent BLM, and privately owned lands each harbor *U. scoparia* populations. While there have been limited quantitative analyses describing life history and status at individual or population levels on these lands, *Uma* populations are thought to be decreasing. In the wake of these declines and given projected increases in human population for the California Mojave Desert, both MCAGCC and the BLM have expressed concern for the future of *U. scoparia* populations on their lands. These concerns stem from certain land use practices and other anthropogenic factors which may contribute to population declines, range limitations, habitat fragmentation, and/or other factors that make all *Uma* vulnerable to extinction or extirpation. In the Mojave, military installations are bearing an increased burden of managing biodiversity. There is cause for further concern by MCAGCC with development pressure adjacent to the installation. If private land habitat for *U. scoparia* is developed and other public lands are not managed for this and other species, the sole responsibility for stewardship could fall on military installations.

The research presented here is a proactive measure to collect baseline data on *Uma scoparia* in an effort to reduce the possibility that MCAGCC will become sole steward of this species and to contribute towards preventing additional listing of this species within its California Mojave range. As such, intensive field surveys were conducted during the summer and fall of 2001 on MCAGCC and BLM lands. The purpose was to identify locations of *U. scoparia* populations and to quantify their habitat requirements. Seventy-three plots in fifteen training areas and seventeen plots in five BLM areas were surveyed. *U. scoparia* were identified in seven training areas and were identified in three BLM areas. Results from this work were in agreement with previous results for *Uma*, identifying soft sand as a major habitat component, although it was also found that *U. scoparia* will tolerate small percentages of gravel, cobble, or stones intermixed. The presence of perennial vegetation did not affect presence/absence of lizards but the presence of annuals (exotic plant species) was a negative factor to *U. scoparia*. Both MCAGCC and BLM were found to have good habitat for this species. Populations on both lands appear to be reproducing, evidenced by the number of juveniles identified during the fall 2001 field season. What remains unknown at this time is the fitness of these populations, where juveniles are dispersing, and information about the genetic structure and interaction of these metapopulations.

Recommendations were made to encourage active management with possible protection of one BLM area that harbors a large number of *U. scoparia* and to monitor two other BLM sites that also have these lizards. Recommendations were made for protecting select areas on MCAGCC. These recommendations vary with training intensity and extent of habitat. Some areas contained large amounts of habitat and received heavy use while other areas had extremely remote habitat and received low levels of use. These factors were taken into consideration when formulating recommendations. Finally, additional research was suggested. Many of these suggestions related to increasing understanding of the status of now-known populations and the genetic diversity of metapopulations in the Twentynine Palms area. Results from this type of work can be integrated with ongoing research Mojave-wide.

INTRODUCTION

Fringe-toed lizards (*Uma* spp.) are characterized by the presence of fringes of elongate spines on digits and by an ocellated dorsal pattern (Heifetz, 1941). Typical of sand burrowing animals they have a flattened body and smooth skin. The range of *Uma* includes aeolian supplied features in the southwestern US and south into northern Mexico. Because they are restricted to loose sand deposits, distribution in this range is discontinuous. Three species of *Uma* are recognized in the American Southwest and all have numerous highly specialized structural and functional adaptations that allow them to survive arenicolous habitat. The most notable adaptation is the presence of valvular scales, or fringes, on certain toes that allow the lizards to locomote on and under the sand. Enlarged scales that cover the ear openings, the eyelids, and valves that close the nasal openings facilitate subterrestrial locomotion. Being heliothermic, *Uma* lizards may also modify temperature with behavioral means (Mayhew, 1966). *Uma scoparia* is found in the Mojave Desert of California, *Uma inornata* is found directly to the south in the Coachella Valley of California, and *Uma notata* is found in the Colorado Desert south of the Salton Sea and also into the west coast of Sonora, Mexico (Stebbins, 1944).

The Mojave Fringe-toed lizard, *Uma scoparia* (Figure 1) is a California Department of Fish and Game (CDFG) species of special concern and a Bureau of Land Management (BLM) designated sensitive species. *Uma scoparia* habitat includes sand dunes, sand sheets, and wind dominated transitional sand-vegetation areas in the California Mojave Desert. Within this geographic region the Marine Corps Air Ground Combat Center (MCAGCC) at Twentynine Palms, BLM managed, and privately owned lands each harbor *U. scoparia* populations. While there have been limited quantitative analyses describing *U. scoparia* life history and status at individual or population levels on these lands, populations are thought to be decreasing.

Figure 1. *Uma scoparia* in breeding colors on MCAGCC Emerson Lake Range Training Area.

Uma scoparia are closely related to the *notata* group. They have a ventrolateral blotch and a dorsal ocelli pattern that is not linear in adults. The gular fold can have one to three black crescents and one to three diagonal black lines, unfused at the throat, running medioposteriorly and anterior to the gular crescents. One to five black shoulder blotches may be prominent and these may have an imprecise edge of yellow or greenish scales. Some individuals exhibit precloacal or lateral cloacal black spots and only a few may have post-femoral bars or spots. As do all *Uma*, *U. scoparia* posess fringes on the posterior edge of the fourth toe of the hind foot, averaging about 32 fringes. As adults males range between 70-116mm and females range 65-88mm snout-vent length. Males and females exhibit sexual pattern dimorphism of the dorsal ocelli. Both sexes present ephemeral breeding coloration (Norris, 1958). *U. scoparia* are almost wholly insectivorous. Natural predators include badgers, snakes, hawks, shrikes, roadrunners and coyotes (Stebbins, 1944).

The United States Marine Corps, Natural Resources and Environmental Affairs Division (NREA) funded a multi-season project to assess population density, distribution and habitat use by *Uma scoparia* on lands managed by the Marine Corps as well as nearby lands administered by the BLM. The primary purpose of this study was to begin the collection of data which would conceivably be utilized in any future discussions of Endangered Species Act (ESA) listing and/or Critical Habitat designations.

Habitat

Deserts are harsh environments but fringe-toed lizards have been successful in their niche within sand dunes. Morphological and behavioral adaptations allow these lizards to survive extreme temperatures and arid habitat. Although *Uma* is the only diurnal lizard species in North America that occurs in dunes with no vegetation, they do occur where vegetation is present and in the Mojave, that vegetation is typically *Larrea tridentata* or creosote bush. In the California Mojave, winter temperatures average between 4-19°C and summer temperatures average between 27-29°C. Temperatures at MCAGCC regularly exceed these desert-wide extremes. Mean annual rainfall is 102mm. Mojave fringe-toed lizards are known to hibernate from November to February (Mayhew, 1966).

The California Natural Diversity Database (CNDDB) lists *U. scoparia* as both potentially rare and having a potentially restricted range of distribution. The California Department of Fish and Game (CDFG) and the Bureau of Land Management (BLM) list *U. scoparia* as a species of special concern. The two other fringe-toed lizard species in the American Southwest, *Uma inornata* and *Uma notata notata*, both retain some form of listing as well. *Uma inornata*, the Coachella Valley fringe-toed lizard is Federally-listed threatened and California state-listed endangered species. *Uma notata notata*, the Colorado Desert fringe-toed lizard, is a CDFG and BLM species of special concern. All fringe-toed lizards have similar habitat and physiological requirements, exploit specific desert niches, are narrowly distributed within their limited ranges, and are especially vulnerable to off-road vehicle use and human development (Turner et al. 1997). *Uma scopariaís* closest geographic neighbor, the Coachella Valley fringe-toed lizard (*U. inornata*) has lost an estimated 84% of its historical habitat (~171000 acres to 27206 acres) to human development and encroachment (Coachella Valley Association of Governments, 2002), thus placing the species on the brink of extinction. In the wake of *U. inornata* rapid declines and habitat loss, in conjunction with projected increases in human population for the California Mojave Desert, both MCAGCC and the BLM have expressed concern for the future of *U. scoparia* populations on their lands. These concerns stem from certain land use practices and other anthropogenic factors which may contribute to population declines, range limitations, habitat fragmentation, and/or other factors that make all *Uma* vulnerable to extinction. Many of the conditions that have contributed to declines in *U. inornata* and *U. n. notata* populations exist or occur within the range limits of *U. scoparia*. As a result, *U. scoparia* may suffer the same fate of its sister taxa if steps are not taken to identify populations, characterize habitat requirements, and establish management objectives that mitigate these adverse conditions. For the purposes of this report *U. scoparia* will hereafter be referred to simply as *Uma*.

<u>Problem Statement</u>

While individual research efforts have examined each of the three fringe-toed lizard species throughout Southwest (Durtsche, 1992; Pough, 1970; Mayhew, 1966), these studies have focused primarily on ethology and on other characteristics at an individual level rather than at the population level. No study has yet empirically derived a predictive habitat model for *Uma* distribution or estimated abundance; nor has previous research examined the unique challenges for environmental stewardship of biodiversity faced by the Department of Defense (DoD) in the California Mojave Desert. The greatest challenge faced by military installations is the threat of encroachment by civilian development. As private lands are developed, suitable habitat for many Mojave Desert species is lost. These animals are either extirpated if unable to reach suitable habitat or if unable to relocate to undeveloped areas. With the development of private lands in the California Mojave, a greater percentage of undeveloped land is managed by either the US Department of the Interior (DOI) or DoD. As a result DOI and DoD both bear an increasing burden of sole stewardship of biological diversity. There is cause for further concern by DoD, however, with increasing development on private lands. This concern is simply the following: If habitat for biodiversity is developed on private lands and DOI lands are not managed for biodiversity, *the sole responsibility for stewardship of biodiversity may, as a result fall on military installations*. Nationwide, this scenario of sole stewardship by DoD already exists at various stages, evidenced by the fact that of all federally managed lands, the DoD harbors the greatest percentage of federally listed threatened and endangered species (TES) both in total numbers and per managed acre (Groves et al., 2000).

The difficulty of having sole stewardship of biodiversity, particularly for TES, is the potential conflict with the military mission. DoD lands are charged with military readiness for National Security and each installation serves a unique purpose in defense preparedness. However, as Federal land managers, DoD must also comply with the Sikes Act and the Endangered Species Act, both of which require adequate knowledge of the numbers and locales of threatened and endangered species within installation boundaries. Until the 1990ís, DoD operated in a reactive mode with respect to fulfilling the requirements of the ESA. That is, resources were not allocated towards a TES species until it became Federally listed and/or interfered with the military mission.

Previous *Uma scoparia* research on MCAGCC

Fromer and Dodero (1982) conducted a reptile survey on MCAGCC between October 26, 1981 and June 15, 1982. The purpose of this survey was to collect baseline data on the occurrence and distribution of reptiles on the base. *Uma* was found to occur and be restricted to areas of fine, windblown sand. Three populations were identified on MCAGCC at North Sand Hill, Emerson Lake, and Pisgah Lava Flow, the latter of which technically is not within military boundaries. Fromer and Dodero (1982) hypothesized that other populations within MCAGCC likely existed, suggesting Surprise Spring and Mainside areas as likely areas to support *Uma*.

A year later Fromer, *et al*. (1983) conducted a population study of *Uma* on MCAGCC. This work was restricted to the populations identified in the 1982 study, above. All lizard species observed were recorded and some discussion of lizard community structure was presented. *Uma* densities were reported between 5.3 and 12.5 animals per hectare. An uneven sex distribution, 20:9 females to males, was found among the animals captured. Based on this work, the authors suggested that training activities on MCAGCC did not significantly affect existing *Uma* populations. At the same time, a recommendation was made that no long term, high intensity, localized activities be conducted on existing habitat areas. Specifically, this referred to construction of permanent structures or activities that resulted in devegetation.

More than a decade later, Cutler *et al.* (1999) found *Uma* in sand dunes within Quackenbush, Lead Mountain, Acorn, and Lavic Lake Range Training Areas (RTAs). They reported that other researchers found *Uma* within Emerson Lake and Sand Hill RTAs, but did not specify whom. It is likely that this reference was to the earlier work of Fromer and Dodero (1982). Cutler *et al*. recommended that efforts focus on locating all populations and determining the extent of their range on MCAGCC.

LizLand

In order to assess and qualitatively predict *Uma* habitat within MCAGCC, we employed the use of the spatially explicit habitat model LizLand (Heaton and Keister, submitted 2001). Prior to LizLand, the existing state-of-the-art in habitat modeling in the California Mojave Desert was the combined work of the California GAP Program (Davis *et al.*, 1998) and the California Wildlife Habitat Relationships System (CWHR) (Airola, 1988). Along with distribution maps the CWHR describes the management status, life history and habitat requirements of Californiaís wildlife species. The USGS National GAP Program (Scott *et al.*, 1993) produced species habitat maps for most mammals (except bats), birds, amphibians and reptiles across much of North America, including those found in the California Mojave Desert. Both the National GAP Program and the CWHR were built upon one of the most successful and widely used means of defining species habitat relationships: the categorization of the landscape into land cover classes based on vegetation composition. The science of wildlife-habitat relationships was developed and continues with birds as model species and vegetation as the habitat predictor (Merriam, 1890; Adams, 1908; Lack, 1933; Svardson, 1949; Hilden, 1965; Verner *et al.*, 1986; McCullough & Barrett, 1992; Scott *et al.*, 1993; Morrison *et al.*, 1998; Scott *et al.*, 2002). The concept of habitat has expanded considerably over the years to include not only environmental structure, but also inter- and intra-specific competition, presence/absence of conspecifics, predators, spatial and temporal climatic variables, evolutionary history and many other factors. However, vegetation, because of historical usage and universal availability, remains the primary variable used to predict animal presence/ absence.

GAP is a biodiversity assessment and inventory tool that employs a ì coarseî vegetation filter of community inventory and protection (Davis *et al.*, 1998). This ì coarseî filter method is hypothesized to protect 85-90% of the species, leaving the remaining 10-15% for ì fineî filter approaches (Jenkins, 1985; Noss, 1987). Because vegetation is sparse to non-existent across much of the California Mojave Desert, we suggest that the ì coarseî vegetation filter approach employed by GAP is also likely to work in only a portion of the total number of ecosystems. A ì fineî filter approach is necessary for ecosystems that are unusual, rare, or in which vegetation is sparse, such as the California Mojave Desert. California GAP does not adequately describe the habitat requirements of reptiles in the California Mojave Desert because it relies on vegetation and ignores geomorphic patterns/processes as habitat descriptors, and because it does not address the disparity between the scale of research used to study reptiles, or more importantly, the scale at which reptiles perceive/respond to the environment.

Conceptually, LizLand is centered on geomorphic landforms, but also considers the contribution of vegetation composition and structure to habitat requirements at a species level. To date, an appropriately scaled, reliable, accurate, and consistent spatial representation of vegetation across the entire Mojave Desert does not exist. As a result, the LizLand GIS model is based solely upon the characterization of the macro landform and its link to lizard habitat. However, due to the limited habitat requirements, and the patchy distribution of those features, the identification of geomorphic sand dunes and sand sheets remains an adequate method for locating habitat for all *Uma* species. By focusing the characterization of habitat on geomorphic landforms rather than vegetation, the unique biological requirements of *Uma* species desert reptiles are addressed. By linking large-scale macro landforms to lizard habitat via micro landform characterizations, the issue of management scale and ecosystem research is addressed as discussed by Heaton & Keister (submitted 2001).

Military installations, like deserts, are not the vast, homogeneous, single land use entities as perceived by the public. They often have highly complex and heterogeneous assemblages of landforms along with associated vegetation types. Large installations may have dozens of separate habitat types that, individually, or together support numerous animal species. While many of these species occur over large areas and in abundant numbers, others are rare, threatened or endangered. Too often this rarity is due to land use practices outside the boundaries of the installations that diminish or eliminate habitat. As external pressures continue, the military is now finding its officials have also become managers of wildlife refuges to some extent, rather than or in addition to being providers of training and testing facilities for national security. As a result, the military must make use of existing information such as wildlife habitat relationships, or develop its own data, to identify those sites which may need further protection or study.

If the data on species are minimal or the ìcoarseî filter approach inadequately protects a given species or fails to capture the unique complexity of the at-risk ecosystem, the result can lead to inaccurate perceptions of the amount of associated habitat on the installation. The result might be pressure to set aside more land than is warranted, thus unnecessarily removing it from training and testing, or the military might find itself inadvertently disturbing land which in fact harbors the very species they are trying to protect. More detailed information provides the military, as well as other interested stakeholders, with a better and more accurate picture of the value of land from a habitat perspective. In this position, the military, as well as other federal agencies, are better able to negotiate, and potentially mitigate, issues related to biodiversity with surrounding stakeholders, all of whom must comply with local, state and federal laws related to rare, sensitive, threatened or endangered species and associated habitat.

OBJECTIVES

MCAGCC employed a proactive approach with the Mojave Fringe-toed lizard in an effort to build and employ a collaborate effort among federal land managers to maintain population viability and to potentially prevent Federal listing of *Uma*. MCAGCC spearheaded and funded this effort to investigate *Uma* within MCAGCC boundaries and on adjacent BLM land. By including data beyond its political boundaries, MCAGCC has sought to accomplish the following: 1) collect critical baseline information on *Uma* at individual *and* population levels, 2) determine the similarities and differences in distribution of *Uma* on both MCAGCC, adjacent BLM, and potentially some private lands, and 3) create an empirical habitat relationship model for *Uma* in designated focal areas. The results of this research will contribute to efforts towards reducing or potentially eliminating the risk of Federal listing of *Uma*. If *Uma* were to be Federally listed as threatened or endangered, aspects of MCAGCC daily operations might face major alterations, potentially resulting in elimination of operations. MCAGCC is taking a proactive stance by collaborating with BLM to better understand the habitat requirements and distributions of *Uma* thus reducing its chances of following the same trajectory as other *Uma* species in the desert Southwest.

We evaluated habitat and population location parameters for *Uma* within designated MCAGCC training areas and surrounding BLM lands and to create an empirically based habitat suitability model based on these data. The terrain based lizard habitat model, LizLand, successfully developed on MCAGCC and Joshua Tree National Park for other Mojave Desert lizard species, was adapted to accommodate the specific requirements of *Uma*. LizLand is a spatially explicit, landform based habitat model that links the requirements for individual and population distributions of lizards with geomorphological landscape characteristics.

We addressed the following objectives:

1. Develop a predictive model of *Uma* habitat on MCAGCC and adjacent BLM lands based upon landform characteristics.

2. Determine presence/absence (p/a).

3. Describe and compare the physical characteristics of those areas where *Uma* does and does not occur.

4. Provide management recommendations to MCAGCC and BLM.

STUDY AREA

The study area for this research is MCAGCC and a limited extent of adjacent BLM lands (Figure 2). Proposed study sites included the following MCAGCC Training Areas (RTAs): Acorn, East, Emerson Lake, Gypsum Ridge, Lavic Lake, Lead Mountain, Maumee Mine, Prospect, Quackenbush, and West. Because MCAGCC lands are used for active testing and training exercises that may pose safety threats to civilians, access is both restricted and limited. BLM managed study sites included areas to the north of MCAGCC, particularly the Sunshine Peak-Pisgah Lave Flow, and the western and the southeastern boundaries of MCAGCC. All BLM sites were to be within close proximity to MCAGCC boundaries and no farther than 15km from the nearest MCAGCC border point. The study area included MCAGCC and a buffer strip of BLM land between 0 and 15 km from the installation boundaries.

METHODS

Sample points were randomly generated for a total of 87 potential dunes to be sampled. The number of sample points was generated based on sample size estimates of (Get Ref: Surveying Sample Size) where $n = Z^2 * var/[(\%)(mean)]^2$. The Z-value of 1.96 was based on a 0.95 confidence level and ì%î is desired tolerance ± the mean density. The desired tolerance was set to 25% and mean density was based on estimates from previous research on MCAGCC FTL of Fromer and Cutler *et al*. (1999). Based on these calculations, a minimum of 80 sample points were required to achieve estimates between ±25-30% of the true mean estimates. Within each sample dune (location), a 0.5 ha sample plot was randomly generated. The order each site was visited was also randomized and was accommodated as well as could be scheduled in accordance with MCAGCC Range. Rules for determining the number of sample sites with a selected dune were:

- Dunes < $2km^2$ get maximum of 1 sample site
- Dunes > $2km^2$ but < $4km^2$ get maximum of 2 sample sites
- Dunes between 4-$6km^2$ maximum of 3 sites
- $6km^2$ maximum five sites
- The large sandsheet within Range Range Training Area was not sampled due to safety issues

Locations of sample sites were generated using a random-stratified sampling regime. Dune features including sand sheets were delineated from 1m true color DOQs for the Marine Corps Base at Twentynine Palms. A total of 59 dune and sand sheet features were identified based in part on interpretation of the DOQs and validated by ground truth collected while

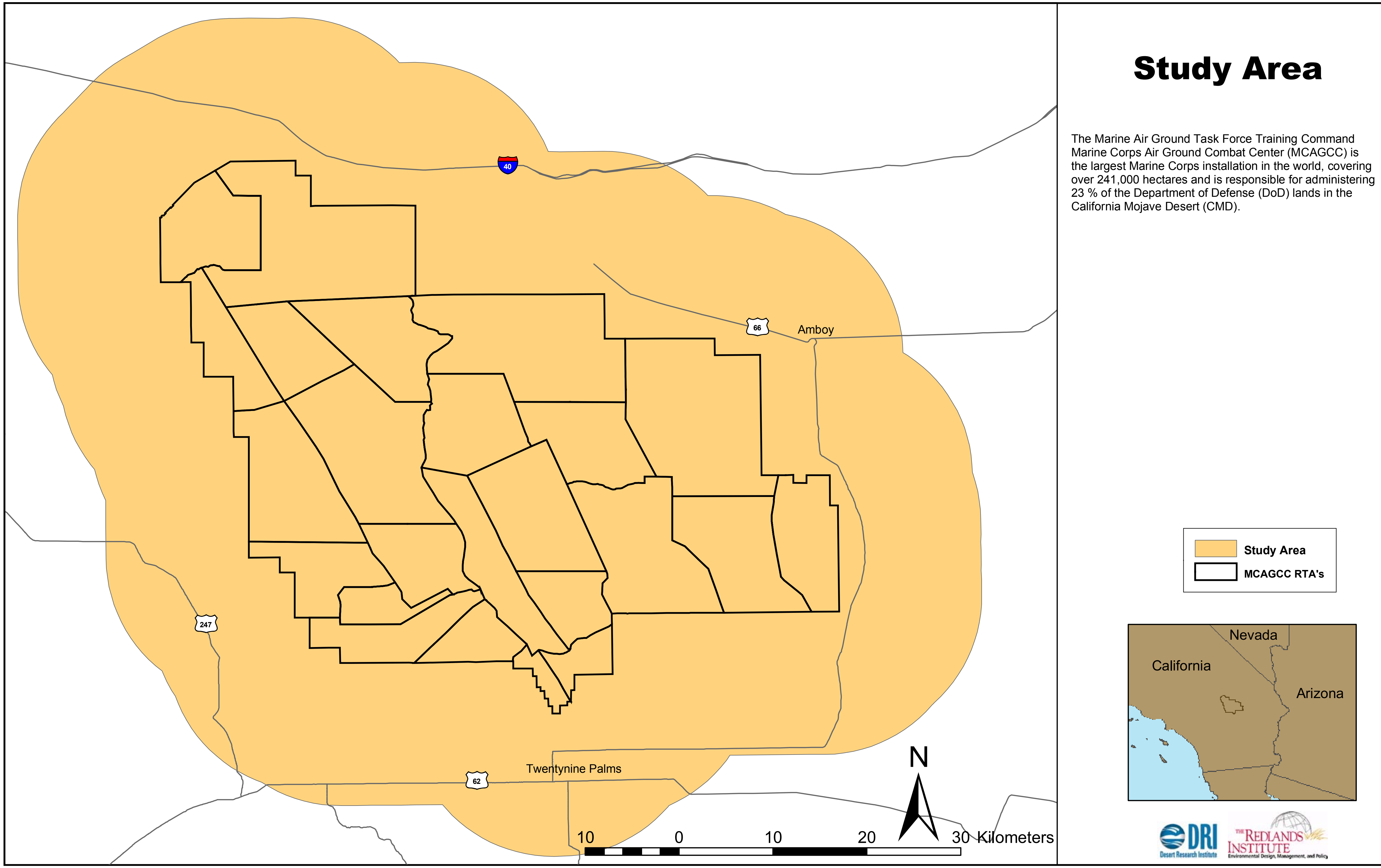


Figure 2. Study area including 15km buffer to include adjacent BLM managed land.

visiting MCAGCC in October 2000. Sample points were generated randomly within each dune and sand sheet. A total of 124 possible sample points were generated on MCAGCC and 22 points were generated for adjacent BLM land. Using data collected by Cutler *et al*. (1999) and Fromer *et al*. (1983) on MCAGCC we estimated that a sample size between 65-93 would need to be taken in order to achieve 75% to 85% confidence intervals around our estimate of lizard density. This is well within the expected confidence limits for this type of fieldwork (Hayek and Buzas 1997). Of the complete set of 124 MCAGCC and 22 BLM potential sample sites, 87 points on MCAGCC and 10 points on BLM lands were randomly selected and surveyed.

After the first field season it became apparent that the dune features identified from the DOQs did not effectively capture potential *Uma* habitat. The reason for this lies in the physical properties of sand as a substrate and its reflective properties in the visible portion of the spectrum. Recall that the DOQs were photographs taken in the visible wavelengths of the spectrum. Compacted sand ìlooksî like soft sand. Color differentiation between soft, unconsolidated sand features, cemented, hard sand surfaces, and cemented, hard clay surfaces is virtually impossible. As an example, there appears to be soft sand present within and next to the lava fields in Lavic Lake. Ground truth revealed this sand to be a mini playa, compact and solid-surfaced. Spectrally, these would-be dune features appear identical to other features, such as those found to be actual soft dunes on Prospect or Emerson. Likewise areas that, based on ground knowledge, were known not to be unconsolidated sand, appeared spectrally similar to true dunes or sand sheets. Investigation of the Dokka data, a geomorphological coverage generated at 30m spatial scale Mojave-wide, did not offer additional features because only one sand sheet was identified to exist on MCAGCC (which was delineated also with DOQs). Shape and texture are the other elements used to identify and delineate features from a DOQ. A star dune was identified in Maumee Mine, although ground truth revealed it was ancient and had long ceased to function as a dune. The substrate surface was compact and was primarily large cobbles. It was also heavily vegetated.

In the process of sampling, features identified as dunes on the DOQs, both errors of omission and commission were found to occur. These two error types are standard in any ecological survey, particularly in the use of remote sensing data, and are unavoidable. Research cannot be one hundred percent accurate despite best efforts. For reasons explained above, dunes and sand sheets were located on the ground that were not identified in the DOQs (error of omission). Areas that appeared to be sand dune features or sand sheets in the DOQs were not features of this type on the ground (error of commission). For this reason the sampling design was amended to maximize sampling in suitable habitat and to better delineate suitable habitat on MCAGCC. The original protocol was amended to maximize *Uma* sightings and data collection. The protocol for the fall field season was expanded to locate sample points based on two criteria: 1) identification of potentially suitable habitat in the form of a sand dune, sand sheet, or other loose sand area; and 2) identification of *Uma* while driving or walking. The original protocol used only the DOQ-generated dune features and was designed to evaluate differences in habitat at the plot level where *Uma* do and do not occur. The data collected in the first field season support a complete research study designed to address questions relating to *Uma* habitat based on data that characterize where these lizards are and are not found.

In the amended protocol, the field crew spent time searching for potential habitat in as many training areas as possible. Time spent searching (i.e. driving and hiking) was proportional to the relative area of the training area and estimates of potentially suitable habitat. In other words, training areas that were primarily mountainous but of relatively large size, such as Cleghorn Pass, had less intensive efforts spent searching than Lead Mountain or Lavic Lake. This revised method also served to better delineate dune and loose sand habitat throughout MCAGCC.

Under the amended protocol, the crew drove appropriate roads, which did not include washes or unofficial travel routes. When potential habitat was sighted they hiked to that location and digitized the boundaries, if possible, or approximate center point coordinates if delineating the entire perimeter was not possible. Delineating the entire perimeter was not necessarily possible due to size and time constraints or due to ëfuzzyí boundaries of the dune feature. Using random selection techniques within each dune feature, a plot was delineated and data collected in the exact manner as was done for the summer fieldwork. The same data were collected in plots during each field season. Plots of 0.5 ha were delineated and walked using constrained area search techniques. Start and stop times and temperatures were recorded, respectively. Percent cover of particle size and vegetation were assessed. All other vertebrate species encountered were recorded.

To summarize, as a result of the limitations of using DOQs to delineate suitable FTL habitat two protocols were employed that maximized data collection on FTL habitat on MCAGCC. The first field season was devoted to a statistically designed random-stratified plot survey protocol based on *a priori* habitat assumptions. The analyses of these data yielded information about *Uma* habitat at a plot level. These plots were completed before the amended protocol was implemented. The second field season was used to continue data collection to add to the database on FTL locations but was designed to maximize ground observation based sampling. Data from the amended protocol were analyzed to compare differences in *Uma* observations, primarily between adults and juveniles. The amended protocol was exploratory in that it served to expand the existing database on recorded *Uma* observations. The net result of both field seasons was a more thorough and complete sampling of both MCAGCC and BLM.

<u>Data collection</u>
For each survey plot, the date and the location were recorded in UTM zone 11, NAD 83. Each survey plot was given a survey plot ID consisting of a training area abbreviation and a number. The number was either previously assigned, as in the summer field season protocol, or for fall season designated by increasing sequential numbers. BLM plots started at 101, and used the abbreviation of ìblmî (e.g. BLM101). MCAGCC plots started at 200 and used abbreviations of the training areas (e.g. EL200 for Emerson Lake). Plot locations were not pre-assigned in the fall season because the survey points were not generated *a priori.*

The start time for each plot was recorded as the time at which data collection began, or the time at which the first *Uma* was seen when using the fall protocol. At this time air and surface temperatures were taken. Ambient air temperature was recorded at chest height in the shade 4-6 inches out from the body. Surface temperature was recorded in the shade (body shadow) on the ground, with the thermometer tip in contact with sand, but not covered by it. Subsurface temperature was taken with the probe inserted approximately four centimeters into the sand. The end time reflects the time at which transects were completed. Air and surface temperatures at end time were also recorded. Wind bearing and speed was recorded at the beginning of the survey. If it was not windy at the beginning of the survey, but developed and existed for the majority of the plot, the wind reading was taken at the finish time. The field crew also took note of cloud cover and recorded when the last known rain in the area had occurred based on their field notations. Because rainfall is spotty in both time and location in deserts, particularly in the Mojave, standardized weather or climate data were not used to populate this field. This particular field of information in the database was collected for future reference purposes only.

In each plot, the general condition of the area was recorded as climbing/falling dune, a sand sheet, or hummock habitat. In addition, the field crew noted if the sand was loose wind blown, soft-medium, or hard packed; and the presence of Mediterranean grass, Russian Thistle, Saharan Mustard, tire tracks, trash, foot traffic or any other unusual physical characteristics.

Using random sample plots within each dune sample location the percent cover of perennial and annual vegetation, as well as the substrate composition (particle size distribution) was estimated. Substrate composition was broken into four categories as listed in Table 1.

Table 1. Particle size class recorded for each plot.

Sand	<5 mm
gravel	5-75 mm
cobble	75-250 mm
boulder	>250mm

Summer field season

A stratified random sample design was developed based on sample size calculations as described above (see METHODS). Surveys serve to sample populations because we cannot count every individual within a population. Sampling is a means to make estimates about the population. It is important to note that while different means of sampling yield data that may or may not be comparable with similar statistical tests, there are a number of statistical tests that can be applied to the same data set. In this research, therefore, different statistical tests were applied to data collected in the same manner at the same time. The reason for this is that the inherent data properties, such as distribution, vary significantly. There are different tests for data that are normally distributed than for data that have non-normal distributions. Without an evaluation of the sampled data, statistical results may be invalid as assumptions are violated.

The stratified random sample design is a form of probability-based sampling and serves to maintain the independence of the sampled data points but also allows incorporation of *a priori* knowledge-based sampling. In the instance of *Uma scoparia*, it is known that the lizards occur in sandy substrate typically in the form of sand dunes, sand sheets, or other windblown (aeolian) sand features. They are not known to occur in lava, rocky surfaces, cliff faces, mountainous areas, or on paved surfaces. Looking for these animals in these locations will certainly yield negative results; they will not be found to occur there. There is a gradation in suitable habitat where they may be found, however, and evaluating this gradation is a part of the research question. These lizards do occur where vegetation exists, but the question remains as to how much vegetation is acceptable. There are other levels of detail to be investigated such as what kind of vegetation is tolerable ñ annuals, perennial shrubs or both? How much of these vegetation types is tolerable? From an abiotic habitat perspective there are also questions to be addressed such as what proportion of sand is tolerable to these lizards? Must an area be comprised entirely of loose, windblown sand or do these lizards occur where there is a mix of substrate sizes? If there is a mix, what size classes and associated proportional amounts are acceptable? These refined habitat questions can be addressed only with an experimental sample design. The sample design allows us to better refine our understanding of habitat preferences of *Uma scoparia* rather than simply surveying for presence.

The first step of the stratified random design is the ìstratifiedî portion. This means that we refined our sampling to areas where *Uma* should occur, but did not restrict the sampling to what would be considered, based on existing literature, excellent habitat. Interpretation of the digital orthophotographs (DOQs) for dune features identified the features within which sampling would occur. Features that did not appear to be comprised of loose sand such as lava or desert pavement were not sampled.

The second part of the stratified random sample was the random selection of plots within dune features identified as described above, to be surveyed. Statistically, plots are selected randomly to maintain independence and minimize bias. Because we had a variety of sizes of dune features and a wide range of dune feature frequency among training areas, the actual number of random samples per training area were weighted by amount of dune surface. In other words, training areas with a large area coverage of dunes received more random sample plots than a training area with less total area coverage of dunes. This process focused sample efforts to locations where *Uma* were expected to occur while allowing for statistical tests to be run on the data. Without the stratified random sample, no valid statements could be made about the differences in habitat where *Uma* did or did not occur.

The sample design was created to maximize identification of *Uma* habitat as evidenced by the occurrence of individual animals. Survey plots were sampled regardless of appearance on the ground because the objective was to quantify habitat characteristics of *Uma* on MCAGCC. To make valid statements about where individuals do occur, it is necessary to compare against where they do not occur. As an example, if *Uma* were found in areas that contained 97-100% sand, it would not be valid to say that any area with 97-100% sand is *Uma* habitat because we cannot say that they *do not* occur under the same conditions. If however, it was found that *Uma* occurred in areas with 87-100% sand but individuals were at the same time found *not* to occur in areas with 0-95% sand, we could test for statistical significance between the sampled areas and make conclusions about percentage of sand as an indicator of habitat suitability. Without data on both where individuals occur and where they do not occur, no conclusions about the measured variable can be drawn with the exception of measured range of the data set.

The protocol for the summer field season was as follows. The field crew navigated to each of the selected locations using Global Positioning System (GPS) technology. The GPS coordinate was used as the center of the first 0.5 ha plot (70x70m). On rare occasions the survey plot was altered from the designated coordinates and size because the actual dune was significantly less than 0.5 hectare and/or bordered by boulders. Survey plots were only completed when the air temperature was between 29 and 40 degrees Celsius and this range was based on published literature. Plot boundaries were delineated and data were collected within each plot with no time limit. The 0.5 ha plot was walked in repeated linear non-overlapping transects to identify any *Uma*. Transects were approximately 5 meters apart, parallel with one of the survey plot borders. When a lizard or other reptilian species was sighted in the survey plot, the location of the lizard was recorded with the GPS. If the lizard was an *Uma* the air, surface, and sub-surface temperatures were recorded and a soil sample was taken. Other characteristics of the original location of the *Uma* were recorded (i.e.- open/shade, sun/perennial/annual). The field crew also recorded any significant behavior. Once the survey plot was completed, the field crew took final air and surface temperatures and recorded the finish time. Start and stop time, ambient air, surface and subsurface temperatures, wind speed, vegetation cover and substrate composition were recorded at all plots. Other species, such as desert tortoises, were noted and locations taken with the GPS. The last known rain, cloud cover, and any other notable topographic features were also documented.

All but 12 plots were sampled in the summer field season. These remaining 12 plots were visited during the fall field season, completing the stratified random sampling survey. Only after these 12 plots had been completed did the ground-based survey protocol begin.

Fall field season

The field crew drove throughout the designated training areas on MCAGCC or through BLM land looking for suitable *Uma* habitat. Suitability was determined by the presence of large patches or continuous loose to medium packed non-granular sand. The field crew often looked in areas of hard packed sand, Mediterranean grass, or otherwise marginal habitat, as it is often difficult to distinguish the quality of the habitat without walking through the area. Approximately 20 minutes was spent investigating potential habitat on foot once identified as such from the road. During this time coordinates for any reptilian species found were recorded. If suitable habitat was not found, the crew returned to their vehicle and continued driving. If suitable habitat was located, survey data were collected, in the method described above for ìsummer field season.î

Searching for suitable habitat was done only when the temperature was above 23 degrees Celsius. If an *Uma* was seen at temperatures this low, the field crew recorded its location and all related data as described above under ìsummer field seasonî. Survey plots were typically not started until the air temperature had reached 25 degrees Celsius. The maximum ambient air temperature for conducting surveys was 40 degrees Celsius.

Once habitat was determined to be suitable, or an *Uma* was seen, a survey plot was delineated and data collected. Generally the first *Uma* became the center point for the survey plot, which was then oriented with the coordinate system. The exception to this was when *Uma* was located on the edge of the habitat, in which case the individualís location became a corner for the survey plot. This enabled the field crew to ensure that the survey plot covered the majority of the suitable habitat, and therefore gave a better assessment of the number of *Uma* in the area. If no *Uma* were seen initially, the corner of the survey plot was randomly chosen by the toss of a pin flag.

The manner in which the survey plot and sample plots were completed did not vary between the summer and fall protocols.

In the fall field season, the field crew took note of any lizard that they saw while traveling and recorded its position with GPS as well as the species name and other ancillary information. This same information was taken for reptilian species other than *Uma* that were found in survey plots. Species were noted by a four-letter designation, using the first two letters of the genus and the first two letters of the species.

Species Abbreviations

Cadr	*Callisaurus draconoides*	Zebra-tailed Lizard
Cnti	*Cnemidophorus tigris*	Western Whiptail
Cova	*Coleonyx variegateus*	Western Banded Gecko
Dido	*Dipsosaurus dorsalis*	Desert Iguana
Gasi	*Gambelia silus*	Blunt-nosed Leopard Lizard
Gawi	*Gambelia wislizenii*	Long-nosed Leopard Lizard
Goag	*Gopherus agassizii*	Desert Tortoise
Phpl	*Phrynosoma platyrhinos*	Desert Horned Lizard
Uma	*Uma scoparia*	Mojave Fringe-toed Lizard
Urgr	*Urosaurus graciosus*	Long-tailed Brush Lizard
Utst	*Uta stansburiana*	Side Blotched Lizard

Each *Uma* that was found within a survey plot was given a unique identification consisting of 'uma', the sequential number that identified that individual, and the survey plot ID. For example, the fourth *Uma* in Emerson Lake 208 was designated as: "uma04EL208". For each *Uma* found in a survey plot, time of sighting, air, surface, and sub-surface temperature were taken. The field crew also recorded if the *Uma* was seen in the open or shade, in a perennial, annual, or burrow. In the fall season a large number of juvenile *Uma* were seen, and when the field crew could determine the juvenile or adult status, it was noted.

In the fall season data was taken from the data sheets and entered into ArcView manually. A polygon theme for survey plots, a point theme for *Uma* in each survey plot and a point theme for other species seen (including other species and *Uma* seen on the way to the survey plot) were created for both BLM and MCAGCC land. A theme that identified the location of and type of other reptiles that were found was also created. Data was entered within one week of visiting each plot to help ensure accuracy, and was double-checked for quality control at the end of the field season. The themes were then merged with the summer season once all the data had been collected and entered for the fall. One file with all *Uma* data was then created from all files.

MCAGCC Training Areas

The field crews sampled fifteen of the twenty-four training areas on MCAGCC between June and November 2001 (Table 2). These training areas were sampled for a total of 27 days in the summer field season and 22 days in the fall season.

Table 2. Number of plots and days spent in each MCAGCC Range Training Area.

MCAGCC	Summer Plots	Fall Plots	Total Number of Plots		Number of Days Summer	Number of Days Fall	Total Number of Days
Acorn	6	1	7		3	1	4
Bullion	0	0	0		0	1	1
Cleghorn Pass	0	0	0		0	1	1
Delta	0	0	0		0	1	1
East	2	0	2		2	0	2
Emerson	16	2	18		4	6	10
Gays Pass	0	0	0		0	1	1
Gypsum Ridge	4	4	8		2	2	4
Lavic Lake	8	0	8		4	1	5
Lead Mountain	4	2	6		2	2	4
Mainside	6	0	6		2	2	4
Maumee Mine	4	0	4		1	1	2
Prospect	4	2	6		3	2	5
Quackenbush	4	0	4		2	1	3
Tortoise	4	0	4		2	0	2
Total	62	11	73		27	22	49

Bureau of Land Management Areas

DOQs were not available for BLM land within the 15km buffer of MCAGCC. Although the DOQs for MCAGCC did extend beyond the installation boundary, the additional coverage was not extensive and no dune features were identified within the area covered by the MCAGCC DOQs. Dune features to sample were identified based on knowledge of the area from multiple sources, including NREA officials, BLM officials, and researchers personal knowledge of the areas. The stratified random sample approach was employed for these identified areas in the same manner as was done for MCAGCC plots.

BLM land was surveyed four days in the summer and 12 days in the fall. All the BLM lands visited in the summer had survey plots, but some of the visits in the fall were of a purely exploratory nature and did not have survey plots, as suitable habitat was not found in these areas. To clarify, exploration on BLM land was undertaken to locate previously unknown habitat areas, particularly since adequate dune coverage did not exist for BLM land and DOQs were not available from which to derive a dune feature coverage. BLM plots and exploration occurred when scheduling did not permit surveying on MCAGCC as well as after survey plots for the entire study were completed. Exploration on BLM land in no way inhibited or reduced the amount or quality of data collected on MCAGCC. Exploration of BLM land was part of the amended protocol and was therefore run parallel and as a part of the amended fall sampling strategy. There were a total of five areas of BLM in which plots were completed in the summer and fall (Table 3):

1. Spy Mountain, west of the Acorn training area is bordered to the north and east by MCAGCC and by private land to the west and south. Sites were completed in the summer field season. Further investigation in the fall season determined that there was no suitable habitat and additional plots were not generated for this area.

2. West Mainside was visited during the summer season, and four plots were completed at predetermined locations. This area is located just west of MCAGCC. No further investigation was required in the fall field season.

3. Copper Mountain is southwest of MCAGCC. Plots were done in the fall season only. The area is surrounded by private land.

4. Valley Mountain is south of Cleghorn Pass. The western border is a combination of MCAGCC and private land, the southern border is private land, and the eastern border is the Cleghorn Wilderness. Plots were visited in the fall field season.

5. Bristol Mountain is north of Highway 40, and east of the town of Ludlow. Plots were done in the fall field season. Plot locations were believed to fall within wilderness. Two BLM access roads create the northern and southern boundaries of the dune habitat.

Table 3. Number of plots and days in each BLM study area.

BLM	Summer Plots	Summer Days		Fall Plots	Fall Days
Copper Mountain	0	0		6	6
Valley Mountain	0	0		2	2
Bristol Mountain	0	0		2	2
West Mainside	4	2		0	0
Spy Mountain	3	2		0	1
Total	7	4		10	11

Scheduling

The work was scheduled by submitting requests for access to training areas through MAGTFTC NREA. Scheduling with MAGTFTC Range Control (BEARMAT) is critical for a number of reasons. First, safety was the highest priority. Some training areas were available for surveying at any time, as they are not used for live-fire military training. Other training areas were off limits entirely and were not sampled. The field crews and NREA were able to schedule sampling within the training areas that were indicated to have suitable FTL habitat. The days in which MCAGCC training areas were unavailable were used to survey BLM land.

Equipment

Various kinds of equipment were necessary for fieldwork. A 4X4 vehicle was required for travel throughout the installation. A Motorola cell phone with AT&T wireless services was used to communicate with BEARMAT and for emergency purposes.

A Garmin 12XL GPS receiver was used for data collection and in conjunction with topographic maps provided by MCAGTFTC for navigation. The field crew used ArcView generated maps with ownership layers created by the lab at MCAGCC to determine the extent of BLM land. In addition, a 1997 BLM Special Edition Surface Management Status Desert Access Guide was provided. The GPS was also used to navigate to the corners of the survey plots and the UTM coordinates were marked at all lizard sighting locations. All of the data was taken on field sheets, and then transferred into a laptop using ArcView version 3.2.

Statistical Analyses

Plot level analyses were conducted on the data collected at the plot level based on stratified random sampling. F-tests were run on vegetation, particle size, and temperature data to determine the appropriate comparative tests for significant difference of plots with and without *Uma.* F tests determine whether or not the variance of two samples, in this case plots with *Uma* and plots without *Uma*, are similar or not. Summary statistics were also calculated to determine distribution frequencies of the data. The Shapiro-Wilk W test, in combination with frequency histograms and normal plots were used to evaluate which habitat variables were non-normally distributed.

Based on the results of the F-tests, Shapiro-Wilk W test, frequency histograms, and normal plots, Mann Whitney U tests, also called the Wilcoxon rank-sum test, were then run to determine if there were statistically significant differences between habitat variables in plots where *Uma* were and were not found. A significance level of $\alpha = 0.05$ was used in all calculations. Mann Whitney U tests, which are non-parametric, are more appropriate than an independent samples t-test when data are non-normally distributed. Confidence intervals around the difference between medians were computed using the Hodges-Lehman method. T-tests were appropriate to compare temperature data sets as these data were normally distributed. Two-sided t-tests were run at a significance level of $\alpha = 0.05$ on temperature data.

Spearman-rank correlation was used to determine the degree of association between the number of *Uma* found in a given plot and habitat variables. This was done to determine if there were an obvious relationship between density of individuals and physical habitat. This test statistic is also non-parametric and is equivalent to ranking the observations then analyzing the ranks using the Pearson correlation. P-values were computed using the t-approximation.

One-way analysis of variance (ANOVA) was run on individual *Uma* observation data. This is a formal test of the difference between the means of samples. Total variance is partitioned into components due to between-group variation and within-group variation. Contrasts were also run to determine whether or not adults and juveniles differed. Although this is rather redundant given only two groups, it allowed evaluation of confidence intervals (95% CI) about group means.

LizLand Analysis

The LizLand spatial model was based upon primary and secondary data, as well as qualitative and quantitative data. The digital LizLand base map was composed of geomorphic landform and surface composition (MDEP, 2000), heads up digitized sand dunes from MAGTFTC provided DOQís, and USGS 1:100,000 Digital Line Graph (DLG) hydrology data (USGS, 1989). Unfortunately, the MAGTFTC DOQís were limited to a very short buffer zone around MCAGCC, thus the LizLand model for the majority of the BLM lands cannot be considered as accurate. The original MDEP (2000) geomorphic landform and surface composition data consisted of 32 geomorphic landform and 24 surface compositions categories. The data were collapsed categories into 10 relevant habitat classes based upon geomorphic landform (i.e. macro landforms), surface composition and relative rockiness: Sand and Gravel, Sandy Wash, Rocky Wash, Sand Sheet, Wind Blown Sand, Erosional Highland, Inselberg, Desert Pavement, Rocky, Playa, and two non relevant habitat classes: Reservoir and Unmapped. The DLG linear hydrology data were buffered 50m on either side to create a 100m wide polygon hydrology data set. The polygon hydrology data were intersected with the 12 habitat classes and then collapsed into two categories: rocky wash or sandy wash. A DLG derived wash was considered rocky if it intersected one of the following habitat classes: Erosional Highlands, Inselbergs, Desert Pavement, Rocky or Rocky Washes. A wash was considered sandy if it intersected Sand and Gravel, Sandy Wash, Sand Sheet, Wind Blown Sand or Playa. Finally, the 12 habitat classes derived from the MDEP (2000) data were merged with the two-category (either rocky or sandy wash) hydrology data set to form a single data layer, the base map of geomorphic classes for LizLand.

Assignment of suitability to any one habitat class was based upon quantitative data (primary fieldwork) and "weight of evidence" qualitative data (existing literature, expert opinion and author knowledge). In both cases we searched for a link between habitat preference and macro landforms via micro landform characterizations.

RESULTS

MCAGCC Training Areas

Tables 4 and 5 show the number and species of herpetofauna located and identified on MCAGCC for summer and fall field seasons, respectively. Figure 3 shows the locations of all *Uma* observed to date from MCAGCC surveys. Figure 4 shows the locations of *Uma* sightings for the entire survey. In the summer, *Cnemidophorous tigris* was the most abundant species found and *Uma scoparia* was third most abundant. In the fall, *Uma* was by far the most prevalent lizard on the installation with more than 126 individuals identified.

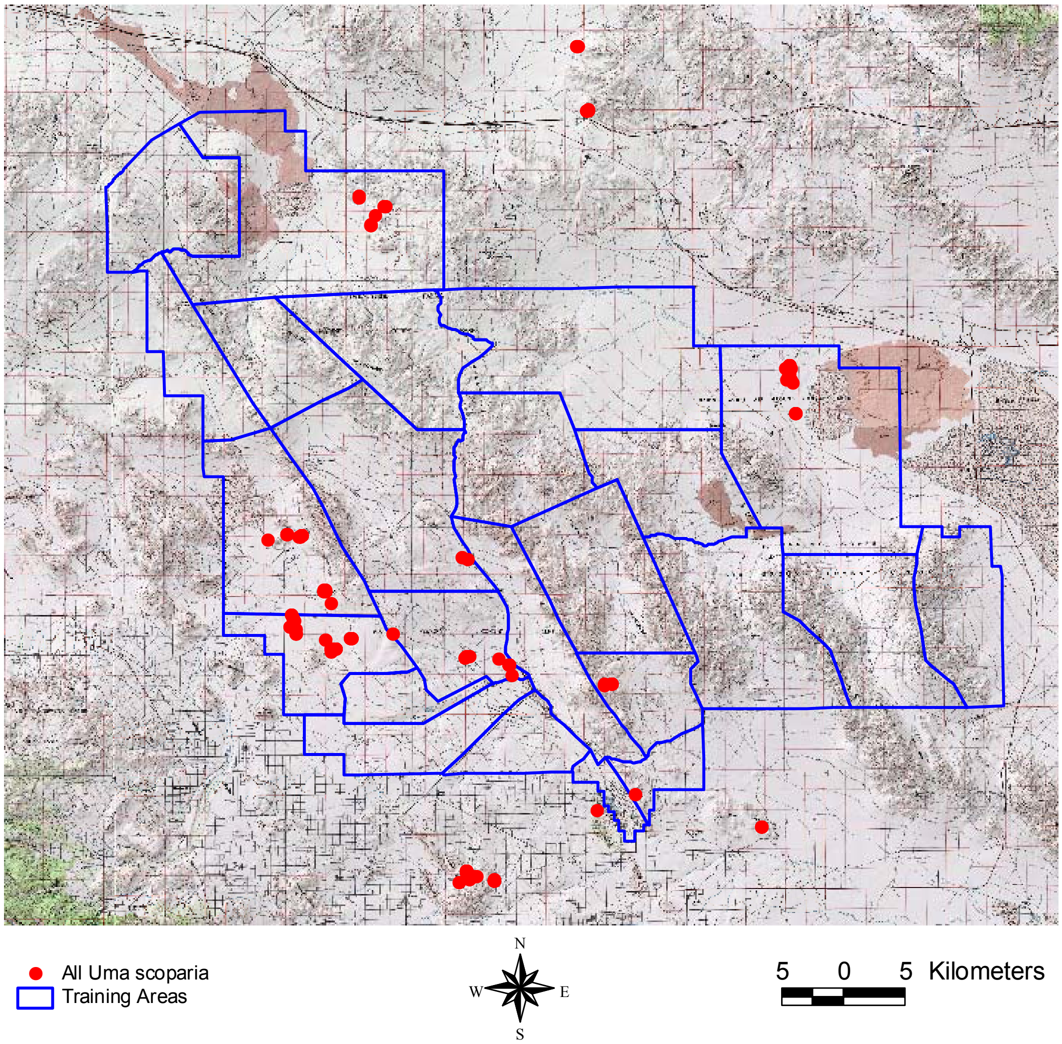


Figure 3. Representation of all *Uma* sightings for 1983-2001.

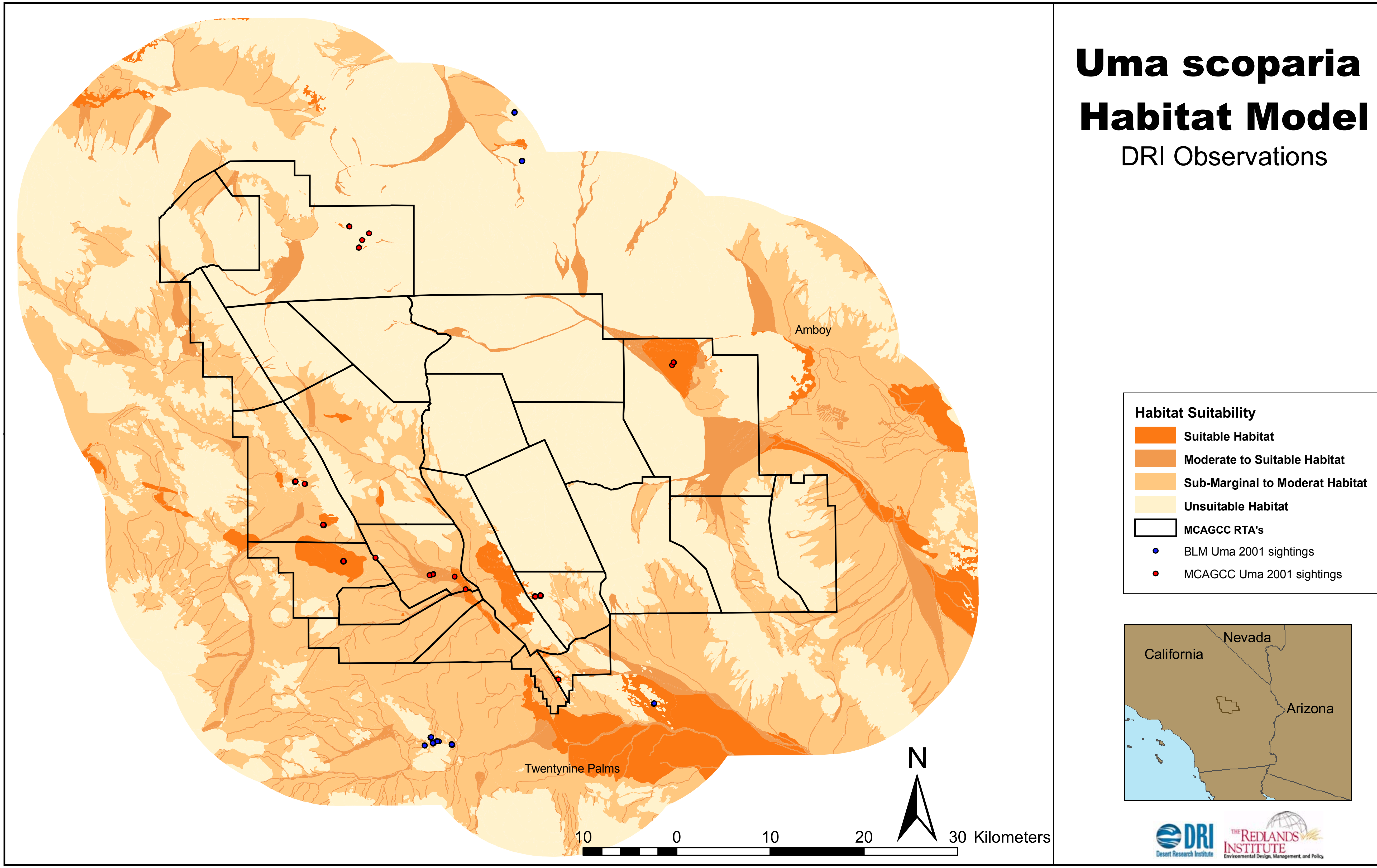


Figure 4. All *Uma* sightings for the 2001 survey.

Table 4. Number and species of lizard observed in the summer sampling period in each MCAGCC Range Training Area, including animals seen outside the individual survey plots.

MCAGCC	Uma*	Cadr	Utst	Cnti	Phpl	Goag	Gawi	Gasi	Dido	Cova
Acorn	6	9	0	11	3	0	0	0	0	0
Emerson Lake	0	2	2	1	4	0	0	0	0	1
Gypsum Ridge	3	0	0	3	1	0	0	0	2	0
Lead Mnt.	0	11	0	1	1	0	0	0	0	0
Lavic Lake	14	5	10	3	8	0	0	0	0	0
Prospect	9	6	4	6	2	0	0	0	2	0
Quackenbush	0	2	0	10	2	0	0	0	1	0
Mainside	0	0	3	0	0	0	0	0	1	0
Maumee Mine	0	1	0	1	1	0	0	0	0	0
Tortoise	0	1	0	13	1	0	0	0	1	0
Total	32	37	19	49	23	0	0	0	7	1

Table 5. Number and species of lizard observed in the fall sampling period in each MCAGCC Range Training Area, including animals seen outside the individual survey plots.

MCAGCC	Uma	Cadr	Utst	Cnti	Phpl	Goag	Gawi	Gasi	Dido	Cova
Acorn	15	0	0	1	1	0	0	0	0	0
Bullion	0	0	0	0	0	0	0	0	0	0
Cleghorn Pass	0	0	0	0	0	0	0	0	0	0
Delta	0	1	0	0	0	2	0	1	0	0
East	0	11	1	5	1	0	3	0	0	0
Emerson Lake	54	22	8	17	5	0	0	0	0	0
Gays Pass	0	0	0	0	0	0	0	0	0	0
Gypsum Ridge	9	9	0	1	0	0	0	1	0	0
Lead Mountain	4	0	0	0	0	0	0	0	0	0
Lavic Lake	0	0	0	0	0	0	0	0	0	0
Prospect	31	3	1	6	0	0	0	0	0	0
Quackenbush	0	1	0	0	0	0	0	0	0	0
Mainside	2	0	2	1	0	0	0	0	0	0
Maumee Mine	0	2	4	5	0	1	0	0	0	0
Total	115	49	16	36	7	3	3	2	0	0

Acorn

The southwest part of this training area consists of a hard packed sand sheet with several washes running throughout the area. The northeast part of the training area consists of a continuous soft packed sand sheet that extends into Emerson Lake. Fifteen juvenile *Uma* were observed here on October 29, 2001 between 1010 and 1149. Vegetation cover was 8%

perennial with no annuals and 98% sand where *Uma* were identified. Figure 5 shows the vegetation cover and Figure 6 shows the surface composition for all plots in Acorn training area, respectively. Air temperature increased from 25 to 29 degrees C, surface temperature increased from 32 to 41 degrees C and subsurface temperature ranged between 26 and 34 degrees C during the survey. There was no wind. All animals identified were juveniles.

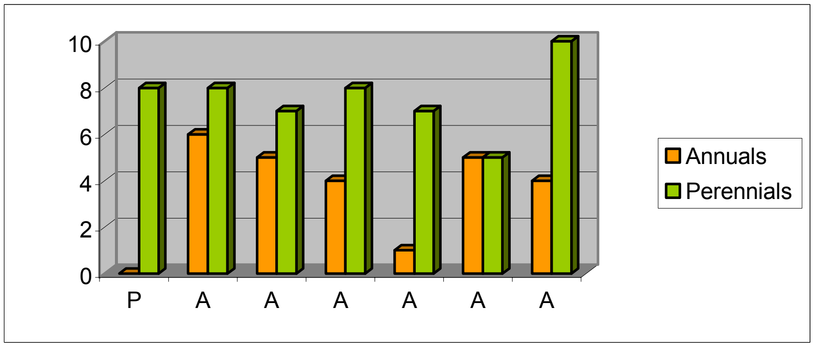


Figure 5. Percent vegetation composition for plots on Acorn RTA. ìAî indicates no *Uma* in plots. ìPî indicates *Uma* present in plot.

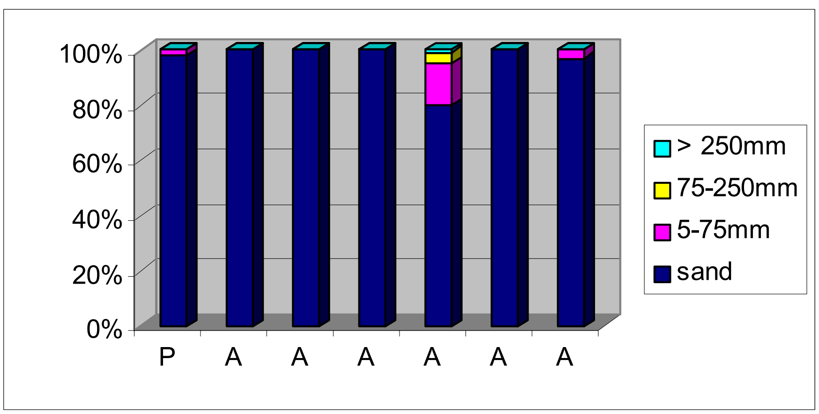


Figure 6. Percent particle size distribution for plots on Acorn RTA. ìAî indicates no *Uma* in plots. ìPî indicates *Uma* present in plot.

Bullion

This training area is mountainous, with one large valley that acts as a wash. No dune features were identified within this training area in the DOQs and thus no plots were identified for sampling. Therefore this training area was only sampled in the fall using the amended protocol to verify that no habitat pockets existed that were missed in the DOQs. The few sandy areas the field crew found was of a coarse grain that was hard packed. It is also one of the more pristine training areas, with little trash, tracks or unexploded ordnance. No *Uma* were found here.

Cleghorn Pass
The training area has little loose sand, and where sand does accumulate, it has high rock content. In general the area is rocky and hard packed. No dune features were identified within this training area in the DOQs and therefore it was only sampled in the fall. No *Uma* were found here.

Delta
The training area is heavily used in training exercises. A climbing dune exists here but no *Uma* were observed. Three other species were recorded, however, including two tortoises in one burrow. Also two tarantulas were observed.

East
This training area consisted of hard packed, rocky washes. Two juvenile *Uma* were found here on the border of East and Mainside training areas on November 6, 2001. Dune features were identified in the DOQs but these dunes are highly variable in terms of loose sand quality. The individual *Uma* were located in a 99% sand sand sheet (Figure 7). Vegetation cover was estimated to be 2% annuals and 2% perennials. Figure 8 shows the range of vegetation cover for plots surveyed in East Training area. Ambient air temperature remained a constant 25 degrees C while surface temperature increased from 29 to 32 degrees C.

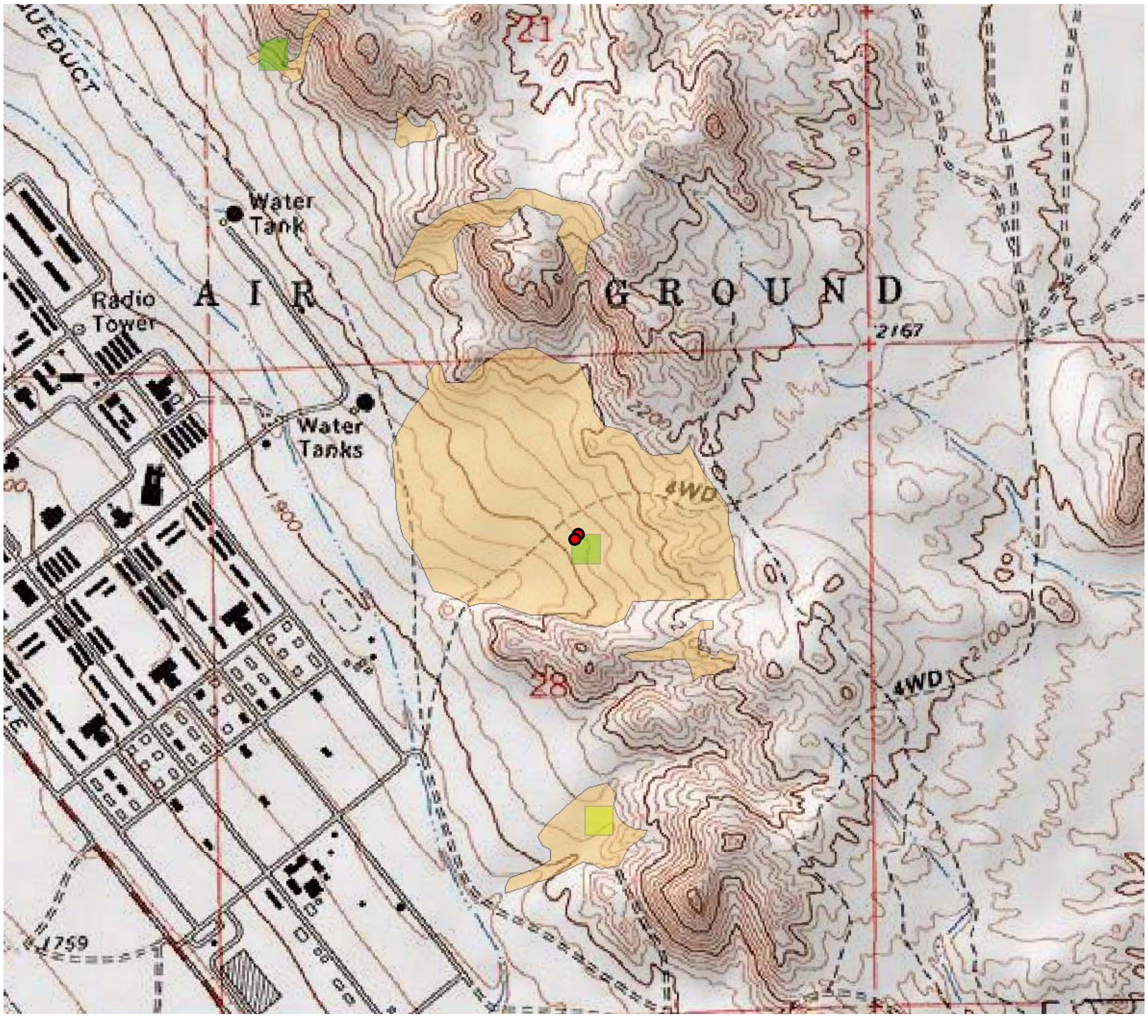


Figure 7. Representation of location of *Uma* sightings (red) on East RTA near Mainside. Survey plots depicted in green and DOQ delineated sand dunes are tan overlaid on 1:24k USGS topographic maps.

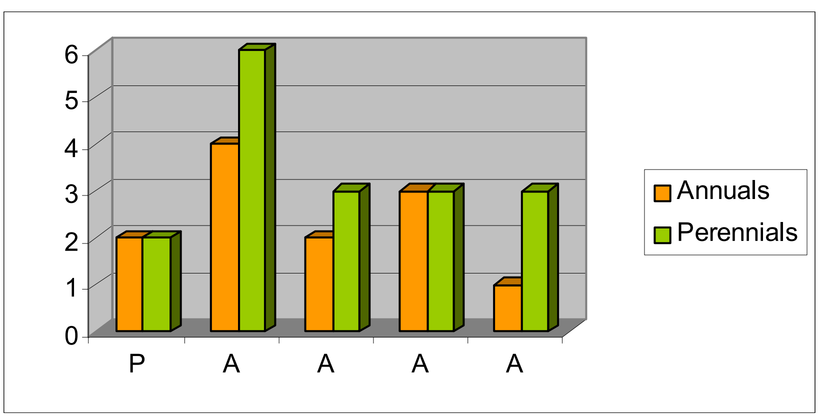


Figure 8. Vegetation composition for plots on East RTA. "A" indicates no *Uma* in plot. "P" indicates *Uma* present in plot.

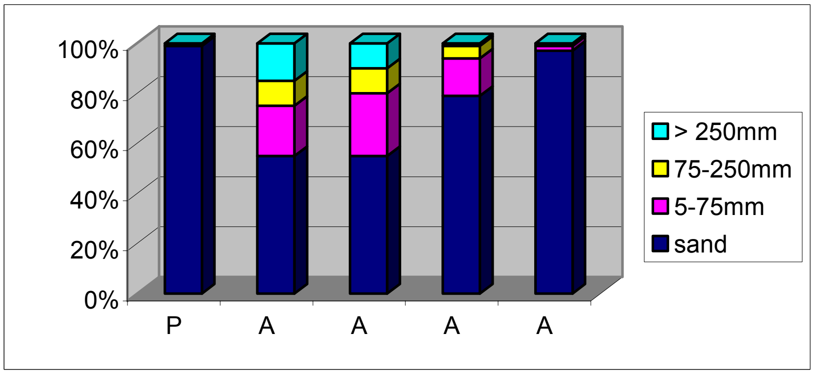


Figure 9. Particle size distribution for plots on East RTA. "A" indicates no *Uma* in plots. "P" indicates *Uma* present in plot.

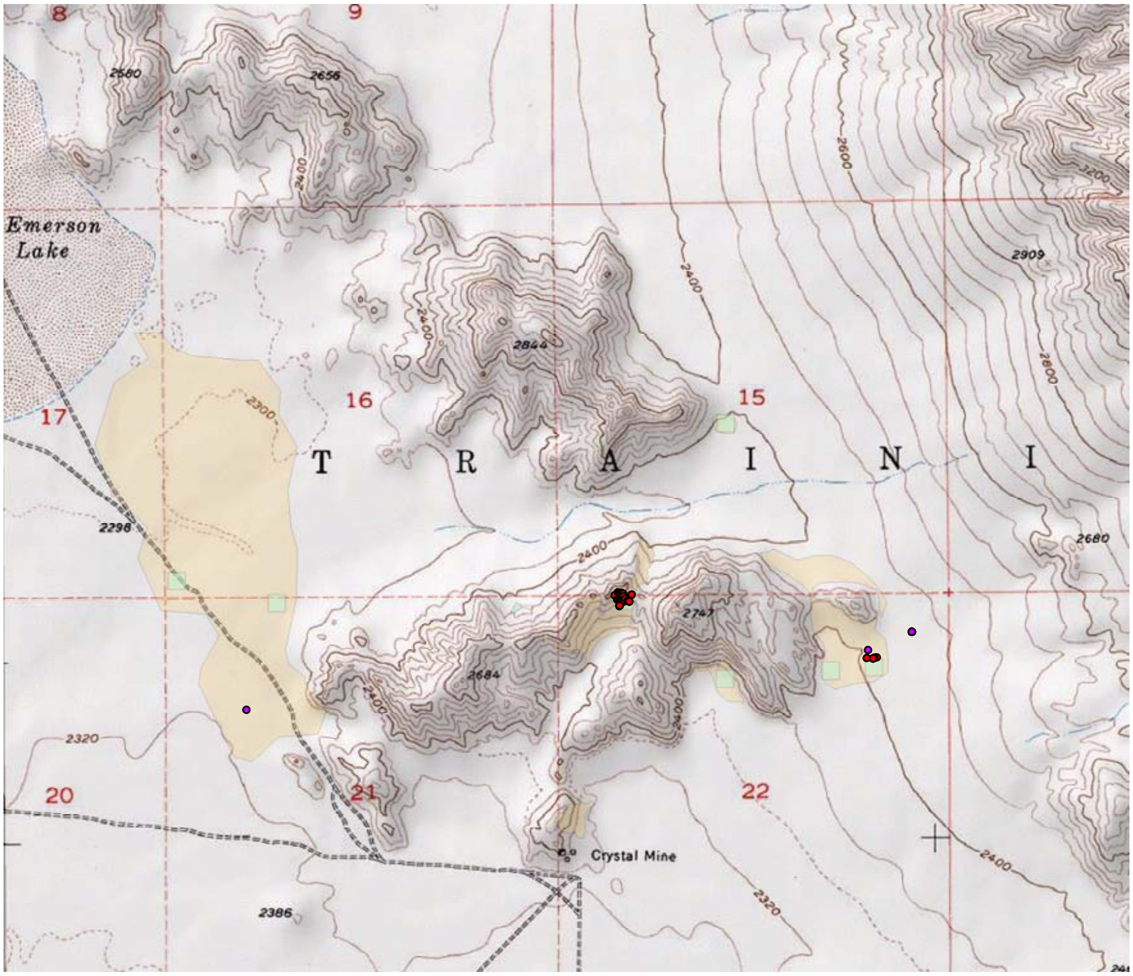


Figure 10. Example of sample plots (green) and locations of *Uma scoparia* identified in year 2001 (red) and in 1982 (purple) for Emerson Lake. Potential dune features identified from DOQs shown in tan.

Emerson Lake

Fifty-four individual *Uma* were identified in Emerson Lake. Figure 10 gives an example of plots and locations of lizard observations in 2001 and 1983 by Fromer *et al*. In 2001 a total of forty-five juvenile, seven adults and two unknown were observed. Ambient air temperature ranged between 23 and 31 degrees C. Surface temperatures ranged from 24 and 44 degrees C and subsurface temperatures ranged from 20 to 43 degrees C. Wind speeds ranged between 0 and 11 mph during sampling. Individuals were observed between 0953 and 1329 on three different days between October 7 and October 24, 2001. Perennial cover where *Uma* were observed ranged between 4 and 7% (Figure 11) and substrate was between 97 and 100% sand (Figure 12). The field crew noted there were ìlots of tank tracksî in the plots where *Uma* were observed.

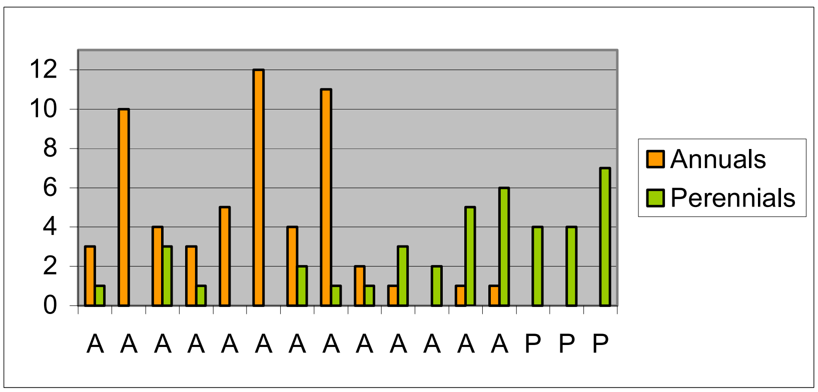


Figure 11. Vegetation composition for plots on Emerson Lake RTA. ìAî indicates no *Uma* in plot. ìPî indicates *Uma* present in plot.

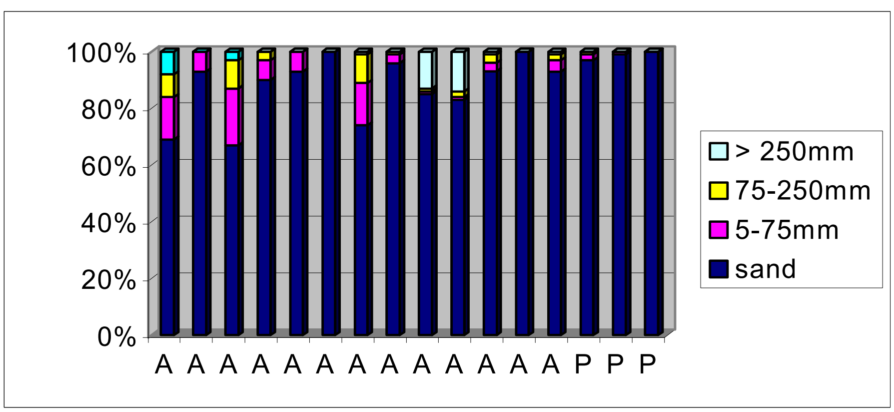


Figure 12. Particle size distribution for plots on Emerson Lake RTA. ìAî indicates no *Uma* in plot. ìPî indicates *Uma* present in plot.

Gays Pass

The only sand identified in this training area was the coarse sand in the road. Most of the surface was rock, and vegetation was sparse. No *Uma* were observed here and no dune features were identified.

Gypsum Ridge

A total of nine *Uma* were were located here. Individuals were located between 0945 and 1400 on four different dates: 6/12, 7/16, 9/27, and 10/15/2001. Ambient air temperature ranged between 29 and 37 degrees, surface temperature ranged between 25 and 45 degrees, and subsurface temperatures ranged between 26 and 41 degrees. Wind speeds ranged between 0 and 18 km/hr. All *Uma* were observed on sand sheets. Locations which had *Uma* had 7% cover each of annuals and perennials, respectively (Figure 13). The other two locations had no annuals and 4% perennials. Substrate was between 99 and 100% sand although two locations were noted as being ìhard packî (Figure 14). There is hummock habitat throughout this training area and several patches of medium packed sand sheets interspersed with hard packed sheets were noted. Tank tracks were moderately abundant throughout the training area and potential habitat exists throughout the entire training area.

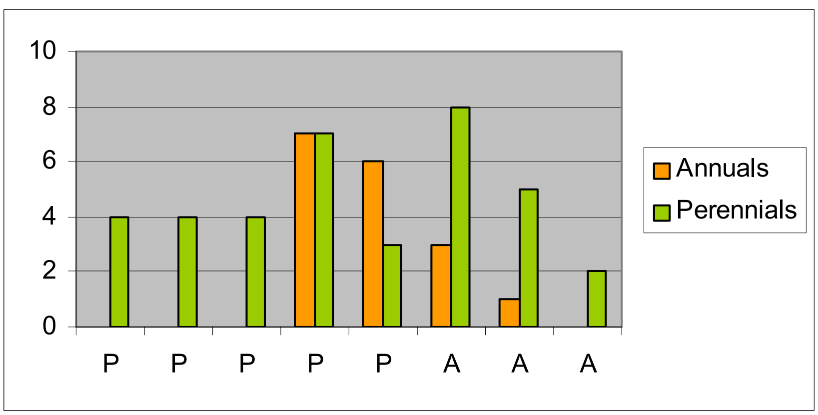


Figure 13. Vegetation composition on plots surveyed in Gypsum Ridge RTA. ìAî indicates no *Uma* in plot. ìPî indicates Uma present in the plot.

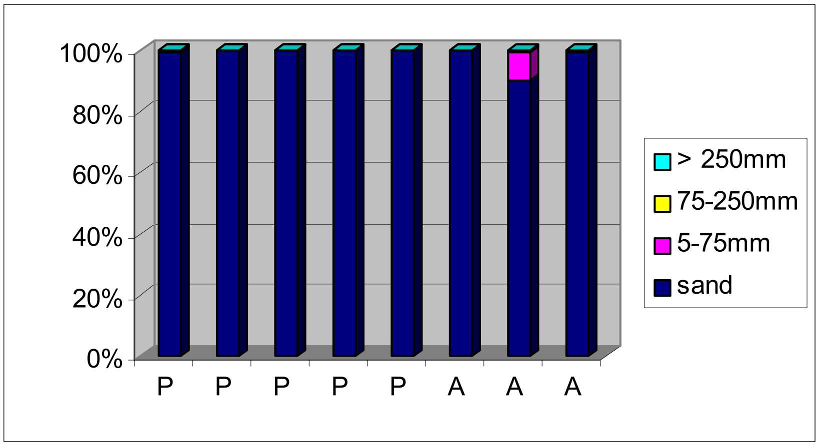


Figure 14. Particle size distribution for plots on Gypsum Ridge RTA. ìAî indicates no *Uma* in plot. ìPî indicates *Uma* present in plot.

Lavic Lake

Eleven *Uma* were located in four locations in the only potential habitat in this training area characterized as climbing/falling dune or sand sheet. These sand features were identified on the DOQs. Most of Lavic Lake training area is rocky substrate and lava flow and contains a great deal of military training trash and ordnance. The surveys were conducted between 0847 and 1002. Air temperatures ranged between 29 and 36 degrees, surface temperatures between 35 and 50 degrees, and subsurface temperatures between 31 and 35 degrees C. Wind speeds ranged between 0 and 10 km/hr. Percent vegetation cover where *Uma* were observed ranged between 2 and 4 percent for annuals and 5 to 7 percent for perennials where *Uma* were observed (Figure 15). Plots ranged between 63 and 91 percent sand where *Uma* were observed. Figure 16 shows particle size for all plots in Lavic Lake training area.

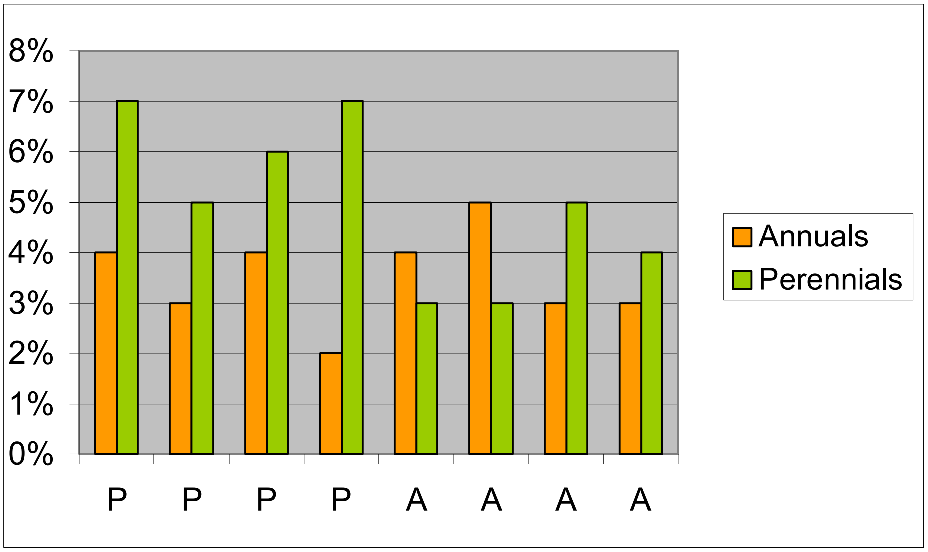


Figure 15. Vegetation composition on plots surveyed in Lavic Lake RTA. ì Aî indicates no *Uma* in plot. ì Pî indicates Uma present in the plot.

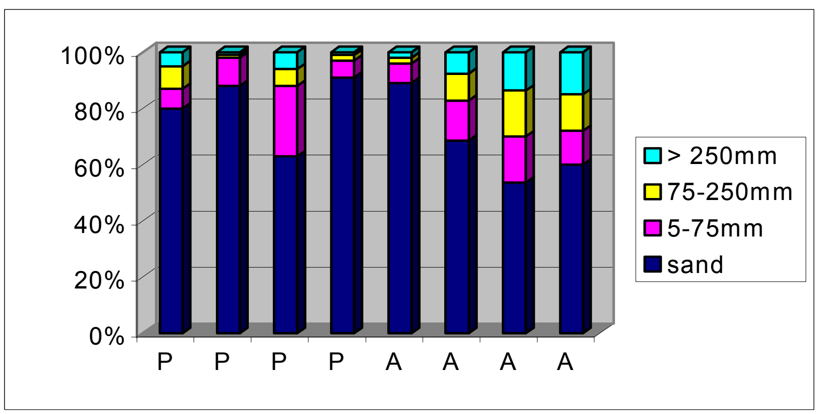


Figure 16. Particle size distribution for plots on Lavic Lake RTA. ì Aî indicates no *Uma* in plot. ì Pî indicates *Uma* present in plot.

Lead Mountain

Three *Uma* were identified here, one juvenile and an unknown on 9/24 and one juvenile on 9/25/2001. The surveys were conducted between 0951 and 1210 on what was characterized as a dune sheet. A hard packed rocky sand sheet covers most of this training area and Lead Mountain training area is surrounded by rocky mountains. A small strip of hummock habitat exists in the northern part of the training area, west of Dry Lake. Ambient air temperatures range between 34 and 40 degrees, surface temperatures ranged between 39 and 47 degrees, and subsurface temperatures ranged between 34 and 47 degrees C. No annuals occurred in plots where *Uma* were identified and perennial cover ranged between 3% and 6% (Figure 17). Plots were between 97% and 100% sand with no more than 3% of particles between 5-75mm (Figure 18). Wind speed was 7 km/hr. Figure 18 shows the particle size distribution for all plots surveyed in Lead Mountain training area.

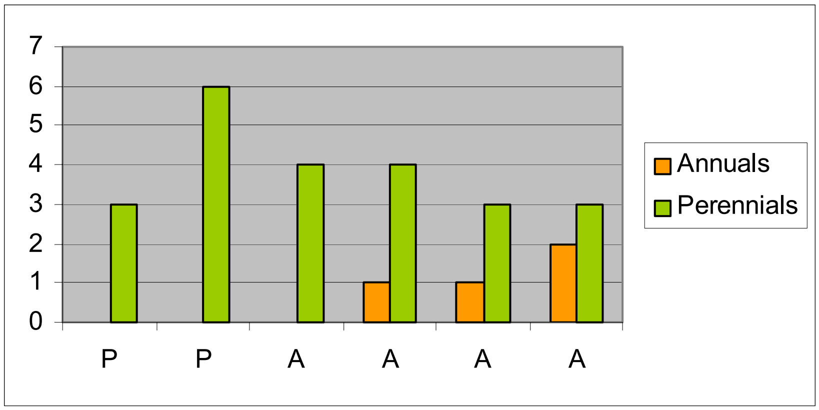


Figure 17. Vegetation composition on plots surveyed in Lead Mountain RTA. ì Aî indicates no *Uma* in plot. ì Pî indicates Uma present in the plot.

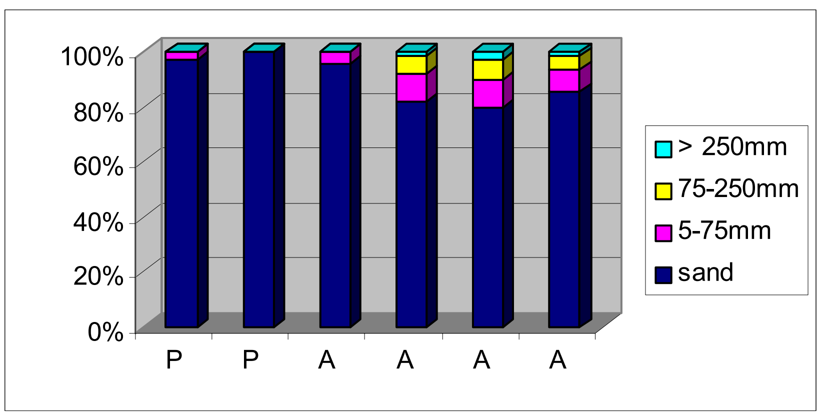


Figure 18. Particle size distribution for plots on Lead Lake RTA. ì Aî indicates no *Uma* in plot. ì Pî indicates *Uma* present in plot.

Mainside

This training area is a high use area and is covered in foot traffic, trash, and several running paths. The sand in the area has drifted east into the hills and sand dunes in this training area are soft packed. No *Uma* were found here, but what would appear to be suitable *Uma* habitat does exist.

Prospect

This training area is mostly covered by a continuous rocky sand sheet and is surrounded by mountains. Where potential habitat exists, there is little indication of mechanical disturbance from training or testing. This may be due to the extremely difficult terrain that must be traveled to get to the habitat location. Thirty-seven *Uma* were located at two plots in Prospect. Ambient air temperature ranged between 27 and 32 degrees C, surface temperature was between 22 and 44 degrees C and subsurface temperatures ranged between 22 and 44 degrees C. One plot, surveyed on 6/26/01, had 5% annuals and 8% perennials. On the other plot surveyed on 10/17/01, no annuals were present and perennials were estimated to be 11% on a surface of 100% sand. Figure 19 shows vegetation cover for all plots. Surface substrate for plots are shown in Figure 20. No wind occurred on either of the sample days.

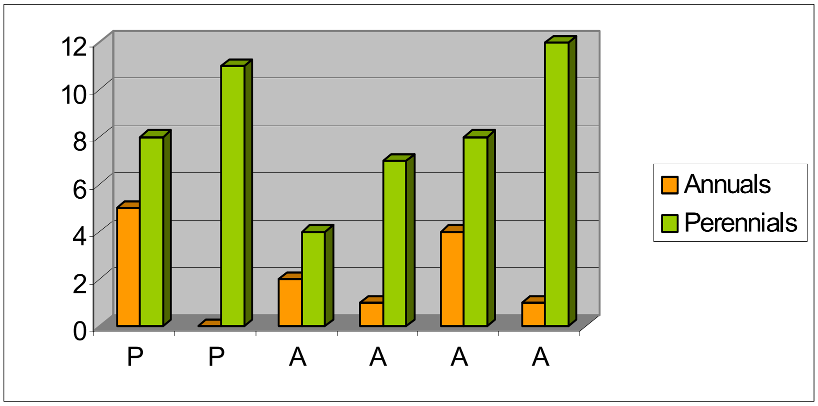


Figure 19. Vegetation composition on plots surveyed in Prospect RTA. ìAî indicates no *Uma* in plot. ìPî indicates Uma present in the plot.

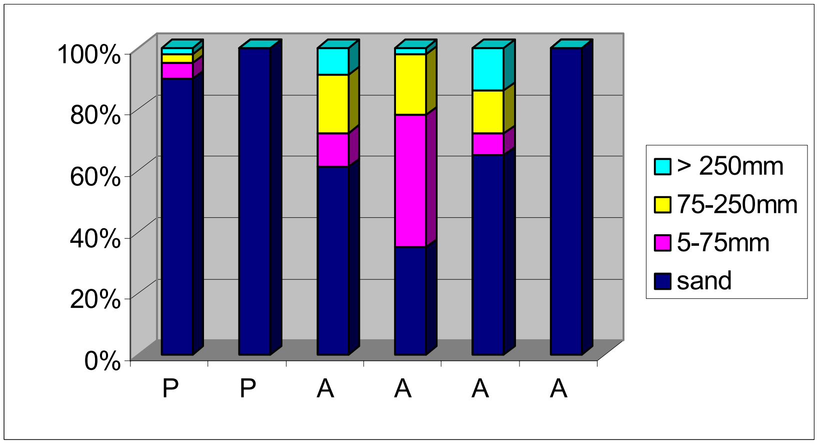


Figure 20. Particle size distribution for plots on Prospect RTA. ìAî indicates no *Uma* in plot. ìPî indicates *Uma* present in plot.

Maumee Mine
This training area consisted of hard packed rocky substrate. There were several washes throughout the training area. There were small patches of medium packed sand but in the four survey plots no *Uma* were observed. Figure 21 shows the vegetation cover for the four plots surveyed. Figure 22 shows the substrate composition of those same four plots.

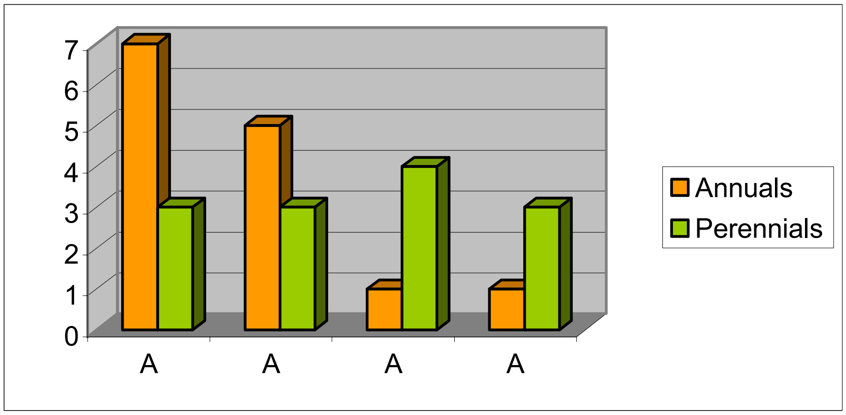


Figure 21. Vegetation composition on plots surveyed in Maumee Mine RTA. ìAî indicates no *Uma* in plot. ìPî indicates Uma present in the plot.

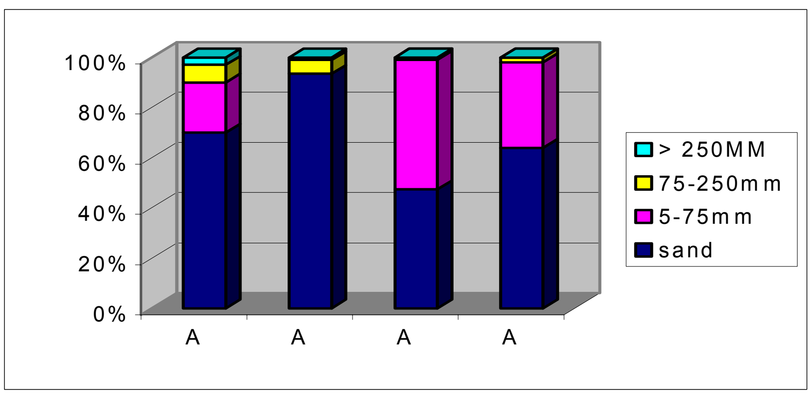


Figure 22. Particle size distribution for plots on Maumee Mine RTA. ìAî indicates no *Uma* in plot. ìPî indicates *Uma* present in plot.

Quackenbush
One dune feature was digitized in Quackenbush from the DOQs. Closer inspection proved the substrate to be too hard packed for *Uma*. The majority of the remainder of this training area is rocky and hard packed without wind blown sand features.

Tortoise (Restricted Area)
A large medium to hard packed sand sheet covers this training area and there are several large washes throughout the training area. No *Uma* were located here.

BLM Managed Land

Table 6 and Table 7 show the number and species of herpetofauna located and identified on BLM land for summer and fall field seasons, respectively. In the summer, *Cnemidophorous tigris* was the most abundant species found and no *Uma scoparia* were found. In the fall, *Uma* was by far the most prevalent lizard located with 78 individuals identified.

Table 6. Number and species of lizard observed in the summer sampling period in each BLM area, including animals seen outside the individual survey plots.

BLM Areas	Uma	Cadr	Utst	Cnti	Phpl	Goag	Crru	Urgr	Gasi
Spy Mountain	0	0	4	11	1	0	0	0	0
West Mainside	0	3	0	2	0	0	0	0	0
Total	0	3	4	13	1	0	0	0	0

Table 7. Number and species of lizard observed in the fall sampling period in each BLM area, including animals seen outside the individual survey plots.

BLM Areas	Uma	Cadr	Utst	Cnti	Phpl	Goag	Crru	Urgr	Gasi
Bristol Mountain	18	1	0	1	2	0	0	0	0
Copper Mountain	54	1	3	10	0	0	2	5	0
Valley Mountain	6	4	5	0	1	0	0	0	0
Cleghorn Wilderness	0	2	0	0	0	0	0	0	0
Total	0	8	8	11	3	0	2	5	0

Bristol Mountain

This sandy area is visible from National Trails Highway Route 66 near Ludlow, and borders Interstate Highway 40. Loose to medium packed sand exists throughout the land between the two survey plots, filling side canyons and climbing up the mountain. In some areas the wind blown sand has little vegetation, but the lower and level spots have large creosote bushes. It is pristine with no trash or evidence of traffic of any kind. Eighteen *Uma* were located here on two plots surveyed 10/31/01 and 11/07/01. Ambient air temperature ranged between 23 and 28 degrees C, surface temperature ranged from 31 to 44 degrees, and subsurface temperatures ranged between 30 and 46 degrees C. Percent vegetation cover was zero annuals and 6% perennials throughout the area where *Uma* were located. Figure 23 shows the distribution of particle size class. Most (94-98%) of the substrate is sand. Wind ranged between 7 and 9 km/hr.

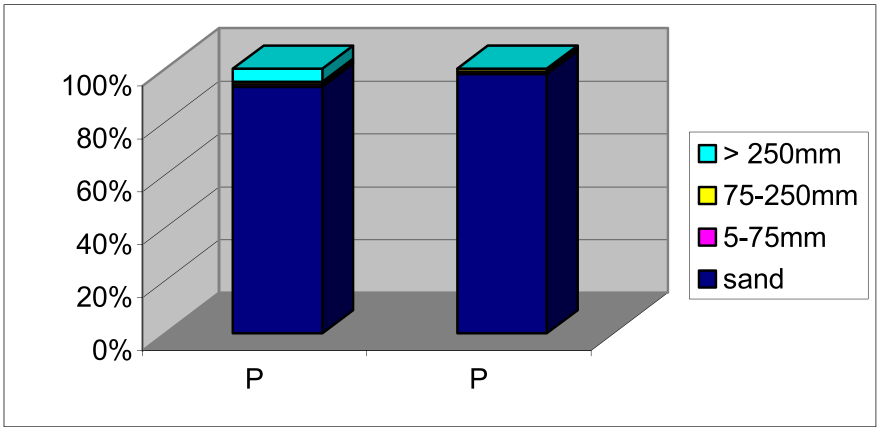


Figure 23. Particle size distribution for plots on Bristol Mountain BLM plots. ìAî indicates no *Uma* in plot. ìPî indicates *Uma* present in plot.

Copper Mountain
This is a large area that receives a large amount of OHV use on its periphery. It includes one steep dune that is highly tracked, littered with burnt cars, and is devoid of vegetation. The area varies between loose and medium packed sand, and in general is prime habitat. Some of the medium packed areas may not have carried *Uma* if they were isolated, but the area seems to be continuous habitat as it shifts between sand dunes and medium packed sheets. Fifty-four *Uma* were located here during the fall field season. Ambient air temperatures ranged between 25 and 35 degrees C. Surface and subsurface temperatures ranged between 22 and 47, and 21 and 46 degrees C, respectively. Figure 24 shows the percent of annuals and perennials for each of the six plots. Plots were 99-100% sand and wind ranged between 0 and 6 km/hr during sampling.

Spy Mountain
Most of this area consisted of hard packed and rocky substrate. There were a few areas with small soft packed sand, but no *Uma* were seen in these areas.

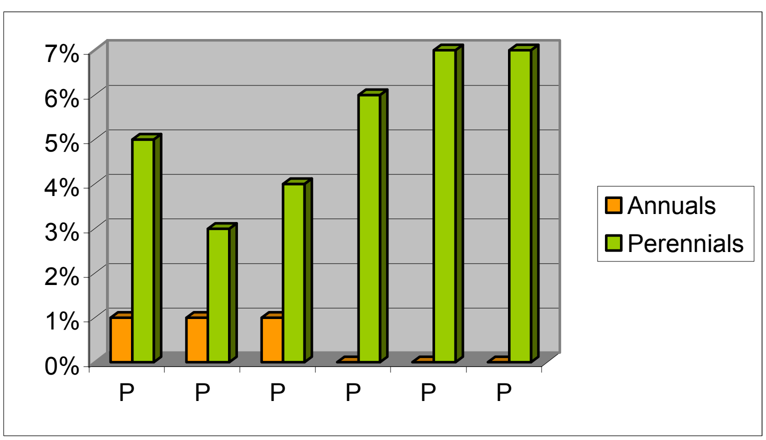


Figure 24. Percent vegetation for Copper Mountain plots.

Valley Mountain

The sand in this area is patchy. When approaching the base of Valley Mountain, the sand becomes hard packed with *Schismus* more prevalent. Two plots were completed in areas of loose sand. Both areas were steep, and vegetation was located in the margins of the dunes, nearing the boulders that encased the dune. In the first area OHV tracks were evident, and no *Uma* were found. In the second area, OHVs had no access due to the topography, and six *Uma* were found. From far away it is apparent that there is potentially additional habitat higher in the mountain, but the field crew was unable to access those areas due to the steepness of the terrain. This area was surveyed on 10/12/01. Ambient air temperature ranged between 25 and 26 degrees C. Surface temperature ranged between 31 and 38 degrees C while subsurface temperatures ranged between 29 and 36 degrees C. Surfaces were 96% sand and 4% rocks (> 250mm). Vegetation was 2% annuals and 4% perennials. Wind speed was 9 km/hr. Figure 25 compares ambient air and surface temperatures for plots with and without *Uma*.

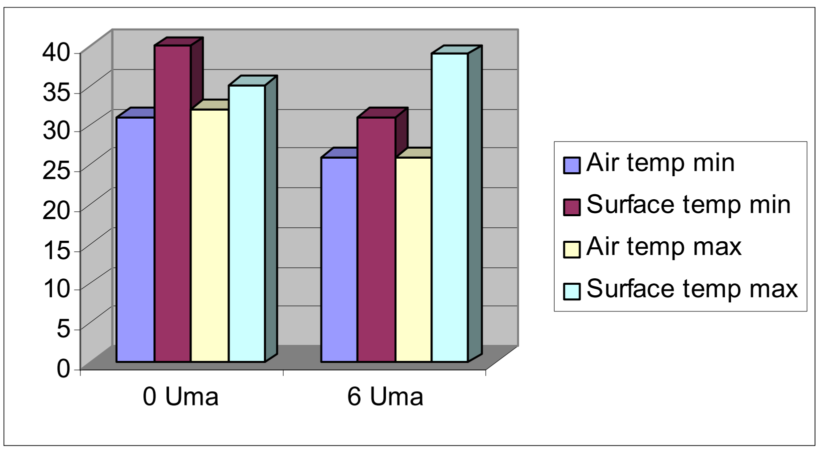


Figure 25. Comparison of temperature in plots with and without *Uma* on Valley Mountain BLM plots.

West Mainside

This area was covered by mesquite. The surface substrate is medium to hard packed sand sheet and no *Uma* were found in the survey plots.

Statistical Analyses

Data Summary

A total of 211 individual *Uma* were identified during the survey periods on seven MCAGCC training areas and in three locations on BLM land. Data were collected on a total of 19 plots on MCAGCC training areas where *Uma* were found while a total of 54 MCAGCC plots had no *Uma*. A total of 77 *Uma* were identified on BLM land in 8 plots, with 10 plots having no *Uma*. For the study area, the highest and the densest number of *Uma* within a single 1 ha plot were found on Prospect (33), followed by two highly dense plots on Emerson (26 and 24 respectively), followed by Copper Mountain (22 and 16). Table 8 summarizes the frequency of individuals per plot where *Uma* were found, on each training area.

Table 8. Number of *Uma* observed per plot for the MCAGCC and BLM sample areas. Dune number refers to the attribute Dune in the BLM and MCAGCC GIS plot coverageís.

Sample Area	**Plot #1** (Dune #)	**Plot #2** (Dune #)	**Plot #3** (Dune #)	**Plot #4** (Dune #)	**Plot #5** (Dune #)	**Plot #6** (Dune #)	**total**
Prospect	33 (207)	4 (6)					37
Emerson	26 (53)	24 (208)	4 (38)				54
Acorn	15 (210)						15
Lavic Lake	6 (62)	3 (14)	2 (10)	1 (59)			12
Gypsum	3 (202)	2 (203)	2 (206)	2 (205)	1 (91)	1 (71)	11
East	2 (79)						2
Lead Mtn	2 (200)	1 (201)					3
Copper Mtn	22 (106)	16 (101)	9 (107)	4 (105)	2 (108)		53
Bristol Mtn	14 (109)	4 (110)					18
Valley Mtn	6 (103)						6

Basic statistics on plots where *Uma* were and were not found are given below in Table 9. The table includes results of tests on data summarized by plot where *Uma* were found and where *Uma* were not found.

Table 9. Basic statistics for where *Uma* were and were not found for the combined MCAGCC and BLM plot data.

Variable	***Uma***	**Median**	**Min**	**Max**	**SD**	**Range**
Annuals	Present	0.00	0.00	0.07	0.02	0.07
	Absent	0.02	0.00	0.13	0.03	0.13
Perennials	Present	0.06	0.02	0.11	0.02	0.09
	Absent	0.04	0.00	0.49	0.09	0.49
Sand	Present	0.99	0.63	1.00	0.08	0.37
	Absent	0.90	0.35	1.00	0.16	0.65
Gravel	Present	0.01	0.00	0.25	0.05	0.25
	Absent	0.07	0.00	0.51	0.11	0.51
Cobble	Present	0.00	0.00	0.08	0.02	0.08
	Absent	0.01	0.00	0.20	0.05	0.20
Stone/Boulder	Present	0.00	0.00	0.06	0.02	0.06
	Absent	0.00	0.00	0.15	0.05	0.15

The results of the F-test for determining statistically significant differences in sample variance between plots with and without *Uma* are presented in Table 10. Statistically significant differences were observed for perennial vegetation cover, sand, gravel, cobble and stone/boulder. However, Shapiro-Wilk W test results, in combination with frequency histograms and normal plots (see APPENDIX 1.), indicated that the majority of data were non-normally distributed and thus not suitable for parametric methods (i.e., t-test). As a result the non-parametric Mann-Whitney U test was used to determine differences between plots with and without *Uma* for non-normally distributed data, and Analysis of Variance (ANOVA) for normally distributed data.

Table 10. F-test statistical results to determine difference between plots with and without *Uma*.

	F-test	Shapiro-Wilk W
Annuals	1.83	P < 0.0001[1]
Perennials	17.37[2]	P < 0.0001
Sand	3.82[2]	P < 0.0001[1]
Gravel	4.15[2]	P < 0.0001[1]
Cobble	6.60[2]	P < 0.0001[1]
Stone/Boulder	6.06[2]	P < 0.0001[1]
Air temp (start)	1.90	P < 0.0001[1]
Air temp (stop)	0.56	P = 0.3040
Surface temp (start)	1.59	P = 0.0002[1]
Surface temp (stop)	1.49	P = 0.0020

[1] Non-normally distributed
[2] Statistically significant at $\alpha = 0.05$

Mann Whitney U test for significant differences in habitat
Results from the Mann-Whitney U test are presented in Table 11. For all tests, N = 63 for presence, N = 27 for absence, and $\alpha = 0.05$. Results show that there is a significant difference between plots with and without *Uma* for percentage of annuals, sand, gravel, cobble, but not for perennials and stone/boulder.

Table 11. Mann Whitney U test results between plots with *Uma* and without *Uma* for annuals, perennials, sand gravel, cobble, and stone/boulder.

Variable	*Uma* Presence/Absence	Median	P Value
Annuals	Present	0.00	0.0006[1]
	Absent	0.02	
Perennials	Present	0.06	0.5379
	Absent	0.04	
Sand	Present	0.99	0.0006[1]
	Absent	0.90	
Gravel	Present	0.01	<0.0001[1]
	Absent	0.07	
Cobble	Present	0.00	0.0054[1]
	Absent	0.01	
Stone/Boulder	Present	0.00	0.1205
	Absent	0.00	

[1] Statistically significant at $\alpha = 0.05$

Differences in temperature data

Temperature data at the start of surveys ranged between 23°C and 39°C. The maximum start air temperature at the plot level was 36°C and the maximum surface temperature at the start of plot surveys was 46°C. Table 12 summarizes temperature observations for individual *Uma* observations.

Table 12. General temperature statistics for fall field survey *Uma* observations.

	Air temp (°C)	Surface temp (°C)	Subsurface temp (°C)
Mean	29	37	34
Median	29	37	34
Min	23	22	20
Max	40	49	47
Std dev	3.1	4.4	4.7
Range	17	27	27

Breaking down the individual *Uma* observation by age, adults were observed when air temperatures ranged between 24-29°C while juveniles were observed between 23-40°C. The same is true for surface and subsurface temperatures as well. Surface temperatures where adults were observed ranged between 34-41°C and between 22-49°C for juveniles. Subsurface temperatures where adults were observed ranged between 27-41°C and between 20-47°C for juveniles.

To compare, we looked at the difference in surface and ambient air temperatures in plots where *Uma* were and were not observed. Table 13 shows the results from the Mann Whitney U test for start and finish ambient air temperature and start and finish surface temperature. For all tests, N = 63 for presence, N = 27 for absence, and $\alpha = 0.05$. The only significant difference was in the air temperature at the start of surveys between plots where *Uma* were and were not found ($\alpha = 0.05$, $p = 0.0053$).

Table 13. Mann Whitney U test results between plots where *Uma* were (present) and were not observed (absent) for air and surface temperature measurements.

Plot Temperature Variable (°C)	*Uma*	Median	P Value
Start Air	Present	31	0.0053[1]
	Absent	29	
Start Surface	Present	35	0.5112
	Absent	34	
Finish Air	Present	32	0.1259
	Absent	33	
Finish Surface	Present	40	0.5700
	Absent	38	

[1] Statistically significant at $\alpha = 0.05$

Simply summary statistics on temperature data of individual observations from the fall field survey are presented in Table 14, below. These are the results from data collected only for observed *Uma* during the exploratory season. Twelve adults, 160 juveniles, and 20 unknown aged *Uma* were observed and comprise this data set.

Table 14. Simple summaries of temperatures taken where individual *Uma* were observed during the fall field season. Temperature in degrees C.

Temperature		N	Mean	SD	Median	95% CI of Mean
Air Temp	Adult	12	26.583	1.5050	26.000	25.627 to 27.540
	Juv	160	28.850	2.9847	28.000	28.384 to 29.316
	Unk	20	31.600	3.0332	32.000	30.180 to 33.020
Surfac Temp	Adult	12	36.750	2.3404	37.000	35.263 to 38.237
	Juv	160	36.731	4.4421	37.000	36.038 to 37.425
	Unk	20	39.250	4.7337	39.500	37.035 to 41.465
Sub- Surface Temp	Adult	12	34.000	3.5162	34.000	31.766 to 36.234
	Juv	160	34.075	4.8064	34.000	33.325 to 34.825
	Unk	20	34.900	4.3030	34.500	32.886 to 36.914

ANOVA results for age observations

Results from the ANOVA test between various age classes and temperature variables are presented in Table 15. For all test, N = 12 for adults, N = 160 for juveniles, N = 20 for unknown, $\alpha = 0.05$, and df = 2. There was a significant difference between air temperatures for detecting adult versus juvenile lizards, with juveniles seen at higher temperatures.

Table 15. ANOVA results between adult and juvenile temperature recordings.

Observation Temperature Variable	*Uma* Age class	Mean Temp. (°C)	P Value
Air	Adult	27	<0.0001[1]
	Juvenile	29	
	Unknown	32	
Surface	Adult	37	0.0542
	Juvenile	37	
	Unknown	39	
Sub-surface	Adult	34	0.7547
	Juvenile	34	
	Unknown	35	

[1] Statistically significant at $\alpha = 0.05$

Spearman-rank correlation

Table 16 summarizes the results of the correlation analysis between habitat variables and *Uma* frequency in plots. A negative spearman-rank correlation coefficient indicates a negative correlation while positive values indicate positive relationship. Values approximating zero indicate no relationship while values approaching one indicate high degree of correlation.

Table 16. Spearman-rank correlation results for habitat and temperature variables against *Uma* counts.

Habitat variable	Coefficient	p-value
Annuals	-0.40	< 0.0001[1]
Perennials	0.10	0.3475
Sand	0.36	0.0004[1]
Gravel	-0.35	0.0007[1]
Cobble	-0.29	0.0057[1]
Stone/Boulder	-0.16	0.1291
Air temp (start)	-0.37	0.0004[1]
Air temp (stop)	-0.21	0.0481[1]
Surface temp (start)	-0.13	0.2190
Surface temp (stop)	0.10	0.3668

[1] Statistically significant at $\alpha = 0.05$

Approximately half of the variables showed a statistically significant correlation with *Uma* frequency in plots. No relationship was indicated between the number of *Uma* observed in a plot and the percentage of perennial cover. There was an inverse relationship between *Uma* count and percentage of annual vegetation. Higher counts of *Uma* were statistically significantly correlated with higher percentage of sand cover; and there exists an inverse relationship between numbers of *Uma* and percent gravel and cobble cover. There was no significant relationship between *Uma* count and stones or boulders. The temperature at the start of surveys was negatively and significantly related to count. Statistically, the air temperature at the completion of surveys was significant but this can be considered a weak relationship at best. There was no significant relationship between the number of individuals observed and ambient air temperatures at the beginning and end of surveys.

To determine if time of day (0700-1430) may have affected the survey crewís ability to observe individuals, Spearman rank correlations were run on time of day and temperatures. No correlation existed between time of day and number of individual *Uma* observed ($rs = -0.01$ $p = 0.8863$). Surface temperature was positively correlated to time of day ($rs = 0.35$ $p < 0.0001$). Subsurface temperature was positively correlated to time of day ($rs = 0.57$ $p < 0.0001$).

Linear regression

Multiple linear regression was run on frequency data where *Uma* were observed to develop a linear model between number of individuals and habitat variables. The residual plot for the full model is shown below (Figure 26) and indicates the need for a transformation of the response variable ($R^2 = 0.13$, adjusted $R^2 = 0.07$):

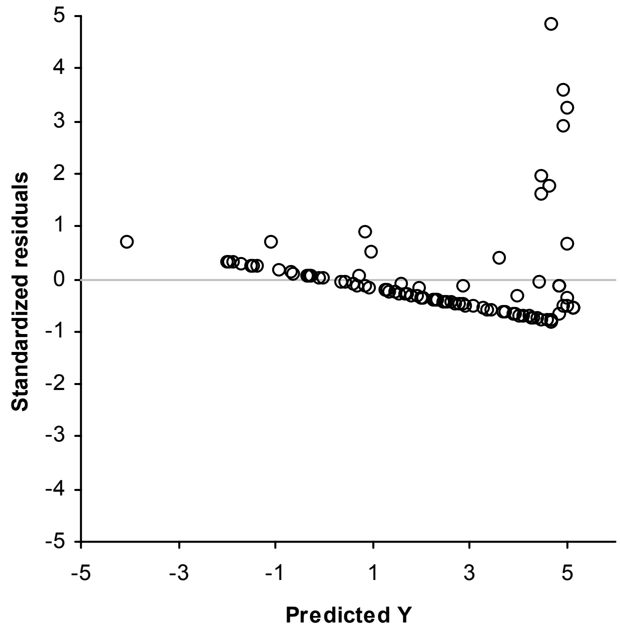


Figure 26. Linear regression residual plot.

The log transformation cannot be computed for values of zero, therefore regressions were run on presence data only. The best model fit on positive observations and all of the physical habitat variables is presented below (Table 17):

LOG(U) = 29.38 ñ11.11(a) + 12.07(p) ñ 29.27(s) ñ 32.16(m) ñ 31.49(l) ñ 16.15(c)

where U = number of *Uma* observed in a plot
a = % annuals
p = % perennials
s = % particles < 5mm (sand)
m = % particles 5-75mm
l = % particles 75-250mm
c = % particles > 250mm (cobbles)

Table 17. Linear regression full model results.

R^2	0.53
Adjusted R^2	0.38
SE	0.3746

Term	Coefficient	SE	p	95% CI of Coefficient
Intercept	29.3786	55.3240	0.6012	-86.0252 to 144.7825
Annuals	-11.1136	4.0169	0.0119	-19.4926 to -2.7345
Perennials	12.0729	3.7615	0.0044	4.2265 to 19.9193
COV<5	-29.2689	55.3407	0.6027	-144.7075 to 86.1697
COV5_75	-32.1633	56.0056	0.5722	-148.9889 to 84.6623
COV75_250	-31.4939	58.6846	0.5974	-153.9079 to 90.9201
COV>250	-16.1508	49.3701	0.7470	-119.1350 to 86.8334

Source of variation	SSq	DF	MSq	F	p
Due to regression	3.106	6	0.518	3.69	0.0124
About regression	2.807	20	0.140		
Total	5.913	26			

Based on these results, a reduced model was fit that produced comparable adjusted R^2 values, but was based on only vegetation data (Table 18). Only adjusted R^2 values can be compared because the number of explanatory variables are not equal in the two regression analyses.

LOG(U) = 0.1325 ñ 10.34(a) + 11.84(p)

where U = number of *Uma* observed in a plot
a = % annuals
p = % perennials

Table 18. Linear regression reduced model results.

R^2	0.44
Adjusted R^2	0.39
SE	0.3722

Term	Coefficient	SE	p	95% CI of Coefficient
Intercept	0.1325	0.2084	0.5310	-0.2977to 0.5627
Annuals	-10.3381	3.4892	0.0068	-17.5395to -3.1367
Perennials	11.8434	3.5460	0.0027	4.5249to 19.1620

Source of variation	SSq	DF	MSq	F	p
Due to regression	2.589	2	1.294	9.34	0.0010
About regression	3.325	24	0.139		
Total	5.913	26			

LizLand

The MCAGCC LizLand model is presented in Figure 27 and the California GAP (CA-GAP) model in Figure 28. *Uma* is restricted to wind blown sand habitats in the LizLand model. Only 5% of MCAGCC is considered Suitable Habitat according to the LizLand model. In contrast, CA-GAP identifies 92% of MCAGCC as ìsuitableî, and only 1% of MCAGCC as completely unsuitable. The remaining 7% is in varying stages of suitability. According to LizLand 42% of MCAGCC is represented by Moderate to Suitable Habitat (6% from sandy washes, the remaining 36% sand and gravel), 29% is Sub-Marginal to Moderate Habitat, and 24% is Unsuitable Habitat. In all cases, from Suitable to Unsuitable the actual amount of suitable habitat is less then the LizLand areal estimate. This is due to the heterogeneous, patchy nature of sandy habitats. However, the qualitative probability of finding sandy habitat within Suitable Habitat is markedly higher then in Moderate to Suitable Habitat, which in turn is higher then in Sub-Marginal to Moderate Habitat, and so forth. This should not be confused with LizLand model accuracy, which would be due to model error or source data error. As such, the area found within the confines of the Suitable Habitat boundaries should be consider ìsuitableî regardless of the presence of *Uma* at a particular point in space. The Suitable Habitat is intended to capture the entire matrix of necessary habitat requirements that in some cases includes hummocky, loose sandy habitats within a matrix of compact soils. The LizLand model for MCAGCC displayed by RTA and BLM area are given in Appendix 2 and Appendix 3, respectively.

DISCUSSION

Twenty-four training areas exist on MCAGCC and *Uma* were found to occur on seven of those areas (Figure 29). The primary reason for the occurrence of *Uma* is that there exists suitable habitat for this species to occur and persist. Figure 3 presented all *Uma* sightings recorded for MCAGCC for all studies as well as the *Uma* sightings on adjacent BLM lands recorded during the 2001 study. Evaluating the spatial distribution of *Uma*, it is most likely the case that these animals are reproducing within installation boundaries, and that MCAGCC may be a source, rather than a sink for its *Uma*. If MCAGCC were a sink for *Uma*, meaning that individual animals could exist within base boundaries but there did not exist a reproducing population, rather individuals entered the base from an external dispersion point, several conditions would have to exist that were not found to exist during the course of this study.

The first condition is that at least one source population would have to exist outside of MCAGCC boundaries from which individuals would disperse onto MCAGCC. *Uma* were found at three locations in the 2001 field season on BLM lands and in the past, *Uma* were also found outside MCAGCC in an additional location (Sanders and Sylber,1990). The distance between the *Uma* sighting in 1990 and the closest *Uma* observed on MCAGCC, on East Range, is 3.3km. While it is unknown if this distance is an unrealistic dispersal distance for *Uma*, the anthropogenic obstacles and fragmentation most likely serve as barriers to dispersal. Between the two locations are a maze of roads, buildings, other paved surfaces, and non-habitat. Additionally, there is no evidence that the 1990 sighting is indicative of a reproducing population as it contains only one sighting. The distances between the other two locations in the vicinity where *Uma* were located outside MCAGCC, Copper Mountain and Valley Mountain, and the occurrences on East range are 13km and 10.5km, respectively. It is highly unlikely that *Uma* are dispersing from these two locations onto MCAGCC due to the lack of habitat and the development between the respective locations. To the north of MCAGCC is the Bristol Mountain sighting location and the closest MCAGCC sightings (Lavic Lake) are more than 18km away. Both adults and juveniles were observed at Bristol Mountain (18 total). On Lavic Lake, *Uma* were observed both by Cutler *et al*. (1999) and during the 2001 field survey (12 individuals).

The second condition that would indicate MCAGCC is a sink for *Uma* and does not harbor reproducing populations would be that adults and juveniles were not identified on MCAGCC. Again, this condition was not found to be true, rather the evidence supports the contrary. Both adults and juveniles were found to occur on MCAGCC in multiple training areas. During the fall field season 12 adults and 160 juveniles were positively identified. Another 20 individual *Uma* were identified but age was not obviously determinable.

Based on the results from the 2001 survey, the evidence indicates that MCAGCC does support viable, reproducing populations of *Uma* and does not serve solely as a sink for this species. That is, animals are living and reproducing within installation boundaries. Furthermore, it seems unlikely that individuals are dispersing onto MCAGCC land from outside installation boundaries. What remains unclear is whether this geographic distance between what would comprise metapopulations is due to modern development and acitivies or is relict from landscape conditions dating back to historic times.

Clearly, studies of *Uma* dispersal coupled with genetic analyses of populations on and off MCAGCC would provide a better picture of the historic and present interactions of populations in the general southern Mojave Desert, centering on MCAGCC. However, given the evidence from our survey (2001) it appears that both MCAGCC and BLM harbor reproducing populations of *Uma scoparia*. The extent to which these populations exhibit

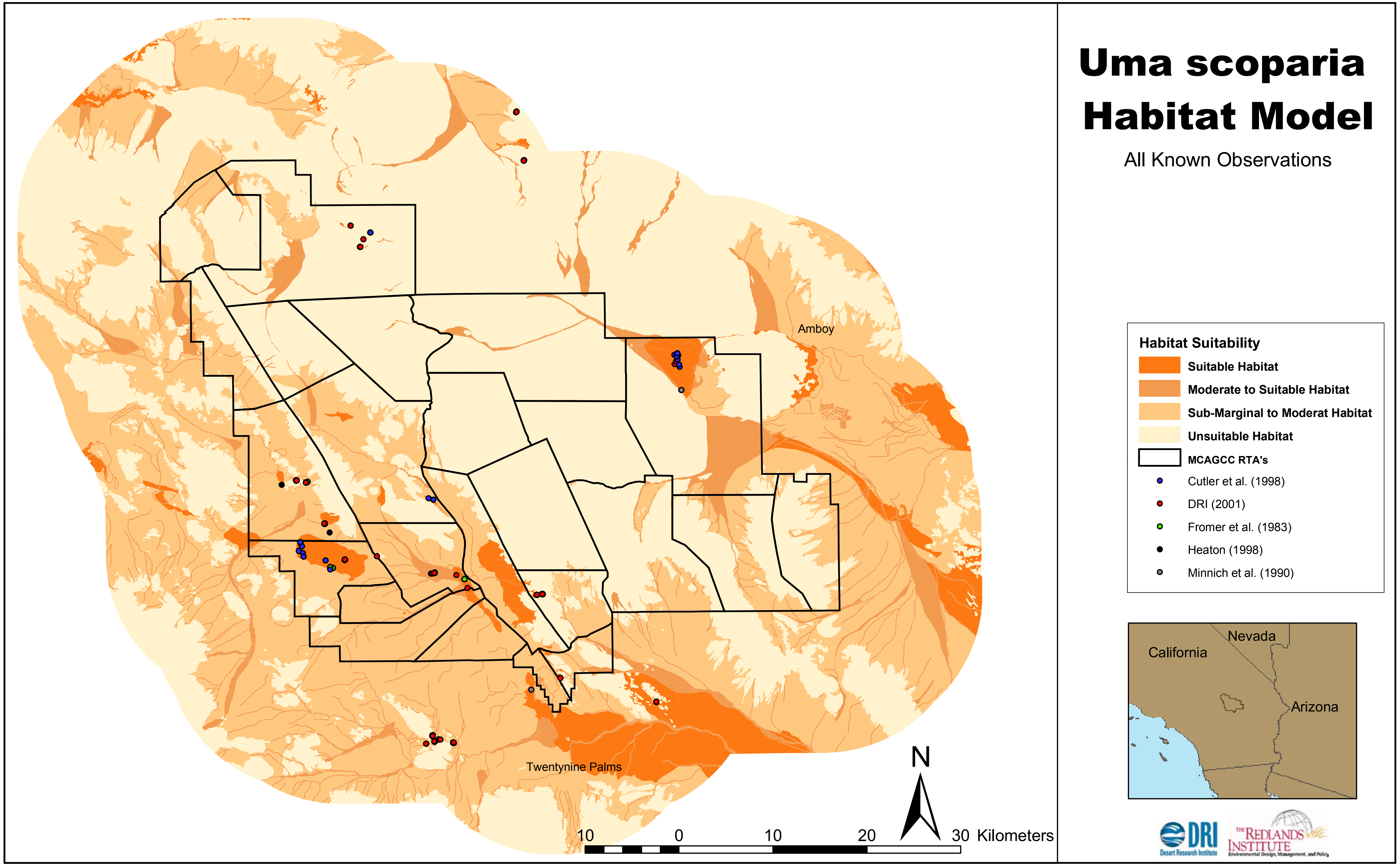


Figure 27. MCAGCC Lizland model along with all recorded *Uma* observations 1983-2001.

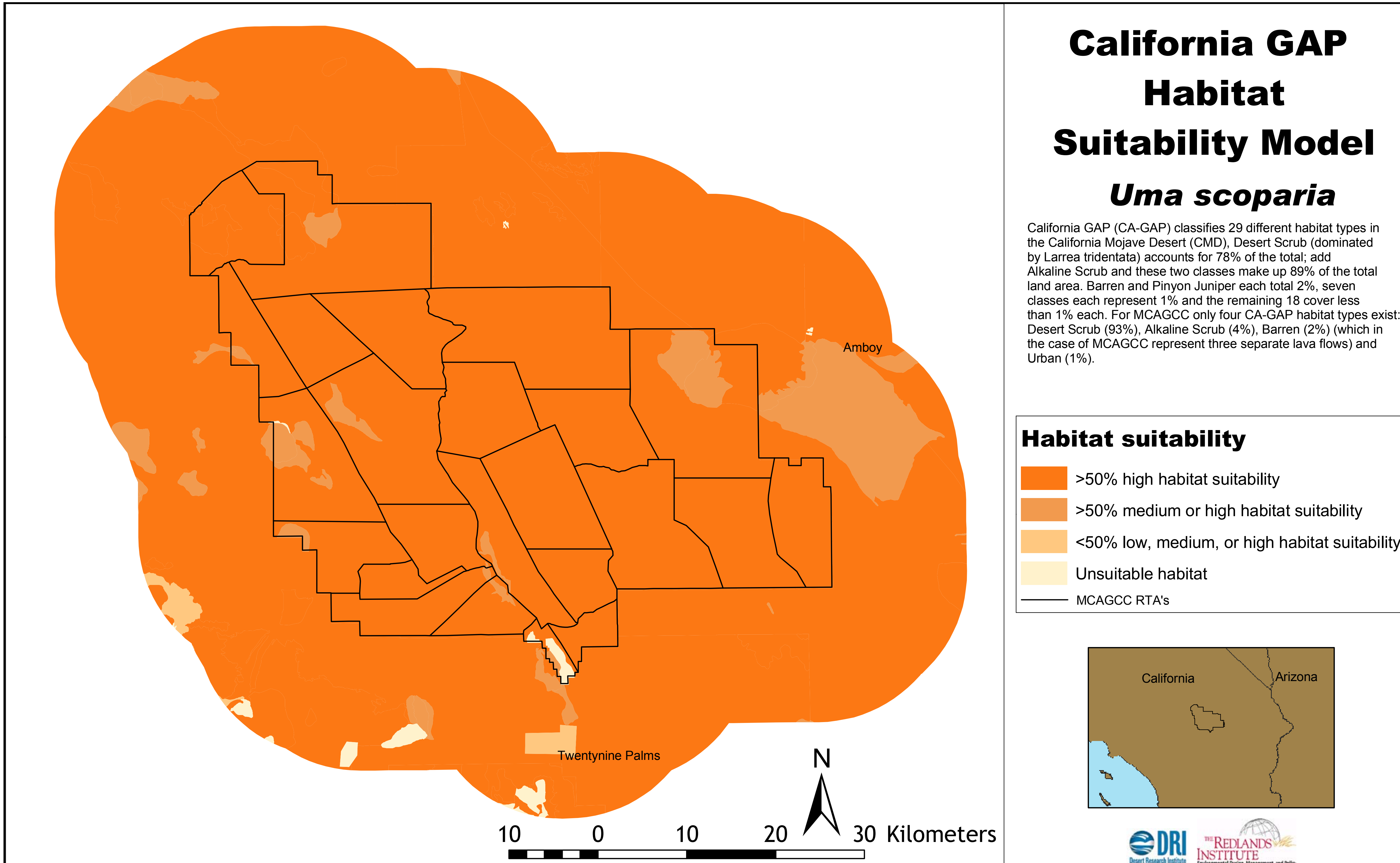


Figure 28. California GAP model for *Uma*.

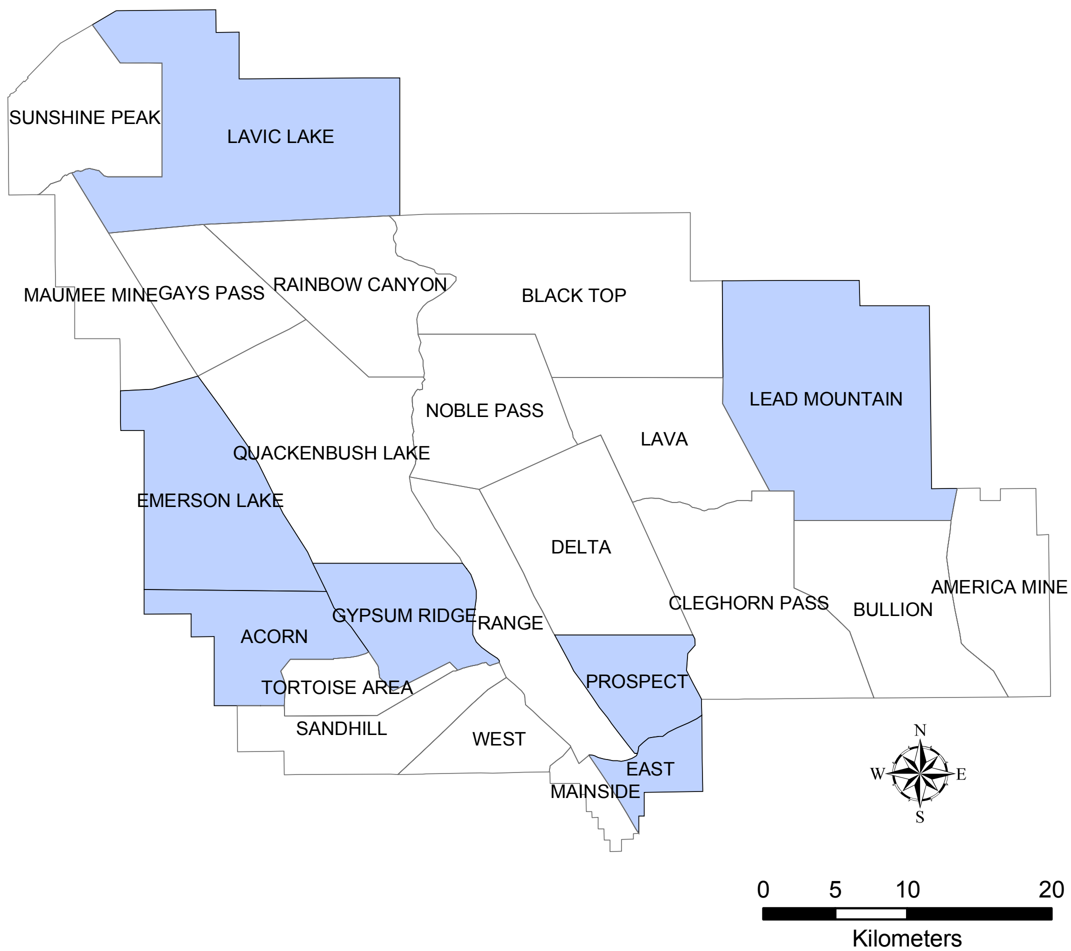


Figure 29. RTAs shown in blue were found to harbor *Uma scoparia* while those shown in white did not harbor *Uma scoparia*.

fitness, particularly from a genetic perspective, remains unknown at this time. Population estimates and genetic analyses would provide insight and definitive answers regarding fitness and status of these populations, as well as defining metapopulations in the area.

Significance of Mann-Whitney tests on cover variables

A great deal of data were collected and analyzed at the plot level to evaluate biotic and abiotic habitat characteristics of *Uma*. There are significant differences between locations that harbor *Uma* and locations where *Uma* were not found to occur. Two biotic parameters were evaluated, percent annuals and percent perennials. There was a significantly lower percentage of annuals on plots where *Uma* occurred but there was no difference in perennial cover. In other words, the amount of perennial vegetation does not seem to impact presence/absence, and on MCAGCC and the surrounding BLM land this vegetation would be primarily *Larrea.* However not any type of vegetation is appropriate, as *Uma* do appear to select against locations where there are, in general, more than 2% cover of annuals. It is important to note that the majority of the coverage of annuals that exceeded 2% were two species of exotic invasives, *Salsola spp.* and *Schismus* grass.

Some level of perennial vegetation is important, as it offers shade for thermoregulation and creates a microcosm environment which may supply insects as prey source. Rodents and other digging organisms create burrows under and in close proximity to woody, brushy perennials and these burrows are beneficial to *Uma*. Detritus accumulates under perennials where more moisture may be available and the environment, in general, is more rich and diverse than between-shrub environments. It was found during this survey that *Uma* would first dive into an existing burrow or hole before characteristically shimmying subsurface in loose sand. This implies some level of importance at the community level in terms of fringe-toed lizards and ground-burrowing animals. To the contrary, annual vegetation over 2% does not offer the same benefits as perennial Mojave vegetation species do. Being annual, or in the case of *Salsola spp.*, bi-annual, these plants do not persist year after year. Because these plants do not persist, the opportunity to accumulate a microcosm does not present itself. Without the microcosm, there is little to draw other species or to otherwise accumulate important resources. The physical structure between *Larrea tridentate* and *Salsola spp.* or *Schismus* differs significantly. This difference also contributes to the useability of plants by would-be obligate or other species. During the survey period there was a heavy standing crop of exotic *Salsola spp.* and *Schismus* due to the exceptionally wet winter in 2000, the year before. Although the study of exotics was beyond the scope of this project, we do recommend that the spread of exotics be monitored and reduced as much as possible. This recommendation is discussed further in the Management Recommendations section.

Three of the four substrate classes were found to be important habitat selection variables. Because the composition of a plot is a proportional measurement, it is not surprising that differences in percent sand appear to be very similar, upwards of 90% for plots with and without *Uma*. There is a very significant difference, however, in what would otherwise appear to be marginal differences in amount of sand. *Uma* prefer areas with higher sand proportions. Particle sizes greater than 250mm, mainly stones and boulders, were just as abundant where *Uma* were located as where they were not. It should be noted that because sand dunes and sheets were specifically selected for surveying and these features typically do not contain significant amounts of stones and boulders, areas with high amounts of stones and boulders were not surveyed. In other words, sandy areas were selected for this survey and by definition, there are few large rocks in these areas. Stones and boulders exhibit spatial distribution, and therefore can be easily avoided within a larger sand dune or sand sheet. There were few rocks of this size class in all plots and we do not purport that larger rocks control *Uma* distributions in any way. Of the remaining substrate classes, the most significant difference was with the percentage of gravel (5-75mm) in plots. The same is true for cobble (75-250mm). *Uma* prefer areas without gravel or cobble, which do tend to exhibit a random or regular spatial distribution, and thus interfere with locomotion for predator avoidance, subsurface shimmy or sand-swimming. Based on the analyses of biotic and abiotic habitat characteristics, *Uma* were found to occur in areas with high percentage of sand with few gravel and cobble size rocks and less annual exotic vegetation. These findings are consistent with published literature in terms of preferring primarily sandy substrate.

The results presented here also support the fact that *Uma* do use areas with perennial vegetation, provided the substrate contains appropriate amount of sand. Excessive exotic annual vegetation, to the contrary, is not a component of preferred *Uma* habitat. Although *Uma* are the only North American lizard species known to utilize pure sand sheets as habitat, their range of habitat extends from this extreme to areas with some percentage of perennial cover. It is not known, however, what quality levels can be attributed within this range of habitats, nor is it known for certain how these habitat types are being used by *Uma*. For example, if pure sand dunes are available adjacent to sandy areas with some perennial vegetation, how are these areas, respectively, being used by individuals? Further investigation is warranted to better understand the use of this range of habitat, from pure sand to the composite of sand and perennial vegetation, now that this range has been better defined.

Age observations and implications from temperature data

There was a difference in the ambient air temperature of plots where *Uma* were and were not observed. Temperatures were generally higher in plots where *Uma* were observed, but there was no significant difference in surface temperatures or in the ambient air temperature of plots when surveys were completed. Air temperature plays a greater role in the thermoregulation of these lizards than the surface temperature, at least in the morning as temperatures are warming at the start of the day. Our data indicate that air temperatures were changing more quickly between plots than was surface temperature. However, it is important to note that *Uma* may have occurred in those plots with lower air temperatures, but those individuals were not warm enough to run away and chose a different predator avoidance strategy that did not allow the field crew to identify those individuals. In other words, lizards that are warmer are also faster, to a point, however, lizards that are cold tend to respond more readily to a threat and thus move sooner. Lizards that run away are more easily seen by a human than lizards that remain stationary or that do not move a significant distance. It is also important to recognize that these analyses are not cause and effect, rather, they are correlative and must be interpreted as such. Therefore, these results can be interpreted to indicate that *Uma* are more likely to be seen where median air temperatures are around 31°C and when median temperatures hover around 29°C they are less likely to be spotted.

No significant difference was found in surface temperatures at locations where adults and juveniles were identified. Mean temperatures for both age groups were identical. This provides some evidence that adults and juveniles are operating within the same temperature range. There was no significant difference between subsurface temperatures where adult and juvenile individuals were observed. This is not unexpected, although it is unknown how many, if any, individuals were subsurface. There was a significant difference in the average air temperature where adults and juveniles were observed. Juveniles were, on average, observed at higher air temperatures than adults. The mean air temperature of the ìunknownî age group was approximately 3°C. Unknowns comprised 10% of the entire data set.

To determine if time of day may have affected the survey crewís ability to observe individuals, Spearman rank correlations were run on time of day and temperatures. More lizards were seen later in the day. Positive correlations existed between surface and subsurface temperatures and time of day. Overall, *Uma* were observed between 0700 and 1430. This can be interpreted to indicate that the landscape did heat up as the day progressed and that as the land surface became heated so did the subsurface. The warmer the individual lizards are, the more active they become. Hence, as the day progresses and temperatures rise, *Uma* reach a metabolic state that allow them to run quickly. Therefore, it is possible that the field crew were more likely to see individuals as a function of time of day simply due to the metabolic-related activity of individuals as a function of time of day.

<u>*Uma* density as related to habitat</u>

More *Uma* were observed in areas with highest percentage of sand (see Appendix 2 for additional graphics). Fewer individuals were observed where the substrate contained more annuals, gravel and cobble sized rocks. Overall, the results from correlation analyses are consistent with the other statistical analyses. Not only are certain habitat variables significant to presence or absence of *Uma* but they are also related to observed counts. That is, *Uma* are more likely to be found on sandy areas and the more sandy the area, the more *Uma* there are likely to occur. Similarly, *Uma* were not found to occur with increasing percentages of annual vegetation and there was a strong negative relationship between how many individuals were observed with percent annuals. The greater the amount of annuals in an area, the fewer the number of *Uma*.

The fact that the number of *Uma* observed and the percent perennial cover were not significantly correlated is also consistent with plot level data, but this does not indicate the significance of perennial cover to individuals, as discussed above. In other words, likelihood of observing *Uma* in an area with perennial vegetation the same as in an area without perennial vegetation, but there is no relationship between how many individuals are likely to occur in any area based on perennial vegetation cover. You are just as likely to observe one single individual as you are ten individuals. However, it should be noted that with more vegetation, *Uma* or any lizard species, is more difficult to observe simply due to physical obstruction of view.

What is the role of temperature in *Uma* habitat? It would not make sense to distinguish the temperature differences of plots where *Uma* did and did not occur based solely on temperature because other factors clearly play a role in where *Uma* are found. However, the relative importance of these factors remain unknown. Temperature is a consideration in terms of the probability of seeing an individual, as animals will locate themselves on the surface only during certain temperature ranges. At the plot level, there was a negative relationship between temperature data and ambient air temperature at the start of plot surveys, ranging between 23°C and 39°C. The maximum start and stop air temperature at the plot level was 36°C and 46°C, respectively, and the maximum surface temperature at the start and stop of plot surveys was 46°C and 49°C, respectively. Overall, the temperature rose 10°C during the actual plot survey. Most individuals in plots were observed between 24°C and 29°C and as air temperatures climbed, fewer *Uma* were observed.

Comparing this to the data collected on individuals during the fall survey, we see that juveniles appear to be more tolerant of higher air temperatures than adults and that adults were observed within a subset range of temperatures as seen for juveniles. This is the only statistically significant difference discernible for individual observational data. While the same relationship appears true for surface and subsurface temperatures, that adults are found within a subset temperature range of juveniles, there is no difference between temperatures on the surface or below surface where adults and juveniles were observed. Due to the differences in numbers of adults versus juveniles, this apparent difference in temperature range merits further study with a more even sample distribution of adults and juveniles.

<u>Landscape perspective using LizLand (Geomorphic Land Features)</u>

Unfortunately, the MAGTFTC DOQís do not provide coverage beyond the geographic boundaries of MCAGCC. Because a reliable data source was not available for this area with respect to delineating dune features, the LizLand model for adjacent BLM lands do not have the same level of accuracy as for the MCAGCC LizLand model. The majority of the *Uma* observations on BLM appear to fall within less then suitable habitat based on the LizLand model. Better, more accurate delineation of the geomorphology and specifically dune features, would create a more accurate LizLand model for *Uma* on BLM land. However, results from LizLand remain relevant and reliable and are presented here with confidence.

According to the CA-GAP analysis (Figure 28), 99% of MCAGCC is suitable *Uma* habitat and only 1% of MCAGCC is considered unsuitable habitat, suggesting that *Uma* could be found almost anywhere within MCAGCC. Under such cartographic generality MCAGCC would be forced to manage virtually the entire base as suitable habitat for *Uma*, when in fact results from this work indicate otherwise. According to the criteria established by Marcot *et al.* (1983) for validating wildlife-habitat relationship models, the CA-GAP *Uma* model lacks appeal, breadth, depth and validity as well as being neither precise, real, accurate, useful, resolute or whole.

According to the LizLand model (Figure 27), 5% of MCAGCC is considered suitable *Uma* habitat. The LizLand model effectively reduces the amount of necessary manageable suitable *Uma* habitat by 87% (99%-5%). After accounting for that 5%, an additional 42% of the landscape is considered important as sand sources for sand dunes and sand sheets, and for the potential that these areas may hold small isolated patches of undetected suitable habitat. That is, some component of this 5% suitable *Uma* habitat is maintained by these sand sources that exist on MCAGCC. For example, Emerson Dry Lake and the dry lake in Lead Mountain training area are upwind from many locations where *Uma* were found to occur.

These findings are significant for several reasons. First, the LizLand model for *Uma* on MCAGCC supports different scenarios setting aside land to protect and/or preserve *Uma* habitat. Under the LizLand model of habitat definition, suitable habitat is much more refined and, just as importantly, sand sources that contribute to maintaining these habitat areas are identified and thus can be protected as warranted. Second, using LizLand as guidance, high quality habitat can be identified for conservation and management. The probability that MCAGCC will set aside lands that are not, in fact, suitable *Uma* is reduced. Third, more detailed information provides MCAGCC and other land managers with a better and more accurate picture of the value of their land from a habitat perspective. In this position, all are better able to negotiate (and mitigate) issues related to biodiversity with surrounding land managers and interested stakeholders, all of whom must comply with local, state and federal laws related to rare, sensitive, threatened or endangered species.

CA-GAP greatly over-generalizes the habitat of *Uma*, producing what more resembles a range map than a habitat suitability map. There are significant ramifications of this over-generalization under a scenario of any type of listing of *Uma*, either federal or state. Under the scenario of *Uma* having some federal or state listing, MCAGCC, BLM, and surrounding land managers are left with what may be perceived as an enormous amount of "associated" *Uma* habitat. Using only the CA-GAP map for determining conservation action for *Uma*, the consequence to MCAGCC, as well as the other large DoD military installations in the California Mojave Desert (U.S. Army National Training Center at Ft. Irwin, Edwards Air Force Base and China Lake Naval Air Weapons Station), would be pressure to set aside more land than is warranted, and possibly, setting aside land that is actually unsuitable for the target species. Those lands would thus be removed from training and testing for conservation purposes that may not, in fact, support the desired conservation outcome. Similarly, the consequences of using such a coarse level of cartographic generality make it more difficult for other federal agencies, such as the NPS and BLM, to accomplish their mission of protecting species. It is impossible to select critical habitat for a target species at a resolution below that of a large polygon mapped as uniform habitat. The more difficult it is for the NPS and BLM to accomplish their mandated goal of species protection and preservation, the more difficult it is likewise for the DoD to accomplish their goal of national security due to burden of sole stewardship on one agencyís part. Collaborative efforts on all stakeholder fronts would benefit all.

<u>What can be said about predicting *Uma* occurrences?</u>

Accurate predictions are made only when deterministic processes are operating. This means that predictions are made when some set of processes always produce identical results in identical circumstances. For the purposes of predicting *Uma* occurrence, simply understanding the biotic and abiotic habitat variables is not enough to predict with certainty where these animals will occur. The main reason for this statement is that there are other factors that play an important role in presence or absence. First, there must be at least one set of reproducing parent individuals from which new *Uma* may generate and disperse. Second, it must be possible for individuals to survive elements like predation pressure and fluctuations in prey base. Anthropogenic disturbance is a consideration as well and the effects are difficult to effectively capture. Although some effects may be measured within the biotic and abiotic variable measurements, the impacts of human activities on the microscale, such as insect prey base richness and abundance, to the macroscale, such as climate change, are intricate and difficult to effectively capture. Regression does not take into account these variables that are difficult if not impossible to measure, and which are spatial.

In this light, it is not surprising that regression methods did not prove useful in this analysis. Regression analysis looks for dependence between things, in this case between *Uma* and selected habitat variables. The basic question needing an answer by looking at regression analysis in this study was *Is there a linear relationship, a dependence, between Uma and the measured habitat variables?* We assume, in using regression, that the numbers of individuals in an area are dependent on the values of those measured habitat variables. In other words, more *Uma* are expected in better habitat and there is some implication of cause and effect, but clearly more is at play than simply habitat.

None of the diagnostics from regression analyses indicated that a well-fit model could be generated for these data. This is not surprising because most of the assumptions of regression were violated by the inherent nature of the data. These assumptions include constant variance, normally distributed dependent variable, normally distributed residuals, and independence of residuals. Nonetheless, regression is often used as a statistical tool for investigating potential relationships in nature and because it was presented as one analytical option, results are discussed here.

Results from these regression analyses provide little information about the relationships between *Uma* and the landscape because the relationships are non-linear. For example, the R^2 value is a measure of how close predicted values are to observed values. Perfect regression results in an R^2 value of 1 while no relationship whatsoever results in a value of 0. It is often used as the sole indicator of how well the model ì fitsî the data. Using R^2 value as a measure of goodness-of-fit, the best values presented in this analysis are not high (adjusted R^2 value 0.39). Although it may appear that annuals and perennials were significant variables in terms of modeling *Uma*, as indicated by the reduced model produced with only the two vegetation variables, common sense tells us otherwise. Not every area that has both annual and perennial vegetation can be considered *Uma* habitat. When using regression to make predictions, it is also important to remember that predictions can only be made within the extent of the original data. In other words, not every location falls within the same range as the data analyzed during this study and therefore it would be erroneous to make predictions using this model for other areas. It is clear from other analyses presented in this report that there are significant relationships between abiotic variables such as sandy substrate composition, as discussed above, and *Uma*. To disregard these variables would be to ignore valuable and significant information that does expand our understanding of *Uma* habitat requirements.

This is not to say that *Uma* occurrences cannot be predicted in the probabilistic sense. Given the results of this study we have gained a tremendous amount of information on what comprises *Uma* habitat in and around MCAGCC. Predictions can be made based on the LizLand model and further refined using vegetation and surface composition surveys. From a management perspective, the question is not are there *Uma* at a specific location, rather, the question is, is this suitable habitat that may be important to *Uma* on MCAGCC? The difference in these two questions is critical. The only way to know for certain that any species occurs for certain at any location is to survey for that species at that location. This is why all federal, state, and local agencies charged with managing or monitoring species (i.e.

US Fish and Wildlife Service or state level fish and wildlife or fish and game departments) include surveys as the basis for their management protocol. Those agencies that do not manage specifically for wildlife species but rather manage habitat, such as the US Forest Service or the Bureau of Land Management, may or may not include wildlife surveys. Typically agencies managing habitat work in conjunction with agencies that manage wildlife. Military installations manage both for wildlife and for wildlife habitat, which requires an understanding of both the wildlife biology and the wildlife-habitat interactions. Understanding both the geographic distribution and life requirements of *Uma* individuals, populations, and metapopulations has equal importance for managing and maintaining suitable habitat.

The fact that Maumee Mine, for example, was surveyed and found to have neither individual *Uma* nor apparently suitable habitat, is useful information to the NREA in its management and coordination with training and testing operations. Not only was the only potential habitat surveyed and found not to be appropriate habitat at all, but the geographically nearest *Uma* population located was 17.5km away on Emerson Lake RTA. If suitable habitat had been located in Maumee Mine RTA but no *Uma* were observed, further investigation might have been warranted to find out why no *Uma* occurred there. To give a concrete example of this situation, consider Quackenbush RTA. *Uma* were identified there by Cutler *et al*. in 1999. In our 2001 survey of the same sand sheet, no *Uma* were identified in any of four plots. Two of the plots were considered to be typical *Uma* habitat, being between 98 and 100% soft sand. The other two plots had similar characteristics but were considered medium packed sand, rather than loose sand. One plot was located in a wash. This begs the question, do *Uma* still occur at this location and if not, why not? In one case, the 2001 plots are located less than 0.5km from the location where the original sightings were made in 1997. Within dune features, particularly sand sheets, the environment may be described as hummocky, where there is a high degree of heterogeneity within a given area. That is, pockets of suitable and unsuitable habitat exist within the greater defined suitable dune habitat feature. Within this heterogeneous matrix of soft sand and hard packed sand, *Uma* would of course only be found to occur in the soft sand under suitable conditions. In this scenario, it is possible that *Uma* do occur in the greater dune, but were not found to occur within sampled plots. The other possible explanation is that *Uma* no longer occur at that location. Where small, isolated populations of habitat-restricted species exist it is not uncommon for temporary extinctions to occur with population reestablishment later. This is a cyclical phenomenon, where extinction and reestablishment occur repeatedly over time. This is one possible explanation for the documented presence of *Uma* in 1997, but apparent absence in 2001, where the last few individuals were identified in 1997. Now, in 2001, in is possible that the population is in a state of local extinction. The nearest known populations that would support reintroduction are Emerson Lake and Gypsum Ridge.

It is also possible, that individuals occur on Range Range, which was not surveyed for safety reasons. This brings forth a management issue for MCAGCC officials, namely, if there is local extinction of *Uma* at this location, do avenues exist to allow the natural cycle of extinction-reestablishment to continue? That is, are there sufficiently close populations that can support reestablishment and are these populations suitably maintained?

Similarly, in 1990 Minnich *et al*. identified an *Uma* just to the west of Mainside on BLM land. Again, four plots in the vicinity (less than 1km from the original sighting in 1990) yielded no individuals. In fact, the sand at that location was found to be consistently hard packed and was not considered, upon visitation, suitable habitat. Three plots on BLM land immediately adjacent to Acorn TA yielded no *Uma*. One of the plots may have been marginal habitat, consisting of soft substrate, but with an estimated 13% cover of annuals and a mix of gravel and sand. Again, the heterogeneous matrix of soft and hard packed sand within a sand sheet feature plays a role in the distribution of individual within a population and potentially in the distribution of metapopulations as well. Emerson Lake is another good example of the relationship between pockets of habitat and non-habitat within a larger identified dune feature and the distribution of *Uma* individuals. Here, 63 individuals were observed between 1983 and 1998 and an additional 15 were observed during this 2001 survey. Six plots were surveyed in 2001 but only one plot yielded positive results for *Uma*. One plot, located 138m from a location where 31 individuals were observed in 1983, was found to be hard packed sand and not considered suitable habitat. It is unknown whether the state of the substrate has changed in the past 18 years and in 1983 *was* soft sand but is now hard pack or if this location has always been in its present state. Given the dynamic nature of the sand systems, it is unlikely that any area can be considered static over time. Although other plots were found to be suitable habitat for *Uma* but were not found to contain individuals, the field crew reported identifying individuals outside plot boundaries in the immediate area. Again, this illustrates the fact that habitat variables alone cannot be predictive for wildlife. There must be some factor(s) other than those measured, or those that can be quantified, that act in location selection at the individual level.

What is clear is that to maintain existing *Uma* populations, more area than just the locally suitable habitat must be identified for management. Suitable habitat exists within a matrix of heterogeneous conditions such as hummocks or pockets of soft sand with few annual species interspersed with hard packed sand and less suitable levels of vegetation and vegetation composition. Clearly individuals are moving within this matrix of suitable and unsuitable habitat throughout the greater identified dune feature. In fact the idea of labeling hard packed sand as unsuitable habitat may be in error. Hard packed sand interspersed with soft sand may serve a different purpose altogether, and as such is not unsuitable, but rather serves a specified purpose for *Uma* at the population level. What that purpose may be is unknown. *Uma* were found, for example, in what was termed medium-pack sand in Lead Mountain during the 2001 survey. Individuals were also identified in nearby areas in 1996, 1997, and 1998. One individual *Uma* observed in 2001 was noted to have ìleft a soft sandy spotî within the medium packed sand of the survey plot and traveled through more firmly pack sand. From a practical perspective, the scale at which this matrix occurs prohibits specialized protection of tightly defined *Uma* habitat. Clearly, *Uma* occur within a range of habitat extent from homogeneous classically defined soft sand to very heterogeneous patchworks of mixed sand compaction.

<u>Habitat comparison between BLM and MCAGCC</u>

Three locations were found to have *Uma* on BLM land. Two areas, Spy Mountain and Cleghorn wilderness, were not found to have *Uma* or potential *Uma* habitat. This indicates that there is suitable habitat adjacent to MCAGCC that support *Uma* populations. Some locations on BLM land were found to harbor *Uma* in the past, but were not found to have individuals during this survey. For reasons described in the previous section, this may be a function of local extinction (temporary), of actual extinction (permanent) due to habitat loss or alteration, or due to the location of survey plots within a matrix of heterogeneous landscape conditions.

What can be said about BLM *Uma* habitat is that where *Uma* were found outside MCAGCC boundaries in this survey, habitat conditions could be considered ìgoodî to ìexcellentî. At the same time there is less habitat on BLM lands from a cumulative area measure. In other words, there is good quality habitat on BLM land confined to very specific areas. These areas vary in size from rather extensive, as on Copper Mountain, to highly contained, as in Valley Mountain and Bristol Mountain.

Bristol Mountain is perhaps the most remote location found to harbor *Uma*. At one site *Uma* were found to occur on a climbing/falling dune (Figure 30) with no annuals, 6% perennial cover, and a mix of soft, loose sand and large stones. Similarly, the second Bristol Mountain Similarly, the second Bristol Mountain site had no annual vegetation, 6% perennial cover, and was 98% soft loose sand. This second site, situated close to a pipeline and a power line maintenance road, was located in an area otherwise characterized as ìpristineî, indicating little evidence of human activities in the form of vehicular tracks, litter, or graffiti. Given the predominant winds in the southern Mojave, source sand feeding these dune features are outside of MCAGCC.

Copper Mountain, where more than 50 *Uma* were documented, also had very low annual vegetation cover. Only half of the plots in this area had annuals, and this was only 1%. Perennial vegetation ranged between 3 and 7 percent. This area is almost entirely loose, soft sand and what is notable is the proximity of urban/suburban development to this area. Two plots were noted to have vehicular tracks and one plot contained a lot of trash. Most of the individuals observed were juveniles, which may have been a function of the timing of the survey (mid to late September).

Figure 31 shows the location of the plots where *Uma* were found at Copper Mountain and also identifies those plots found to have annual vegetation. If these annual species are exotics, it would be of interest to investigate the spread of these exotics with off-road vehicle or other recreation in this area. Two elements are of concern to the *Uma* in the Copper Mountain area. The first is source sand that maintains the dune habitat. Upwind of this area, development is occurring, converting landscape that provides Aeolian sand to hardened surface, incapable of blowing away. Second, it is unknown the exact effects of OHV activities on either the sand substrate or *Uma.* Certainly, vehicular recreation serves to break up surface crusts, but loose sand can be maintained only where the hard pack does not extend beyond the depth to which heavy vehicles can take effect. Furthermore, certain types of OHV activities are targeted to dune and soft substrate areas. Again, the extent to which those activities perpetuate the state of loose sand is unknown. Neither is the effect known of OHV activities on increasing sand losses from aeolian transport. The effect of the physical presence of OHVs or humans on *Uma* in terms of disturbance, prey reduction, interference with reproduction, or foraging is being partially addressed by Dr. Dave Morafka in the El Mirage Dry Lake, Rasor Road and Dumont Dunes OHV areas (Morafka, pers. comm.).

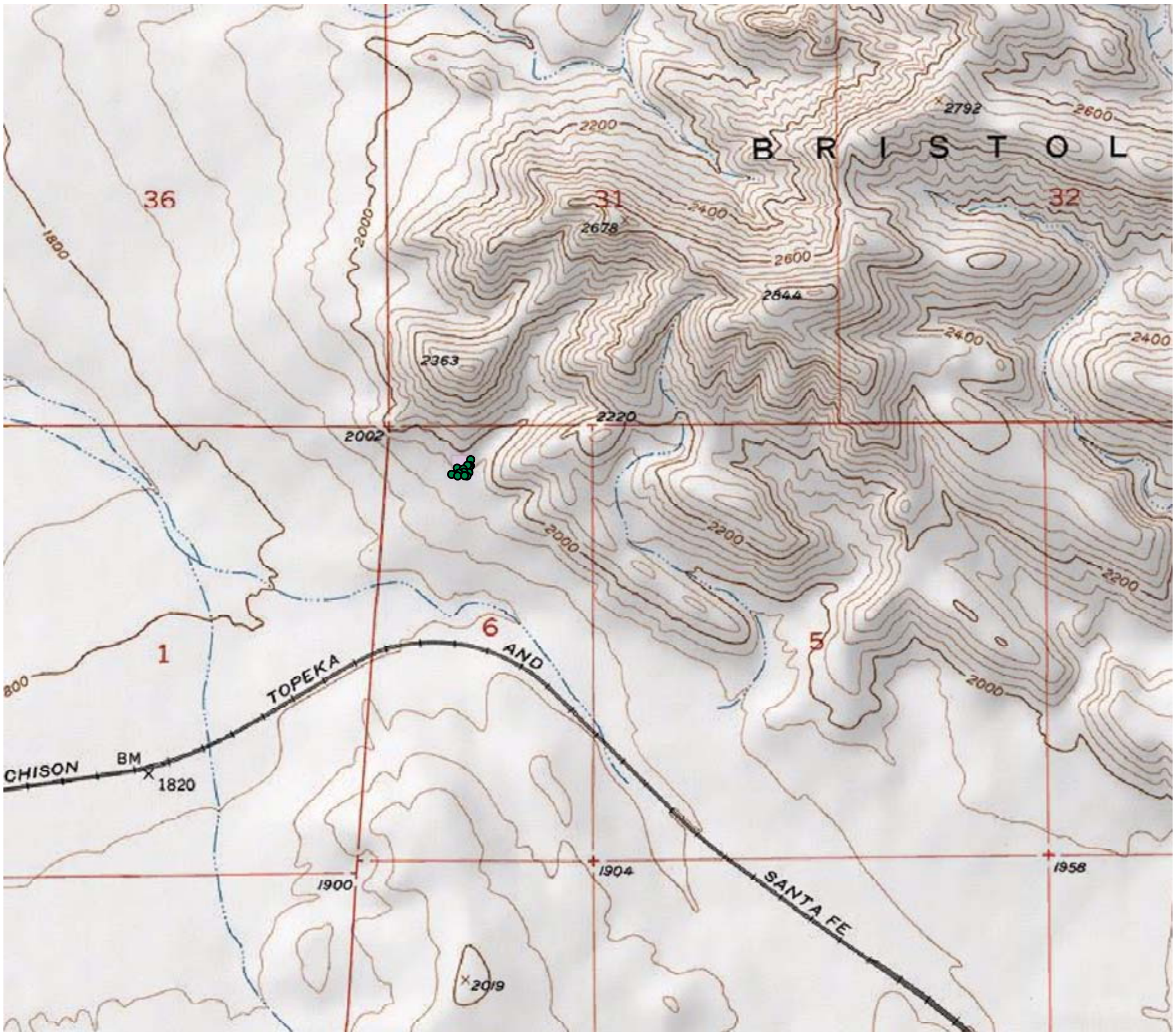


Figure 30. Representation of Bristol Mountain site on BLM land. Plot in pink with Uma observations as green dots. Data overlaid on USGS 1:24k topographic maps.

Two plots in the Valley Mountain area were surveyed. Six *Uma* were identified in one plot characterized as ì good dune habitat; undisturbedî . This plot was primarily loose sand (96%) with a few stones (4%), 2% each of annual and perennial vegetation. In the plot where *Uma* were not found no perennials occurred but habitat variables were otherwise nearly identical. The two plots were less than 0.5km apart and habitat conditions were very similar. There is a 4x4 road indicated on topographic maps to the east of these plots, but this area is relatively undisturbed especially when compared to Copper Mountain or heavily used training areas on MCAGCC.

On MCAGCC, plots where *Uma* were observed ranged between zero and seven percent annual vegetation cover and between 63 and 100% sand substrate. In general plots were considered by the field crew to be good dune habitat. Some plots where *Uma* were identified were noted to be a mix of compacted sand (soft and hard). Tank tracks were noted in plots where *Uma* were observed in Acorn, Gypsum Ridge, and Emerson Lake training areas. The extent of annual invasion throughout MCAGCC was not part of this survey, but some information may be useful to NREA for management and monitoring purposes. For example, Figure 32 depicts percent coverage of annuals in eight plots surveyed on Emerson Lake. Each plot is color-coded according to the percent annual (exotic) coverage, ranging from lowest (green) to highest (red).

Annual coverage for the entire survey area is as high as an estimated 12%. Maumee Mine plots, located on the westernmost border of Maumee Mine TA also had relatively high percentage of annuals (7%). Likewise, the same pattern is seen in Lead Mountain, where plots are even more remote to concentrated human activities such as Mainside. Compare these to plots in Lavic Lake, shown in Figure 33, where the highest cover of annuals was an estimated 5%. Although close to vectors of spread, (i.e., roads) highest concentrations of annual vegetation does not appear to be directly related to distance to road. Figure 34, depicting percent cover of annuals immediately adjacent to Mainside, demonstrates that a direct relationship between roads and annual vegetation may not be straightforward. What is apparent is that plots on Acorn, Emerson Lake, and on adjacent BLM land, had highest percentages of exotic annuals.

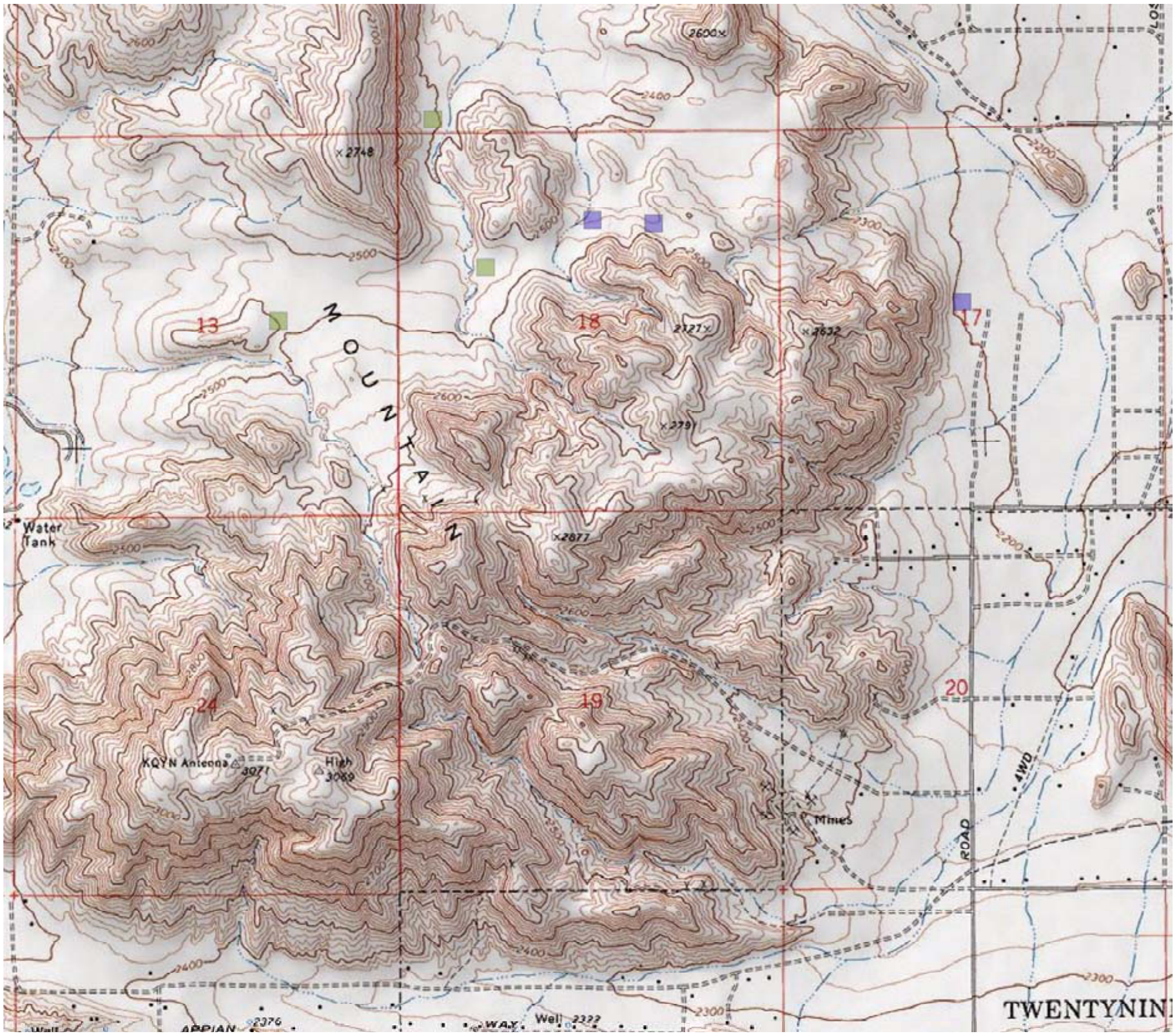


Figure 31. Plot location at Copper Mountain overlaid on 1:24k USGS topographic map. Purple plots were found to have annual vegetation (exotics) while green plots had no annual vegetation (exotics).

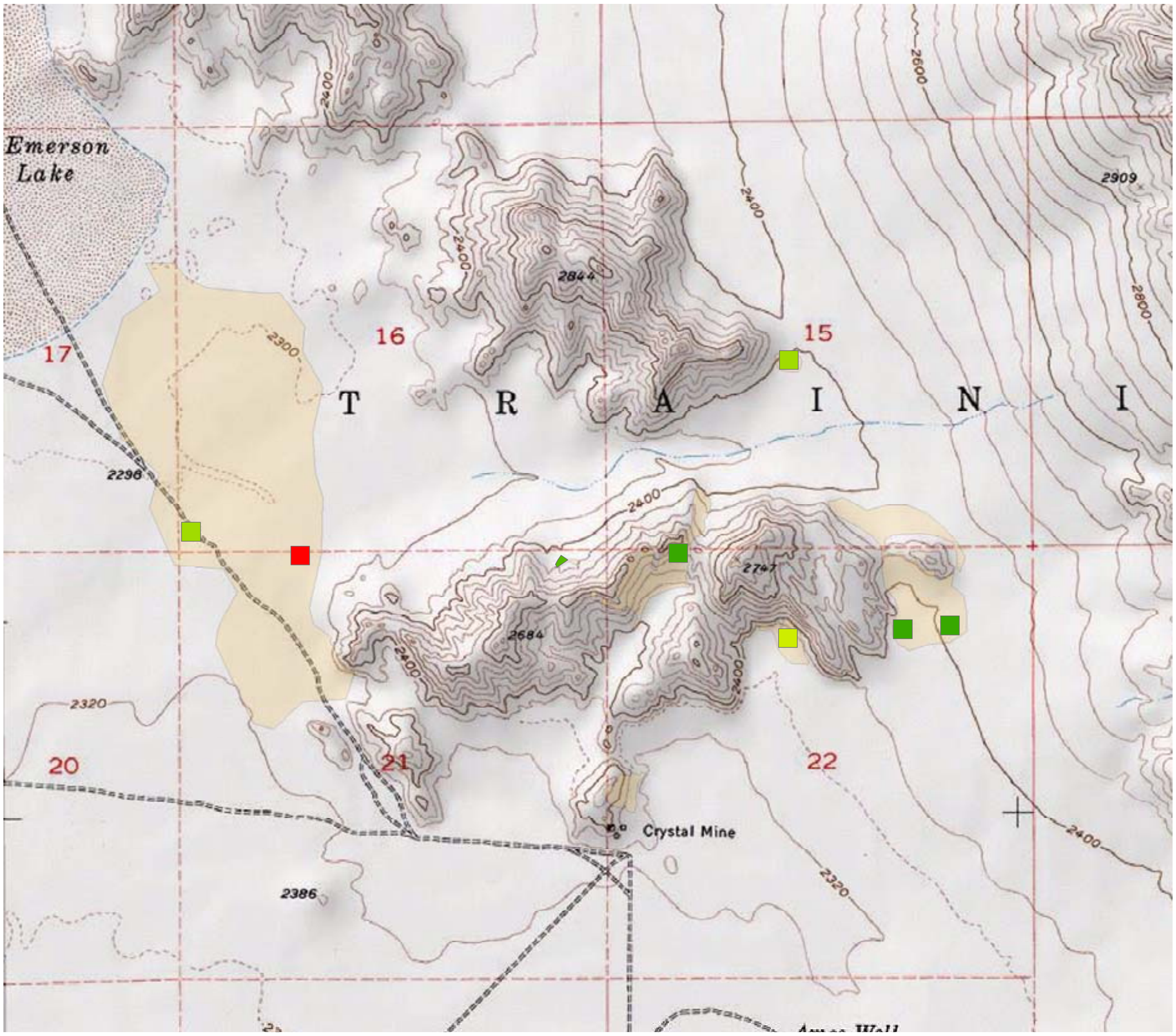


Figure 32. Example plots surveyed on Emerson Lake color-coded by the percent annual (exotic) vegetation. Green plots are lowest percent, yellow are mid-level, and red is highest percent. Dune features are shown in tan and data are overlaid on USGS 1:24k topographic maps.

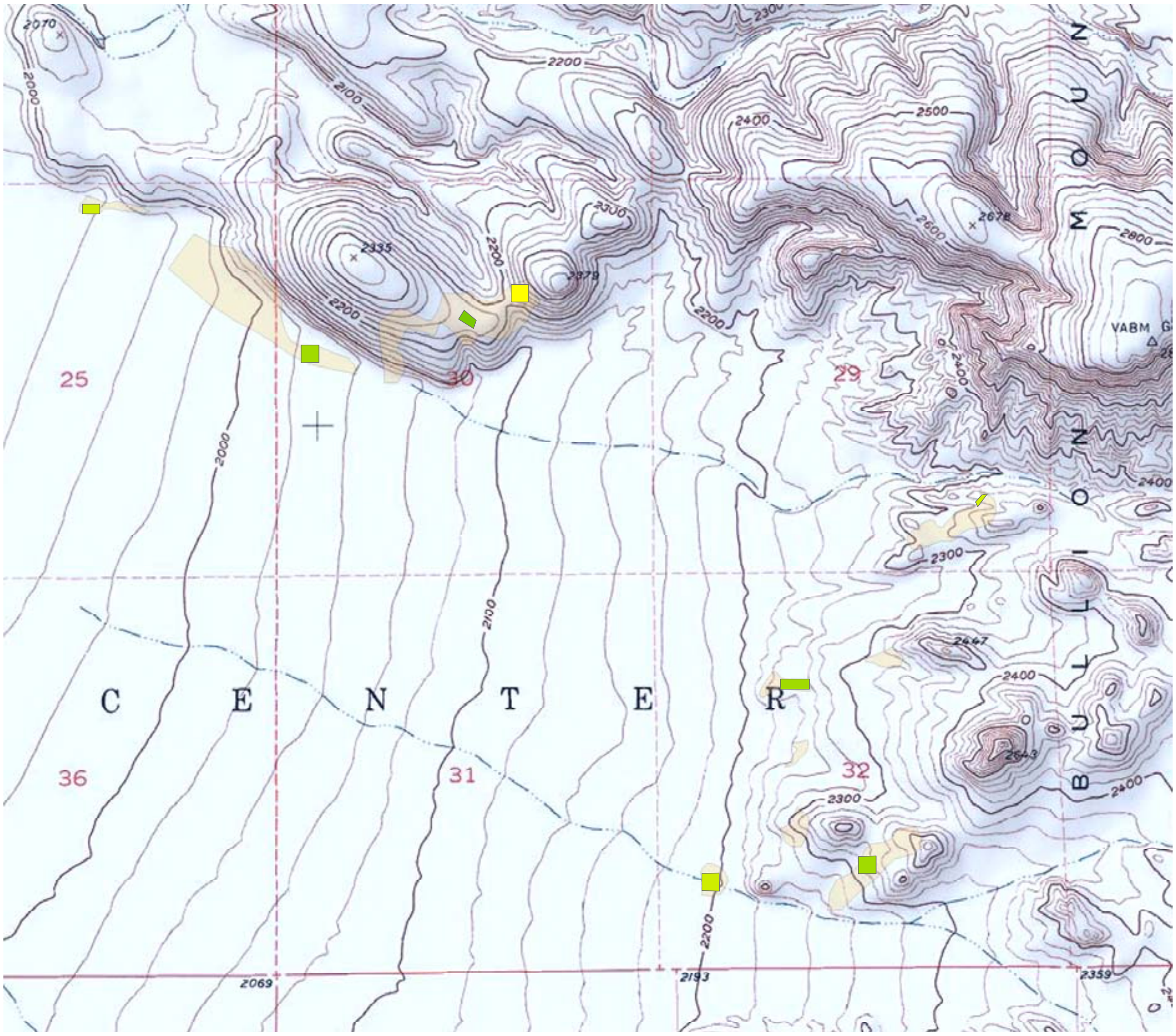


Figure 33. Representative plots in Lavic Lake mapped percent annual (exotic) coverage by color. Greens are lowest percent and yellow is highest percent relative to the entire database. Dune features are shown in tan and data are overlaid on USGS 1:24k topographic maps.

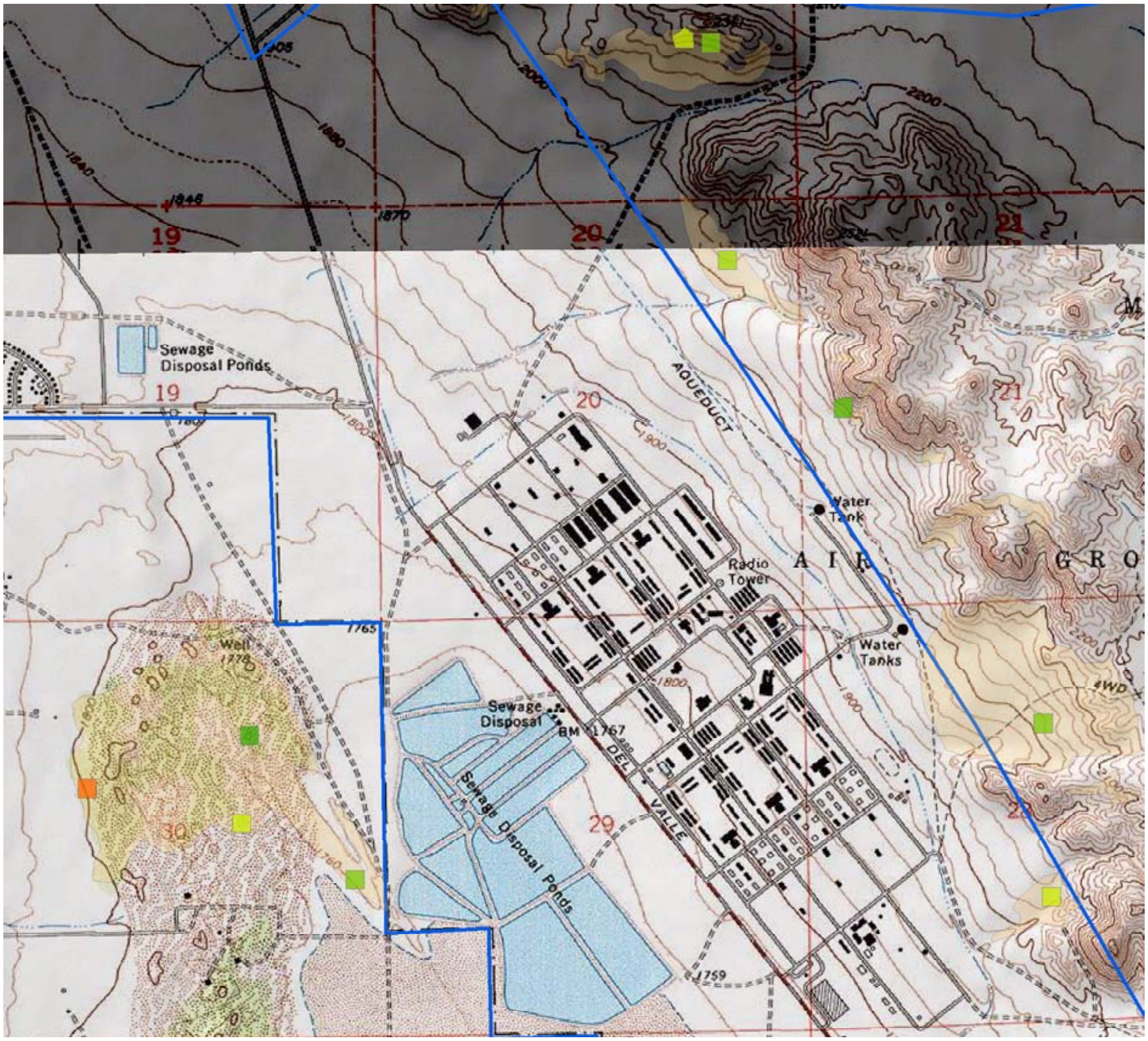


Figure 34. Example plots surveyed near Mainside, color-coded by the percent annual (exotic) vegetation. Green plots are lowest percent, yellow are mid-level, and red is highest percent. Dune features are shown in tan and data are overlaid on USGS 1:24k topographic maps. Dark shading at the top of this figure is due to quality of digital topographic map.

Management Recommendations

Based upon the findings of this study and that of Cutler *et al.* (1999) we provide management recommendations that fall within three main categories:

1. Strengthen the coordination, data sharing, and joint research efforts with neighboring land management agencies who have species protection mandates;

2. Preservation of a maximum amount of habitat within RTAs that receive minimal use or areas that receive minimal use and are a subset area within heavily trained RTAs;

3. Preservation of a minimal amount of habitat within heavily trained RTAs.

Without question the most effective and long-term solution for maintaining viable populations of *Uma*, under the threat of potential federal or state listing, that the MAGTFTC could pursue is to encourage and collaborate with the BLM to aggressively and actively manage the Copper Mountain and Copper Mountain vicinity lands for *Uma* populations and habitat. *Uma* were not reported to occur at this location before this study, but it is now clear that there is a population of *Uma* at Copper Mountain and there is heavy use of the area by OHV and similar recreation types. These Copper Mountain vicinity lands hold dual importance for the BLM, as this area has been recommended by BLM staff as potential desert tortoise ìreserveî habitat (LaRue, pers. comm.). The desert tortoise was listed as a federally threatened species in 1990. This area also contained the largest number of *Uma* observed during our study at any one location. More importantly, perhaps, is the finding that those *Uma* were found to be by overwhelming counts, juveniles, suggests that this area may be a source population (in contrast to a sink).

The two other locations identified as supporting *Uma*, appear at this time to receive low-level disturbance from human activities. The habitat appears to be in good condition, although the Valley Mountain site exhibited low levels of exotic annual vegetation. This relatively undisturbed state should be maintained and we recommend that the BLM monitor these two sites for *Uma* at a frequency that reflects expanding use of remote areas by people. At this point in time, these areas have low use but as development pressure continues and as more people move into and visit the Mojave, the condition of the Bristol and Valley Mountain sites is expected is decline. Periodic visitation, such as annually, by BLM officials to each of these two sites to record disturbance in terms of amount of trash, vehicle tracks, footprints, graffiti, and exotic vegetation should be sufficient to indicate when degradation of these sites begins.

There is some evidence to suggest that exotic vegetation is invading the Copper Mountain area and if true, this spread could be detrimental to both *Uma* and tortoise populations. The same potential threat of spread is true for the Valley Mountain site and on public land due west of Mainside in the hummocks due west of the Sewage Treatment Ponds (see Figure 34). Highest levels of exotics outside of MCAGCC boundaries were identified less than 200m from Acorn RTA boundary. Densest coverage of exotics within the installation were found on Emerson Lake and relatively high percentages were also recorded in Lavic Lake plots. The pattern of spread appears to be along the north-south axis, although no concrete statements can be made because spread of exotics was not a component of this study. However, taken as preliminary evidence of a potentially significant problem, both economically and ecologically, we recommend some effort be taken to identify the mechanism of transport and level of threat of exotic species, particularly *Salsola spp.* and *Schismus*.

Another area for potential collaboration with MCAGCC and BLM is with Joshua Tree National Park (JOTR). JOTR acquired a significant amount of potential *Uma* habitat in the northeast area of the park with passage of the 1994 California Desert Protection Act. No *Uma* locations have been officially documented within Joshua Tree National Park, although the park does list it as a species that is ìknownî to occur within the park. Currently a reptile inventory project is being conducted within the park, however it remains questionable as to whether or not potential *Uma* habitat is included in the survey for sampling (Rodgers, pers. comm.).

With the understanding that training intensity, frequency, and location change continually, it is critical to maintain existing populations of *Uma* within installation boundaries. In addition to encouraging and supporting the protection of *Uma* and its habitat within the BLM Copper Mountain lands, we recommend preserving the maximum allowable amount of habitat within minimally trained RTAs. We identify these RTAs to be Mainside, East, Prospect, Acorn, and/or areas that see minimal amount of training activity such as the small isolated climbing dunes in Lavic Lake that border the Bullion Mountains, the sediment hills of Gypsum Ridge and Quackenbush, and the dunes along Deadman Dry Lake. Some of these specified areas harbor *Uma* and some areas are believed to contribute source sand.

Prospect may be considered a heavily trained area, however, the type of training does not involve activities which would impact the locations where *Uma* were found to occur. This area is remote and not accessible with surface vehicle, only on foot or via helicopter. *Uma* were not found to occur in Mainside but suitable habitat does exist and *Uma* are known to occur in extremely close proximity to that suitable habitat, on East RTA. Mainside is therefore included in this recommendation. Protection in Mainside and East RTA would include maintaining habitat that is free of human disturbance such as trash and also monitoring ecological condition of exotics. The proximity of *Uma* habitat and known locations to development in Mainside is both positive and negative. No heavy vehicle traffic occurs here, but this area is easily accessible by people. The areas cited above provide maximum trade-off between species protection and military mission priorities. Protecting these areas may contribute to species protection with minimal amounts of conflict with military training mission. As training requirements change, we recommend avoiding training in these specified areas as much as possible.

We recommend MAGTFTC set aside a minimal amount of area within heavily trained RTAís such as Emerson Lake and Lead Mountain, with the exception of at least one climbing/falling dune complex (dune #53, 4 digit grid ~5909) within Emerson Lake (Figure 35). This dune is suited for protection due to its isolation, relative vehicle access difficulty, and the large number of *Uma* observed there. These areas provide minimal trade-off between species protection and continued military mission. Recent surveys (ours and Cutler, *et al.* 1999) suggest that *Uma* populations are stable within these areas. As long as military training activities do not change in intensity, frequency, duration, or type, we so no reason to expend a large amount of management effort protecting *Uma* and their habitat within these areas other than to reduce the amounts of exotic vegetation if and where. However, in choosing to not protect habitat, we recommend that MAGTFTC commit to a monitoring program, targeting the same areas as sampled by Cablk and Heaton (2001) and Cutler, *et al.* (1999). This will help ensure that the stability of these populations can maintained through early indication of change through monitoring. If and when populations begin to decline, this management recommendation will need to be revisited.

Given the results of work within Lead Mountain, it seems most appropriate to consider protecting the areas where Cutler *et al.* (1999) and Cablk and Heaton (2001) found high numbers of *Uma*, particularly in the vicinity of the six-digit grid 004230. Figure 36 depicts that location including the great matrix of dune feature that is comprised of hummocks with varying levels of compacted sand. Two roads traverse this specific location, where *Uma* were found to occur. Protection for this specific location could include prohibiting travel off the established ìroadî and prohibiting associated foot traffic involved in training exercises.

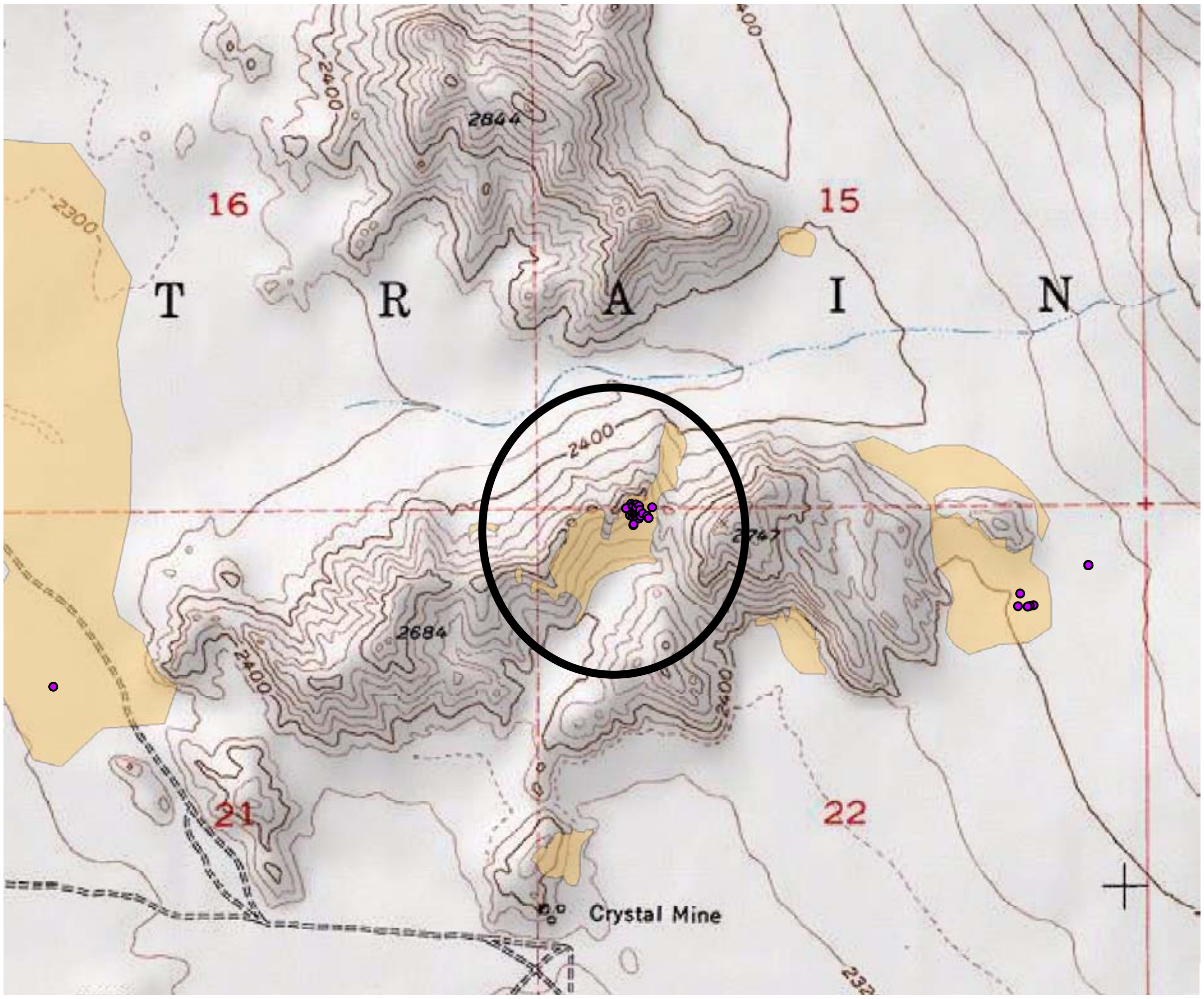


Figure 35. Dune suggested for protection in Emerson Lake RTA, circled in black, approximate grid 5909. Purple dots indicate *Uma* sightings between 1983 and 2001.

Suggestions for Further Study

There are many questions that inevitably arise from studies, especially from studies with the breadth and depth of this one. Some questions arise from literature-based protocol. For example, it is known that temperature plays an important role in the activity of *Uma* and there are published temperature ranges that were used to set survey limitations to maximize efficiency. However, the field crews were not satisfied with the temperature ranges restrictions, as they consistently observed *Uma* out in cooler weather than previous studies have indicated as they were en route to sites or as they were waiting for temperatures to reach the lower range value. This may be due to a combination of higher surface temperatures that negate the cooler air, or a function of the size of the *Uma*, as the field crew observed that smaller *Uma* were more likely to be out in the cooler temperatures. Further studies into the temperature range of *Uma*, the differences in temperature requirements for adults vs. juveniles, and the temperature differences between adults and juveniles going into torpor may be suggested.

Many additional research questions arise from anecdotal accounts and experience while conducting surveys. For example, during the fall survey of plots, the field crew reported they often found a large number of juveniles and only a few adults. This reported relative proportion is not an unusual phenomenon, as typically juvenile *Uma* out-number adults later in the year, as more and more clutches are successfully hatched. In other words, the observed

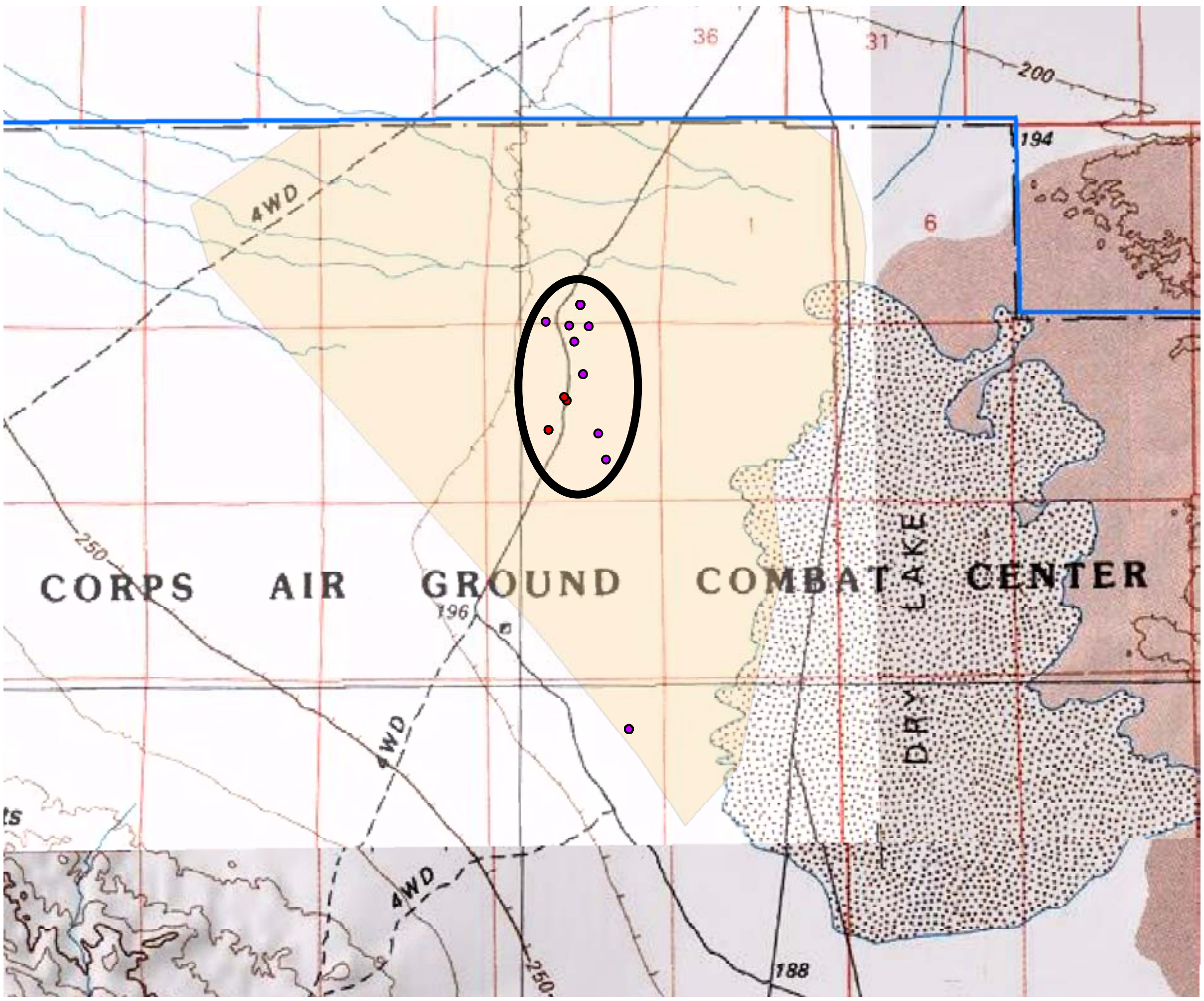


Figure 36. Recommended area for protection in Lead Mountain where Uma were located repeatedly in the past decade, designated in black oval. Purple dots indicate pre-2001 sightings, red dots are 2001 survey sightings. Dune feature overlaid on USGS 1:24k topographic map. Variations in color are due to quality of digital topographic map. MCAGCC boundary indicated by blue line.

high numbers of juveniles probably relates to the fact that clutches are hatching and there are, in fact, more juveniles than adults. There is a time lag between hatching and survival. However, this observation also brings into question relationships between environmental factors and successful clutches. Further studies into the correlation between seasonal and annual precipitation with clutch size, nest success, juvenile survivorship and dispersal would not only add to our knowledge of the Mojave fringe-toed lizard, but possibly help in determining population status and trends.

In the process of locating *Uma* in geographically very small areas, with no surrounding dunes, questions regarding genetic diversity of populations and metapopulations become obvious. The use of hummock habitat, and what might be described as marginal medium-packed sand may increase the individual genetic exchange between populations. Graduate student Tanya TrÈpanier (University of Toronto) is currently working towards identifying and understanding the genetic diversity and biogeography of *Uma spp* under the advisement of Dr. Robert Murphy and Dr. Dave Morafka. Presently, her efforts do not include animals taken from MCAGCC. However, we are working with Dr. Morafka to attempt to obtain samples and develop joint research projects between the MAGTFTC and the National Training Center at Fort Irwin to include MCAGCC animals. Results from this type of work that would include genetic material from individuals on MCAGCC would answer some of the questions regarding population stability from a genetic perspective and would support investigation of population stability from an ecological perspective. Furthermore, it would provide insight into the idea that local extinction with later re-establishment of small populations is or does occur on MCAGCC.

From a biodiversity perspective, it would be interesting to determine what, if any, relationship exists between *Uma* and other flagship species, such as the desert tortoise. In the Copper Mountain area, which has been recommended for protection for desert tortoise, protection of those lands may also benefit *Uma*. How tightly these two species are linked is not well understood and if conservation efforts for one species will benefit the other, then management efforts may provide better coverage in terms of species protection.

And finally, we recommend the continued development of the LizLand model for identifying and predicting *Uma* habitat within, but primarily outside the boundaries of MCAGCC. Currently, the BLM is supporting LizLand model development through a grant to Dr. Dave Morafka in the El Mirage Dry Lake OHV area. There may be opportunities for joint collaboration between the BLM and the MAGTFTC.

Acknowledgements

We would like to thank several people for their contribution towards this work, particularly Mr. Rhys Evans of the Natural Resources Environmental Affairs Division (NREA). Mr. Evans was instrumental in providing support, guidance, and access at all levels of this research. It was because of his vision and foresight that this project was conducted. We thank John Montoya, Jody Fix and Captain Travis Sutton in the contracting office and DRI business manager Linda Piehl. MCAGTFTC staff Brent Husung, Paul (Kip) Otis-Diehl and Lorrie Agnew provided data and support, particularly with scheduling access during field data collection. Three field crew members were outstanding in their tasks collecting data under difficult conditions: Justin Neviakas, Megan Kornbluth, and Angela Rex. We commend them for their tireless efforts and valuable contribution to this project. There are many other MCAGTFTC staff who assisted at various times of need during this project that we wish to acknowledge in spirit. Mr. Tom Egan was instrumental in formulating this work at its conception as BLM representative. Finally, Ayoko Ochi and Tanja Kohls contributed graphics.

REFERENCES CITED

Adams, C. C. (1908). The ecological succession of birds. *Auk,* **25**: 109-53.

Airola, D. A. (1988). *Guide to the California wildlife habitat relationships system*. Sacramento, California, State of California Resources Agency, Department of Fish and Game.

California Department of Fish and Game. (2001). *Special Animals*, http:// www.dfg.ca.gov/whdab/html/lists.html (accessed 30 January 2001).

Coachella Valley Association of Governments. (2002). *The Coachella Valley multiple species habitat conservation plan and Natural Communities conservation plan*. http://www.cvag.org/mshcp/index.htm (accessed 28 September 2002).

Csuti, B. & Crist, P. (2000). *Methods for assessing accuracy of animal distribution maps.* http://www.gap.uidaho.edu/VertebrateDistributionAssessment/default.htm (accessed August 2000).

Cutler, T. L., Griffin, D. J. & Krausman, P. R. (1999). *A wildlife inventory and management recommendations for the Marine Corps Air Ground Combat Center, Twentynine Palms, California.* Tucson, AZ, University of Arizona, School of Renewable Natural Resources. Contract, N68711-93-LT-3026.

Davis, F. W., Stoms, D. M., Hollander, A. D., Thomas, K. A., Stine, P. A., Odion, D., Borchert, M. I., Thorne, J. H., Gray, M. V., Walker, R. E., Warner, K. & Graae, J. (1998). *The California GAP analysis project--Final Report*. Santa Barbara, CA, University of California, http://www.biogeog.ucsb.edu/projects/gap/gap_rep.html.

Dokka, R. K. (1998). *A guide to geomorphic landform and surface composition geographic information system of the Mojave Desert Ecosystem,* http:// www.geol.lsu.edu/rkd_dir/#age (accessed 25 October 1998).

Durtsche, R.D. (1992). Feeding time strategies of the fringe-toed lizard, *Uma inornata*, during breeding and non-breeding seasons. *Oecologica*, **89**:85-89.

Fromer, P.S. and M. Dodero. (1982). Twenty-nine Palms Marine Corps Air Ground Combat Center reptile inventory. Marine Corps Air Ground Combat Center Natural Resources Unpublished Report. R-1308.

Fromer, P.S., M. Dodero, and C. Patterson. (1983). A population study of the Mojave fringe-toed lizard *Uma scoparia* on the Twentynine Palms MCAGCC. Marine Corps Air Ground Combat Center, Twentynine Palms, California, Natural Resources Unpublished Report. R-1397.

Groves, C.R., L.S. Kutner, D.M. Stoms, M.P. Murray, J.M. Scott, M. Schafale, A.S. Weakley, R.L. Pressey. (2000). Owning up to our responsibilities: who owns lands important for biodiversity? *In: Precious heritage: the status of biodiversity in the United States*. B.A. Stein, L.S. Kutner, J.S. Adams, eds. Oxford University Press.

Heaton, J. S. & Kiester, A. R. (submitted 2001). The characterization of lizard habitat using geomorphic landform and surface composition correlates in the California Mojave Desert. *Journal of Arid Environments*.

Heifetz, W. (1941). A review of the lizards of the genus *Uma*. *Copeia*, **2**: 99-111.

Hilden, O. (1965). Habitat selection in birds. *Annales Zoologici Fennici,* **2**: 53-75.

Jenkins, R. E. (1985). Information methods: why the Heritage Programs work. *The Nature Conservancy News,* **35**: 21-23.

Lack, D. (1933). Habitat selection in birds with special reference to the effects of afforestation on the Breckland avifauna. *Journal of Animal Ecology,* **2**: 239-62.

Marcot, B. G., Raphael, M. G. & Berry, K. H. (1983). Monitoring wildlife habitat and validation of wildlife-habitat relationships models. *Transactions of the North American Wildlife and Natural Resources Conference,* **48**: 315-329.

Mayhew, W.W. (1966). Reprodcution in the psammophilous lizard *Uma scoparia*. *Copeia*, **1**:114-122.

McCullough, D. R. & Barrett, R. H., Eds. (1992). *Wildlife 2001: Populations*. Essex, England, Elsevier Science Publishers, Ltd.

Merriam, C. H. (1890). Results of a biological survey of the San Francisco Mountain region and the desert of the Little Colorado, Arizona. *North American Fauna*, **3**: 1- 136.

Morrison, M. L., Marcot, B. G. & Mannan, R. W., Eds. (1998). *Wildlife-habitat relationships: concepts and applications*. Madison, University of Wisconsin Press.

Norris, K.S. (1958). The evolution and systematics of the iguanid genus *Uma* and its relation to the evolution of other North American desert reptiles. *Bulletin of the American museum of natural history,* **114**: 251-326.

Noss, R. F. (1987). From plant communities to landscapes in conservation inventories: a look at the Nature Conservancy (USA). *Biological Conservation*, **41**: 11-37.

Pough, F. H. (1970). The burrowing ecology of the sand lizard, *Uma notata*. Copeia, **1**:145-157.

Scott, J. M., Davis, J., Csuti, B., Noss, R., Butterfield, B., Groves, G., Anderson, H., Caicco, S., D'erchia, F., Edwards, T. C. J., Ulliman, J. & Wright, R. G. (1993). Gap Analysis:

A Geographic Approach to Protection of Biological Diversity. *Wildlife Monographs*, **123**.

Scott, M., Heglund, P., Morrison, M., Rafael, M., Wall, B. & Hoffer, J., Eds. (2002). *Predicting species occurrences: issues of scale and accuracy*. Washington, DC, Island Press.

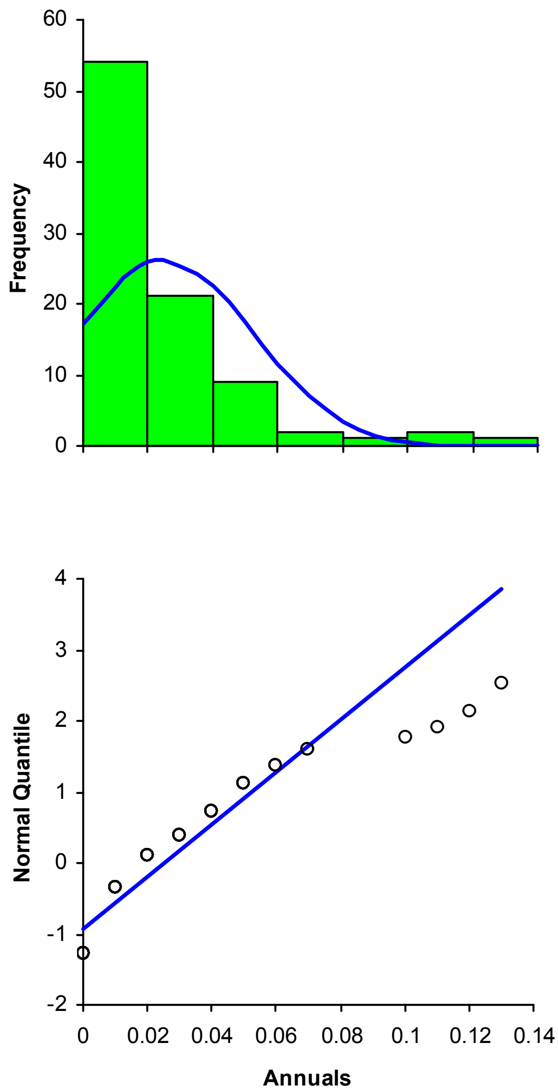
Stebbins, R.C. (1944). Some aspects of the ecology of the Iguanid genus *Uma*. *Ecological monographs,* **14**: 311-322.

Svardson, G. (1949). Competition and habitat selection in birds. *Oikos*, **1**: 157-74.

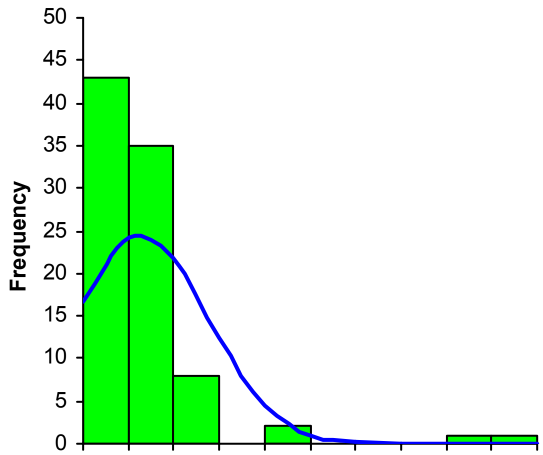
Verner, J., Morrison, M. L. & Ralph, C. J., Eds. (1986). *Wildlife 2000: Modeling habitat relationships of terrestrial vertebrates*. Madison, University of Wisconsin Press.

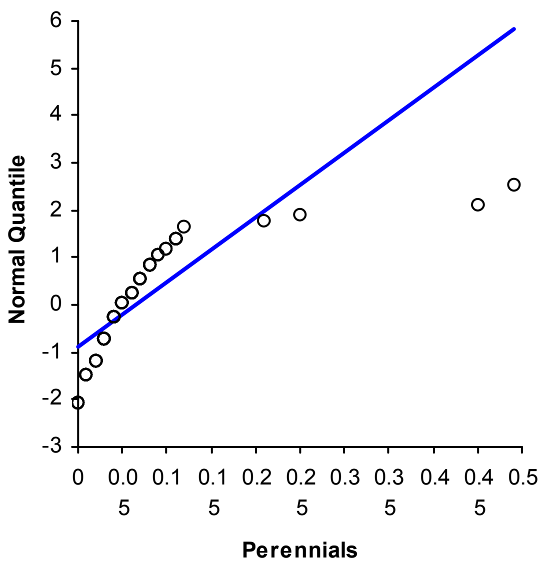
APPENDIX 1.
Frequency histograms and normal plots for habitat variables used to determine normal distribution.

Percent cover of annuals:

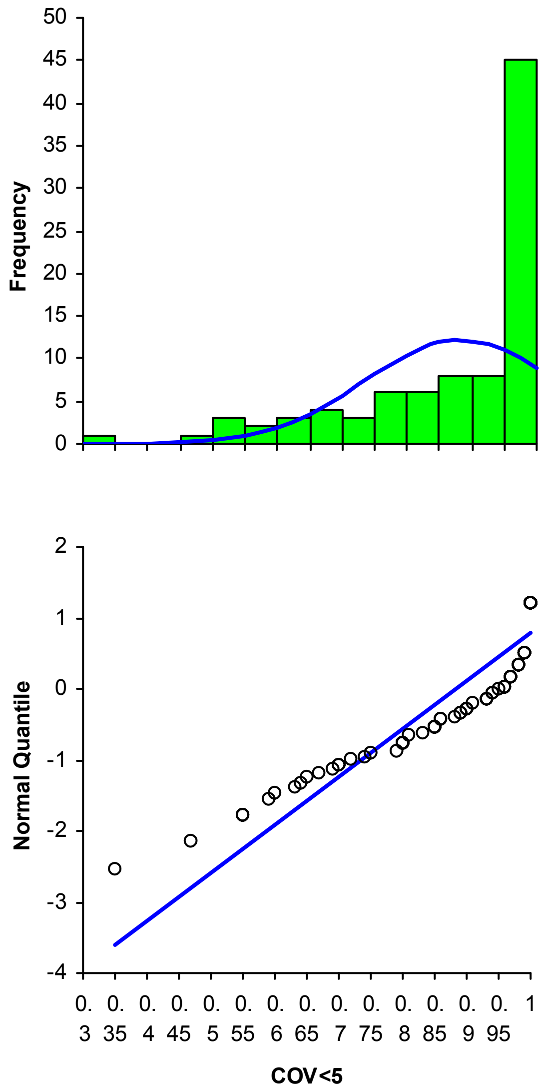


Percent cover perennials:

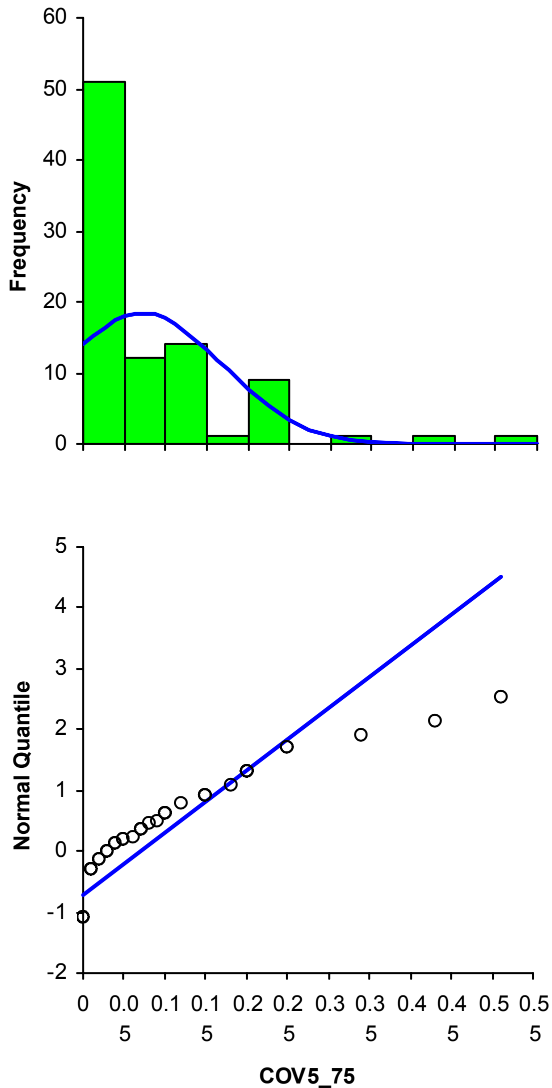




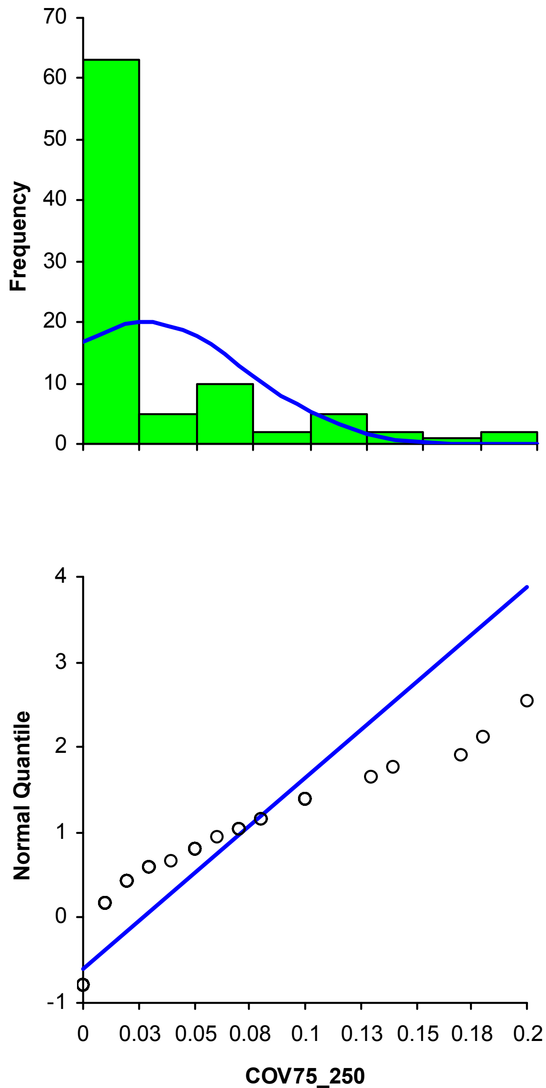
Percent cover sand (< 5mm):



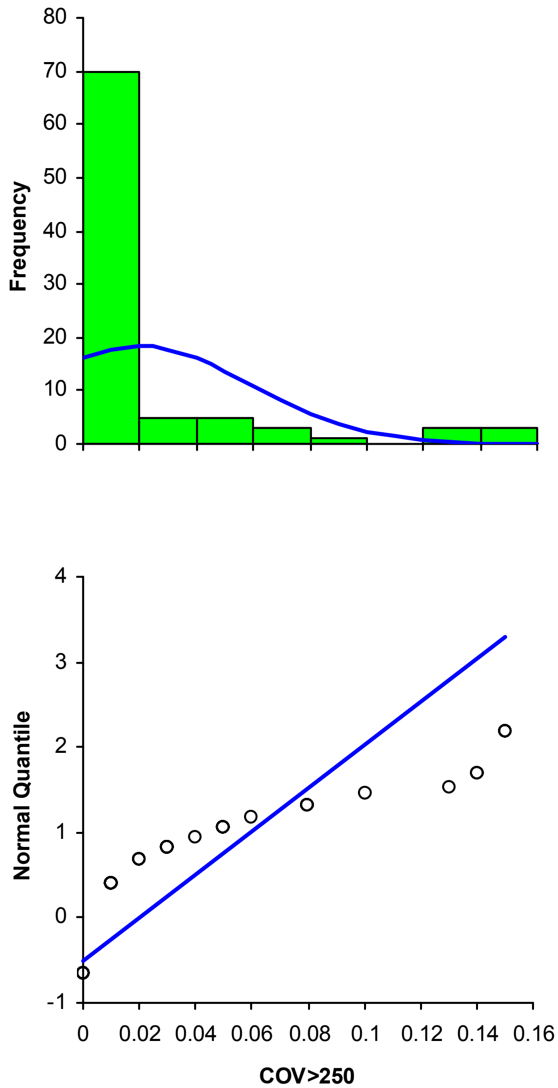
Percent cover particles 5-75mm:



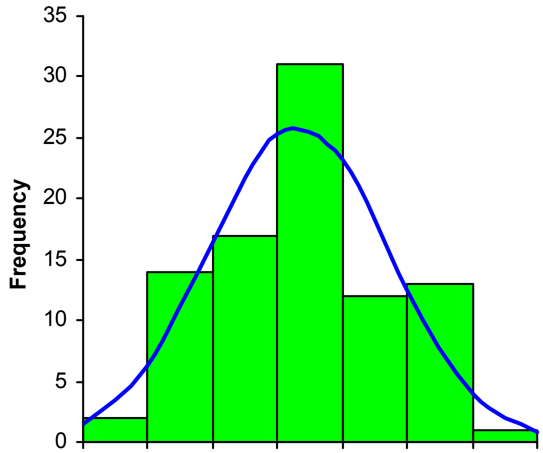
Percent cover particles 75-250mm:

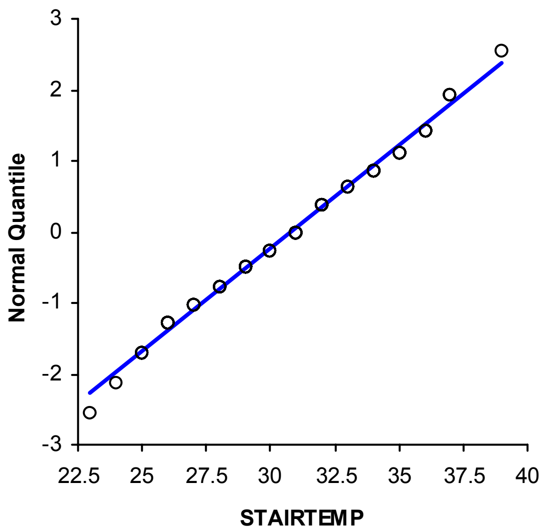


Percent cover particles > 250mm:

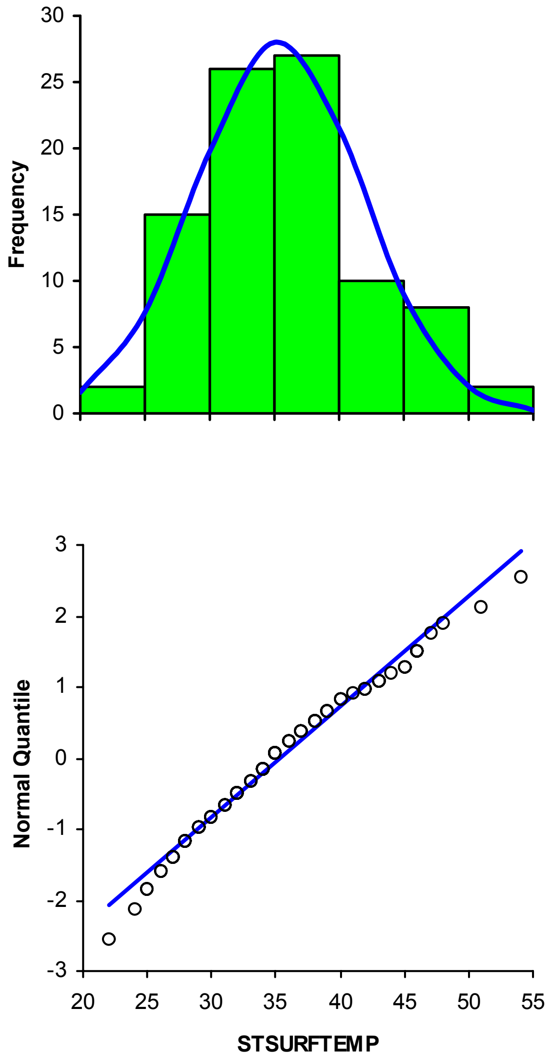


Ambient air temperature at start of surveys:

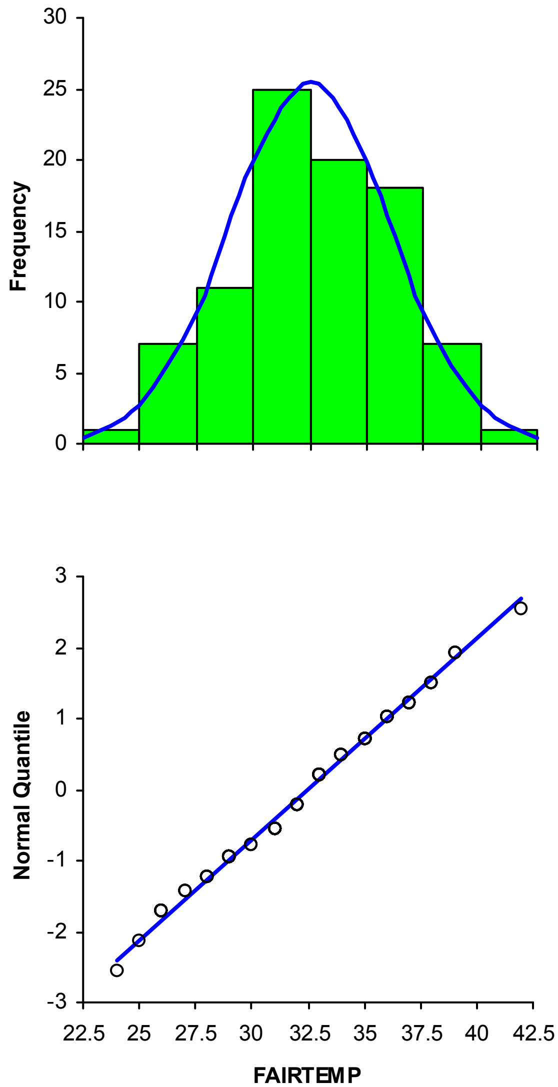




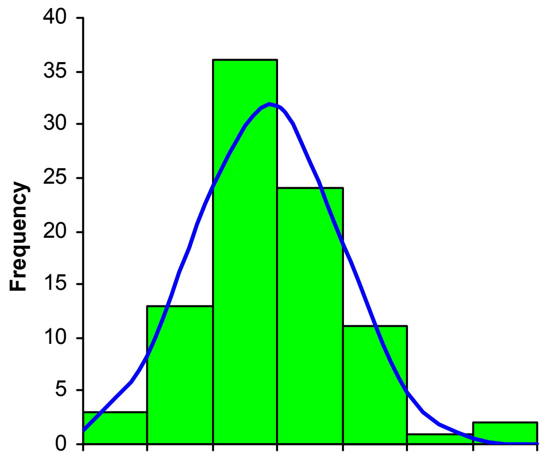
Surface temperature at start of surveys:

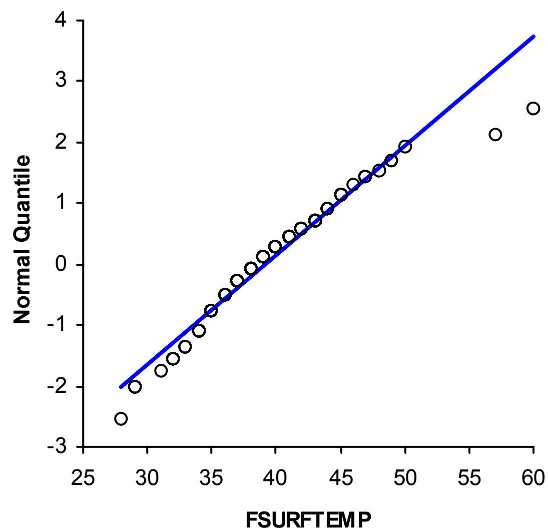


Ambient air temperature at completion of surveys:

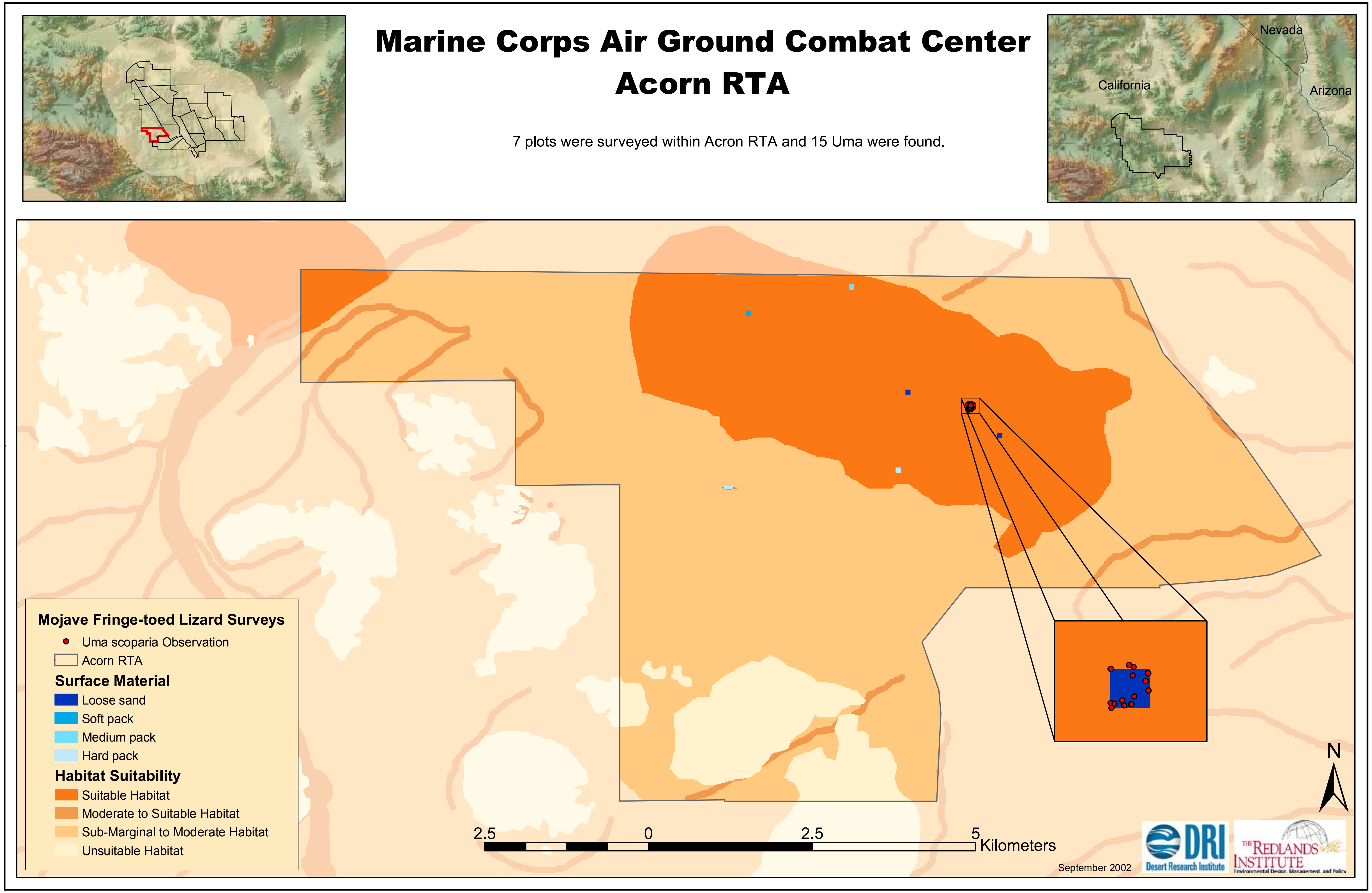


Surface temperature at completion of surveys:

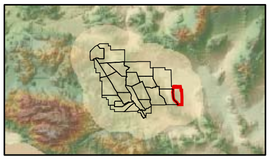




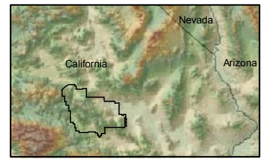
APPENDIX 2.
LizLand Model by RTA for each RTA.

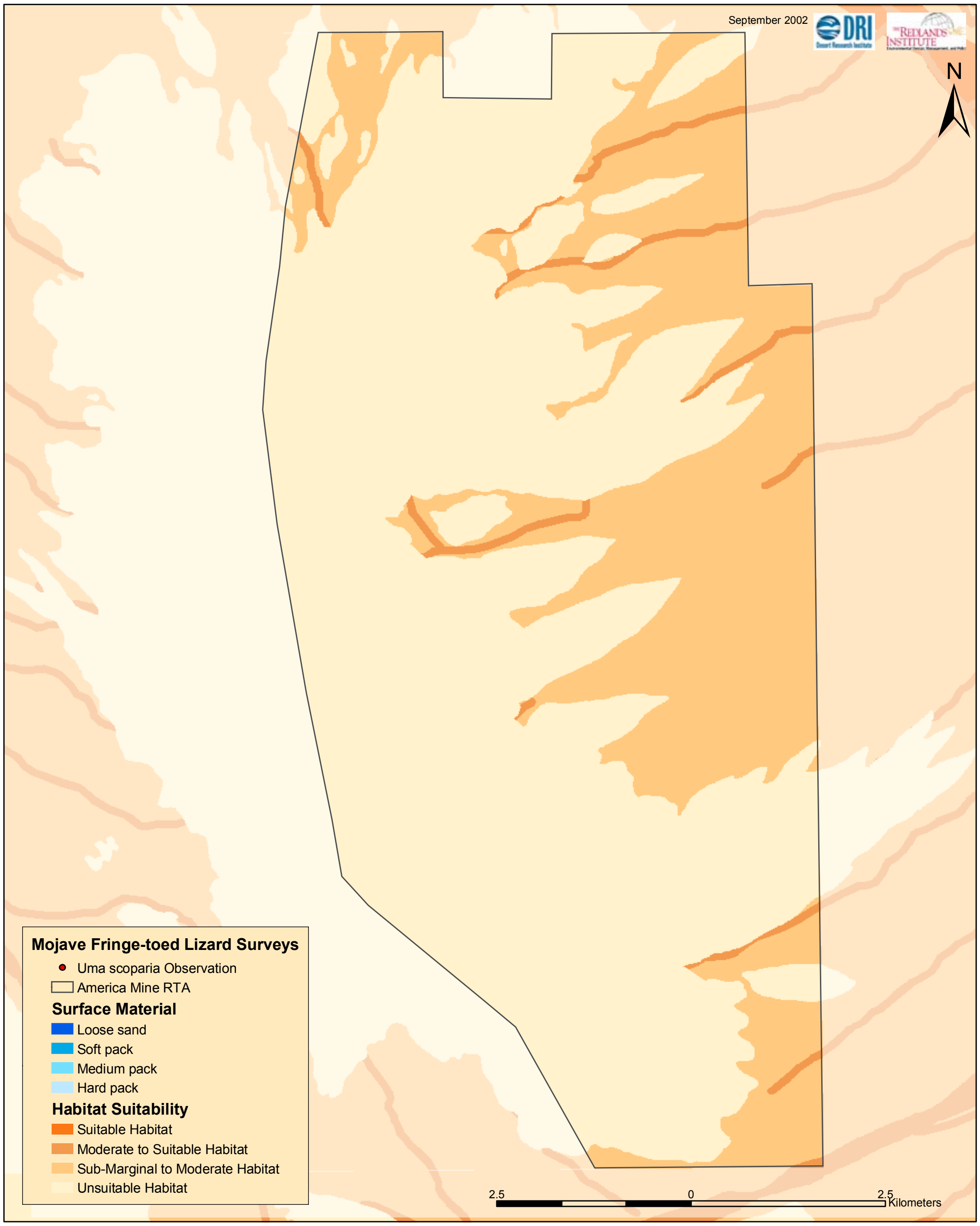


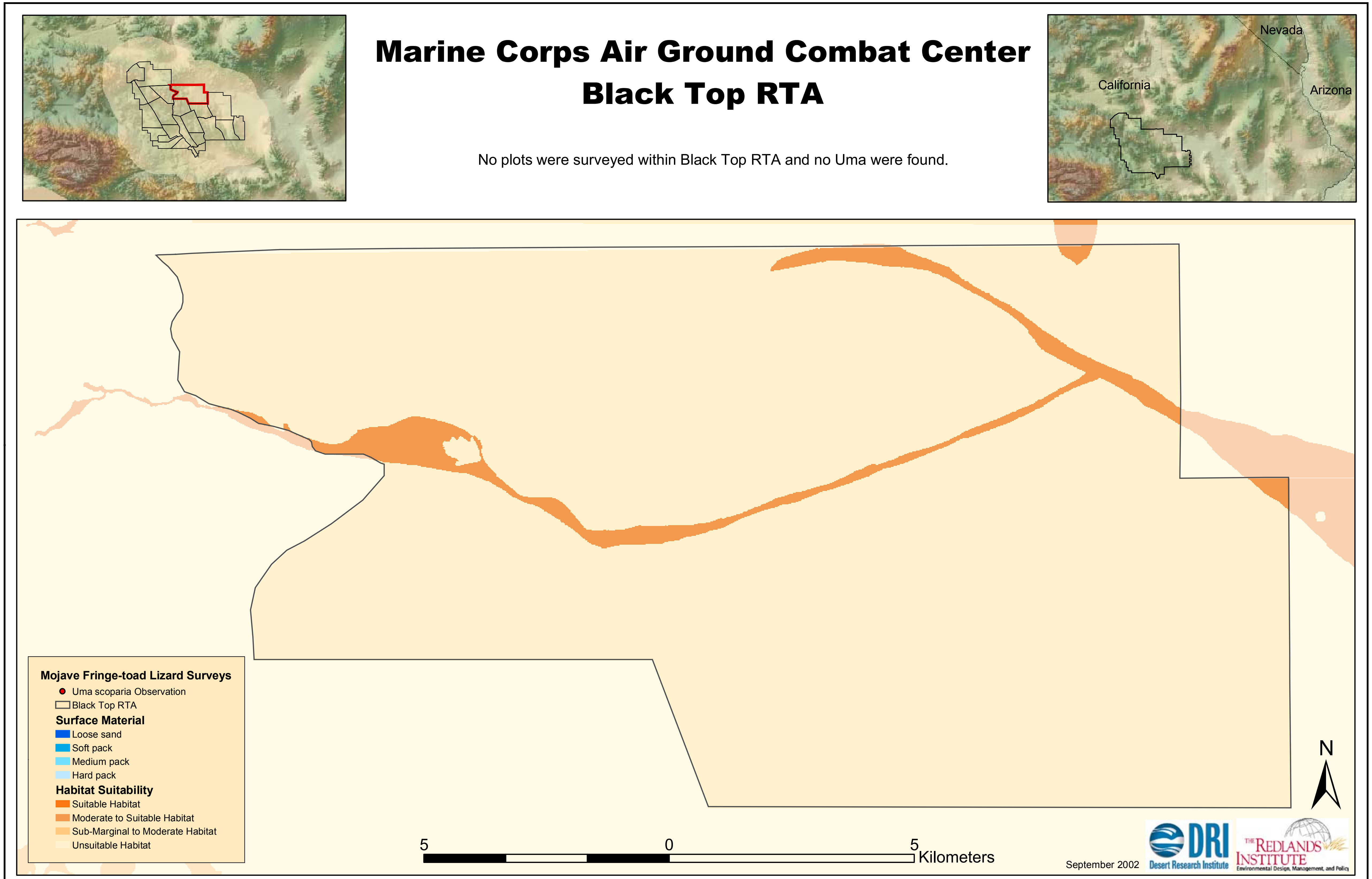
Marine Corps
Air Ground Combat Center
America Mine RTA



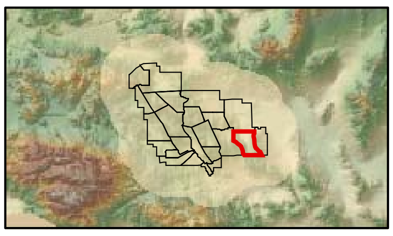
No plots were surveyed within America Mine RTA and no Uma were found.



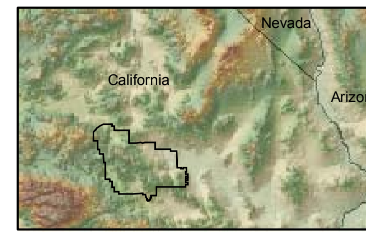


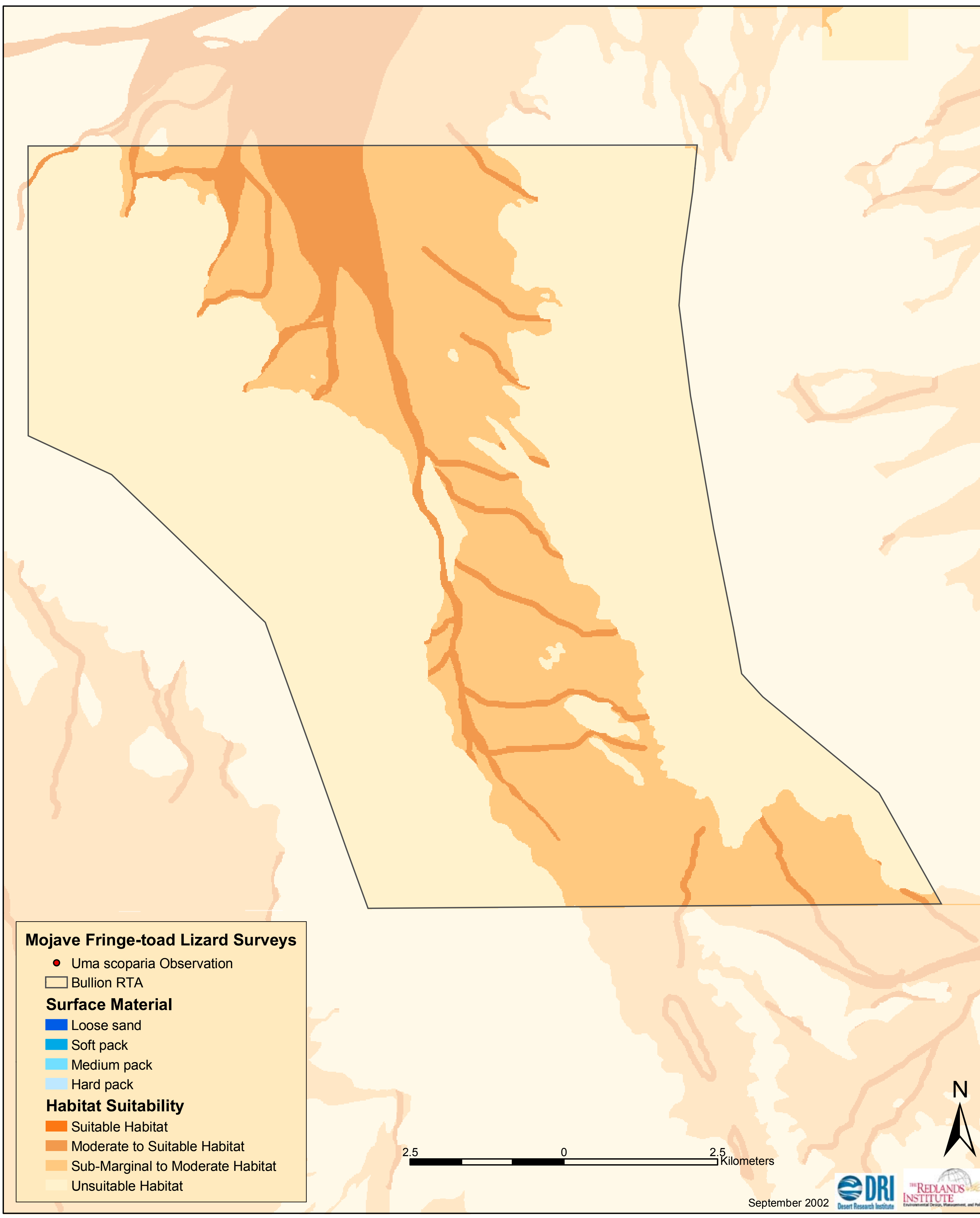

Marine Corps Air Ground Combat Center
Black Top RTA
No plots were surveyed within Black Top RTA and no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toad Lizard Surveys
Uma scoparia Observation
Black Top RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
5 0 5
Kilometers
N
September 2002
DRI Desert Research Institute
THE REDLANDS INSTITUTE
Environmental Design, Management, and Policy

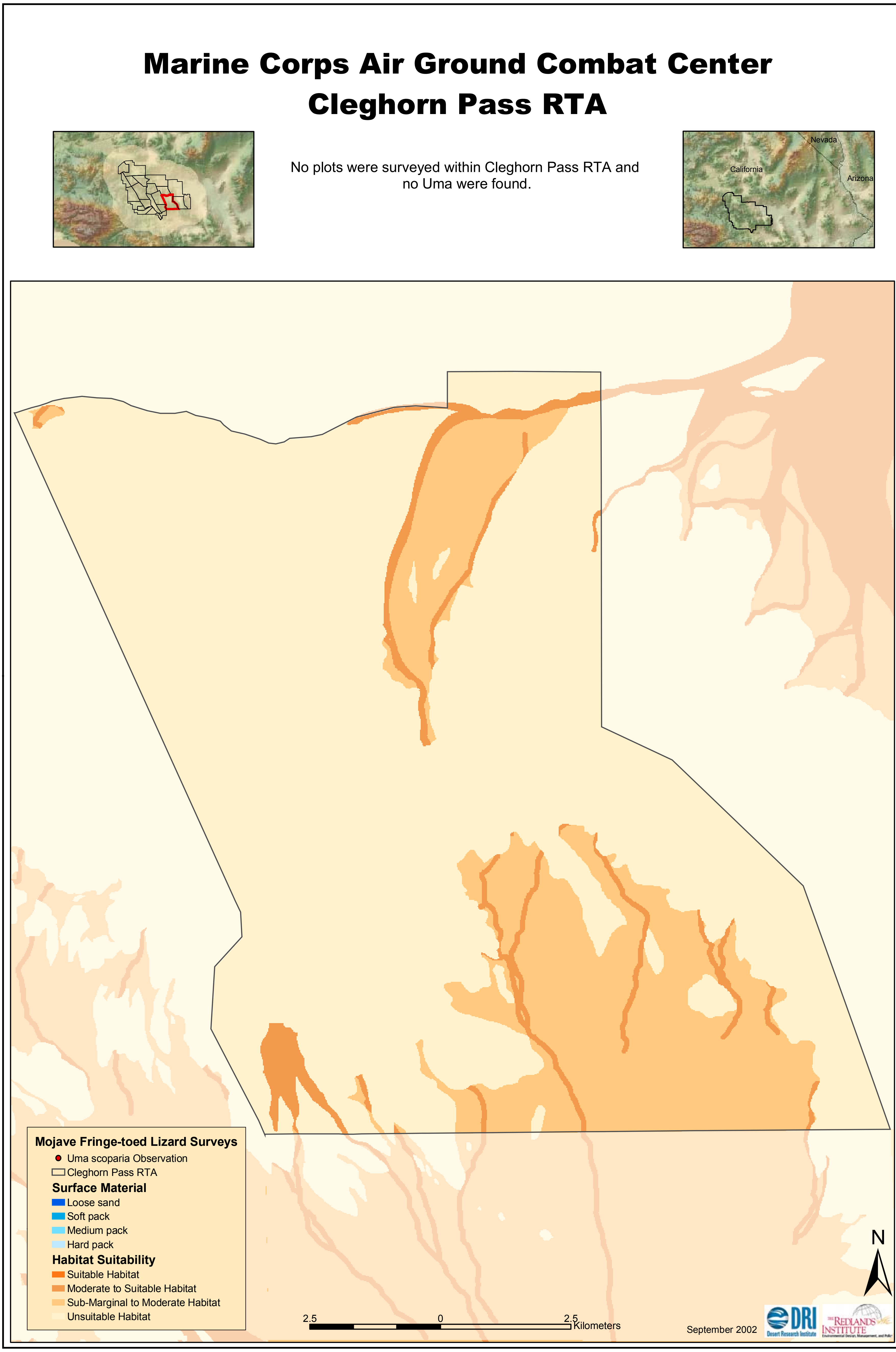
Marine Corps Air Ground Combat Center
Bullion RTA

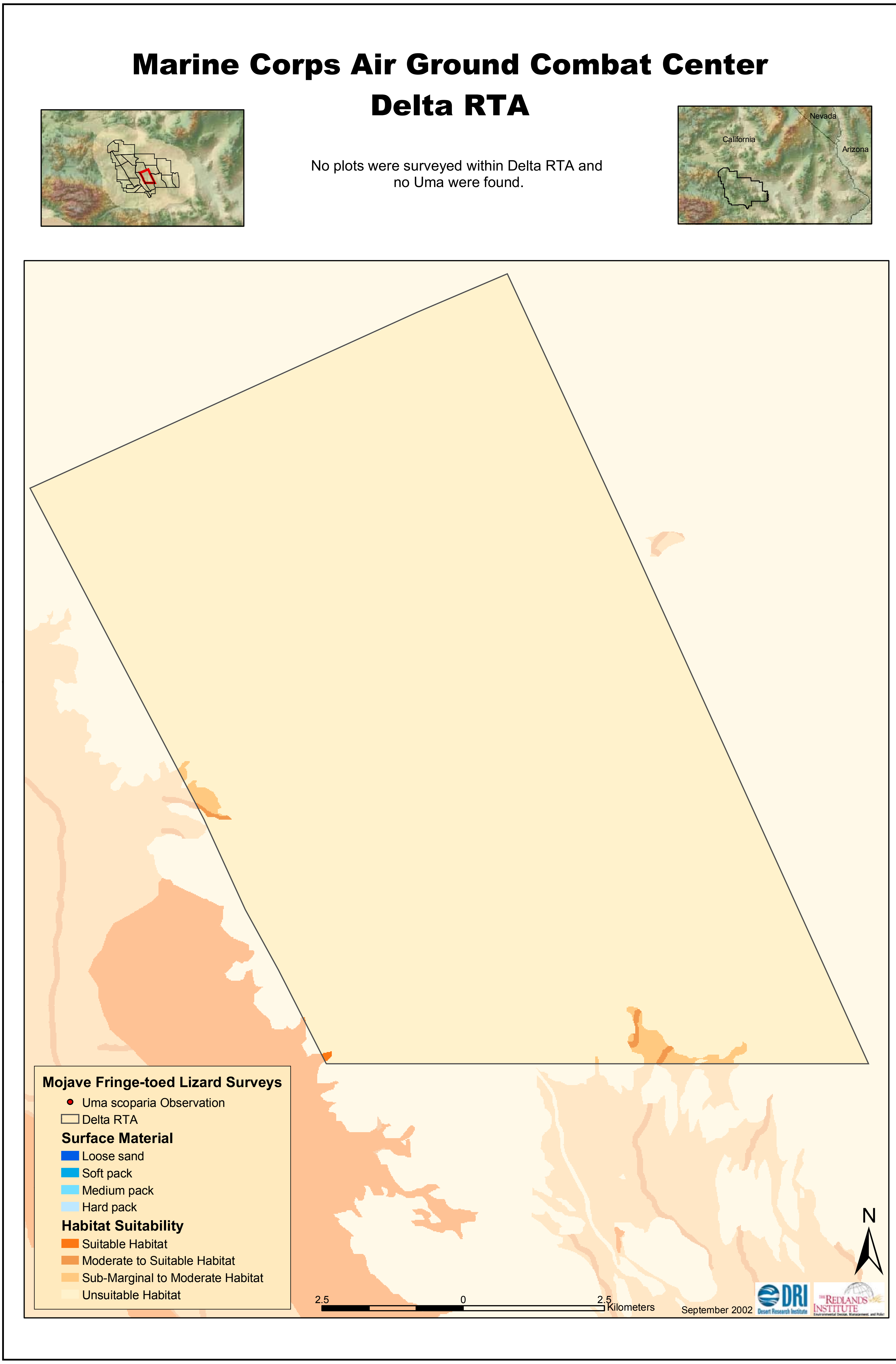


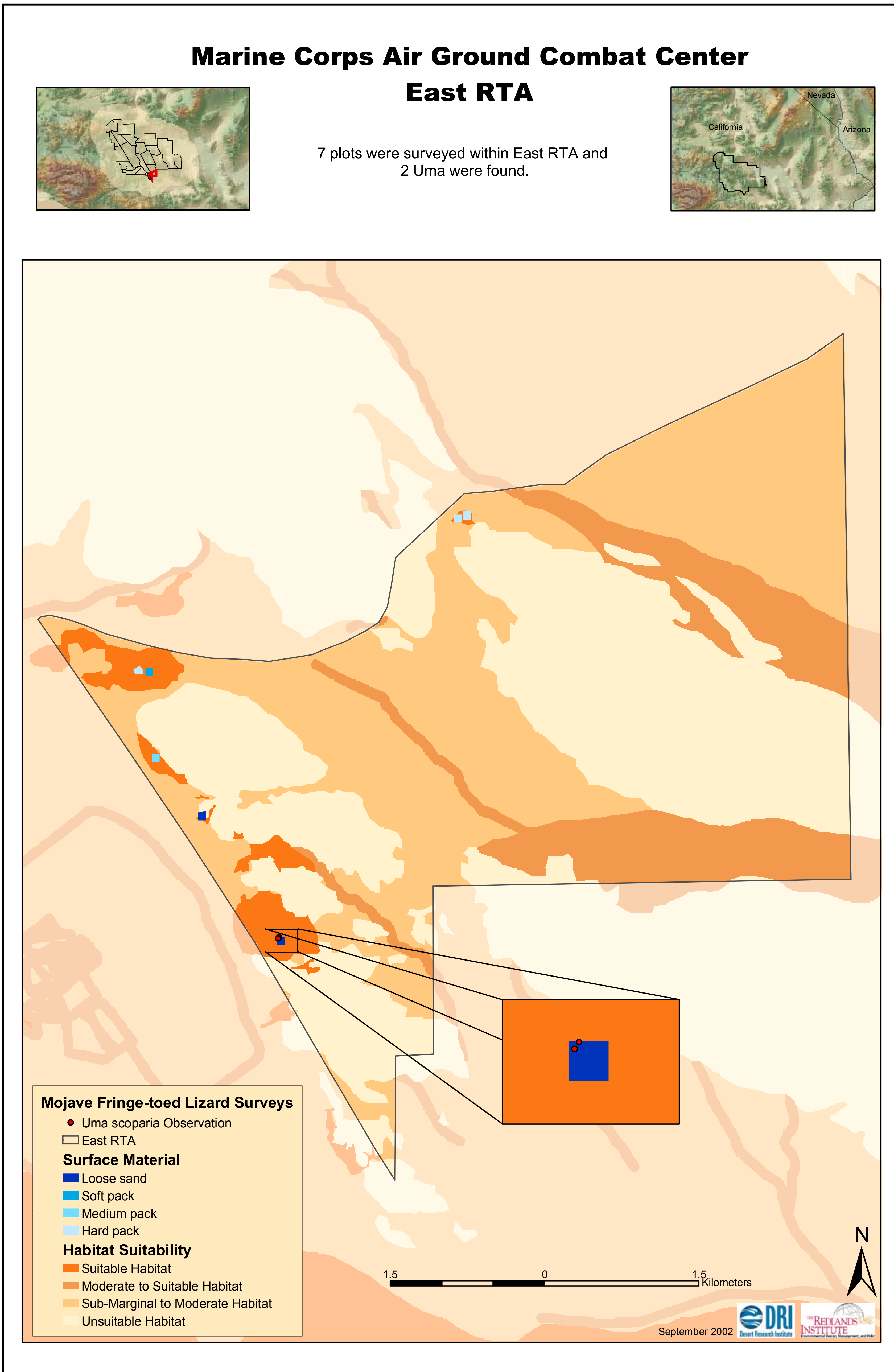
No plots were surveyed within Bullion RTA and
no uma were found.

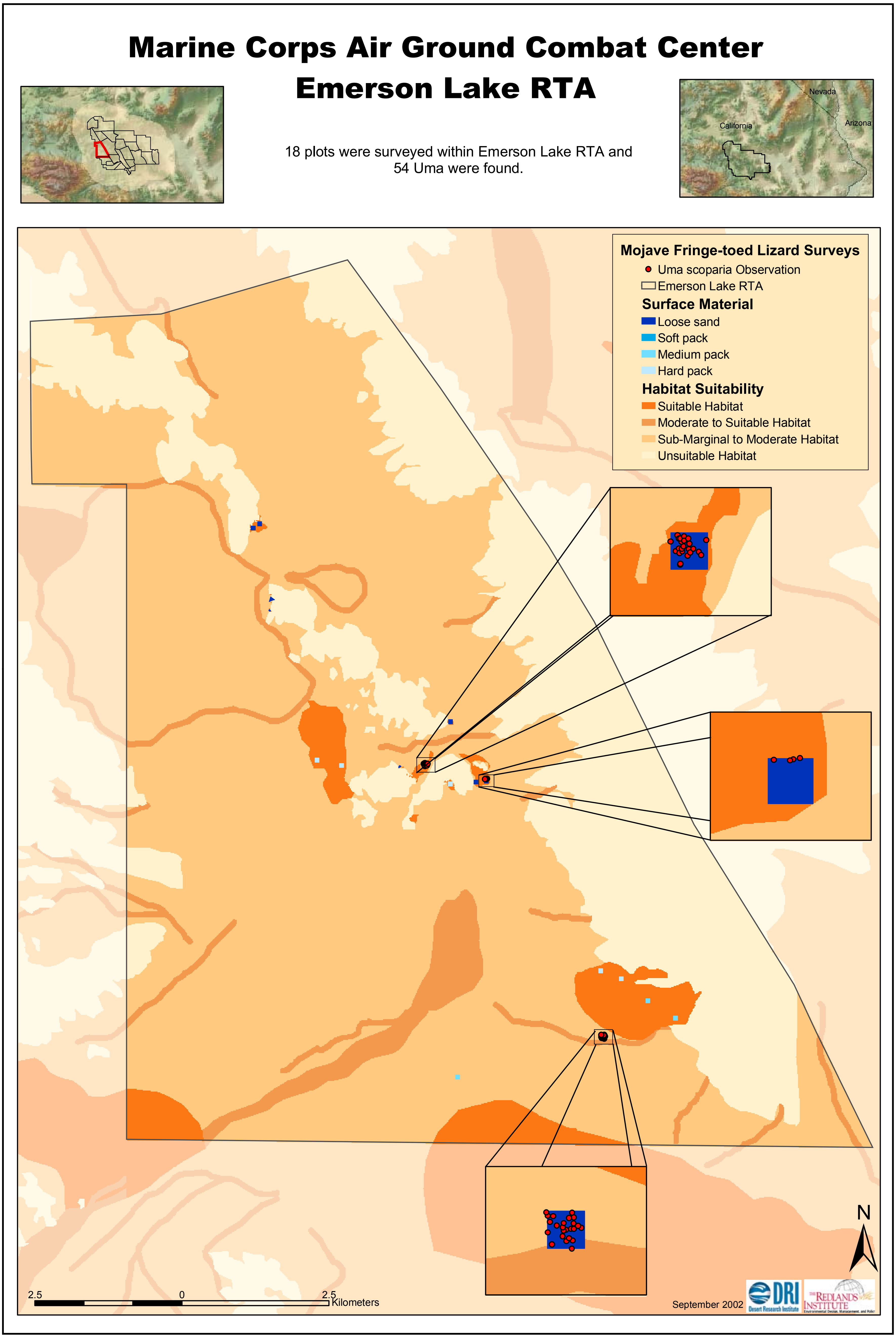


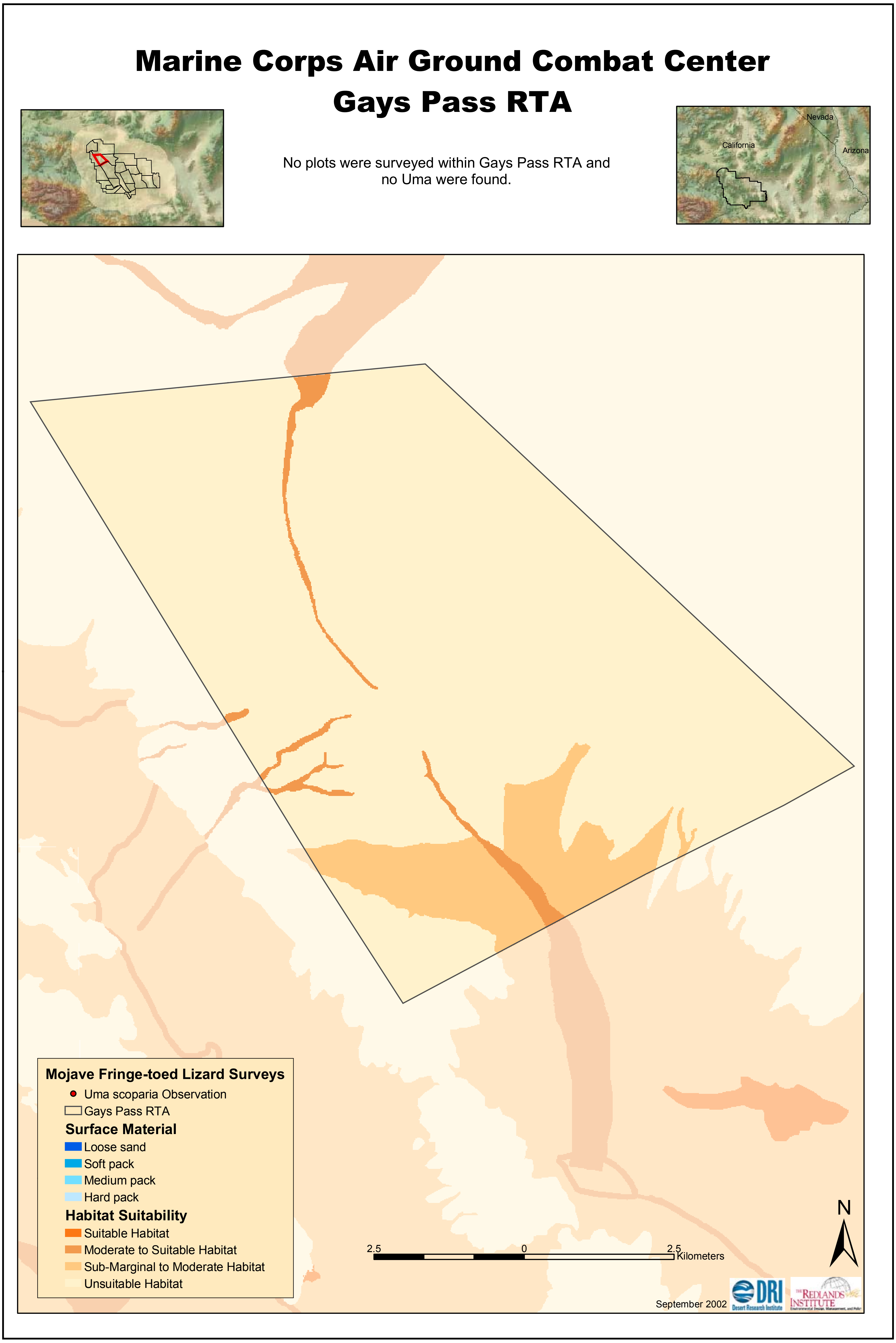


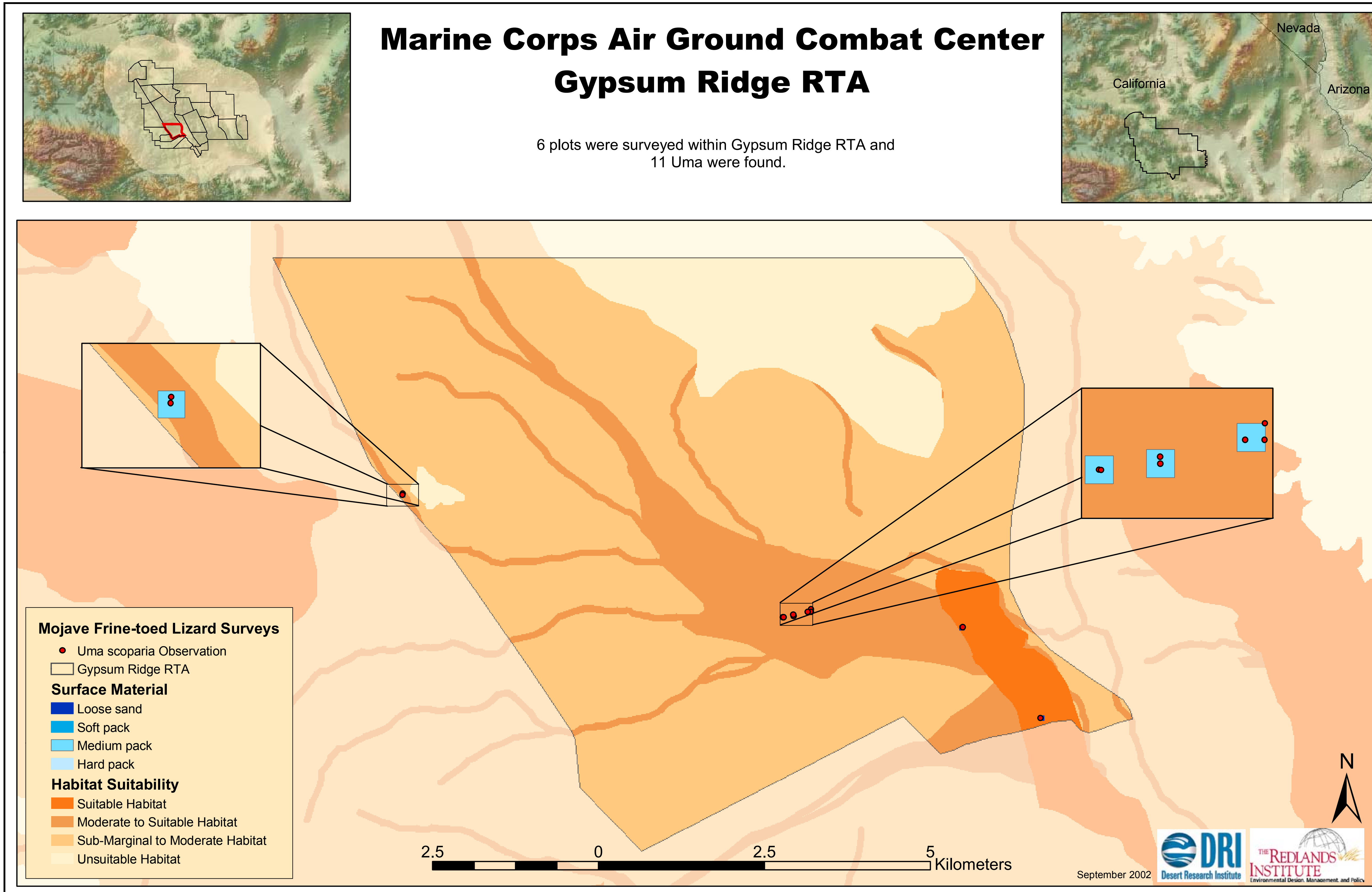

Marine Corps Air Ground Combat Center
Cleghorn Pass RTA
No plots were surveyed within Cleghorn Pass RTA and no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Cleghorn Pass RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
Kilometers
N
September 2002
DRI
Desert Research Institute
The Redlands Institute

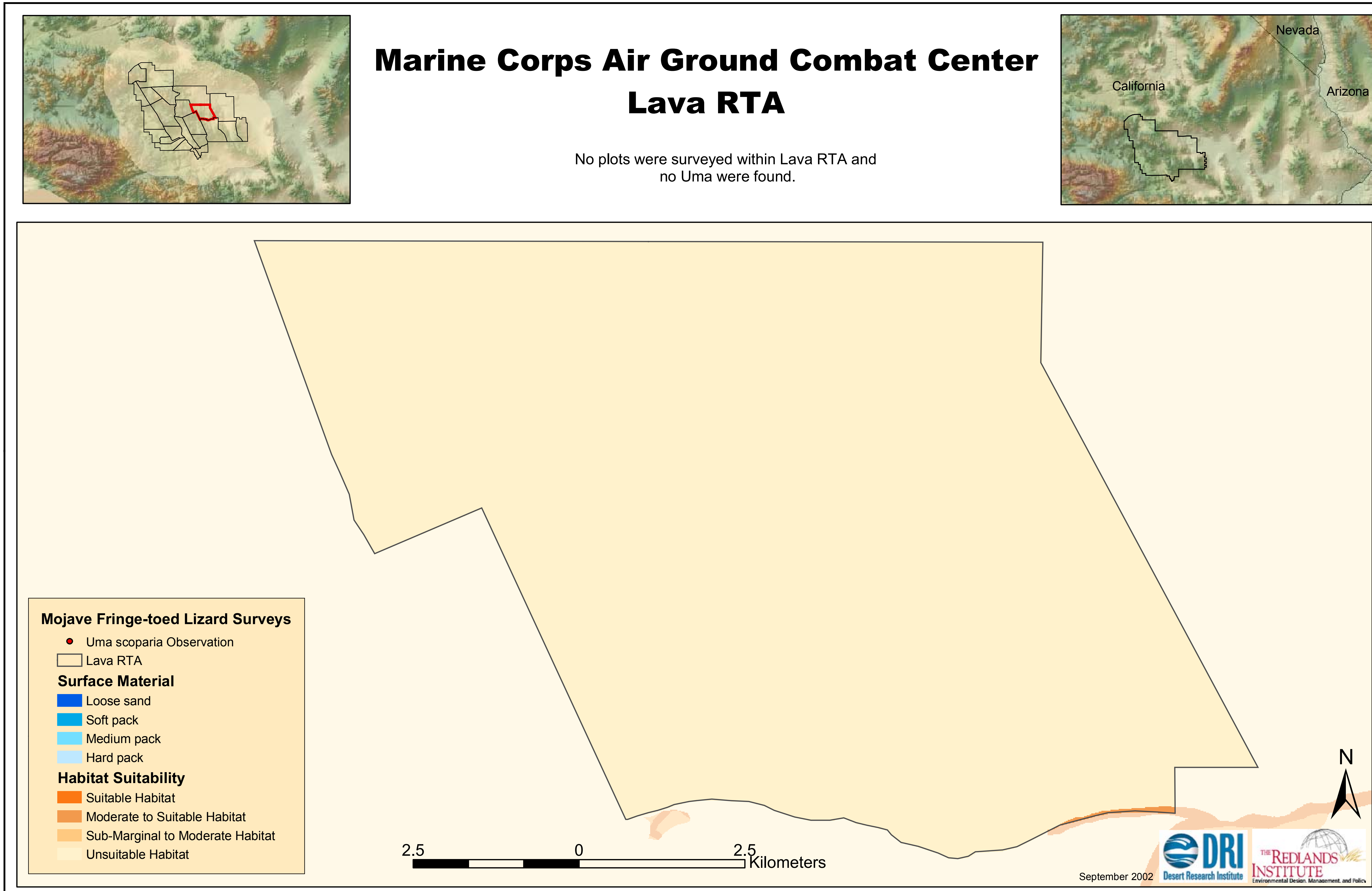

Marine Corps Air Ground Combat Center
Delta RTA
No plots were surveyed within Delta RTA and
no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Delta RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
Kilometers
N
September 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE

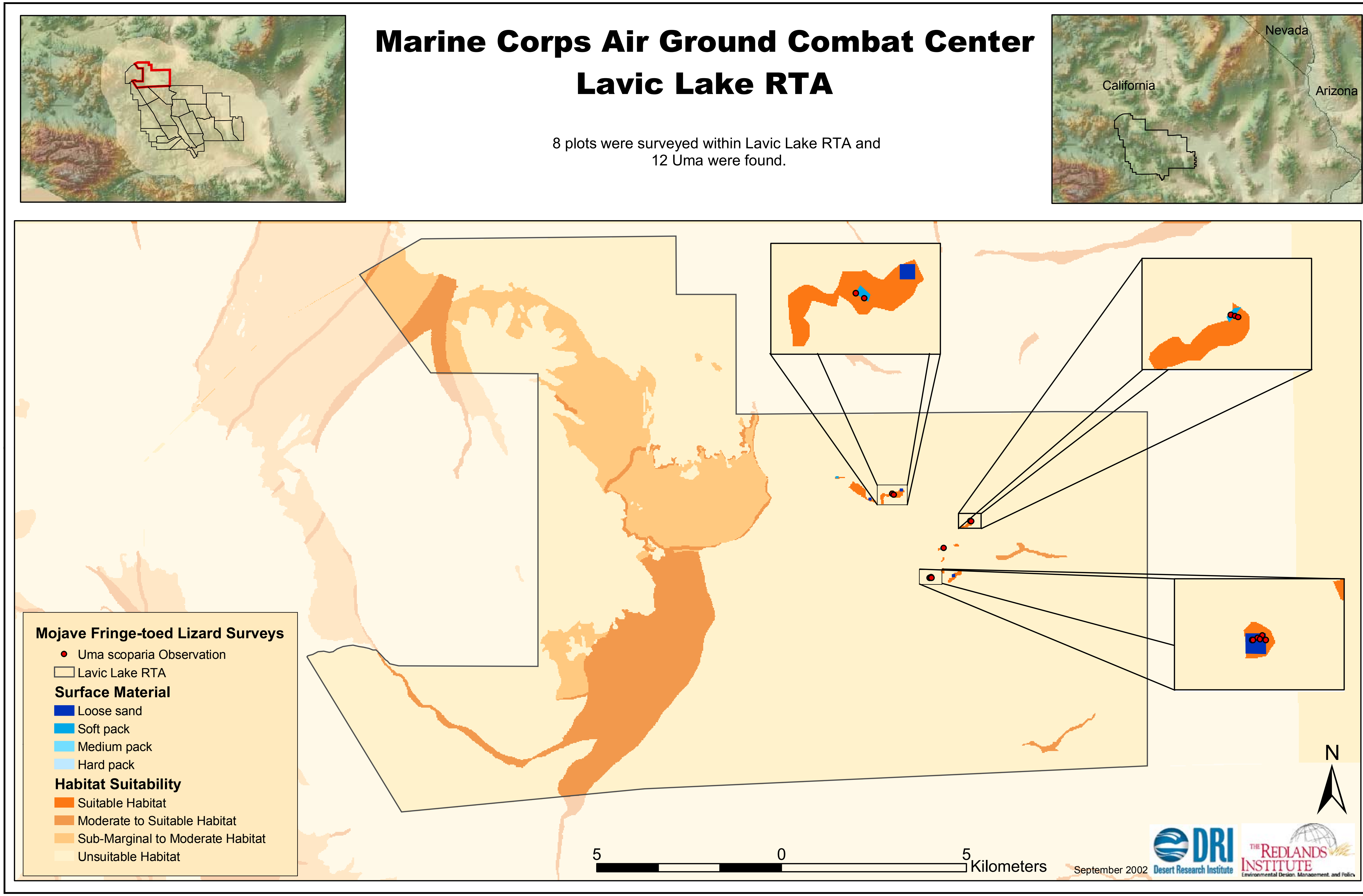

Marine Corps Air Ground Combat Center
East RTA
7 plots were surveyed within East RTA and
2 Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
East RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
1.5
0
1.5
Kilometers
N
September 2002

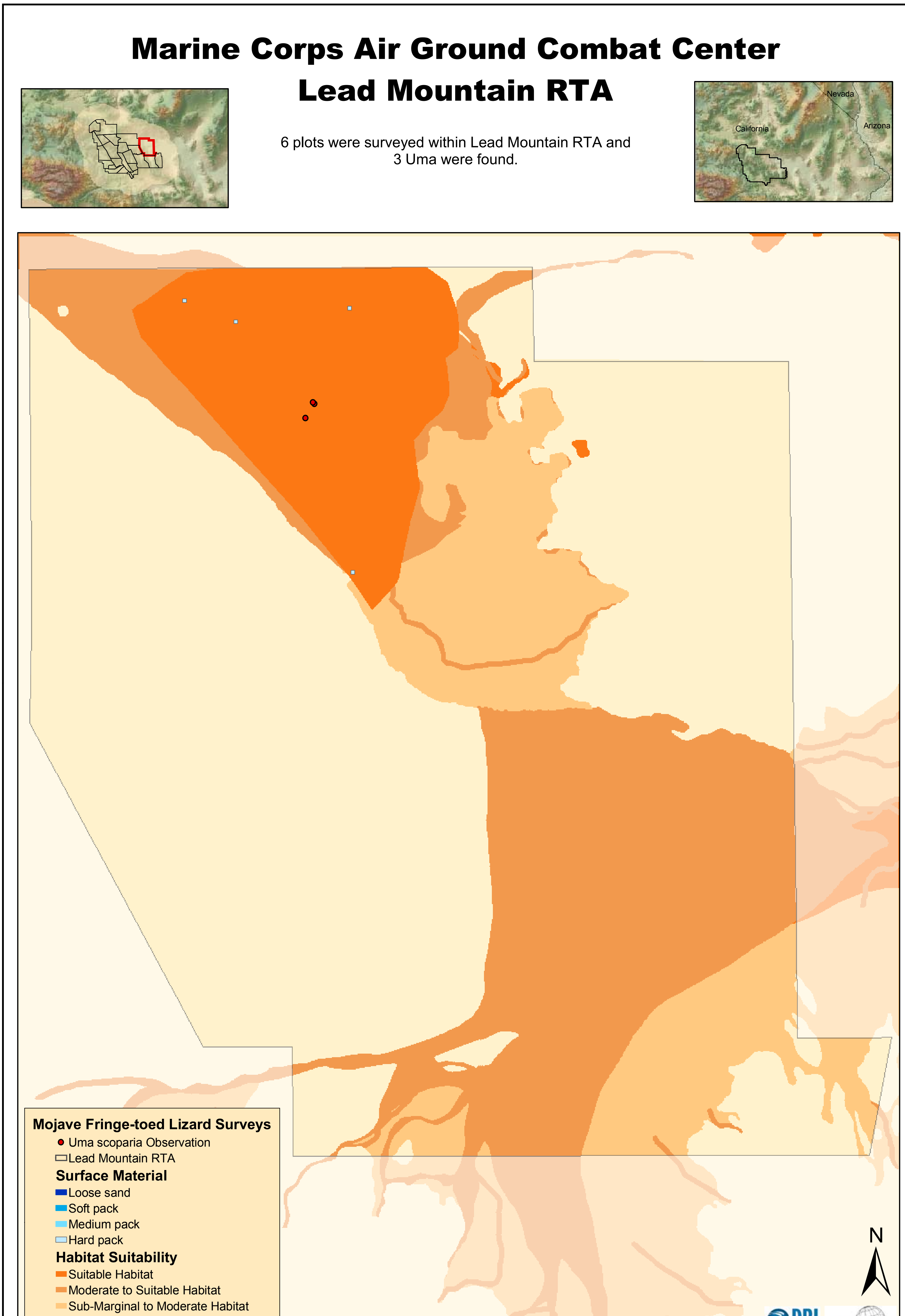

Marine Corps Air Ground Combat Center
Emerson Lake RTA
18 plots were surveyed within Emerson Lake RTA and
54 Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Emerson Lake RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
N
2.5 0 2.5
Kilometers
September 2002

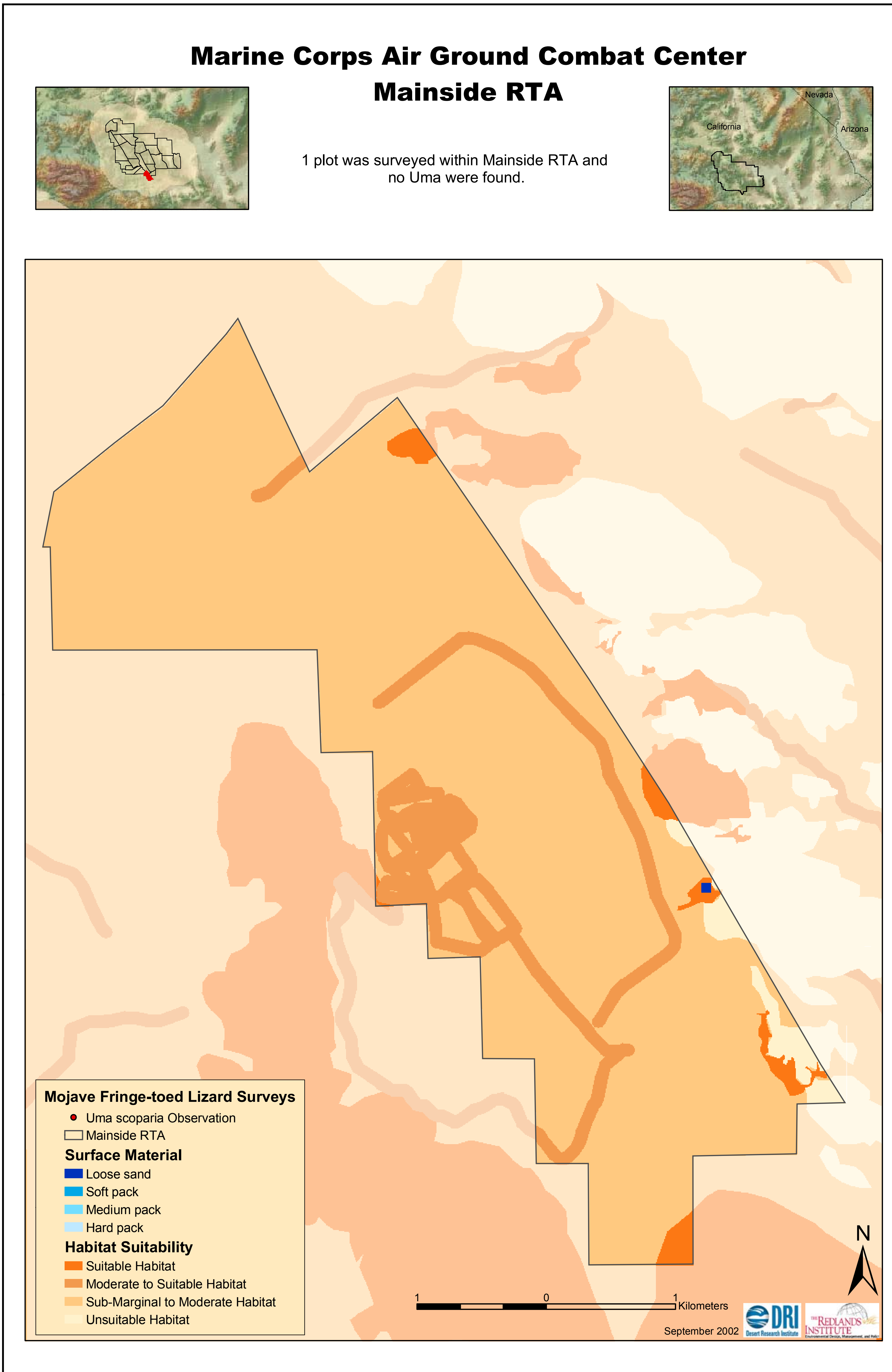

Marine Corps Air Ground Combat Center
Gays Pass RTA
No plots were surveyed within Gays Pass RTA and no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Gays Pass RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
Kilometers
N
September 2002

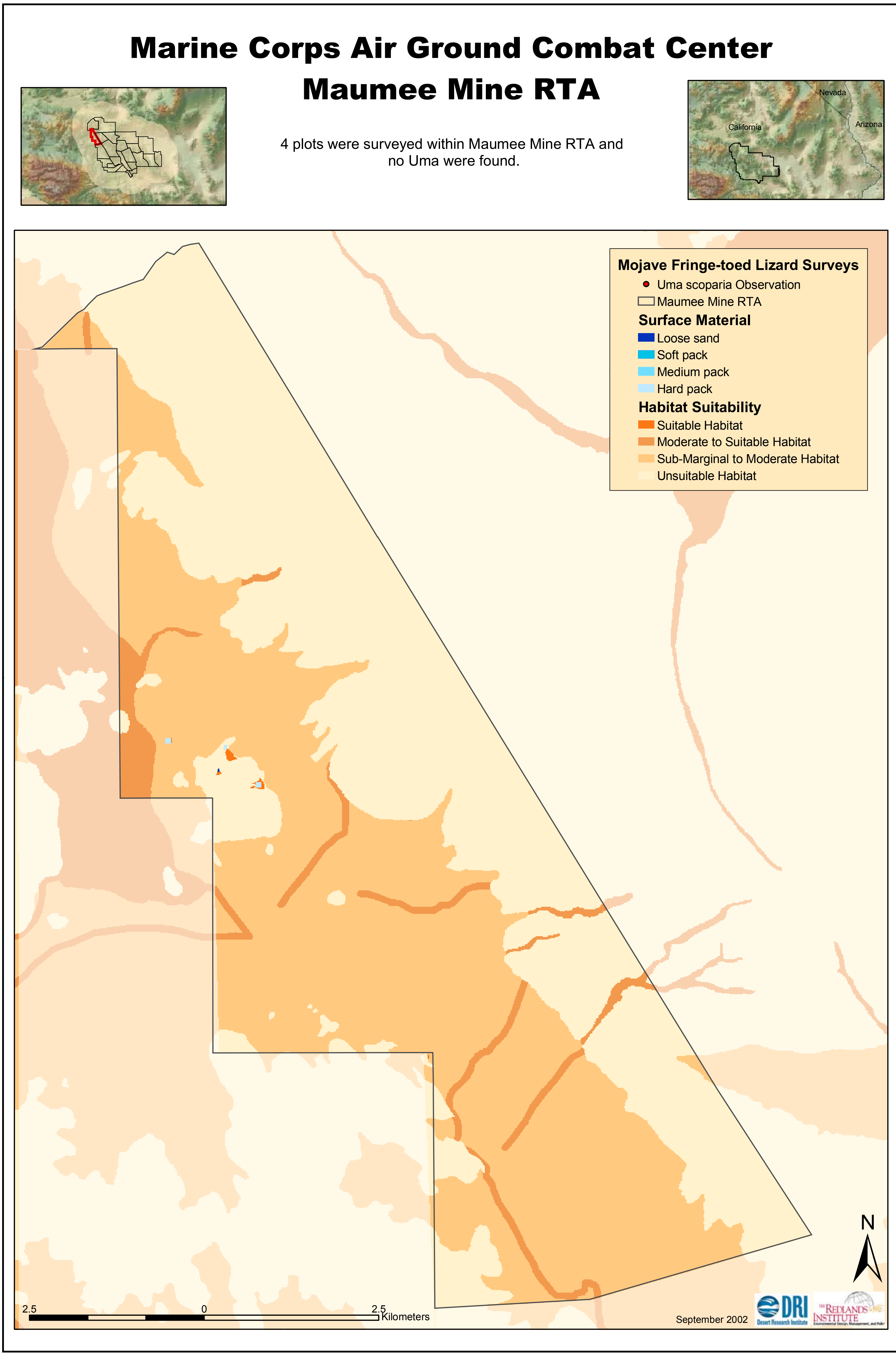

Marine Corps Air Ground Combat Center
Gypsum Ridge RTA
6 plots were surveyed within Gypsum Ridge RTA and
11 Uma were found.
Nevada
California
Arizona
Mojave Frine-toed Lizard Surveys
Uma scoparia Observation
Gypsum Ridge RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
5
Kilometers
N
September 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE

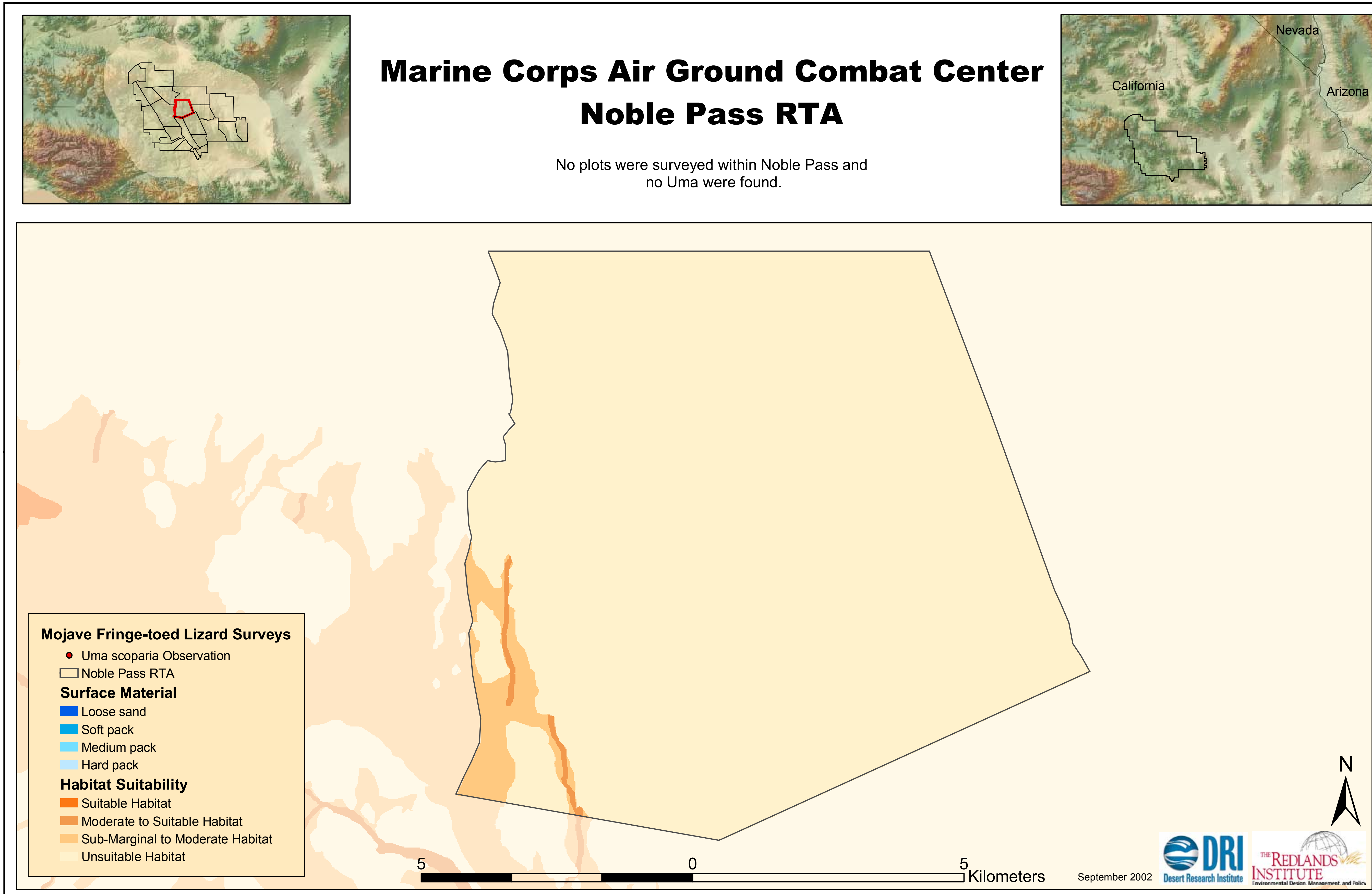

Marine Corps Air Ground Combat Center
Lava RTA
No plots were surveyed within Lava RTA and no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Lava RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5 0 2.5 Kilometers
N
September 2002
DRI Desert Research Institute
The Redlands Institute

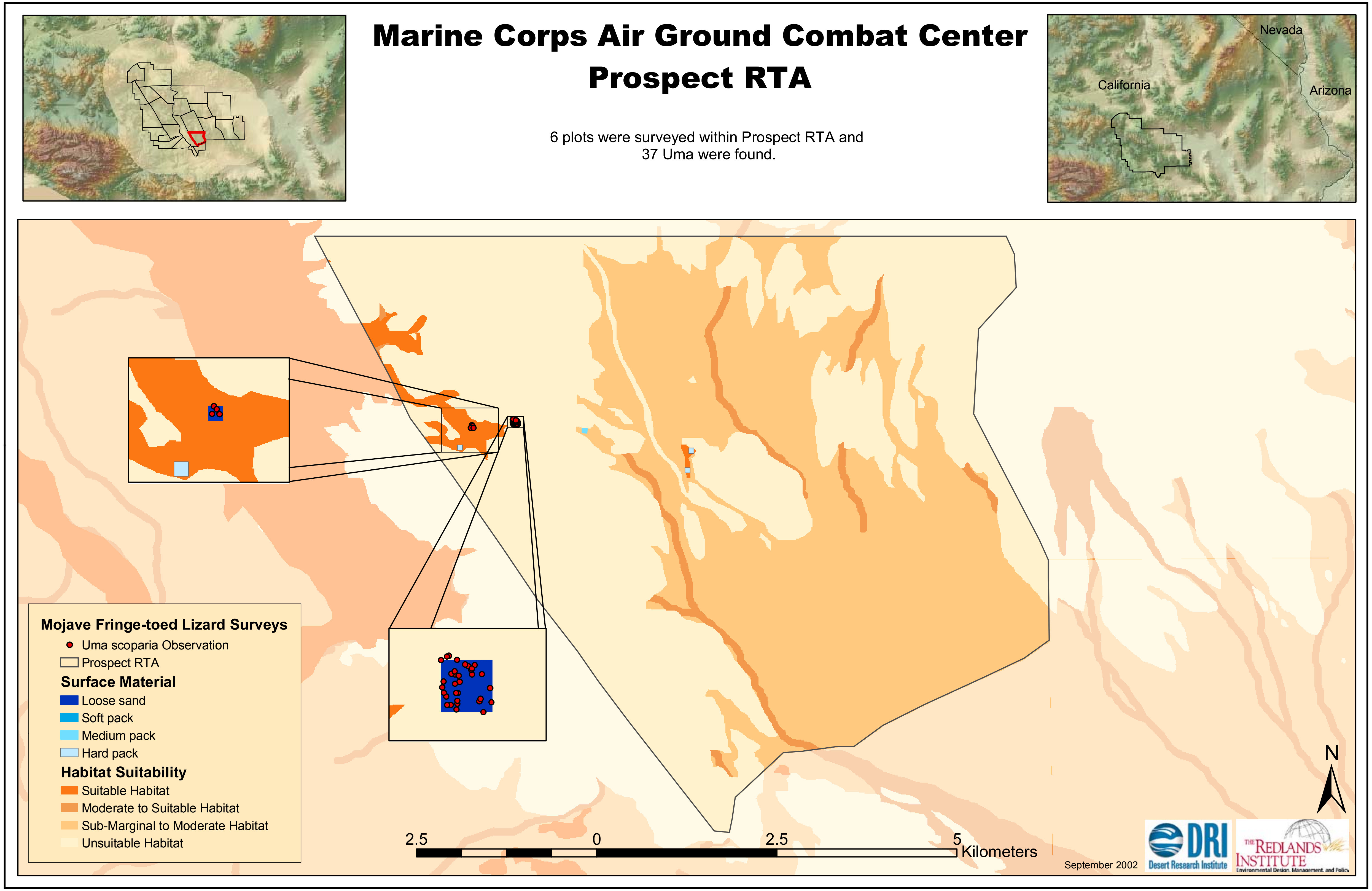

Marine Corps Air Ground Combat Center
Lavic Lake RTA
8 plots were surveyed within Lavic Lake RTA and
12 Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Lavic Lake RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
5
0
5
Kilometers
N
September 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE

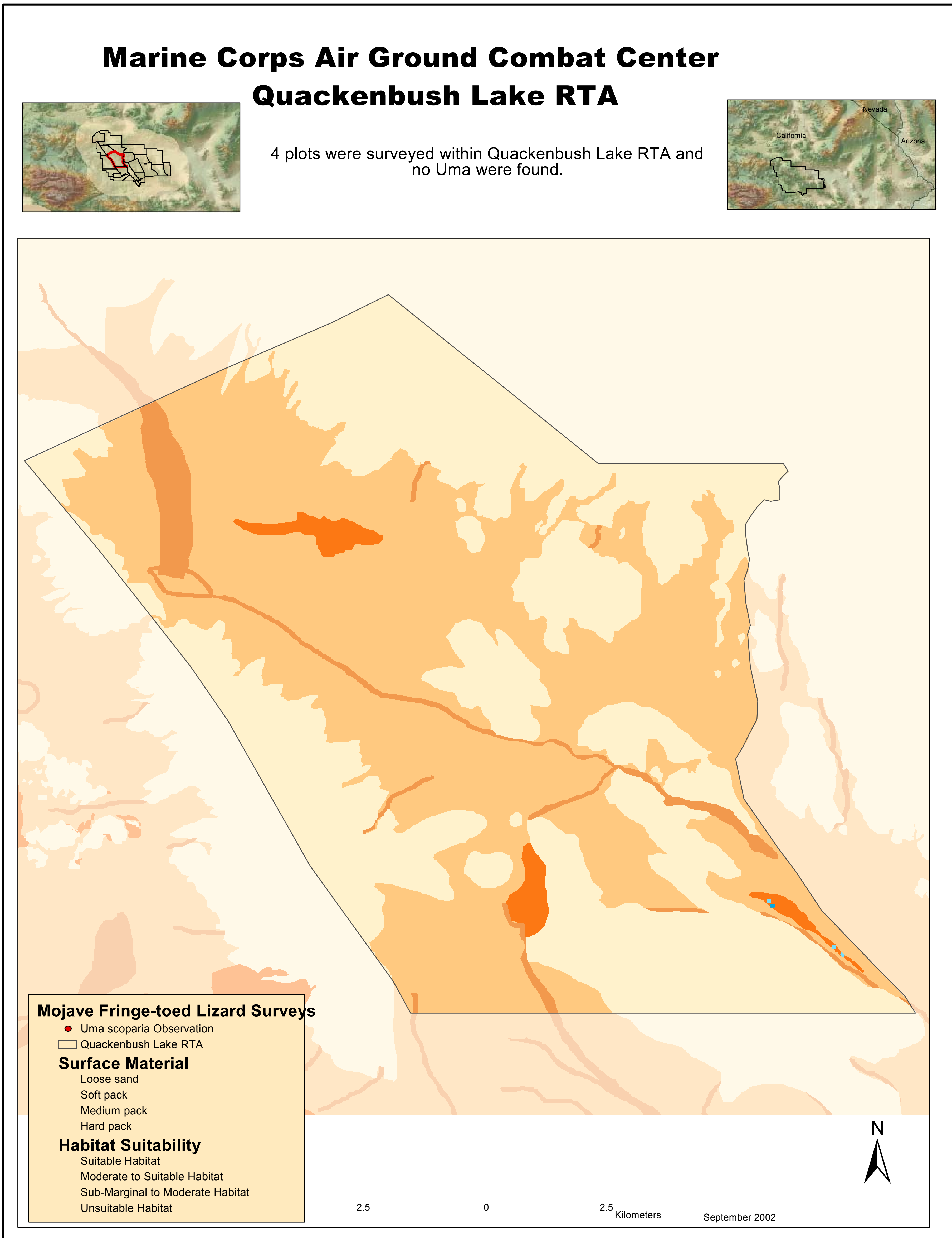

Marine Corps Air Ground Combat Center
Lead Mountain RTA
6 plots were surveyed within Lead Mountain RTA and
3 Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Lead Mountain RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
N
DRI


Marine Corps Air Ground Combat Center
Mainside RTA
Nevada
California
Arizona
1 plot was surveyed within Mainside RTA and no Uma were found.
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Mainside RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
N
1
0
1
Kilometers
September 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE

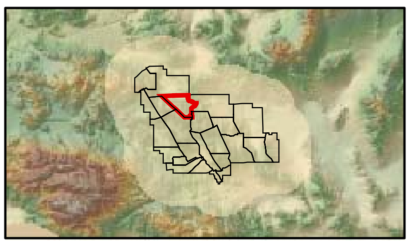

Marine Corps Air Ground Combat Center
Maumee Mine RTA
4 plots were surveyed within Maumee Mine RTA and no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Maumee Mine RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
N
2.5
0
2.5
Kilometers
September 2002


Marine Corps Air Ground Combat Center
Noble Pass RTA
No plots were surveyed within Noble Pass and
no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Noble Pass RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
5
0
5
Kilometers
N
September 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE

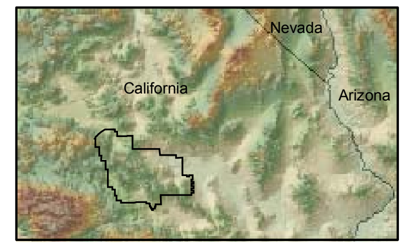

Marine Corps Air Ground Combat Center
Prospect RTA
6 plots were surveyed within Prospect RTA and
37 Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Prospect RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
5
Kilometers
September 2002
N

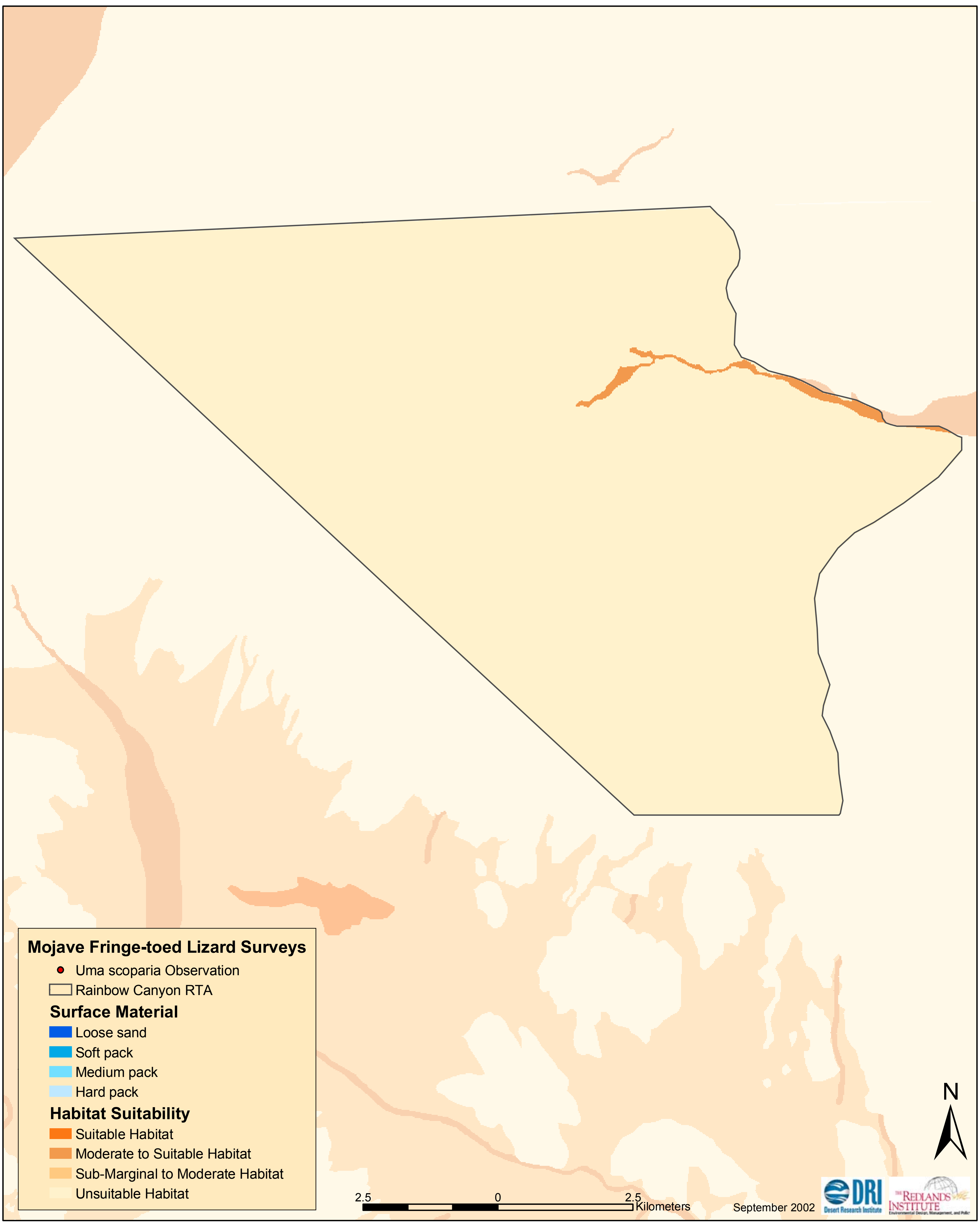

Marine Corps Air Ground Combat Center
Quackenbush Lake RTA
4 plots were surveyed within Quackenbush Lake RTA and no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Quackenbush Lake RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
Kilometers
September 2002
N

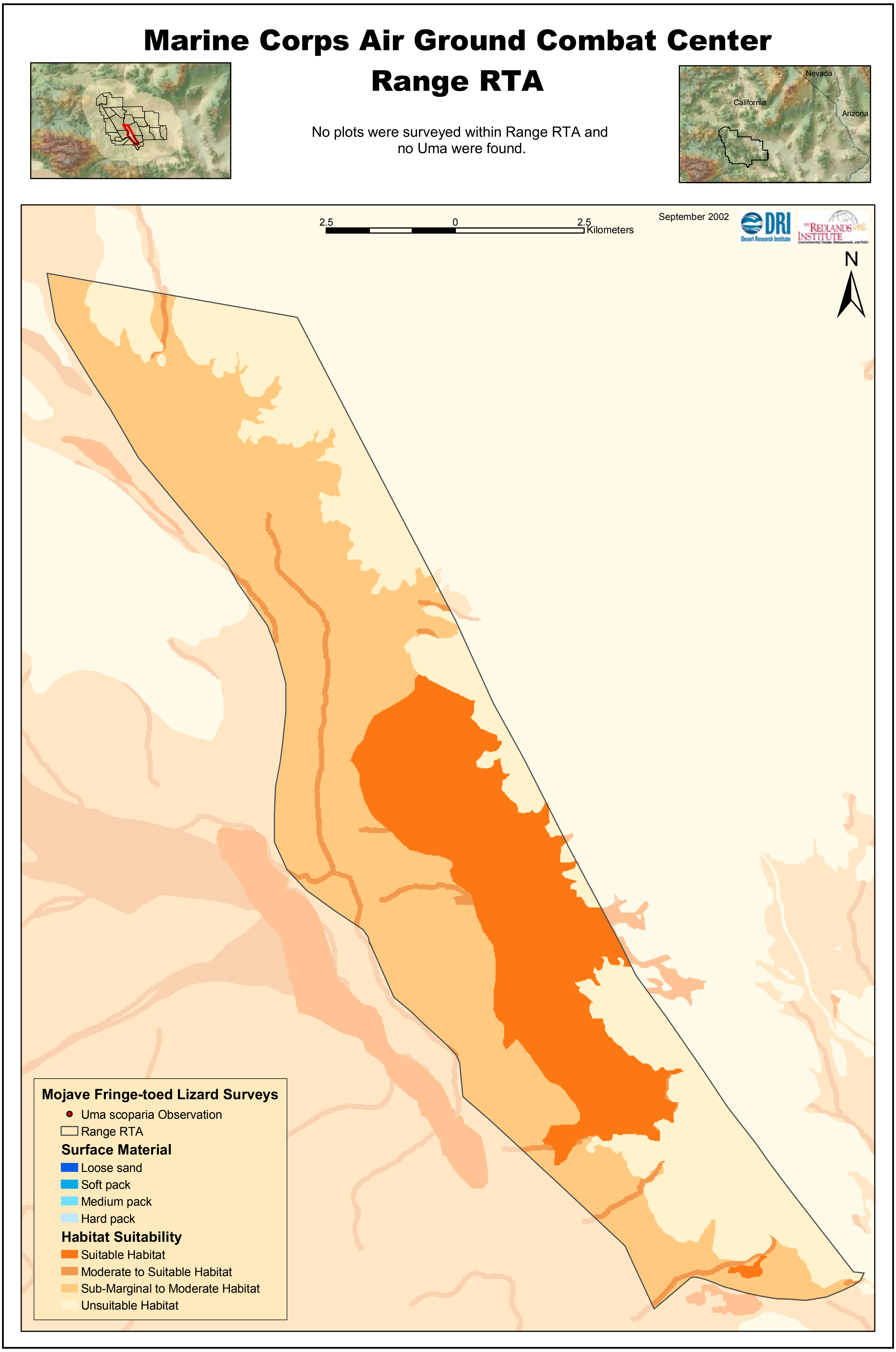
Marine Corps Air Ground Combat Center
Rainbow Canyon RTA

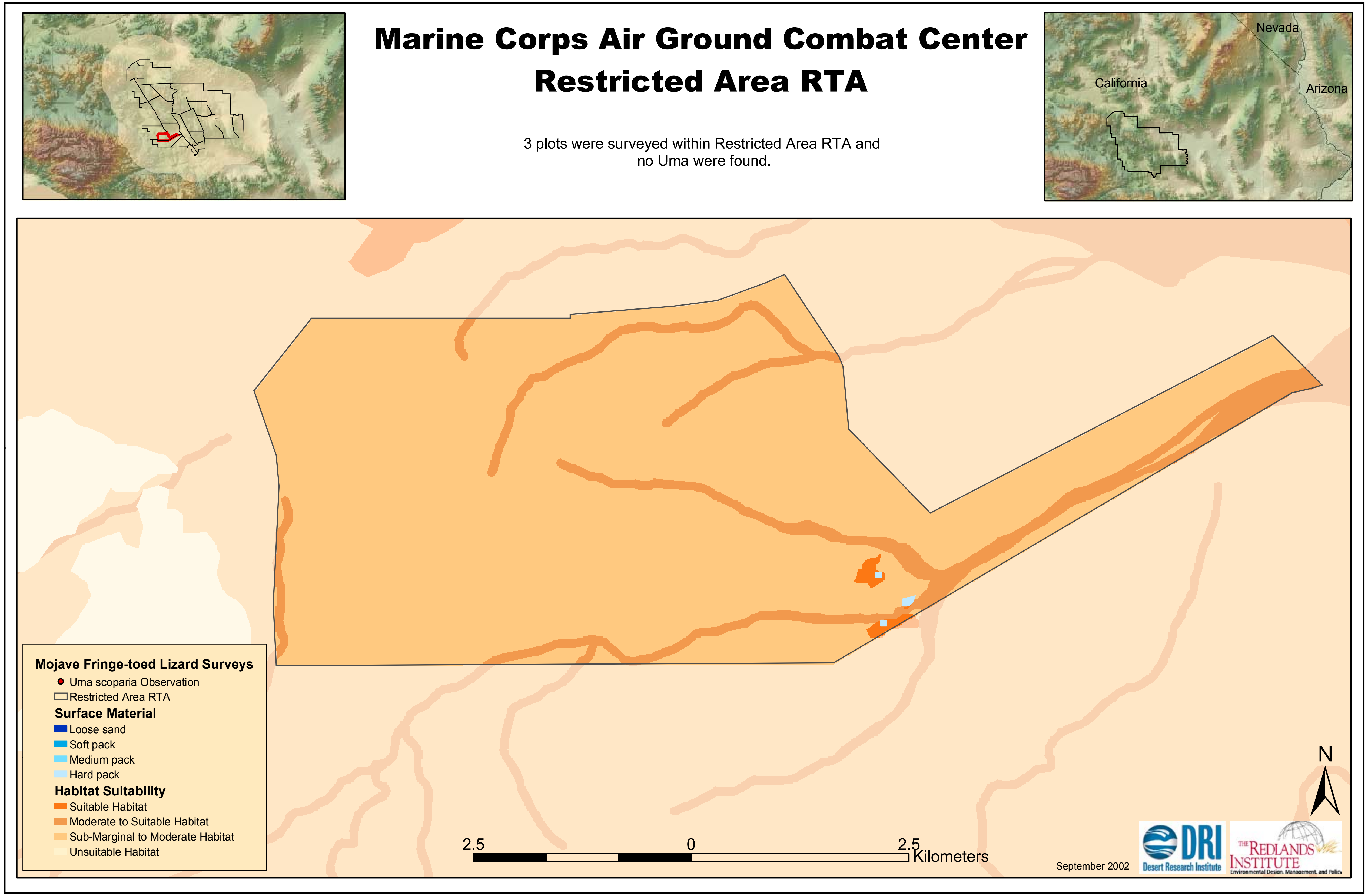


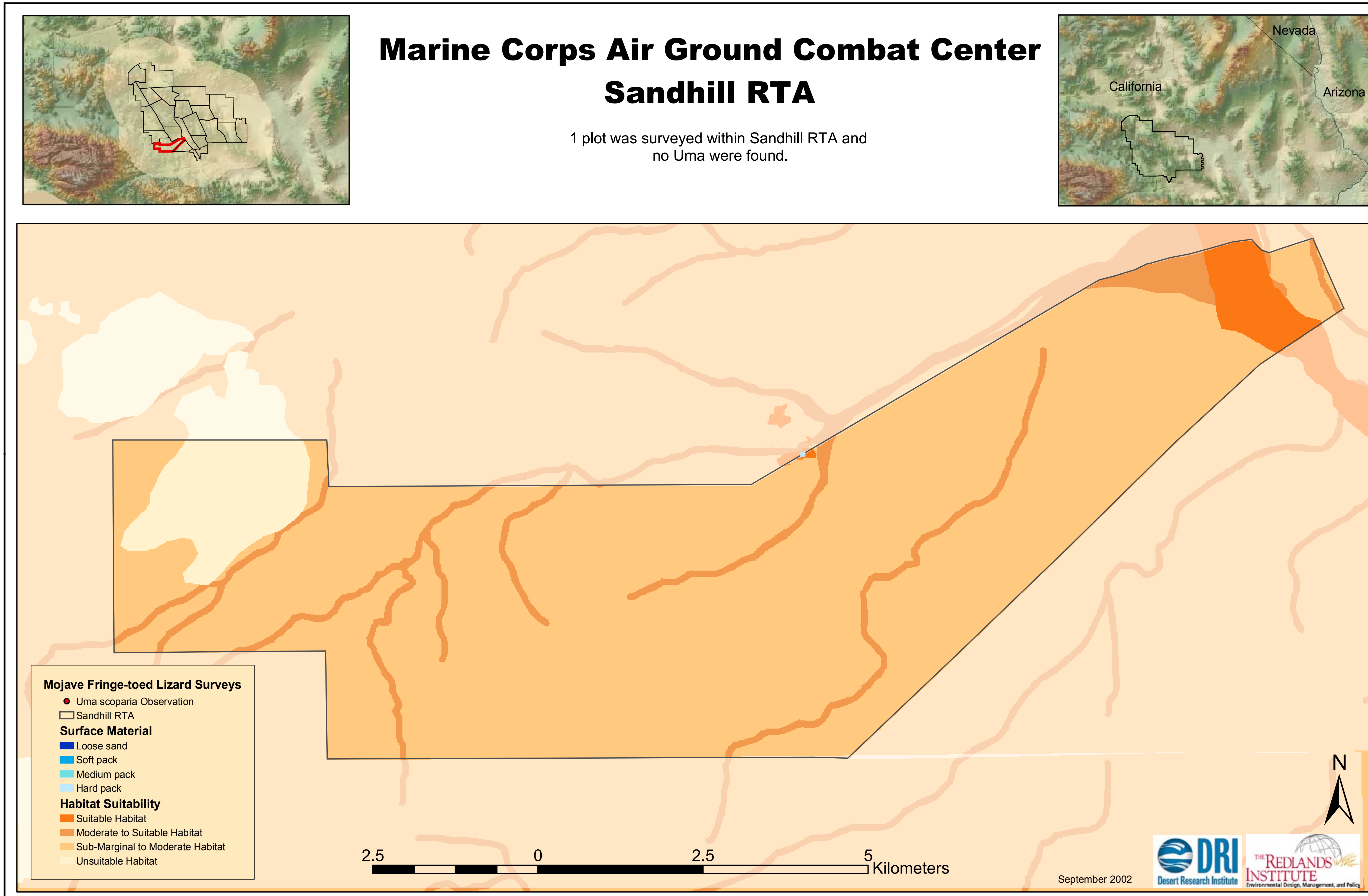
No plots were surveyed within Rainbow Canyon and no Uma were found.



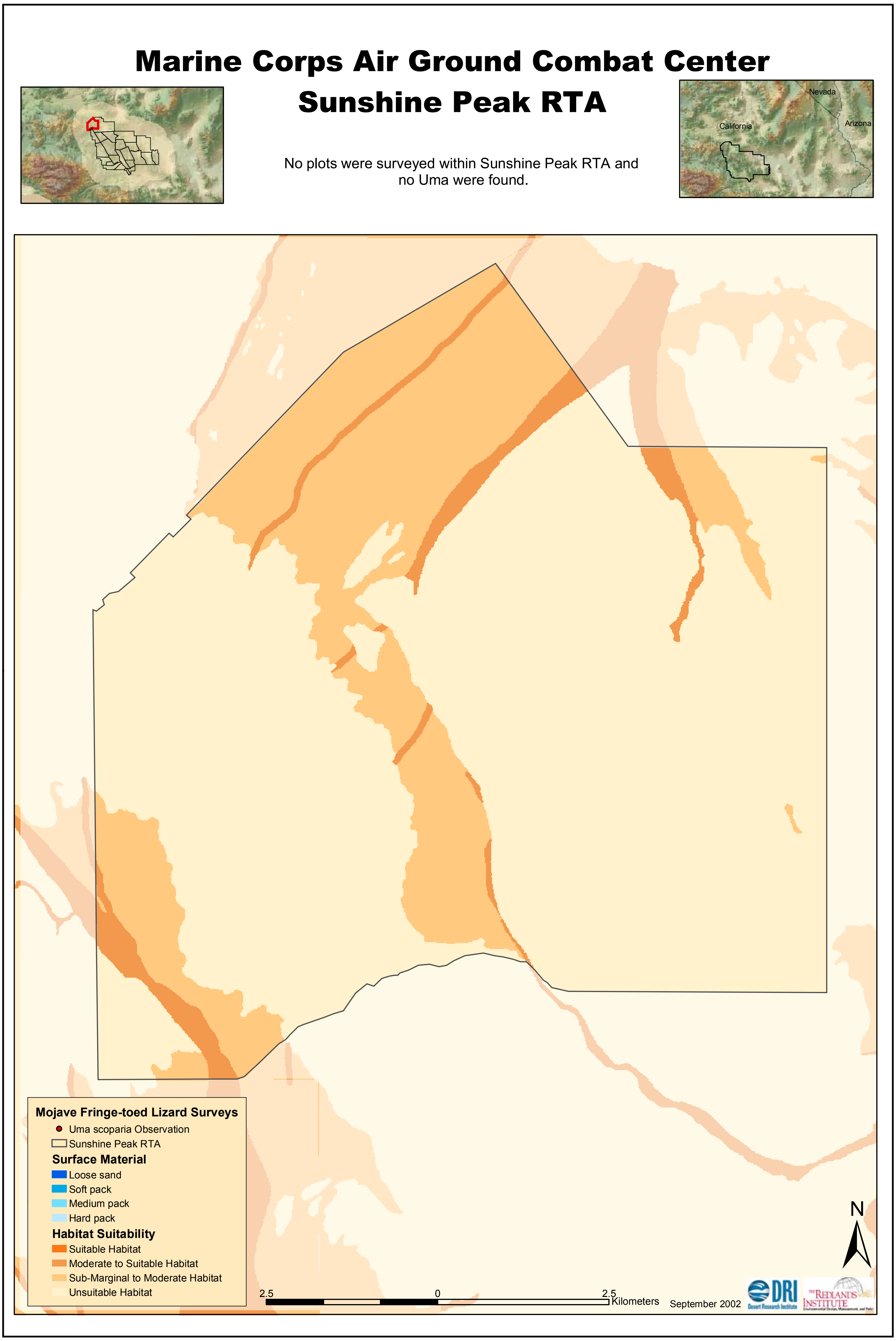


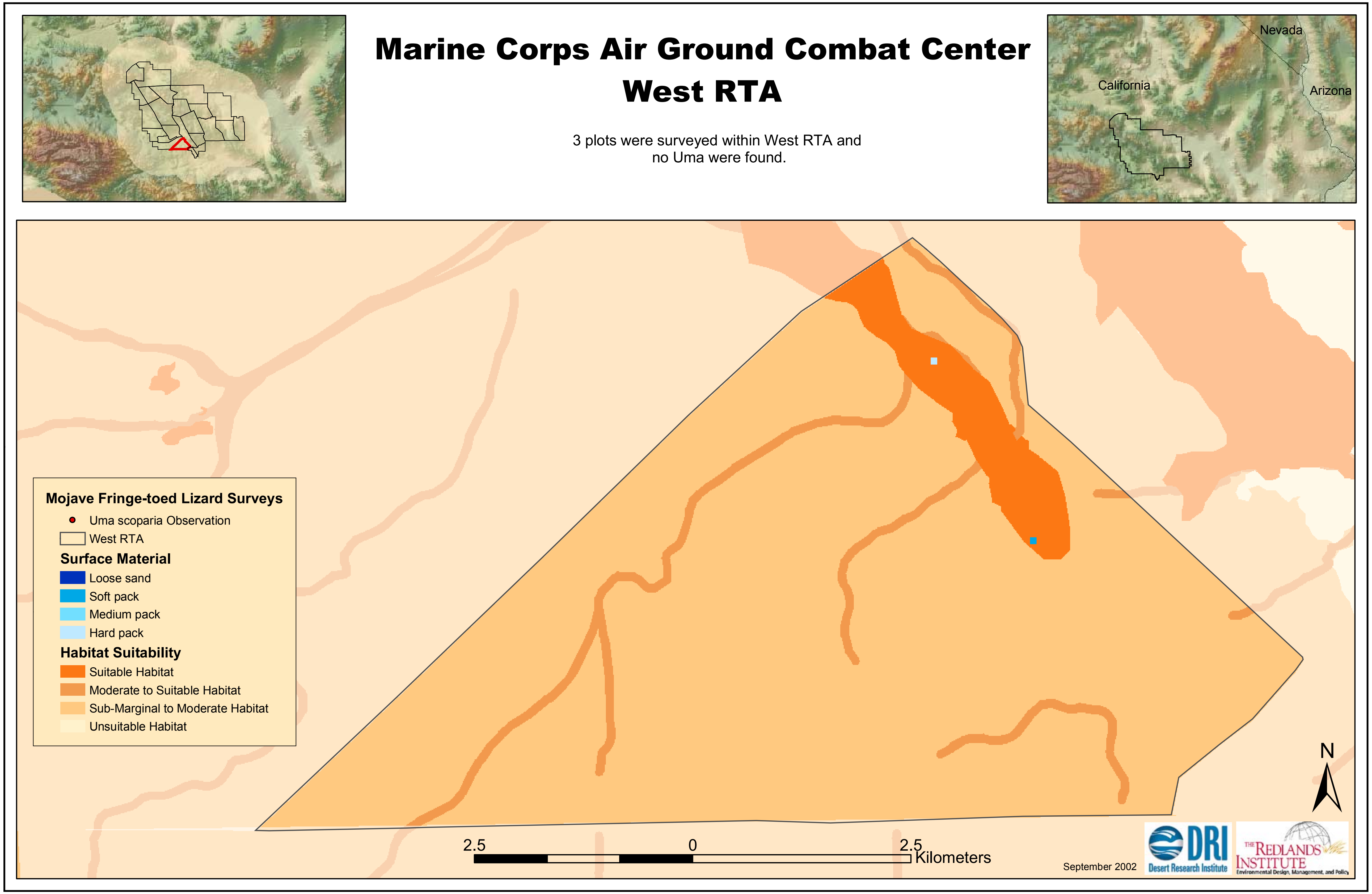

Marine Corps Air Ground Combat Center
Range RTA
No plots were surveyed within Range RTA and no Uma were found.
Nevada
California
Arizona
2.5
0
2.5
Kilometers
September 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE
N
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Range RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat


Marine Corps Air Ground Combat Center
Restricted Area RTA
3 plots were surveyed within Restricted Area RTA and
no Uma were found.
California
Nevada
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Restricted Area RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
Kilometers
N
September 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE
Environmental Design, Management, and Policy

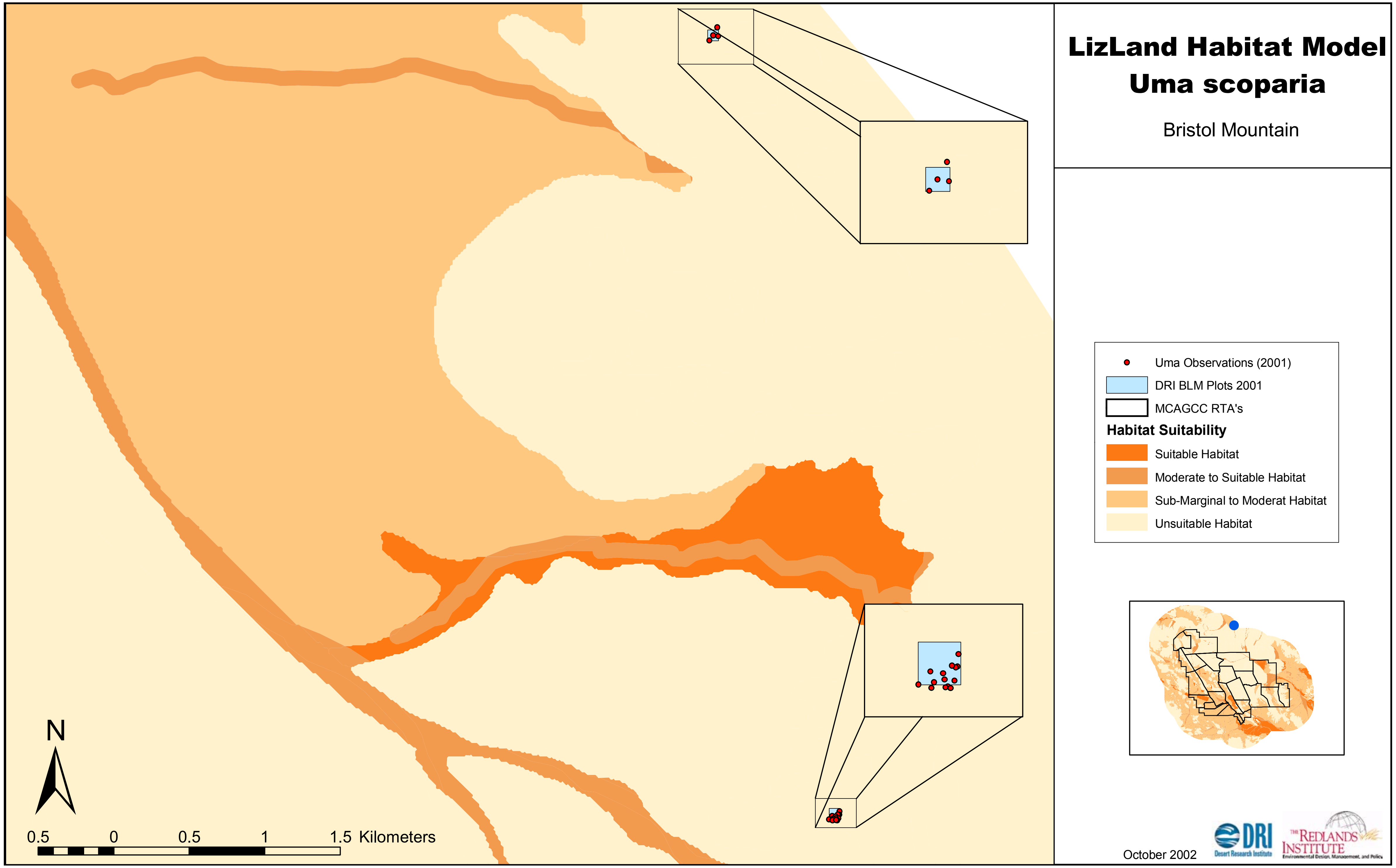


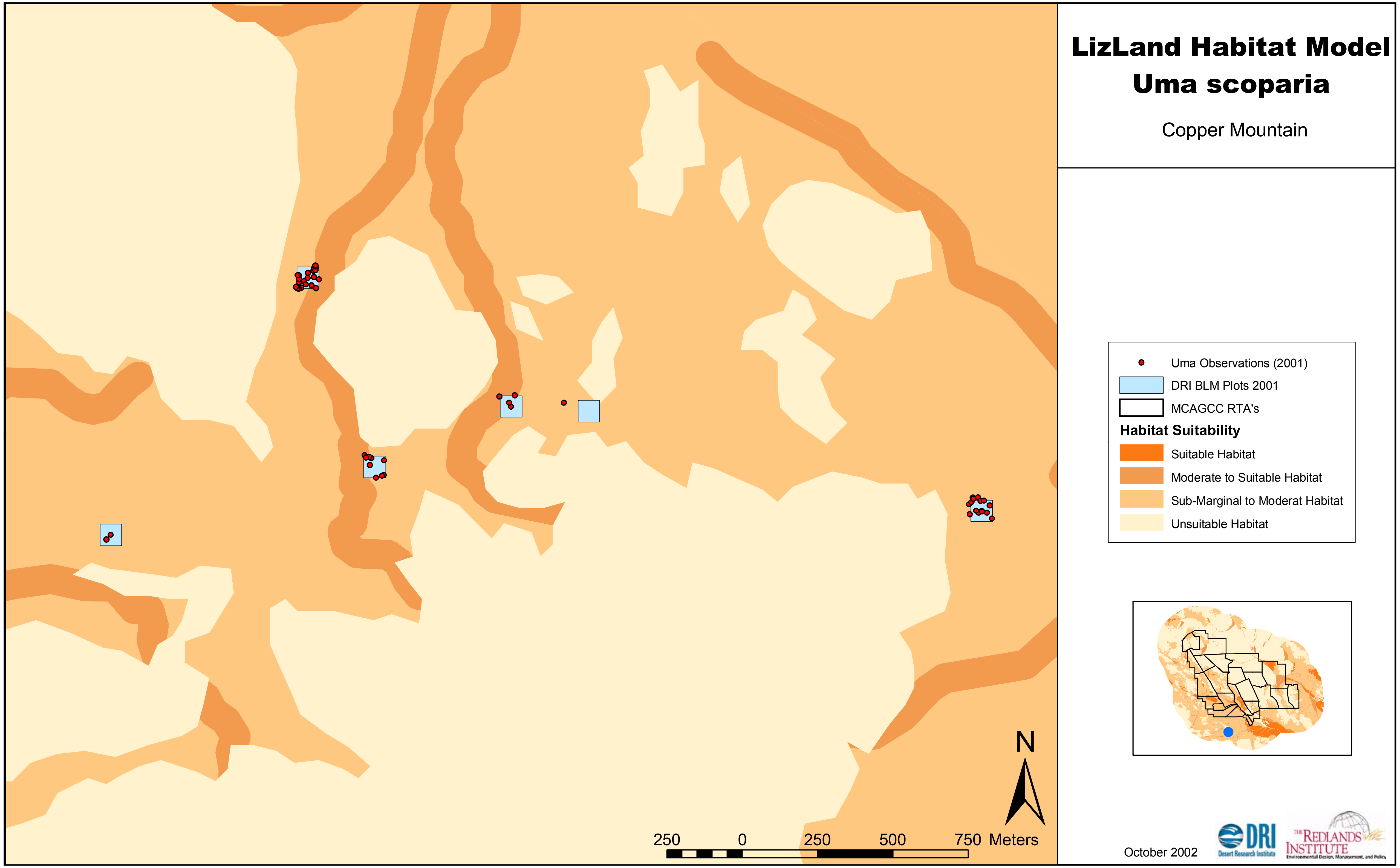
Marine Corps Air Ground Combat Center
Sandhill RTA
1 plot was surveyed within Sandhill RTA and no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Sandhill RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5 0 2.5 5 Kilometers
N
September 2002
DRI Desert Research Institute
The Redlands Institute Environmental Design, Management, and Policy


Marine Corps Air Ground Combat Center
Sunshine Peak RTA
No plots were surveyed within Sunshine Peak RTA and no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
Sunshine Peak RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
2.5
0
2.5
Kilometers
September 2002
N
DRI
Desert Research Institute
The Redlands Institute

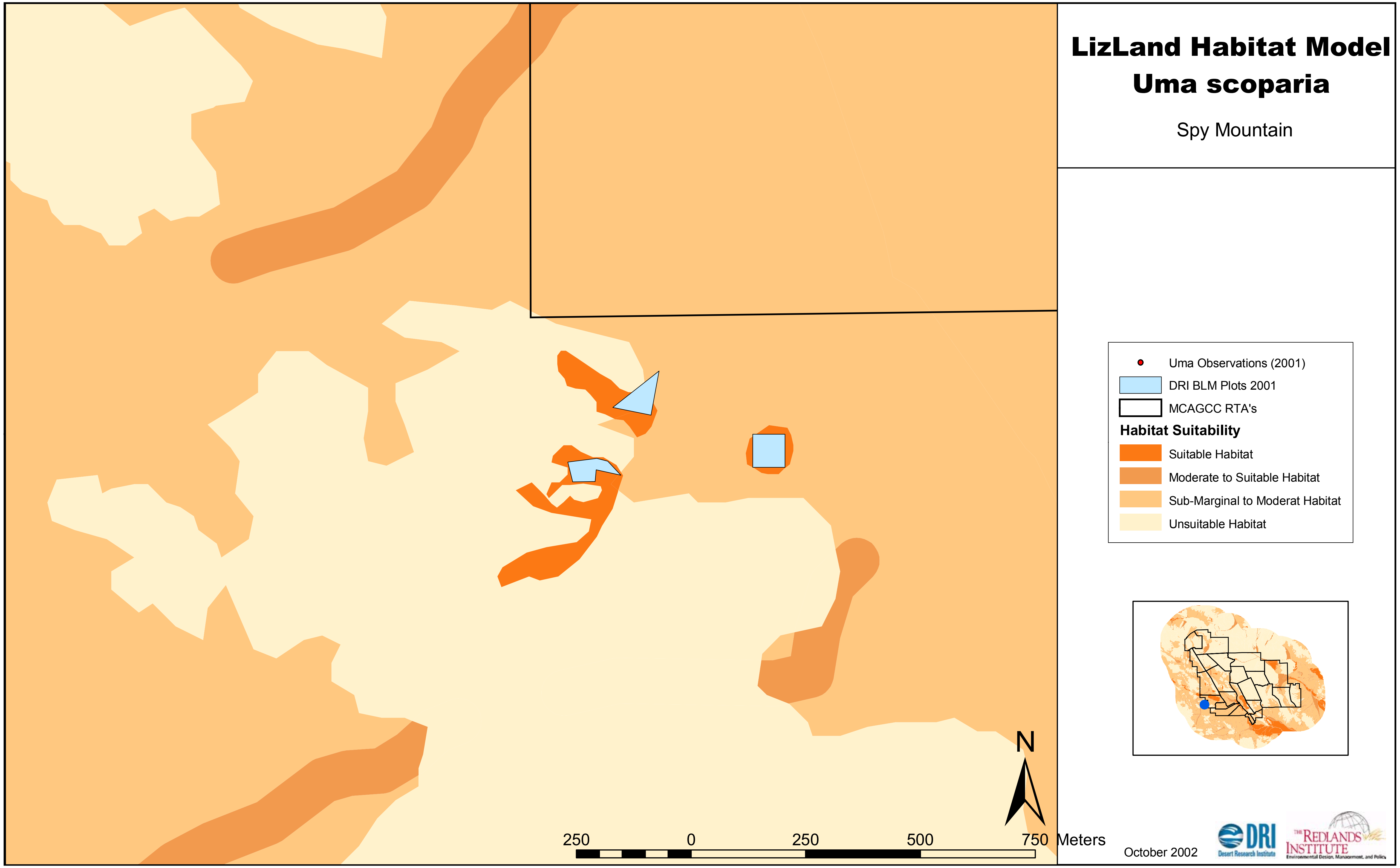

Marine Corps Air Ground Combat Center
West RTA
3 plots were surveyed within West RTA and
no Uma were found.
Nevada
California
Arizona
Mojave Fringe-toed Lizard Surveys
Uma scoparia Observation
West RTA
Surface Material
Loose sand
Soft pack
Medium pack
Hard pack
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderate Habitat
Unsuitable Habitat
N
2.5
0
2.5
Kilometers
September 2002
DRI
Desert Research Institute
The Redlands Institute
Environmental Design, Management, and Policy

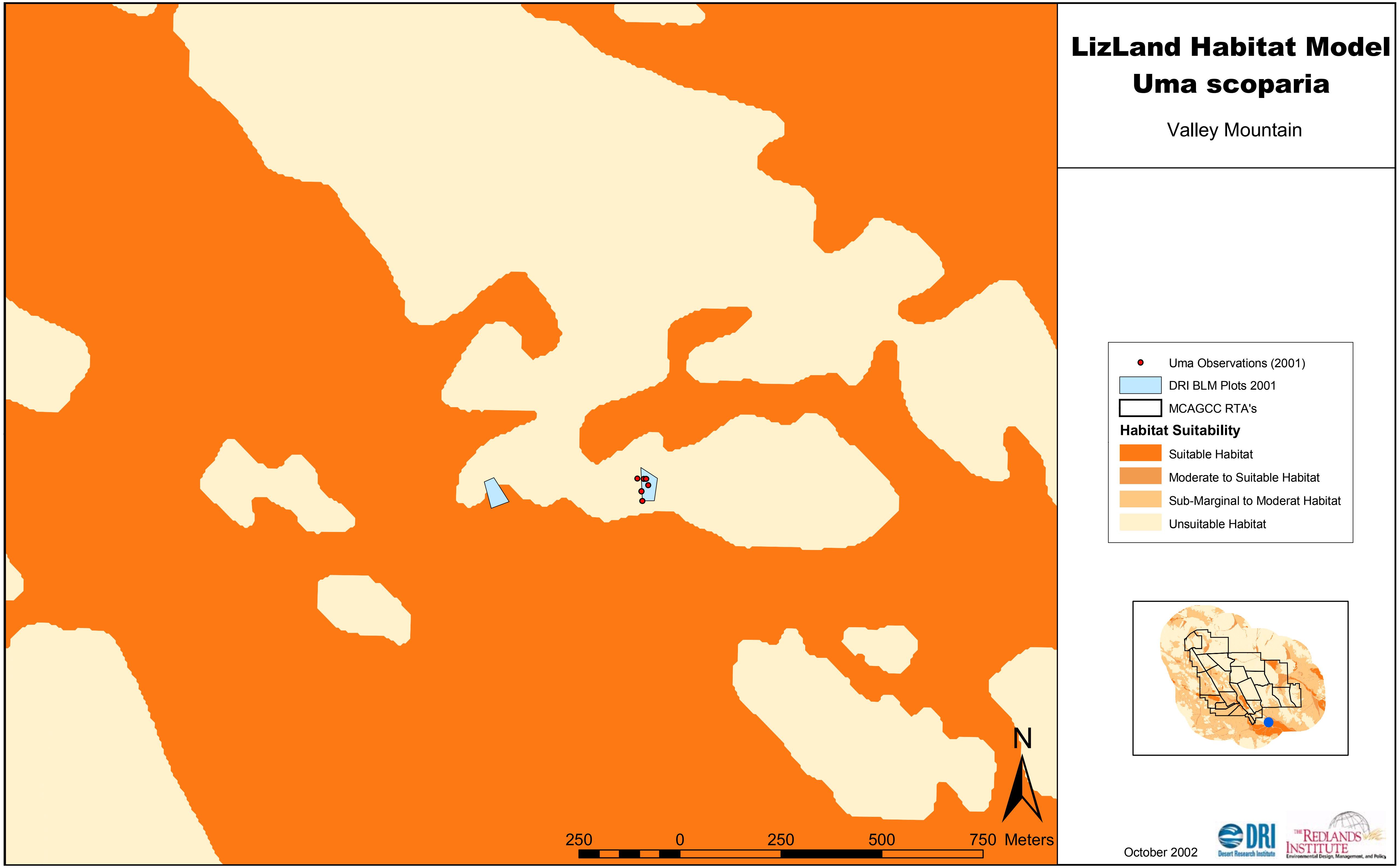
APPENDIX 3.
LizLand models for BLM surveyed areas.



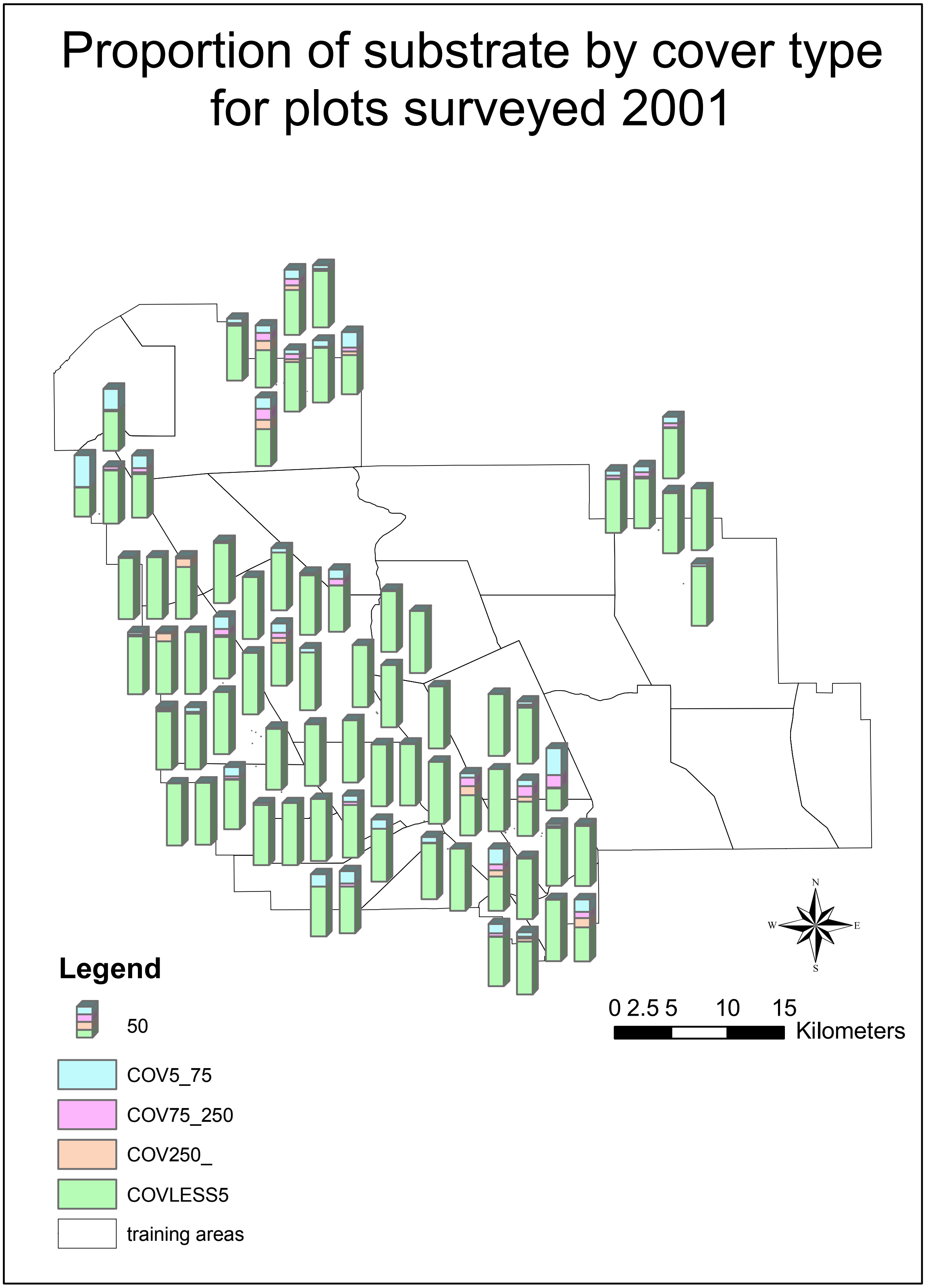


LizLand Habitat Model
Uma scoparia
Copper Mountain
Uma Observations (2001)
DRI BLM Plots 2001
MCAGCC RTA's
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderat Habitat
Unsuitable Habitat
N
250 0 250 500 750 Meters
October 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE


LizLand Habitat Model
Uma scoparia
Spy Mountain
Uma Observations (2001)
DRI BLM Plots 2001
MCAGCC RTA's
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderat Habitat
Unsuitable Habitat
N
250 0 250 500 750 Meters
October 2002


LizLand Habitat Model
Uma scoparia
Valley Mountain
Uma Observations (2001)
DRI BLM Plots 2001
MCAGCC RTA's
Habitat Suitability
Suitable Habitat
Moderate to Suitable Habitat
Sub-Marginal to Moderat Habitat
Unsuitable Habitat
N
250 0 250 500 750 Meters
October 2002
DRI
Desert Research Institute
THE REDLANDS INSTITUTE

APPENDIX 4.


Proportion of substrate by cover type
for plots surveyed 2001
Legend
50
COV5_75
COV75_250
COV250_
COVLESS5
training areas
0 2.5 5 10 15
Kilometers
N
S
E
W

Proportion of substrate by cover type for plots surveyed 2001 (BLM)

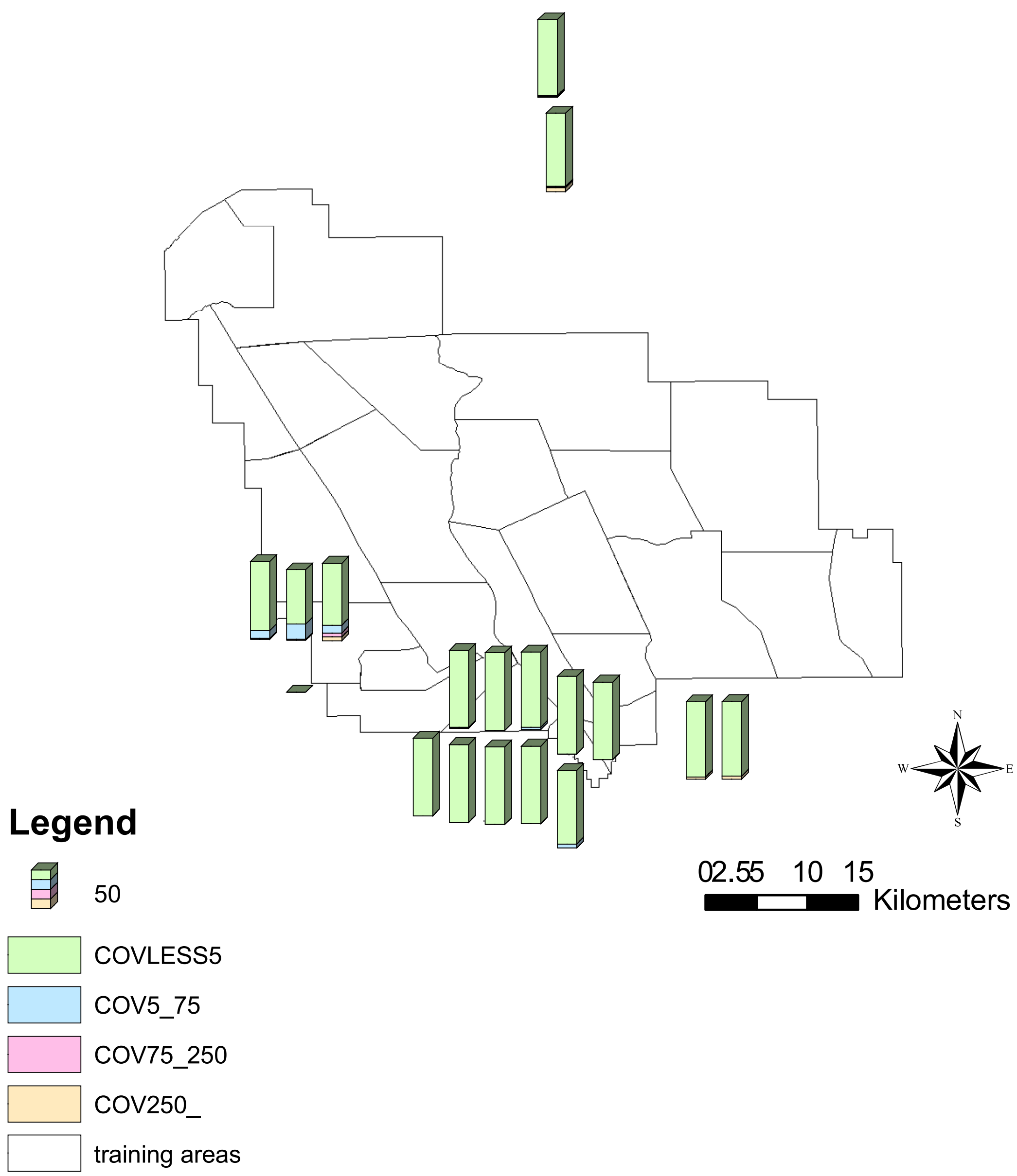


EXHIBIT 544

THE NATURAL HISTORY OF THE MOJAVE FRINGE-TOED LIZARD, *UMA SCOPARIA*: THE NORTHERN LINEAGE, AMARGOSA RIVER, CA

A Thesis

Presented to the

Faculty of

California State University, Fullerton

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

in

Biology

By

Jeffery M. Jarvis

Approved by:

Dr. William Presch, Committee Chair — Date
Department of Biological Science

Dr. Sean E. Walker, Member — Date
Department of Biological Science

Dr. William J. Hoese, Member — Date
Department of Biological Science

ABSTRACT

The Mojave fringe-toed lizard (MFTL), *Uma scoparia*, is isolated on the windblown sand dunes of the Mojave Desert. Due to a recent petition to list the Amargosa River populations as Threatened or Endangered under the Endangered Species Act, the three northern populations have attracted increased attention, with an emphasis on the Dumont Dunes population. Dumont Dunes is a compound star dune system (3,885 ha) open to off highway vehicle activity. Also associated with the Amargosa River are Ibex Dunes and Coyote Holes. Ibex Dunes (688 ha) is protected habitat that is part of Death Valley National Park. Coyote Holes is a small (20 ha) sandy outcrop found along the Kingston Wash in protected wilderness.

Uma scoparia were surveyed in 2007 and 2008 by walking transects during periods of peak activity. Lizards were found from the base of the dunes to the outskirts of the dune systems, where there was Aeolian sand and scattered vegetation.

MFTLs were observed outside the previously documented ranges, two kilometers north of the Ibex Dunes population and five kilometers southeast of the Dumont Dunes population. Vegetation was a necessary habitat requirement, but it was insufficient to predict lizard occurrence. Observations of lizards decreased from 2007 to 2008, but the difference was significant only at Ibex Dunes (obs_{IBX07}=26; obs_{IBX08}=3; p=0.011). The decrease in observations at Dumont Dunes was comparable to *U. inornata*, while the reduction in observations at Ibex Dunes was unprecedented. Future surveys should include mark-recapture techniques to examine population dynamics and dispersal tendencies.

TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGEMENTS

Without the help and support of my committee, wife, family, friends, CSU Fullerton Biology Department, Desert Studies Center, and the Bureau of Land Management, this thesis could not have been completed. Dr. Sean Walker, Dr. William Hoese, and Dr. William Presch have been very supportive throughout the process of this thesis, giving me great feedback, advice, and encouragement; they were always eager to help in any way they could. In addition, I would like to extend additional thanks to William Presch for coordinating lodging, showing me around the Mojave Desert, and sharing many movies and meals together. On the same note, thank you to all of the regulars at the Desert Studies Center (Eric, Jason, Kelly, Marcello, Ray, and Rob) who endured me for two summers, putting a roof over my head (Marcello, Rob and Jason), food in my belly (Eric), and helping me with my fieldwork (Jason, Kelly, Ray and Rob). A special thank you has to go out to Rob Fulton for coming to the rescue twice while I was stuck in the sand. Friends and family often gave me great insight and encouragement when times were rough. My parents provided me with a very flexible job during the off-season. My greatest appreciation needs to go to my wife, Leanne; she not only supported me with my field work and crazy schedule, but she also planned our perfect wedding while I was working.

Four-wheel drive vehicles and fuel were provided by both the Bureau of Land Management and the Biology Department at CSU Fullerton. Funding, satellite phones, and miscellaneous field gear were provided by the Bureau of Land Management as part of the Mojave Fringe-toed Lizard Monitoring Project.

CHAPTER 1

INTRODUCTION

Natural History: Genus *Uma*

Fringe-toed lizards, of the Genus *Uma*, are highly adapted psammophilous lizards that inhabit scattered windblown sand habitats in southwestern North America, from southeastern California to western Arizona and down into north-central Mexico (Norris, 1958; Pough 1974; Schmidt & Bogert, 1947; Williams et al., 1959). The Integrated Taxanomic Information System (2009) currently recognizes six species of fringe-toed lizards in North America: the Mojave (MFTL, *Uma scoparia*), the Coachella Valley (*U. inornata*), the Colorado Desert (*U. notata*), the Yuman Desert (*U. rufopunctata*), the Coahuila Desert (*U. exsul*), and the Chihuahuan Desert (*U. paraphygas*) fringe-toed lizards (Figure 1).

Fringe-toed lizards have multiple morphological adaptations for Aeolian habitats. Scales on the digits are enlarged (Figure 2) to make movement on the sand energy efficient (Carothers, 1986; Stebbins, 1944). The head has several morphological adaptations for sand (Figure 3): the lower jaw is counter-sunk into the upper jaw, the nasal passage is oriented posteriorly, the nasal passage can also be physically constricted, the eyelids have enlarged 'eyelash' scales, and the ears are also covered by enlarged scales (Stebbins, 1944).

Fringe-toed lizards also have interesting behavioral adaptations for their dune habitat. Most notable is their sand burial behavior, which was described as quiescent by Pough (1970), meaning the lizards have not been observed to hunt insect prey while buried or actively move like *Chionactis* sp. after reaching an optimal depth underneath the sand. Fringe-toed lizards tend to bury themselves within 4-6 cm of the sand surface (Norris, 1958; Pough, 1970; Stebbins, 1944). Stebbins (1944) thought the behavior was thermoregulatory in nature, but Pough (1970) later rejected this hypothesis and thought that the burial behavior is mainly for cover. While buried, the lizards position their forelimbs posteriorly along their sides to keep sand from collapsing in around the body after taking a breath (Pough, 1970).

Diet has varied in studies, but all agree that fringe-toed lizards are opportunistic, sit-and-wait omnivores. Sand-dwelling invertebrates are an important food item, and the lizards will feed on flowers and leaves when available (Durtsche, 1995; Kaufmann, 1982 Mayhew, 1966a & b; Stebbins, 1944).

Rainfall has been shown to have an indirect impact on fringe-toed lizard reproduction (Mayhew, 1966a & b). Food intake is directly linked with testes size in males, and possibly, female egg production of fringe-toed lizards (Mayhew, 1966a & b). Winter rain in the Mojave Desert has a positive effect on annual germination in the spring (Hereford et al., 2006). Increased annual germination provides a greater food source for ground dwelling arthropods, which results in a larger food supply for insectivorous animals (Dunham, 1980; Mayhew, 1966a & b; Turner et al., 1982). Mayhew (1966a & b) suggested that insects associated with perennial vegetation, which bloom later in the season than annuals and are still able to flower during droughts because of deeper, perennial water sources, serve as a secondary food source. As a result, reproduction in fringe-toed lizards during drought years is later in the season, producing few juveniles in the fall (Mayhew 1966 a & b).

Natural History: *Uma scoparia*

The Mojave fringe-toed lizard (MFTL) is found only in the Mojave Desert where deposits of fine, windblown sand exist (Figure 4; Mayhew, 1966b; Norris, 1958; Stebbins, 1944). The habitats of the known populations are associated with present and historical river drainages and sand fields of the Mojave, Amargosa, and Colorado Rivers (Enzel et al., 2003).

The Amargosa river populations (San Bernardino County, California) are found at Ibex Dunes, Dumont Dunes, and Coyote Holes. Ibex Dunes (688 ha, UTM 11 S 557200 m E 3950400 m N) is located east of Saratoga Springs and lies within Death Valley National Park. Dumont Dunes (3,885 ha, UTM 11 S 570400 m E 3949300 m N) is southwest of the Kingston Mountains and is an open off-highway vehicle (OHV) recreation area managed by the Bureau of Land Management (BLM). Coyote Holes (20 ha, UTM 11 S 594400 m E 3944800 m N) is a sandy outcrop within BLM wilderness found at the southern base of the Kingston Mountains along the Kingston Wash (Norris, 1958; Pough, 1974).

The Mojave River Drainage populations (San Bernardino County, CA; Figure 4) include Barstow, Lenwood, Pisgah Crater, Coyote Dry Lake, Cronese Dry Lake, Bitter

Spring, Red Pass Dry Lake, Silver Dry Lake, Afton Canyon, Rasor Road, Devil's Playground, and Kelso Dunes (Murphy et al.¸ 2006; Norris, 1958; Pough, 1974).

Further south, other Mojave fringe-toed lizard populations are found in Pleistocene discharge channels of the Mojave River, Colorado River, or a channel connecting both rivers (San Bernardino County, CA unless noted otherwise) (Enzel et al., 2003). These populations include Amboy Crater, Bristol Dry Lake, Cadiz Dry Lake, Dale Dry Lake, Rice Valley, Pinto Basin, Palen Dry Lake (Riverside County, CA), Ford Dry Lake (Riverside County, CA), and Bouse Dunes (La Paz County, Arizona) (Murphy et al., 2006; Norris, 1958; Pough, 1974).

There is limited literature on the natural history of *Uma scoparia*. Stebbins (1944) researched *Uma* anatomy and ecology, while others have discussed behavior (Carpenter, 1963; Pough, 1970), evolution and systematics (Norris, 1958; Trepanier & Murphy, 2001). Reproduction was studied by Mayhew (1966b). More recently the evolutionary genetics (Gottscho, unpublished; Murphy et al., 2006; Trepanier & Murphy, 2001) and conservation (Center for Biological Diversity & Papadakos-Morafka, 2006; Jennings & Hayes, 1994; Murphy et al., 2006; Otahal et al., unpublished; United States Fish and Wildlife Service, 2008) of *Uma scoparia* have been studied. However, survey data of *U. scoparia* is limited and incomplete (Girard, 2004; Morafka, 2003; Otahal et al., unpublished).

Girard (2004), which was a continuation of Morafka's (2003) research, collected and analyzed survey data of *Uma scoparia* at El Mirage dry lake, Rasor Road, and Dumont Dunes. These sites were selected to investigate if off-highway vehicle (OHV) activity has had an effect on these populations. At the Rasor Road population, Girard also measured and tested predictive variables of Mojave fringe-toed lizard observations. Data were collected from four 1000 m transects in three varying OHV use areas (low, medium, and high; total transects varied by site) in June and July of 2003 (Girard, 2004). Predictive variables that were measured were perennial vegetation, annual vegetation, ‘good’ sand, OHV tire tracks, and rodent burrows. No fringe-toed lizards were seen in either year at El Mirage Dry Lake (Girard, 2004; Morafka, 2003), and they suggested the possible extirpation of this population. The results from the 2004 report (Girard) suggest that ‘good’ sand and rodent burrows were the only predictive variables for observations of *Uma scoparia* at Rasor Road. In addition, if the sand and rodent burrows were removed from the analysis, the only variable (of annuals, perennials, and OHV tracks) that was predictive of fringe-toed lizard observations was presence of annuals (Girard, 2004). OHV activity at Dumont Dunes did not seem to have an affect on lizard observations. *U. scoparia* observations at Dumont Dunes were similar in areas of high and low OHV activity, but observations were lowest in areas of medium OHV activity (Girard, 2004; Morafka, 2003).

More surveys like Girard’s and Morafka’s studies should be conducted at the different populations of Mojave fringe-toed lizards before making management decisions. Exemplar research would be Barrows (1996, 1997, and 2006) and Chen et al. (2006). These researchers have surveyed and analyzed extensively at least two populations of the Federally Threatened Coachella Valley fringe-toed lizard, *Uma inornata*. They conducted long term (20 yr) surveys of population dynamics (Barrows, 2006) and constructed predictive modeling on habitat quality and persistence, suggesting for this species that sand source corridors should be preserved and perches for avian predators should be avoided (Barrows, 1996, 1997, 2006; Chen et al., 2006). These studies have been used in management decisions of the Coachella Valley fringe-toed lizard, and similar long-term monitoring studies on *Uma scoparia* could aid agencies like the Bureau of Land Management in making decisions for populations, such as Dumont Dunes.

Despite a lack of survey data and population size estimates, government agencies recognize *Uma scoparia* as a species of special concern by California Department of Fish and Game and a sensitive species by the Bureau of Land Management (BLM) due to the isolated nature of their habitat (California Department of Fish and Game, 2009; Jennings and Hayes, 1994). BLM manages most of the lands where *U. scoparia* can be found, and they allow OHV activity at some sites where the Mojave fringe-toed lizard occurs. Recent genetic research has supported the presence of three unique genetic haplotypes of mitochondrial DNA in the northernmost populations of Mojave fringe-toed lizard, which include Dumont Dunes, Ibex Dunes, and Coyote Holes (Figure 5) (Murphy et al., 2006). This led Murphy et al. (2006) to the conclusion that the Amargosa River populations are a distinct population segment (DPS) in accordance with the Endangered Species Act.

The northern (Amargosa River) populations include Ibex Dunes, Dumont Dunes, and Coyote Holes (Figure 5). At 3,885 ha, Dumont is over five times larger than Ibex Dunes (688 ha) and almost 200 times larger than Coyote Holes (20 ha). Dumont Dunes is open to OHV use, and estimates of OHV activity have exceeded 100,000 people in a single fiscal year (Bureau of Land Management, 2008).

With the recent genetic information and the high levels of OHV activity at the largest dune system of the Amargosa River drainage, there has been concern by conservationists and land management about the effects of OHV activity on the fringe-toed lizard population at Dumont Dunes, and a petition has been sent to the United States Fish and Wildlife Service (USFWS) to take steps in conserving this DPS (Center for Biological Diversity & Papadakos-Morafka, 2006; USFWS, 2008; Murphy et al., 2006). However, most of the information in the petition referenced behaviors, ecology and conservation of the Coachella Valley (*Uma inornata*) and Colorado Desert (*U. notata*) fringe-toed lizards (Barrows, 1996; Barrows, 1997; Barrows, 2006; Barrows et al., 2005; Center for Biological Diversity & Papadakos-Morafka, 2006: Chen et al., 2006; Durtsche, 1995; Luckenbach & Bury, 1983; Pough, 1970; Turner et al., 1984). The petitioners also assumed that Mojave fringe-toed lizards and high OHV activity overlap in the same areas (Center for Biological Diversity & Papadakos-Morafka, 2006). Before government action should be taken at Dumont Dunes, more detailed surveys of the entire dune system for fringe-toed lizard presence needed to be conducted.

This thesis focuses on surveying the Amargosa River populations more completely than previously attempted, while identifying any patterns of behavior and ecology of *Uma scoparia*.

CHAPTER 2

MATERIALS AND METHODS

Study Sites and Transect Placement

Uma scoparia were studied at three sites: Dumont Dunes, Ibex Dunes, and Coyote Holes (Figure 5). Dumont Dunes are a 3,885 ha compound star dune system stretching west-to-east, and it has been open to off-highway vehicle activity (OHV) since the 1960s (Figures 6) (Otahal et al., unplublished). Yearly visitors have grown to over 100,000 people (Bureau of Land Management, 2008). Ibex Dunes (Figure 7) is a 688 ha dune system that is oriented north-south and is located to the west of Dumont Dunes. Ibex Dunes are within Death Valley National Park and the Ibex Wilderness area. OHV activity has been prohibited since 1933 when Death Valley was designated a national park under the Antiquities Act. Coyote Holes stretches east-west and at 20 ha is considerably smaller than the other two study sites (Figure 8). It is a sandy outcrop found within BLM wilderness, along the Kingston Wash about 20 km southeast of Dumont Dunes. OHV activity at Coyote Holes has been prohibited since the establishment of the California Desert Protection Act (1944, Public Law 103-433).

This study included 55 transects at Dumont Dunes, 19 transects at Ibex Dunes, and 4 transects at Coyote Holes (Figure 5). Each transect was 750 m long by 10 m wide and spaced at least 150 m apart from each other to ensure independence. The transect directionality followed the dominant wind direction (Tinant et al., unpublished). BLM provided the start and end waypoints for all transects, except for the four transects at Coyote Holes. The transects at Coyote Holes were established using the same protocol as the other sites but three out of the four transects needed to be shortened from 750 m to 500 m long due to space limitations. All transects were walked twice during the study, once in 2007 and again in 2008. The start and end waypoints were uploaded into a Garmin Rhino 130 GPS/two-way unit, using WGS 1984 datum with 9 m accuracy.

Lizard Counting and Plant Cover

Transects were walked during times of peak activity. The yearly peak activity falls during the breeding season, which begins in March and ends in July, with highest activities occurring in May and June (Mayhew, 1966b). Daily activities peaked during periods when the sand temperatures on the dunes were ideal, ranging between 32^{o}C and 49^{o}C (Norris, 1958; Pough, 1970; Stebbins, 1944). Observational periods varied depending on sand temperatures, wind, and daylight. Early on in each of the seasons (March and some of April), there was one long period in which MFTLs were active that stretched from late morning until early evening. As the season progressed and the sand temperature rose to 32 ^{o}C earlier in the day and remained greater than 32^{o}C later into the day, the activity window increased until the sand temperatures in the afternoon rose beyond the thermal limit (>49 ^{o}C), effectively dividing the lizard activity period into two windows. This afternoon divide continued to increase in length until July through August, when the activity periods are shortest. Transects were walked to maximize ideal sand temperatures. Occasionally, transects were walked when temperatures were above thermal limits due to time constraints. When conditions were too windy (>20 km/h), observations were cancelled for the day. Transects were walked in the evenings occasionally, concluding before sunset.

MFTLs were counted as an observation on a transect only if the lizard originated within a transect. Lizards seen outside of a transect that then ran into the transect were not included in calculations. However, all encountered Mojave fringe-toed lizards were given a waypoint, because of the importance to document where these lizards are active throughout each location. The waypoints were taken as close as possible to where the lizards originated. The MFTLs were identified as an adult or juvenile, using Mayhew's (1966b) definition of an immature or mature adult having a snout-vent length greater than 50 mm (male and female). The locations of lizards were recorded with the GPS unit. Before and after walking each transect and whenever a lizard was observed, the sand temperatures were recorded with a RadioShack infrared thermometer (Cat. No. 22-325). The temperature at the start and end of each transect was taken on the south-facing slope of the nearest hummock (highest sand temperature), while the lizard temperatures were taken as close to where the lizard originated as possible. Potential predators were noted, along with other species of lizards (e.g., zebra-tailed lizard, whip-tail lizard, and desert iguana).

The structure of the *Uma scoparia* habitat was characterized by measuring vegetation. While walking the transects in 2008, perennial plants were recorded with a GPS unit, and the presence of annuals was noted. When a MFTL was seen, the nearest perennial shrub was measured to the nearest half meter by pacing steps or with the GPS device. Due to the potential for error, the GPS device was only used for measuring plants that were greater than 15 m away from where the lizard was observed. Sand samples were obtained from each site to analyze grain size and composition. The sand grains were sorted using a W. S. Tyler Automated Sand Sifter, Model #R-30050. Sand was sorted into 13 size classes with diameters ranging from 0.053 mm to 0.850 mm. Elemental composition of the sand samples was determined by Dr. John Foster in the Geology Department at California State University, Fullerton.

Spatial and Statistical Analysis

Google Earth v.5.0.11337.1968 was used to illustrate patterns of lizard presence. The imagery data varied and are stated in the figure captions and on the maps (bottom-center). The lizard data layer was overlaid with satellite photographs and plant data layers. Polygons representing large expanses of vegetation dominated by flowering annual from 2008 were estimated using field notes, observations, photographs, and satellite imagery. Statistical analyses were completed with SPSS v.16.0 and Microsoft Excel (2003 and 2007).

Data were standardized across all of the dune systems by calculating a density of lizards seen (MFTL/ha) per transect. The densities were not normally distributed at each study site; therefore, the means of lizards seen per hectare per transect were compared between the years at each study site using the Wilcoxon signed ranks test. Comparing temperature and time from 2007 to 2008, histograms of sand temperatures and time were prepared for lizard observation and transects. The sand temperatures of when lizards were observed on transects were analyzed further with a two-sample t-Test assuming equal variance, using the mean difference of start and end transect sand temperatures from 2007 and 2008. The mean distances from vegetation were calculated for each lizard seen in 2008. In addition, the number of *U. scoparia* seen per field day was calculated for both 2007 and 2008.

CHAPTER 3

RESULTS

Lizard Observations

Total Mojave fringe-toed lizards observed, on and off transects, in 2007 and 2008 were 79 and 58 individuals, respectively. *Uma scoparia* were not observed on the large bare dune faces at Ibex or Dumont Dunes. Based on the areas that were searched, Dumont Dunes had more patchy observations (Figure 6). Groups of observations occurred in both years and were focused in the western, southern, and eastern areas of Dumont Dunes (Figure 6). There were 17 transects at Dumont Dunes that had zero vegetation present (Figure 6). All of these transects and the barren dune slopes in between had zero observations of *Uma scoparia*. At Dumont Dunes, there were large areas with zero fringe-toed lizard observations, with 37 out of the 55 (67.3%) transects at Dumont Dunes not having a lizard observation in either year (Figure 6). Similar habitat to areas where the fringe-toed lizards were found extend further south and east than where I surveyed at Dumont Dunes.

At Ibex Dunes, 13 out of the 19 (68.4%) transects had a lizard observation in at least one year. Fringe-toed lizards were found throughout Ibex Dunes in 2007 and primarily in the south and northeast in 2008. No transects at Ibex Dunes had lizards observed on them in both years, but there was one grouping in the southwest with multiple observations on and off transects in both years (Figure 7). An individual was found two kilometers north of the dune field, expanding the previously known range of the *U. scoparia* population at Ibex Dunes (Figure 7).

Coyote Holes produced very few fringe-toed lizard sightings, but they were present both years (Figures 8). The sample size was too small to notice any patterns in observations, except that all fringe-toed lizards were found where the substrate was windblown sand.

In 2007, 60.76% of the lizards were present on transects (obs_{07}=49). In 2008, only 32.76% of the lizards seen were on transects (obs_{08}=19). There were two juveniles observed in 2007, while there were none observed in 2008. Field days spent at Dumont Dunes were 12 in 2007 and 13 in 2008, at Ibex Dunes 6 (2007) and 5 (2008), and at Coyote Holes 1 (2007) and 2 (2008). The field days and lizard observations varied by month (Figure 9). The sand temperatures (Figure 10) were not significantly different by year for lizard sightings. Time of observations (Figure 11) followed the same pattern each year.

At Ibex Dunes from 2007 to 2008, there was an 88.9% (obs_{IBX07}=27; obs_{IBX08}=3) reduction in MFTLs observed. This reduction was significant (Wilcoxon signed ranks test, p=0.011) (Figure 12). Coyote Holes experienced similar reductions in observed lizards with a 62.5% decline (tot_{COH07}=8, tot_{COH08}=3) in lizards overall, and no MFTLs were seen on transects in 2008; however, the sample size at Coyote Holes was very small. More individuals were seen in 2008 overall at Dumont Dunes (tot_{DUM07}=37, tot_{DUM08}=40), but lizards on transects decreased by 20.0% (obs_{DUM07}=20, obs_{DUM08}=16).

Transects

Transects varied in many aspects. The majority substrate type of almost all transects consisted of windblown sand; however, two transects at Coyote Holes only had a short section, approximately one-fifth of the 500 m transects, that had Aeolian substrate. Many of the transects at Ibex and Dumont Dunes were comprised mostly of the large, barren dune faces (slopes).

The substrate varied from Aeolian sand to coarser grained sand to rocky, mountainous terrain. The sand samples that were analyzed did not seem to have a different elemental composition. The grain sizes sorted similarly for samples from Ibex Dunes, Dumont Dunes and Coyote Holes. The only notable difference in sand grain size was the sample from southern Dumont Dunes, which had a monodispersed particle size range of fine grain sand (0.151-0.212 mm) (Figure 13).

Vegetation, Rainfall, and Temperature

The vegetation on transects varied from extensive areas having zero vegetation to areas with sparsely scattered *Larrea tridentata* to areas covered with annual vegetation (predominantly desert primrose and sand verbena). In 2008, lizards seen on transects averaged 27.89 m (SD=36.93) from the nearest perennial shrub. When looking at all vegetation (annuals and perennials), the mean distance of lizards seen on transects from the vegetation is 6.37 m (SD=15.72). There was a large increase in annual vegetation in 2008 (Figure 14).

Rainfall data was collected at the nearest weather station in Baker, CA where the average annual rainfall was 10.69 cm from 1971 to 2007. Rainfall was below average in

2006 and 2007 with 8.13 cm and 3.96 cm of precipitation, respectively. Precipitation in 2008 was above average with 11.66 cm (National Climatic Data Center, 2009).

The sand temperatures recorded when fringe-toed lizards were observed on transects were 44.2°C (2007) and 41.5°C (2008) (Figure 10). With the evening transects removed, the time periods when transects were started was about the same (Figure 15). The mean start times of the day transects were 9:29 AM (2007) and 9:54 AM (2008). The discrepancy in mean start times between the years was a result of more transects being walked earlier in the season in 2008 and cooler temperatures in May. The mean temperature in 2007 in Baker, CA was 27.2°C, while the mean temperature in 2008 for the same month was 24.7°C (National Climatic Data Center, 2009). These cooler temperatures could account for the decrease in the mean temperature when *Uma scoparia* were observed. In addition, most of the transects at Ibex Dunes in 2008 were walked in May during these cooler temperatures, while most of the transects at Ibex Dunes in 2007 were walked in June. The mean start sand temperatures at Ibex Dunes are 44.7°C (2007) and 38.9°C (2008).

The difference between the mean sand temperature at the beginning of transects with fringe-toed lizard observations at all sites in 2007 and 2008 was 2.76°C, and the difference between the mean sand temperatures at the end of the transects with lizard observations at all sites in 2007 and 2008 was 3.32°C. Using these differences as the hypothesized difference, the temperatures when lizards were observed in 2007 and 2008 were not significantly different (Student's *t* test: start, $p=0.99$; end, $p=0.58$).

CHAPTER 4

DISCUSSION

Lizard Observations

The goal of this study was to identify where *Uma scoparia* existed at three locations in the Amargosa River drainage. At Dumont Dunes, the lizards were concentrated in the western, southern, and eastern areas near the transects (Figure 6). Zero Mojave fringe-toed lizards were observed on transects that had no vegetation present. At Ibex Dunes, the lizard observations were scattered throughout the dunes system in 2007 and only observed in the south and northeast in 2008 (Figure 7). At Coyote Holes, *Uma scoparia* were found in low numbers at this small outcrop of windblown sand (Figure 8).

Lizard observations also resulted in the expansion of the known range at Ibex (Figure 7) and Dumont Dunes (Figure 16). During an exploratory trip along the historic Tonopah and Tidewater railroad berm in 2006, a fringe-toed lizard was found in a sandy area about five kilometers southeast of Dumont Dunes near the Valjean Hills. BLM biologists took this discovery a step further and expanded the range of the population at Dumont Dunes to include the Valjean Hills (Figure 16) (Otahal et al., unpublished). In 2007, another exploratory trip to the north of Ibex Dunes yielded a MFTL in a sandy outcrop two kilometers north of the previous range (Figure 7).

The importance of vegetation as cover and a food source for *Uma* has been suggested by many (Barrows, 1997 & 2006; Durtsche, 1995; Kaufmann, 1982; Mayhew, 1966a & b; Minnich & Shoemaker, 1972; Pough, 1970), but none of these researchers documented a fringe-toed lizard's distance from vegetation. Including lizards both on and off transects (tot_{08}=55), only one Mojave fringe-toed lizard in 2008 was observed more than 33 m from vegetation (at Ibex, 69 m). The mean distance from vegetation was 6.37 m for lizards on transects. However, some transects that were walked had windblown sand and vegetation present, but zero lizards were observed in either year on these transects. This suggests that vegetation presence is necessary but not sufficient to define *Uma scoparia* habitat. If further studies were conducted, I would expect that *Uma scoparia* would be found within 100 m of any vegetation, expanding the habitat requirements beyond Aeolian sand only.

The dominant perennial shrubs encountered in MFTL habitat are creosote bush, *Larrea tridentata*, and white bursage, *Ambrosia dumosa*. Two other perennial shrubs that were found nearest to observed fringe-toed lizards were sandpaper plant, *Petalonyx thurberi*, and saltbush, *Atriplex* sp. Vegetation, I presume, served as cover from predators, and the lizards appeared to use the perennial shrubs as refuge from the heat. Durtsche (1995) found very high amounts, both in quantity and mass, of *P. thurberi* flowers in the stomachs of male *Uma inornata* in the month of May. Durtsche (1995) suggested that MFTLs may be utilizing this plant as a major food source, especially mature males during the breeding season as a cheap energy source. This plant was observed in both years to attract large numbers of arthropods while the flowers were in bloom from April through June (Figure 17). *P. thurberi* was observed at both Ibex and Dumont Dunes, but it was not present at Coyote Holes. Similarly, Kaufmann (1982) observed mature male *Uma scoparia* regularly feeding on the sand verbena flowers during the breeding season. Dumont Dunes had large expanses of flowering sand verbena in 2008 (Figure 16).

When comparing observations in 2007 to 2008 at all study sites, there were fewer lizards observed in 2008. Dumont Dunes (Wilcoxon signed ranks test, p=0.544) and Coyote Holes (p=0.317) did not show a significant change between 2007 and 2008. However, Ibex Dunes did show a significant decrease (p=0.009) in total MFTLs seen from 2007 to 2008 (tot_{IBX07}=35; tot_{IBX08}=15). The difference is even greater if only looking at lizard observations on transects (obs_{IBX07}=27; obs_{IBX08}=3, p=0.011). This large decrease in lizard sighting at Ibex appears to be either an anomaly or a result of a series of events leading to a large decrease in sightings. These events are discussed in further detail below, but they consist of effects of drought, differences in times when transects were walked, differences in temperature, problems with walking transects, or a combination of these factors.

Food Availability and Rainfall

Mayhew (1966a & b) was able to show that rainfall plays a large part in determining reproductive success of fringe-toed lizards in the following year. For example, if rainfall is below average during the winter of 2005-2006, then there will be less mating occurring during the breeding season of 2006; therefore, there will be fewer juveniles present in the fall of 2006 and spring of 2007. Mayhew (1966a & b) and others

(Hereford et al., 2006; Turner et al., 1982) have discussed that rainfall directly affects food availability. For *Uma notata*, testes size in males was directly related to food intake, and decreased egg production in female *Uma scoparia* coincided with drought years (Mayhew, 1966a & b).

Barrows (2006) demonstrated that rainfall correlates with *U. inornata* population growth, $r = \ln(N_{i+1}/N_i)$. Applying my data to his model, I get negative population growth for both Dumont (N_{i+1}=16, N_i=21, r =-0.27) and Ibex Dunes (N_{i+1}=3, N_i=26, r =-2.16). The population growth at Dumont Dunes for 2007 compared similarly to the results of Barrows (2006) in five different years (r =-0.27 +/- 0.1). Also similar to my study, the rainfall in all five of these years was below 50 mm. However, the negative population growth at Ibex Dunes for 2007 was unequalled in 20 years of data by Barrows (2006). The year that comes closest had a population growth of approximately -1.9, with an annual rainfall of 20 mm (Barrows, 2006). Rainfall in 2007 was 39.6 mm (National Climatic Data Center, 2009).

Morafka (2003) found the following numbers of fringe-toed lizards per transect (1000 m) during a drought year: 0.583 (low OHV), 0.250 (moderate OHV), and 0.500 (high OHV). In comparison, the number of lizards seen per ha at Dumont Dunes in 2007 (Figure 12) is similar to Morafka's data for low and high OHV activity areas. Girard (2004) found even fewer *Uma scoparia* on the transects (post drought) at Dumont Dunes in both areas of high and low OHV activity, approximately 0.2 fringe-toed lizards per transect, which is comparable to 0.21 *U. scoparia* per hectare in 2008 (post drought) at Ibex Dunes (Figure 12). I am not sure where the transects were placed at Dumont Dunes in these studies or whether they were placed in the same areas in 2003 and 2004, but the location choice could be why they have low observations on their transects. In 1994 to 1998, Morafka recorded 6.714 fringe-toed lizards per transect at Bitter Spring and 6.156 fringe-toed lizards per transect at Red Pass Dry Lake (Morafka, 2003). I have recorded 5.3 MFTLs/ha (equates to Morafka's and Girard's MFTLs per 1000 m) on one transect at Dumont Dunes and 6.7 MFTLs/ha two different transects (one at Ibex and the other at Dumont) in 2007.

Rainfall during the winters of 2005-2006 and 2006-2007 was below average, and two juveniles were observed in 2007 and zero in 2008. These observations are consistent with Mayhew's (1966a & b) results that suggest low reproductive output during a drought. However, I did not sample during the best season (fall) to count juveniles. There may not have been any juveniles observed in 2008 because of an over-abundant food supply to facilitate rapid growth before I started collecting data. In January 2009, five out of six MFTLs that were found in a single field day at Dumont Dunes were juveniles. Similar relationships with rainfall and reproduction have also been demonstrated with other desert lizard species (Dunham, 1980; Turner et al., 1982).

Three outbreaks of ground dwelling insects were observed at Dumont Dunes in the spring of 2008, which included *Phodaga alticeps* (see below, Figure 18), Say's stink bug (*Chlorochroa sayi*), and pallid-winged grasshoppers (*Trimerotropis pallidipennis*). These large insect emergences in 2008 were not observed at Ibex Dunes or Coyote Holes. Hemipterans and orthopterans like Say's stink bug and the pallid-winged grasshopper may be linked to reproduction and population growth in fringe-toed lizards (Barrows, 2006; Kaufmann, 1982)

Not recorded in this study was the presence of the fanleaf crinklemat plant, *Tiquilia plicata*, but there have been interesting observations made. Durtsche (1995) found leaves of this plant in the stomach contents of *U. inornata*, but at the time he was unaware of secondary compounds found in this plant. Seigler et al. (2005) found that the cyanogenic glycoside dhurrin is the major secondary compound found in tissue samples of *T. plicata*. At Dumont Dunes in 2008, there were many blister beetles, mostly *Phodaga alticeps* (Meloidae), walking along the ground feeding on *T. plicata* (Figure 18). Beetles of the family Meloidae are known to produce cantharidin, a highly toxic secondary compound that produces blisters when introduced to skin and can lead to death in mammals if ingested (Moed et al., 2001). Both the plant and the beetles were found in the same habitat as *Uma scoparia*. It would be interesting to find out if fringe-toed lizards consume the beetle and if they are then able to break down the secondary compounds produced by either the plant or the beetle.

Future Research and Conservation

Recently, a petition (Center for Biological Diversity & Papadakos-Morafka, 2006) was investigated by the United States Fish and Wildlife Service (USFWS) to decide whether past data warranted listing the northern Mojave fringe-toed lizard populations as a distinct population segment under the Endangered Species Act (USFWS, 2008). In 2008, USFWS, BLM, and California Department of Fish and Game agreed that a conservation plan would be appropriate, but listing was not yet warranted. A conservation plan for the Dumont Dunes OHV recreation area was created by BLM in 1990, and it is currently being updated with the Mojave Fringe-toed Lizard Conservation Plan (Otahal et al., unpublished).

Transects work well for large projects with lots of people to share the workload (e.g. horned lizard project) or when research methods are limited (e.g. Coachella Valley fringe-toed lizard) (Barrows, 2006; Wright, 2002); however, walking transects alone was not ideal for this study. In the field, transects are difficult for one person to stay on the correct heading, search for lizards, and record data without additional aid. In the BLM protocol, three people were suggested to manage all the tasks of walking a transect. If a waypoint was set for every 50-100 m along a transect, then I think it would be easier to stay on the route, without a third person navigating.

Other problems that arose with transects were that the statistics tended to be nonparametric, the highly mobile and cryptic nature of fringe-toed lizards, and the variation in habitat quality. Transects were difficult to analyze statistically because there were a lot of zeros. Many of the transects passed through non-habitat producing a lot of zeros in the data. Due to the highly adapted and mobile nature of these lizards, many lizards were likely missed. These lizards were very difficult to see unless the animal moved. Fringe-toed lizards were likely alerted to my presence well before I was aware of theirs, allowing them to move out of my way or enter a burrow. As discussed earlier, the substrate, vegetation, and elevation can all change very drastically within a single transect. This variation would be difficult to quantify and standardize. Perhaps a combination of mark-recapture, walking transects, and quantifying habitat variation would be a better survey technique for this species. Some habitat variations and data that should be collected include vegetation (annual, biannual, and perennial), sand grain size, relative slope degree and directionality, abundance of rodent burrows, fecal samples, and documenting tracks.

Mark-recapture studies to estimate population size would work best by using an injectible electronic identification microchip (PIT tagging) in a mark-recapture study (Whitfield-Gibbons & Andrews, 2004). Despite evidence suggesting that toe clipping does not affect the running ability of terrestrial lizards (Borges-Landaez & Shine, 2003), toe clippings should probably be avoided with this species for potential negative effects on the running ability of these animals. Carothers (1986) demonstrated that removing the fringes off the toes will reduce acceleration and velocity of *Uma scoparia* on sand. Removing entire toes and the effect on fringe-toed lizards has not been demonstrated, but it should be done prior to any further mark-recapture studies done with toe-clippings. Paints or dyes also have drawbacks in long term studies due to the skin shedding cycle of reptiles. Despite relatively high costs, the PIT tags could be a long-term solution to measure population dynamics at Dumont Dunes and the extent of dispersal within a dune system.

An exclusion study would be a better way to test the effects of current OHV activity on the dunes. Several plots of varying OHV activity areas could be blocked off to take measurement of plant diversity and succession. These exclusion areas should be compared to areas where lizards are found. Some factors to compare and measure should include: soil composition, presence of rodent burrows, presence of boulders/large rocks that could be used as cover, and contour/directionality (flat, slope, East-facing, leeward, etc.). As supported in this thesis and others, the lizards are very dependent on vegetation, especially annuals when there is rain (Mayhew, 1966a & b; Norris, 1958). As with most other desert organisms, perennial vegetation becomes vital during drought years (Durtsche, 1995; Mayhew, 1966a & b).

If studies are to continue at Dumont Dunes, I would recommend putting in a weather station to measure winter rainfall and ambient temperatures during sampling periods. Baker, CA was the closest weather station with complete data for the study period, but the data was not compared with data from Dumont Dunes to see if there was a correlation.

Summary of Findings

The seasonal and habitat ranges of the Amargosa River populations of the Mojave fringe-toed lizard are more extensive than previously measured. The population at Ibex Dunes extends 2 km north from the past range to some small sandy outcrops with vegetation. The population at Dumont Dunes follows fingers of habitat east to the Valjean Hills. All of the range expansions occur in protected habitat. The lizards do not occur on the large dunes faces of Dumont and Ibex Dunes and the northern areas of Dumont Dunes where vegetation is absent.

Activity varied from 2007 to 2008, especially at Ibex Dunes, but there were many potentially contributing factors. Windblown sand and a mix of perennial shrubs and annual vegetation are important habitat requirements for the Mojave fringe-toed lizard, but vegetation is not predictive. Surveys of fringe-toed lizards would benefit from long term research and incorporating mark-recapture methods into walking the transects. For the future, management agencies should take these habitat conditions and expanded range into account when developing mitigation plans.

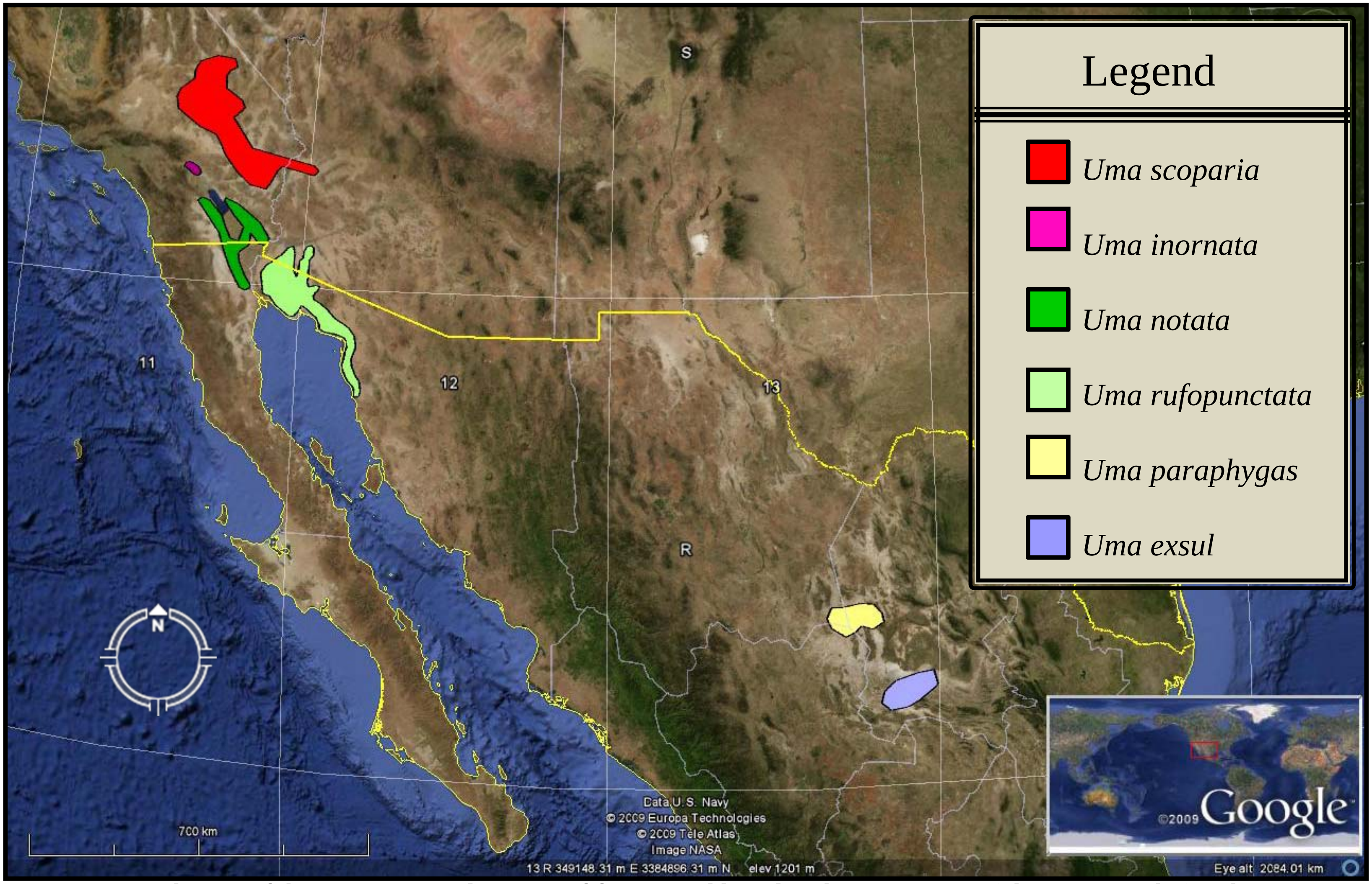


Figure 1: Distribution of the six recognized species of fringe-toed lizard in the Genus *Uma* (Phrynosomatidae). This map is projected on a UTM projection grid with a 700 km scale bar. Imagery obtained from Google Earth, courtesy of ©2009 Europa Technologies, Data U.S. Navy, ©2009 Tele Atlas, and Image NASA.

Figure 2: Picture of enlarged scales on right hind foot of adult *Uma scoparia*. All toes (hind and fore-feet) have posterior-oriented enlarged scales. The 4th digit (shown above) on the hind feet has the largest extensions.

Figure 3: Fringe-toed lizards have several facial adaptations for Aeolian life (*Uma scoparia* pictured). To reduce sand intake when diving into the sand, the lower jaw is counter-sunk below the top jaw, the nasal passages are oriented posteriorly, and a valve can seal the nasal passages shut. The eyelids have enlarged 'eyelash' scales to reduce sand irritation. The ear is covered by enlarged scales.

Figure 4: A map of the extant populations of the Mojave fringe-toed lizard, *Uma scoparia*. The triangles on the map represent the northmost populations of this species and are the study sites for this project. Each shape corresponds with a Pleistocene river drainage. UTM projection, with a 150 km scale bar. Imagery obtained from Google Earth, courtesy of ©2009 Europa Technologies, Data U.S. Navy, ©2009 Tele Atlas, and Image NASA.

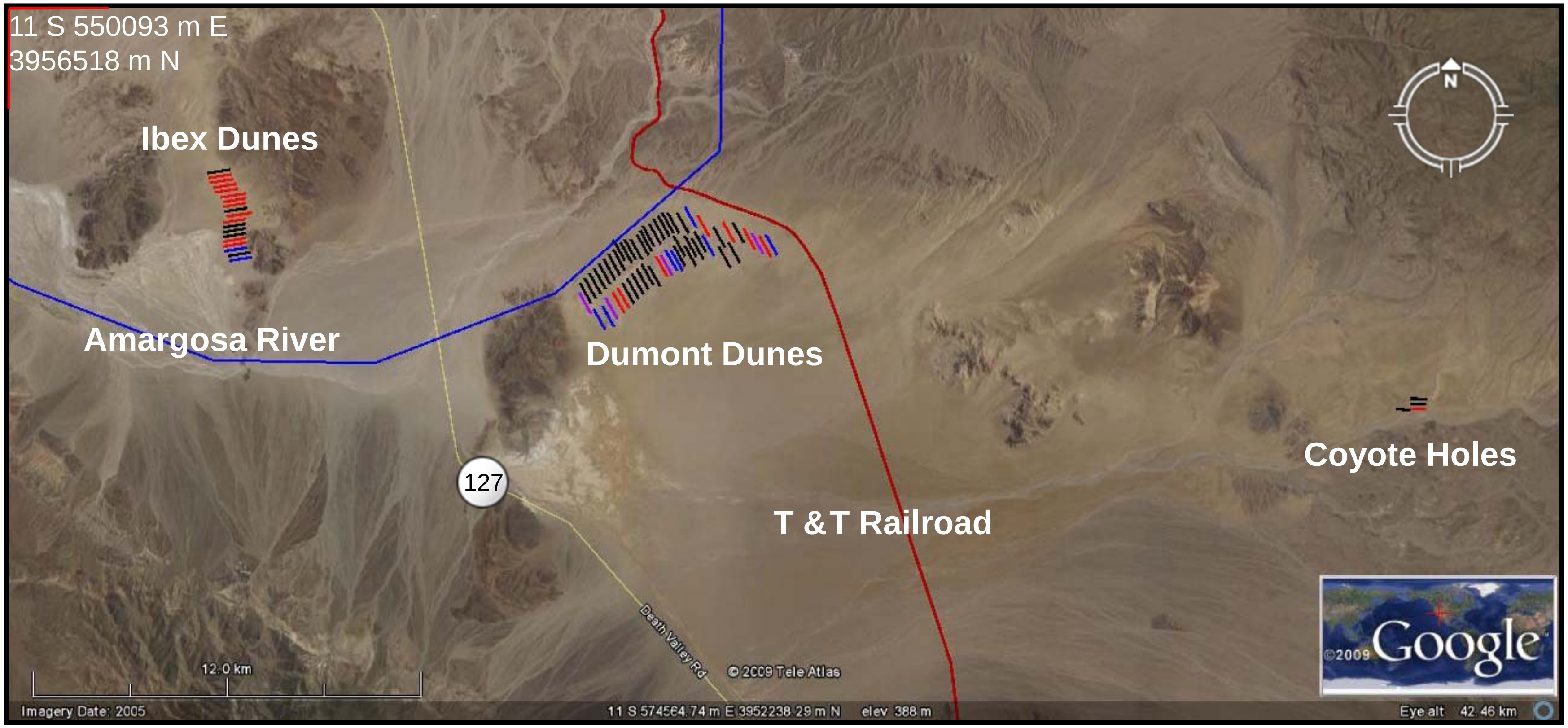


Figure 5: The Amargosa River populations of *Uma scoparia*. The straight, parallel lines represent the transects at each study site. The red transect lines depict the transects with *U. scoparia* observations only in 2007. The blue lines had *U. scoparia* observations in 2008 only. The purple lines had *U. scoparia* sightings in both 2007 and 2008. The black lines did not have *U. scoparia* sightings in either year. UTM projection with a 12.0 km scale bar. Imagery date: 2005, © 2009 Tele Atlas.

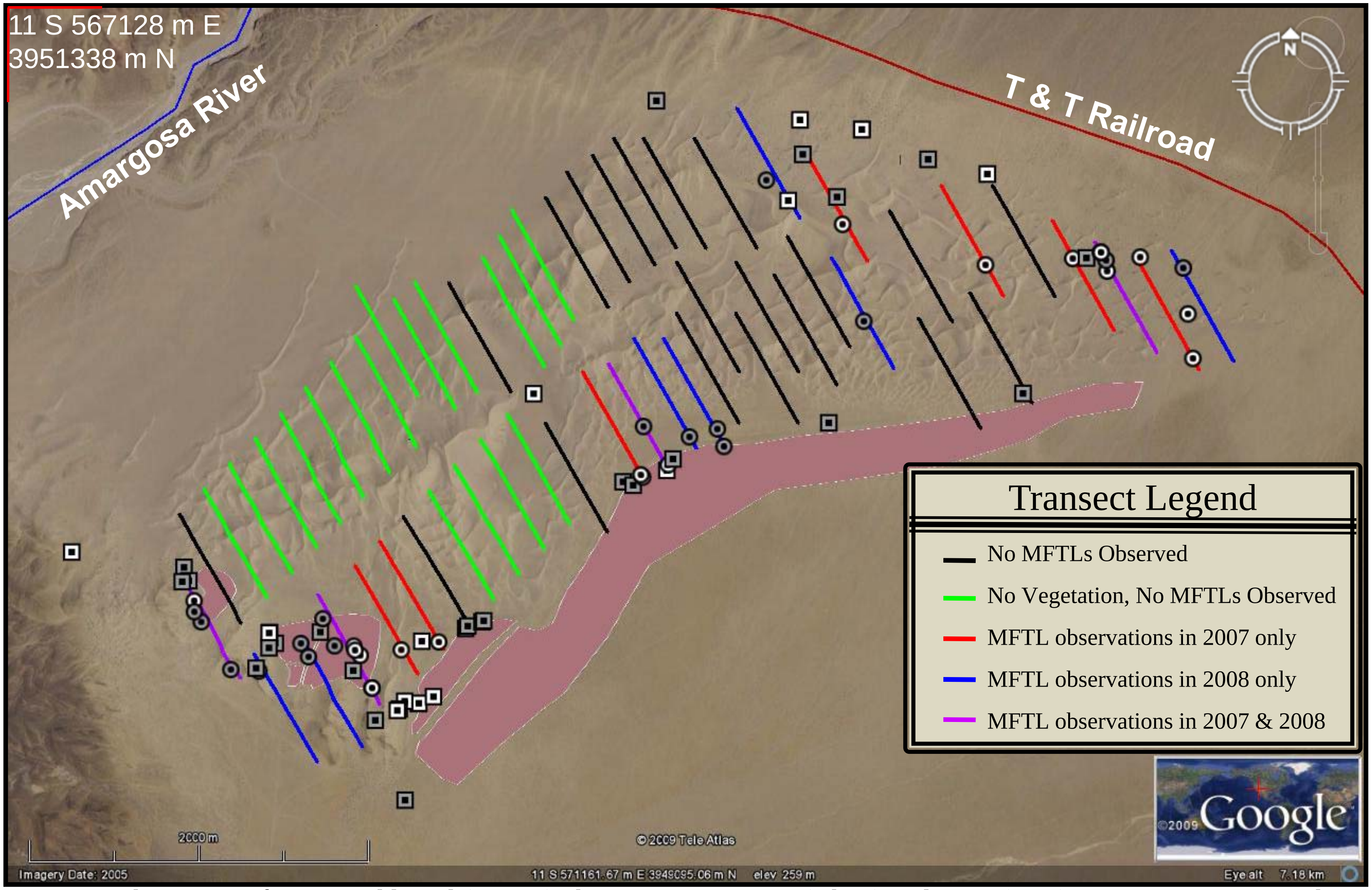


Figure 6: The Mojave fringe-toed lizard (MFTL) observations in 2007 (white) and 2008 (grey) at Dumont Dunes with flower polygons (pale violet-red) and transect layout (straight parallel lines, see legend for color interpretations). The circular waypoints were lizards seen on the transects, and the square waypoints were lizards seen off of the transects. UTM projection with a 2000 m scale bar. Imagery date: 2005, © 2009 Tele Atlas.

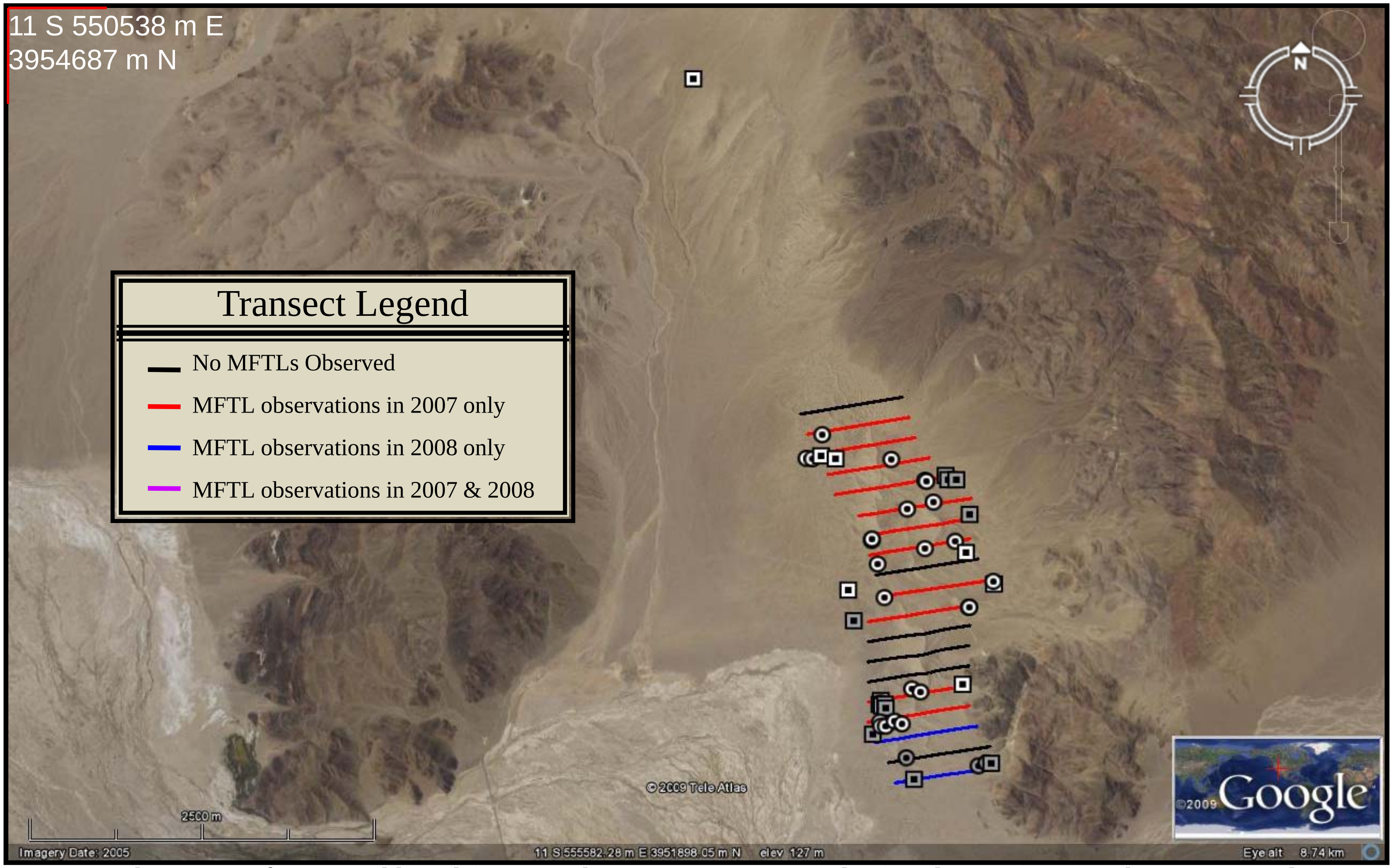


Figure 7: The Mojave fringe-toed lizard (MFTL) observations in 2007 (white) and 2008 (grey) at Ibex Dunes with transect layout (straight parallel lines, see legend for color interpretation). The circular waypoints were lizards seen on the transects, and the square waypoints were lizards seen off of the transects. The northernmost waypoint is 2 km north of the main dune field, extending the previously known range of the Ibex Dunes population. UTM projection with 2500 m scale bar. Imagery date: 2005 , © 2009 Tele Atlas.

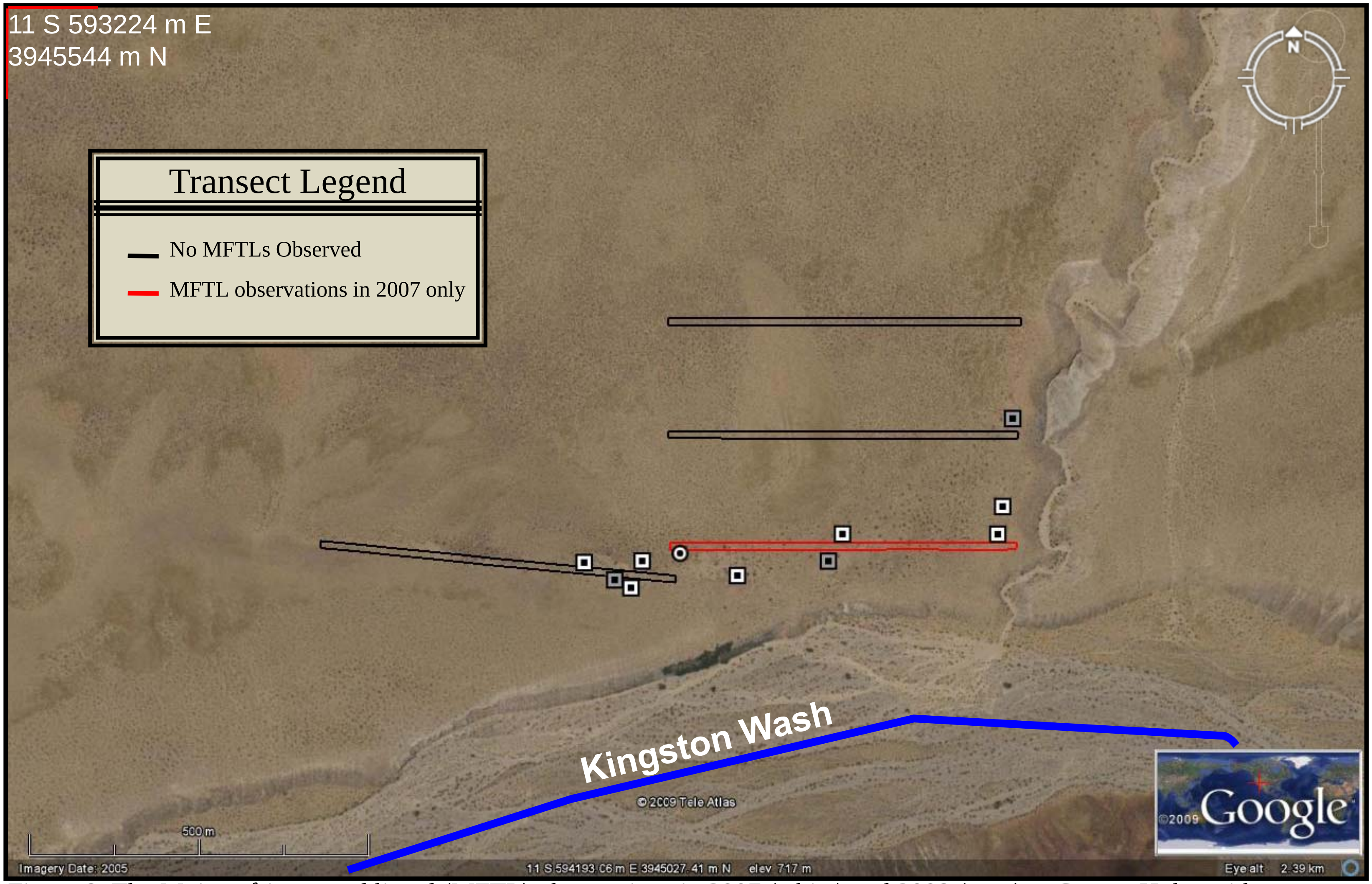


Figure 8: The Mojave fringe-toed lizard (MFTL) observations in 2007 (white) and 2008 (grey) at Coyote Holes with transect layout (straight rectangles). The circular waypoints were lizards seen on the transects, and the square waypoints were lizards seen off of the transects. UTM projection with 500 m scale bar. Imagery date: 2005 , © 2009 Tele Atlas.

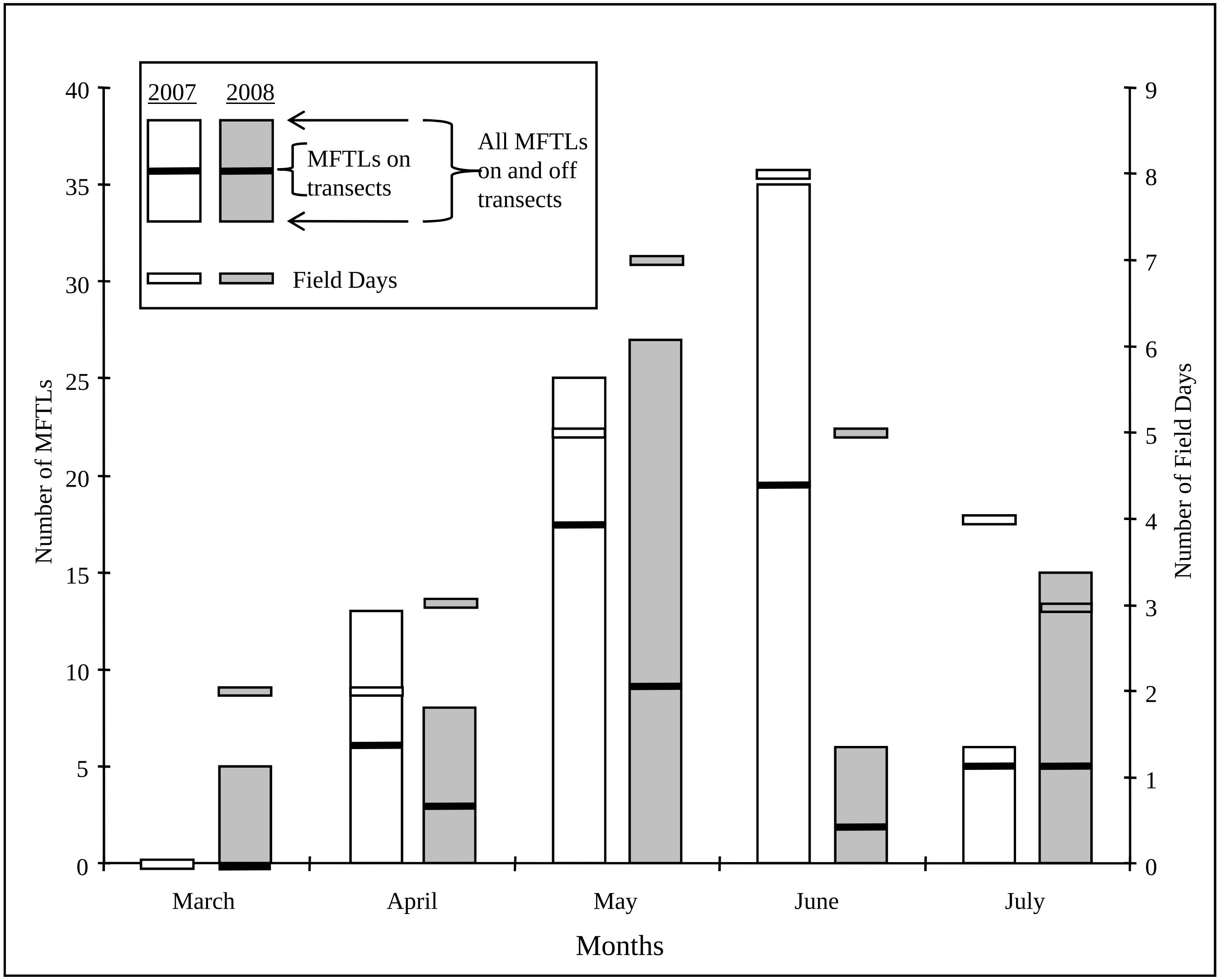


Figure 9: Field days and Mojave fringe-toed lizard (MFTL) observations broken down by month for each field season.

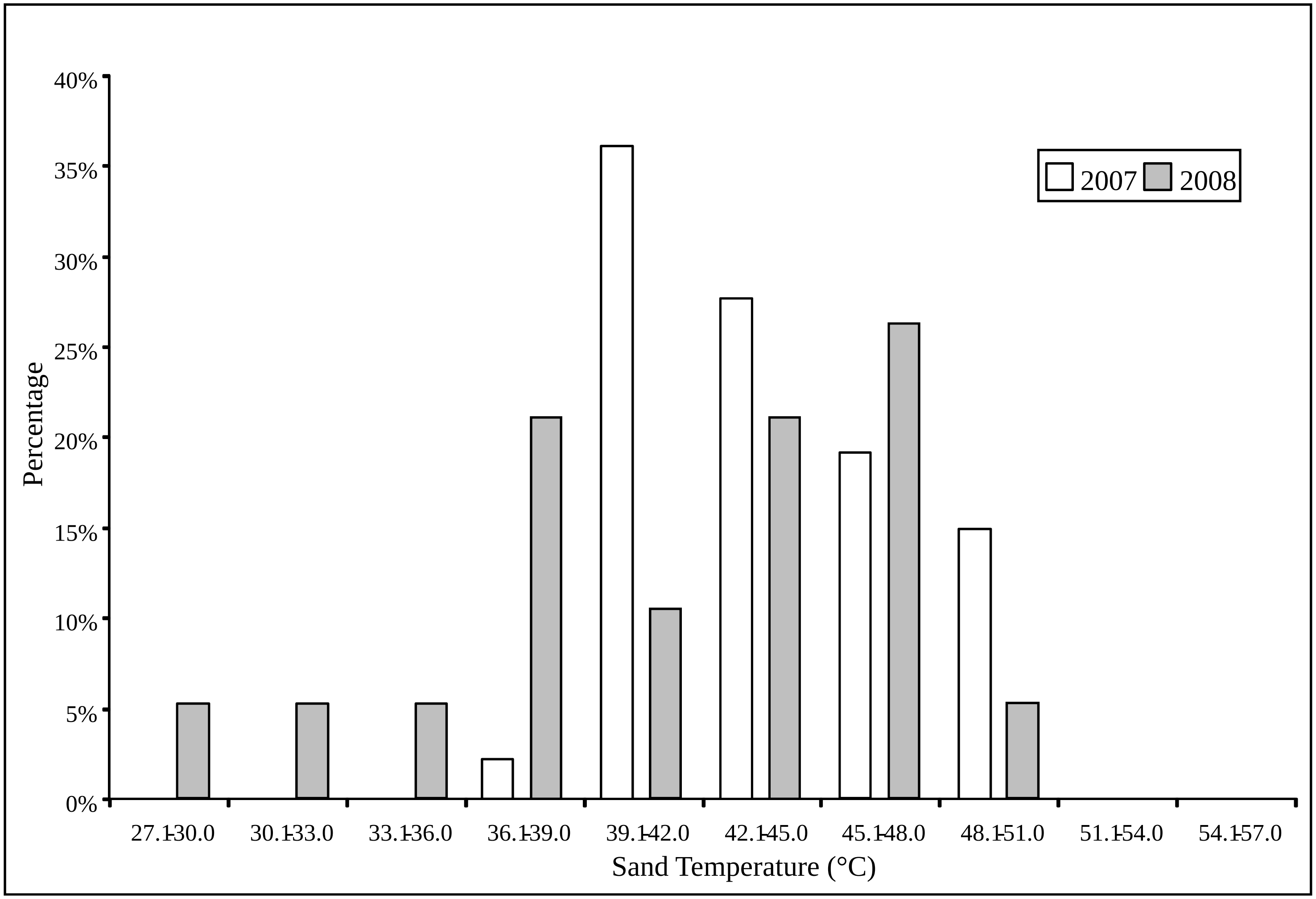


Figure 10: The percent distribution of sand temperatures when *Uma scoparia* were encountered on transects. The mean temperatures were 44.2 °C (2007) and 41.5 °C (2008). This decrease in sand temperature was not significantly different from the variation in the start ($p=0.99$) and end ($p=0.58$) sand temperatures of the transects in which the lizards were seen.

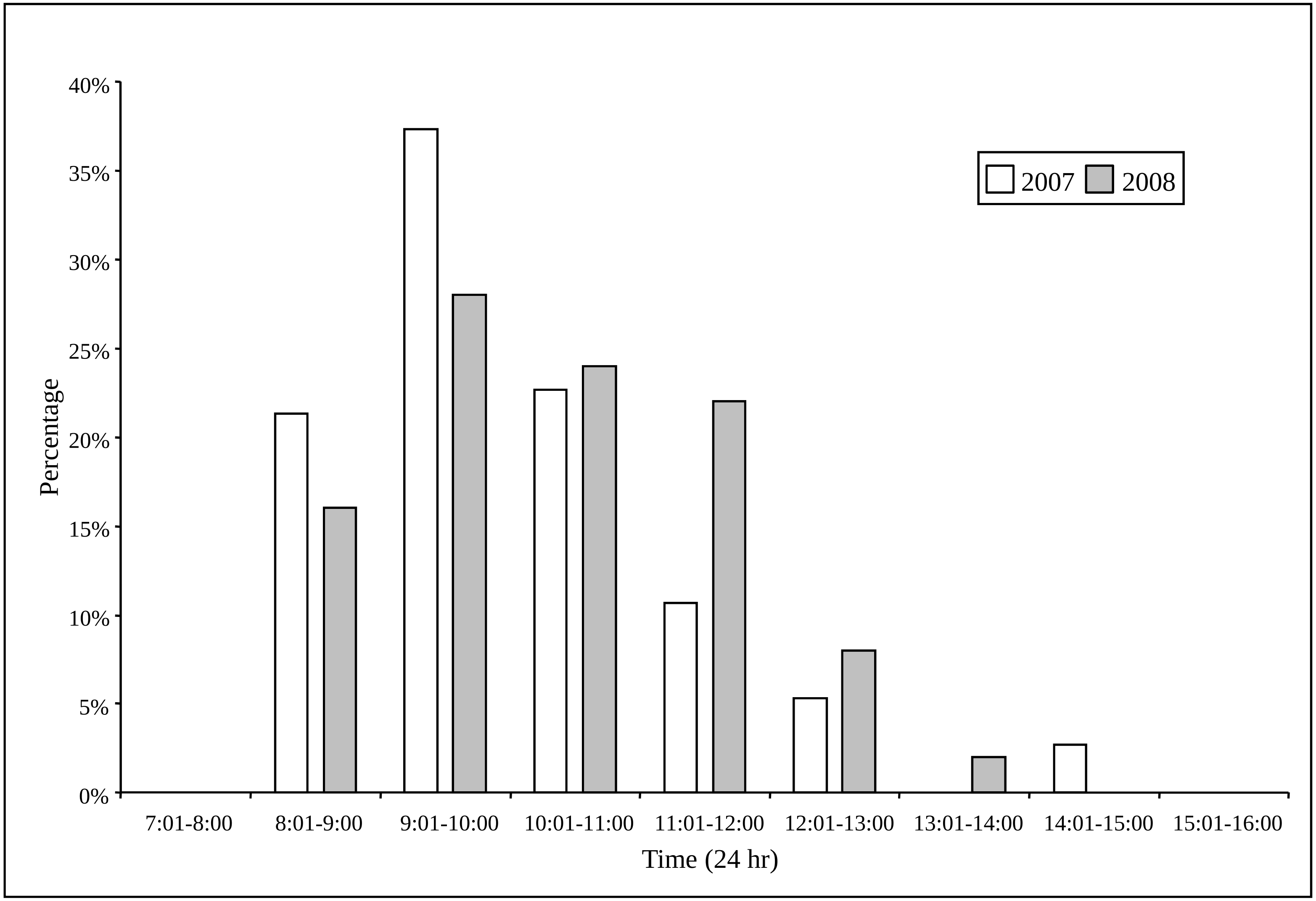


Figure 11: The percent distribution of time periods when *Uma scoparia* were observed, excluding evenings.

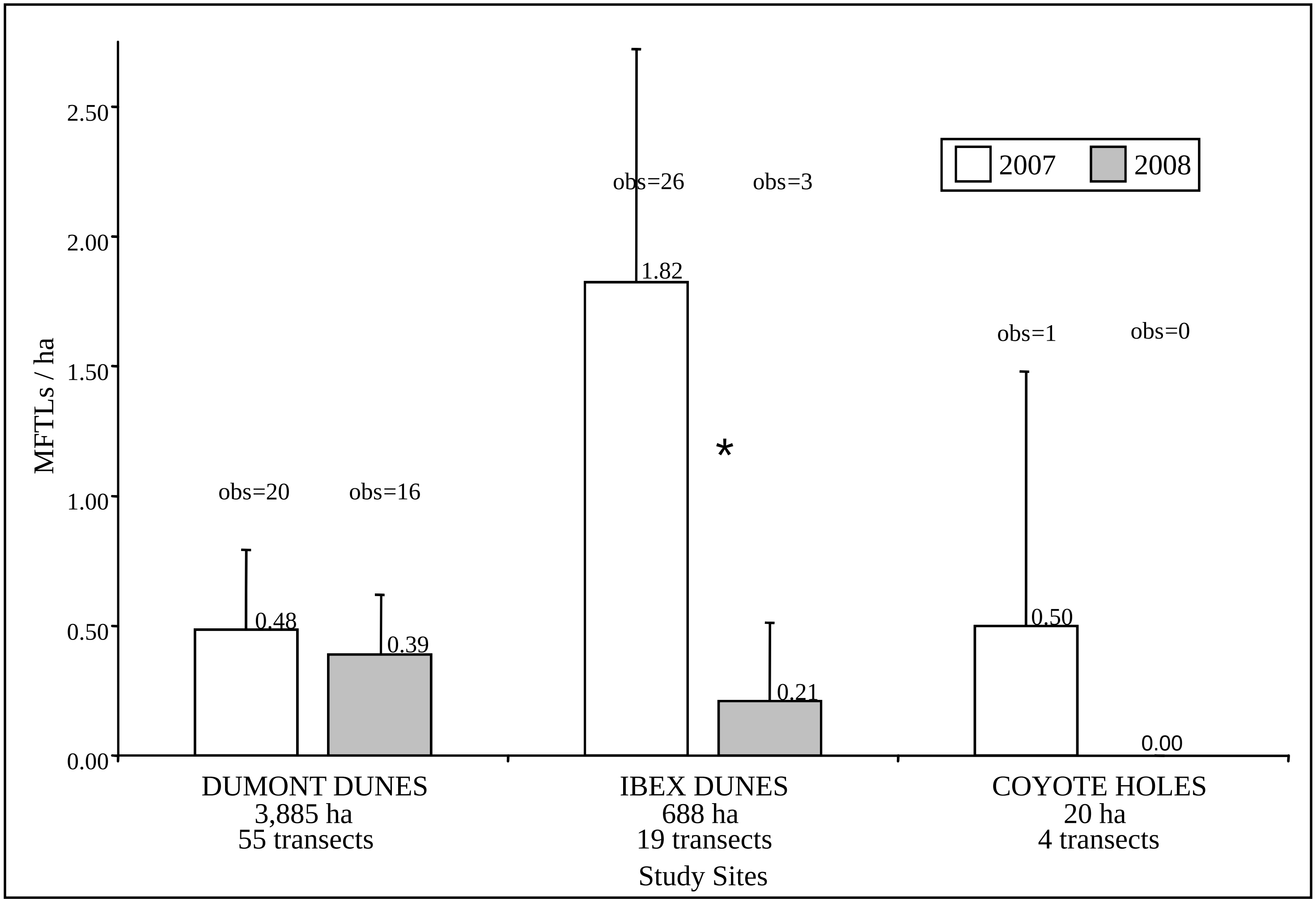


Figure 12: Mean numbers of Mojave fringe-toed lizards (MFTLs) seen per hectare per transect at each study site with 95% confidence intervals (obs=MFTLs seen on transects). Lizards were observed from March through July in 2007 and 2008. The 2007 season was a drought year. In 2008, the rainfall was above the average annual rainfall. Lizard observations at Ibex Dunes was significantly different (Wilcoxon signed ranks test, *p=0.011).

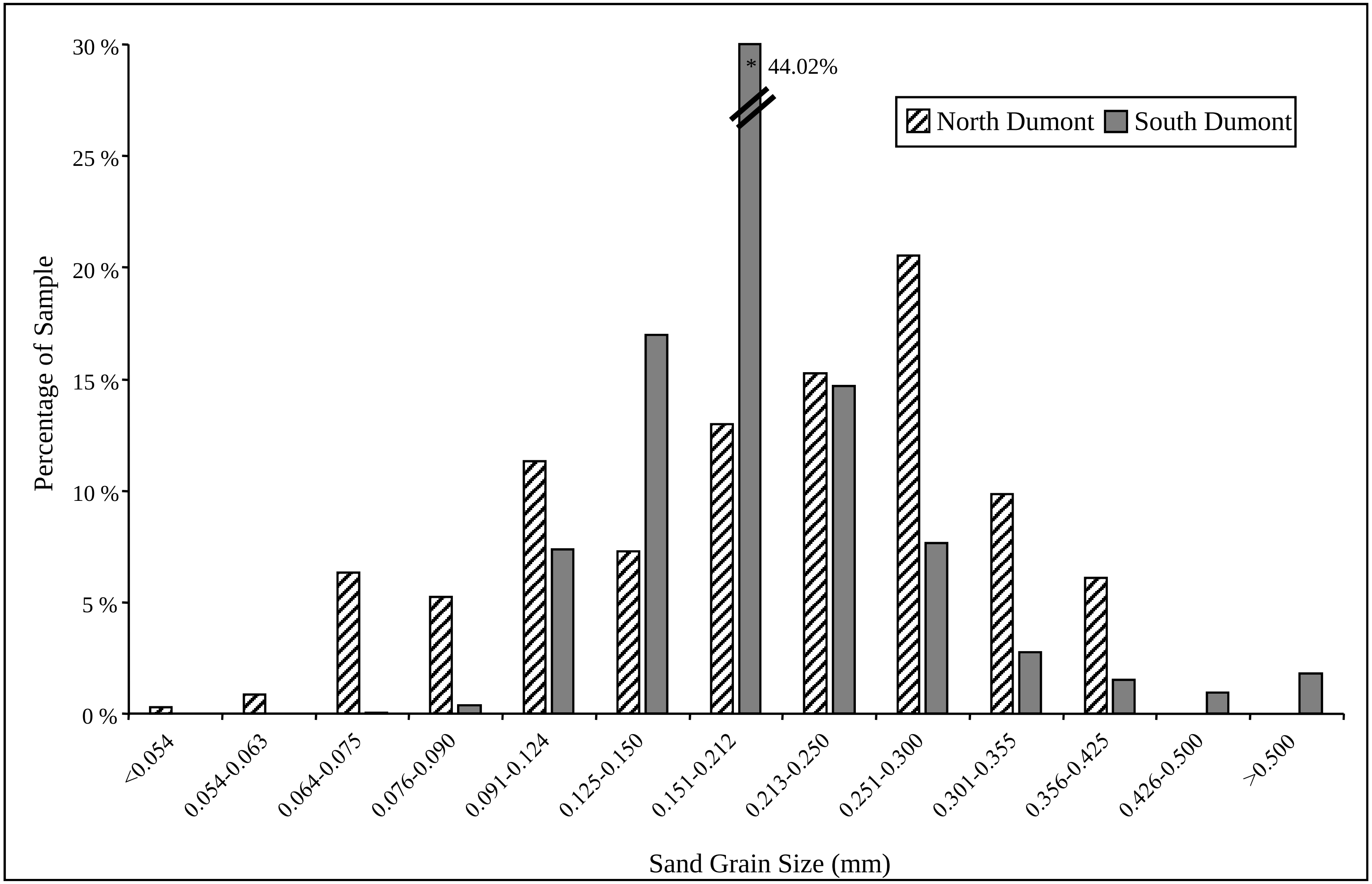


Figure 13: The sand grain size distribution at Dumont Dunes. The southern Dumont Dunes sample is more monodispersed (in particle size) than the sand sample from north Dumont Dunes. A majority of the sand at both locations is classified as fine or very fine grained sand.

Figure 14: Rainfall during the Fall and Winter of 2007-2008 resulted in large expanses of annual blooms throughout the Mojave Desert. Pictured above is a field of annuals in flower at Dumont Dunes. Sand verbena (purple) and desert primroses (white) made up a majority of the flowers present in the dune habitat. This picture was taken in March of 2008.

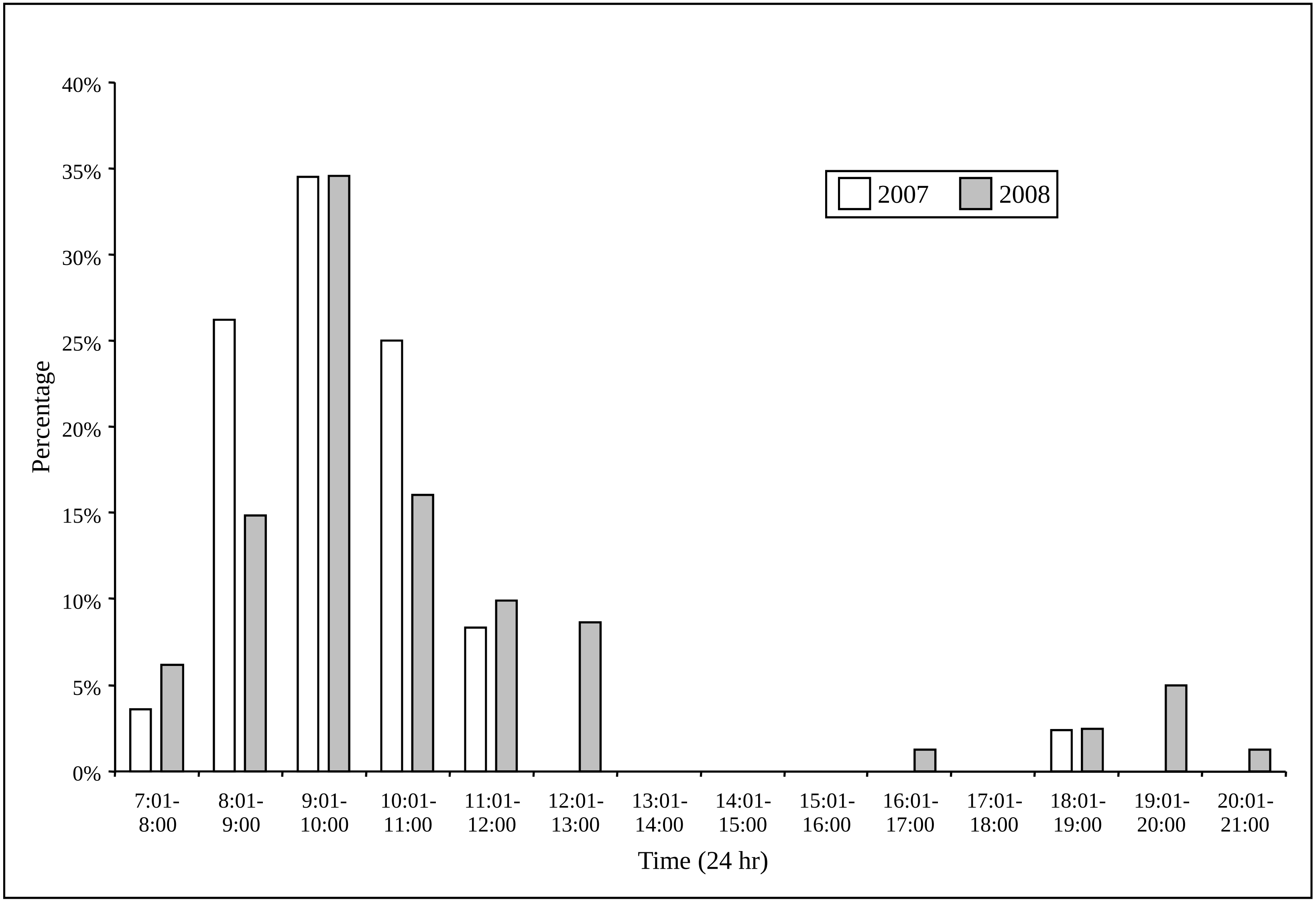


Figure 15: The percent distribution of time periods when transects were started for each season.

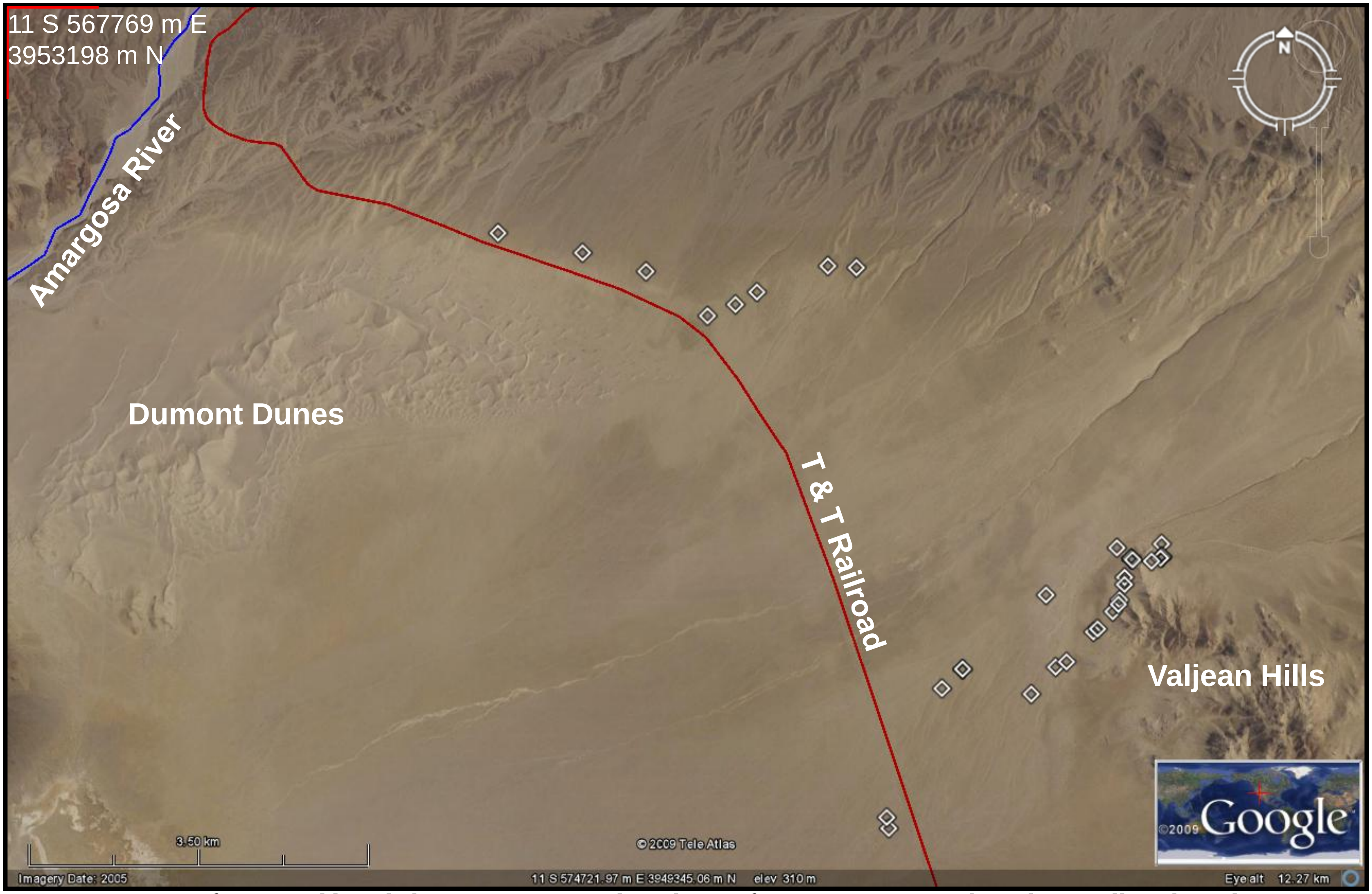


Figure 16: Mojave fringe-toed lizard observations east and southeast of Dumont Dunes, to the Valjean Hills. These data were collected by the Bureau of Land Management. UTM projection with 3.50 km scale bar. Imagery date: 2005 , © 2009 Tele Atlas.

Figure 17: Dipterans and a crab spider on a sandpaper plant (*Petalonyx thurberi*) at Dumont Dunes in 2008. There are actually three dipterans in the frame (circled). The flowers of this plant have been found in the stomach contents of *Uma inornata* (Durtsche, 1995).

Figure 18: A blister beetle (Meloidae), *Phodaga alticeps*, eating the leaves of the fanleaf crinklemat plant, *Tiquilia plicata*, at Dumont Dunes in April of 2008.

REFERENCES

Barrows, C. W. 1996. An ecological model for the protection of a dune ecosystem. Conservation Biology 10: 888-891.

Barrows, C. W. 1997. Habitat relationships of the Coachella Valley fringe-toed lizard (*Uma inornata*). The Southwestern Naturalist 42: 218-223

Barrows, C. W. 2006. Population dynamics of a threatened sand dune lizard. The Southwestern Naturalist 51: 514-523.

Barrows, C. W., M. B. Swartz, W. L. Hodges, M. F. Allen, J. T. Rotenberry, B.-L. Li, T. A. Scott, and X. Chen. 2005. A framework for monitoring multiple-species conservation plans. Journal of Wildlife Management 69:1333-1345.

Borges-Landaez, P. A., and R. Shine. 2003. Influence of toe-clipping on running speed in *Eulamprus quoyii*, an Australian scincid lizard. Journal of Herpetology 37:592-595.

Bureau of Land Management. 1990. Management plan for Dumont Dunes off-highway vehicle area.

Bureau of Land Management. 2008. Recreation fee program management evaluation California state fee projects.

California Department of Fish and Game. 2009. Special animals (901 taxa). California Natural Diversity Database maintained by the Department of Fish and Game.

Carothers, J. H. 1986. An experimental confirmation of morphological adaptation: toe fringes in the sand-dwelling lizard *Uma scoparia*. Evolution 40:871-874.

Carpenter, C. C. 1963. Patterns of behavior in three forms of the fringe-toed lizards (*Uma*-Iguanidae). Copeia 1963: 406-412.

Center for Biological Diversity, and S. Papadakos-Morafka. 2006. Petition to list the Amargosa River distinct population segment of the Mojave fringe-toed lizard (*Uma scoparia*) as Threatened or Endangered under the U.S. Endangered Species Act.

Chen, X., C. W. Barrows, and B.-L. Li. 2006. Phase coupling and spatial synchrony of subpopulations of an endangered dune lizard. Landscape Ecology 21:1185-1193.

Dunham, A. E. 1980. An experimental study of interspecific competition between the iguanid lizards *Sceloporus merriami* and *Urosaurus ornatus*. Ecological Monographs 50:309-330.

Durtsche, R. D. 1995. Foraging ecology of the fringe-toed lizard, *Uma inornata*, during periods of high and low food abundance. Copeia 1995: 915-926.

Enzel, Y., S. G. Wells, and N. Lancaster. 2003. Paleoenvironments and Paleohydrology of the Mojave and Southern Great Basin Deserts. Geological Society of America, Boulder, CO. 249 pp.

Girard, I. 2004. Status of the Mojave fringe-toed lizard (*Uma scoparia*) at off-highway vehicle (OHV) use sites at El Mirage Dry Lake, Rasor Road, and Dumont Dunes (San Bernardino County, CA). Summary Report for 2003, Anteon Corporation, San Diego, CA.

Gottscho, A. unpublished. Landscape genetics of the Mojave fringe-toed lizard, *Uma scoparia*. Proposal for Master's Thesis, Department of Biological Science, Humboldt State University.

Hereford, R., R. H. Webb, and C. I. Longpre. 2006. Precipitation history and ecosystem response to multidecadal precipitation variability in the Mojave Desert region, 1893-2001. Journal of Arid Environments 67: 13-34.

Integrated Taxonomic Information System. 2009. Species in the Genus *Uma*. Retrieved 4 February 2009, from the Integrated Taxonomic Information System on-line database. <http://www.itis.gov>

Jennings, M. R., and M. P. Hayes. 1994. Amphibian and reptile species of special concern in California. Final Report submitted to the California Department of Fish and Game, Inland Fisheries Division. Contract No. 8023. 255 pp.

Kaufmann, J. S. 1982. Patterns in habitat resource utilization in a population of *Uma scoparia*, the Mojave fringe-toed lizard. M. S. Thesis, University of Illinois at Chicago.

Luckenbach, R. A. and R. B. Bury. 1983. Effects of Off-Road Vehicles on the Biota of the Algodones Dunes, Imperial County, California. The Journal of Applied Ecology 20(1): 265-286.

Mayhew, W. W. 1966a. Reproduction in the arenicolous lizard *Uma notata*. Ecology 47: 9-18.

Mayhew, W. W. 1966b. Reproduction in the psammophilous lizard *Uma scoparia*. Copeia 1966:114-122.

Minnich, J. E., and V. H. Shoemaker. 1972. Water and electrolyte turnover in a field population of the lizard, Uma scoparia. Copeia 1972:650-659.

Moed, L., T.A. Shwayder, & M.W. Chang. 2001. Cantharidin revisited: a blistering defense of an ancient medicine. Archives of Dermatology 137: 1357-1360.

Morafka, D. J. 2003. 1000 meter transect analyses of frequencies of Mojave fringe-toed lizards at OHV BLM sites at El Mirage Dry Lake, Rasor Road, and Dumont Dunes, San Bernardino County, California. Summary Report for 2002, Anteon Corporation, San Diego, CA.

Murphy, R. W., T. L. Trèpanier, and D. J. Morafka. 2006. Conservation genetics, evolution and distinct population segments of the Mojave fringe-toed lizard, *Uma scoparia*. Journal of Arid Environments 67:226-247.

National Climatic Data Center. 2009. National Oceanic and Atmospheric Administration's National Climatic Data Center website, for Baker, CA, station#040436. Accessed on 23 February 2009. <http://www.ncdc.noaa.gov/oa/climate/stationlocator.html>

Norris, K. S. 1958. The evolution and systematics of the iguanid Genus *Uma* and its relation to the evolution of other North American desert reptiles. Bulletin of the Natural History Museum of Natural History 114(3): 247-326.

Otahal, C., L. Encinas, M. Quillman. unpublished. Mojave fringe-toed lizard conservation plan for the Dumont Dunes off-highway vehicle area. Barstow Field Office, Bureau of Land Management.

Pough, F. H. 1970. The Burrowing Ecology of the Sand Lizard, *Uma notata*. Copeia 1970:145-157.

Pough, F. H. 1974. *Uma scoparia*. Catalogue of American Amphibians and Reptiles 155.1.

Schmidt, K. P. and C. M. Bogert. 1947. A new fringe-footed sand lizard from Coahuila, Mexico. American Museum Novitates 1339: 1-9.

Seigler, D.S., G.F. Pauli, R. Frohlich, E. Wegelius, A. Nahrstedt, K.E. Glander, & J.E. Ebinger. 2005. Cyanogenic glycosides and menisdaurin from *Guazuma ulmifolia, Ostrya virginiana, Tiquilia plicata,* and *Tiquilia canescens*. Phytochemistry 66: 1567-1580.

Stebbins, R. C. 1944. Some Aspects of the Ecology of the Iguanid Genus Uma. Ecological Monographs 14: 311-332.

Tinant, C. J., J. F. Weigand, and C. Barrows. unpublished. Protocol for monitoring the fringe-toed lizards (genus *Uma*) on lands administered by the Bureau of Land Management (BLM) and the National Park System in California. Bureau of Land Management.

Trepanier, T. L. and R. W. Murphy. 2001. The Coachella Valley fringe-toed lizard (*Uma inornata*): genetic diversity and phylogenetic relationships of an endangered species. Molecular Phylogenetics and Evolution 18: 327-334.

Turner, F. B., P. A. Medica, K. W. Bridges, and R. I. Jennrich. 1982. A population model of the lizard *Uta stansburiana* in Southern Nevada. Ecological Monographs 52:243-259.

Turner, F. B., D. C. Weaver, and J. C. Rorabaugh. 1984. Effects of reduction in windblown sand on the abundance of the fringe-toed lizard (*Uma inornata*) in the Coachella Valley, California. Copeia 1984:370-378.

United States Fish and Wildlife Service. 2008. 90-Day finding on petition to list the Amargosa River population of the Mojave fringe-toed lizard (*Uma scoparia*) as Threatened or Endangered with Critical Habitat. Federal Register 73:1855-1861.

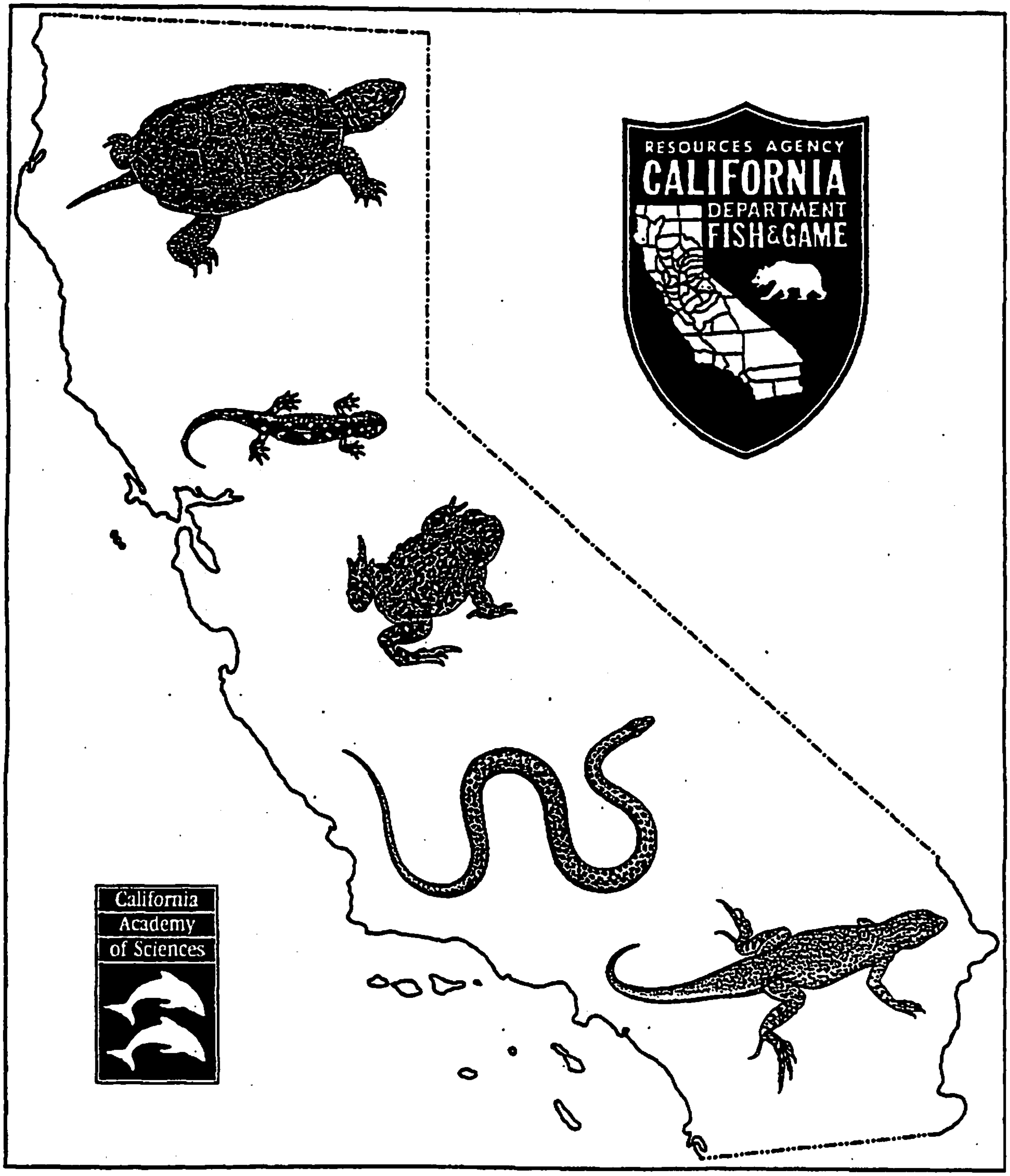
Whitfield Gibbons, J., and K. M. Andrews. 2004. PIT tagging: simple technology at its best. BioScience 54:447-454.

Williams, K. L., P. S. Chrapliwy, and H. M. Smith. 1959. A new fringe-footed lizard (Uma) from Mexico. Transactions of the Kansas Academy of Science 62: 166-172.

Wright, G. 2002. Flat-tailed horned lizard monitoring report. Bureau of Land Management, El Centro, California.

EXHIBIT 545

AMPHIBIAN AND REPTILE SPECIES OF SPECIAL CONCERN IN CALIFORNIA



CALIFORNIA DEPARTMENT OF FISH AND GAME

information (Muth and Fisher 1992). Efforts should be made to regularly collect the data upon which a sufficient-data Commission decision can be based. A more precise understanding of how this species responds to off-road vehicles is especially needed. The dynamics of aeolian sand habitats and adjacent habitats needs to be better understood so that these areas can be appropriately managed to ensure the survival of the flat-tailed horned lizards.

COLORADO DESERT FRINGE-TOED LIZARD
Uma notata notata Baird 1858

Description: A moderate-sized (69.0-121 mm SVL), pale-colored lizard with a dorsal reticulum of black-bordered pale spots with red centers (ocelli: Norris 1958, Stebbins 1985). Ocelli tend to form broken lines that extend the length of the body. Undersurfaces are white except for "chevron-like" diagonal dark lines on the throat, dark bars on the tail, and a single dark spot or bar on each side of the belly (Stebbins 1954b). The side of the belly around each dark spot or bar has a permanent orange or pinkish stripe, colors which may be more vivid during the breeding season (Norris 1958). The iris is black.

Taxonomic Remarks: The taxonomic status of *Uma notata notata* is controversial. Heifetz (1941) differentiated this taxon morphologically from the remaining two of the three members of the genus *Uma* in California *(U. inornata* and *U. scoparia)* based on characters that seem to be variable at a population level (Norris 1958, Mayhew 1964a). These data lent support to the earlier suggestion that all three California taxa represent one species (Stebbins 1954b). Based on behavioral data, Carpenter (1963) regarded two of the three taxa, *U. notata* and *U. inornata,* as subspecies of the former, but accorded *U. scoparia* specific rank. This pattern of allocation creates a historical unit, the *U. notata* and *U. inornata* cluster, that is nonsense (a paraphyletic group) based on genetic data (Adest 1977). The low level of geneticdifferentiation between the three California taxa (Adest 1977) seems to support the suggestion that all three taxa should be considered one species (e.g., Collins 1990). However, the genetic comparison was based on a small number of allozymes and only one sample of each of the three currently recognized members of the genus *Uma* in California. Moreover, morphological and genetic analyses have not been coupled, so it is impossible make a sound systematic determination with such non-parallel data. Comprehensive assessment of genetic variation across the range of *U. notata* and potentially conspecific populations now recognized under other names is needed. Such an assessment should be coupled to a morphological analysis of those same populations. This analysis is of some significance because the potentially conspecific population system currently recognized under the name *U. inornata* is presently listed as being Federally Endangered.

Distribution: This taxon is thought to be distributed from northeast of Borrego Springs (northeast San Diego County) westward to the Colorado River and southward into Baja California (Mexico) at a latitude roughly due west of the mouth of the Colorado River. Heifetz (1941) allocated populations of *Uma* in the Gila drainage (Arizona) to this taxon, but Norris (1958) restricted *U. n. notata* to populations west of the Colorado River. Its known elevational ranges extends from below sea level at -74 m (at the edge of the Salton Sea, Imperial County: Norris 1958) to ca. 180 m (northeast of Borrego Springs, San Diego County). In California, its range extends from northeastern San Diego County through the southern two-thirds of Imperial County to the Colorado River (Pough 1977: Figure 37). We caution that because of the difficulties with this taxon noted above, the distribution we provide here is based entirely on the most recent assessment by previous workers. Verification of the distribution of this taxon will require the systematic analysis we have indicated.

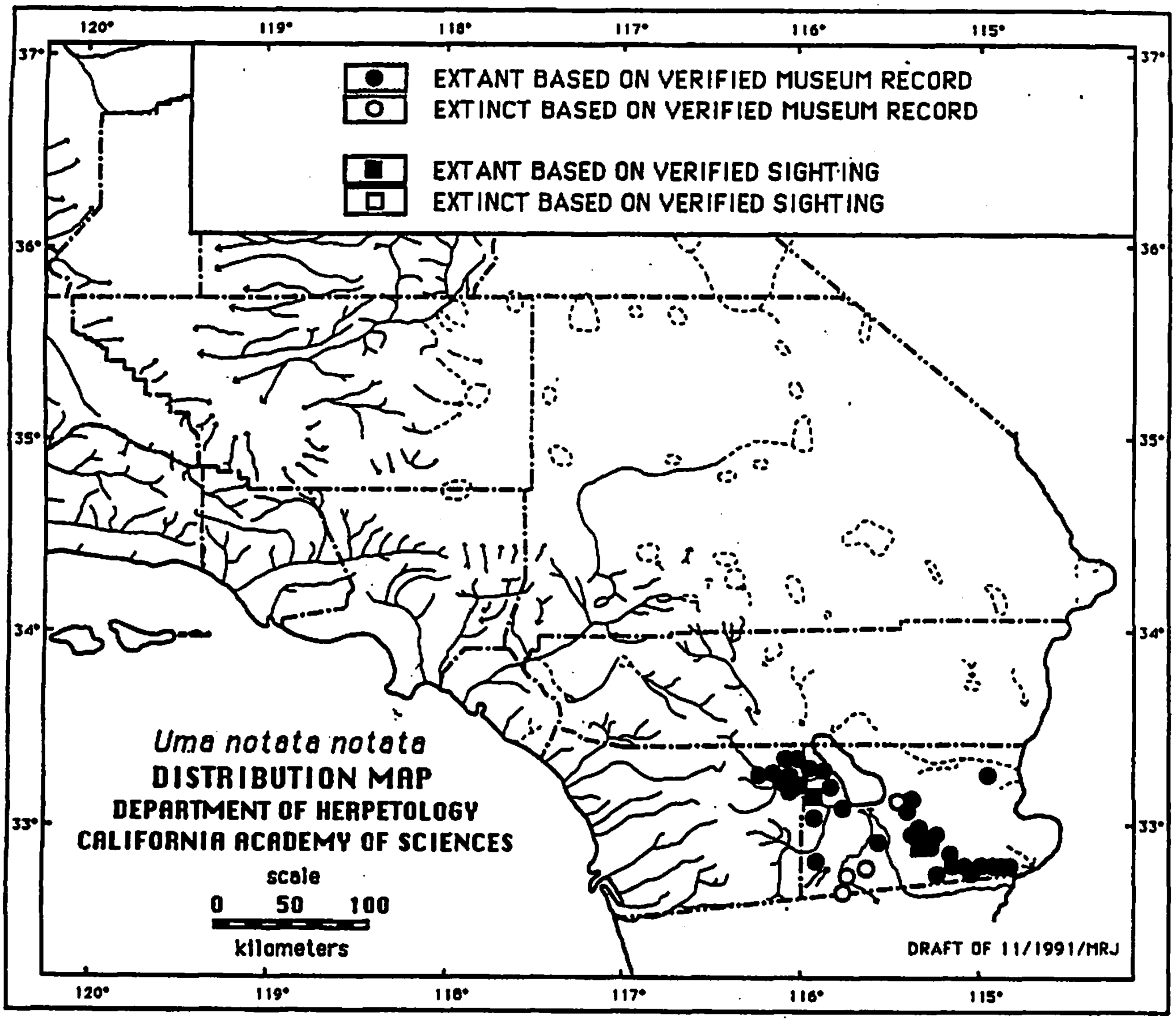


Figure 37. Historic and current distribution of the Colorado Desert fringe-toed lizard (*Uma notata notata*) in southern California based on 143 locations from 451 museum records and 7 records from other sources.

Life History: *Uma n. notata* is a distinctive lizard that is behavioral, morphologically, and physiologically specialized for living in hot, dry, sandy habitats. Its dorso-ventrally flattened body shape, concealed eardrum (tympanum), fringed toes, distinctive pointed and keeled scales below the knee and above the heel, nasal valves, and pale dorsal coloration are all features that facilitate its survival as a sand-dwelling lizard (Stebbins 1944, Norris 1958, Pough 1970; see also Stebbins 1948). Experiments have shown that the fringed toes, the namesake from which the genus to which *Uma* derives its common name, significantly assist movement on shifting sand (Carothers 1986). Adults of *U. n. notata* overwinter at moderate depths (ca. 30 cm) in sand (Cowles 1941), but smaller individuals may remain active throughout the year (Deavers 1972). Colorado Desert fringe-toed lizards do not emerge until substrate temperatures reach at least 26°C (Cowles and Bogert 1944), which typically results in their emerging for overwintering sites in late March or early April. *Uma n. notata* displays several behavioral and physiological traits that allow them to cope with the high temperatures regularly attained by the sandy substrate in which they live. They voluntarily maintain a higher body temperature when active (39.9°C) than most lizards (Deavers 1972); they orient relative to both the sun and the substrate depending on the temperature variation of each (Cowles and Bogert 1944); when sand surface temperatures reach or exceed 43°C, they submerge themselves into the cooler subsurface sand by wriggling violently to avoid overheating (Stebbins 1944, Norris 1958); and they exhibit other physiological features that allow them to cope with this extreme environment (Pough 1969a, Deavers 1972). In addition, *U. n. notata* displays coupled behavioral and morphological features that assist in undersand breathing (Pough 1969b). Adults probably typically mate in May, and females typically deposit clutches containing two eggs from late May to early August (Mayhew 1966). Females may lay more than one clutch per year, but adults are sensitive to food levels and will not reproduce if they do not obtain adequate food (Mayhew 1966). Since insect productivity is directly related to annual rainfall, lizards probably have a significantly depressed reproductive output in years with low rainfall. The known predators of *U. n. notata* are badgers, glossy snakes *(Arizona elegans)*, sidewinders, coachwhips, loggerhead shrikes, roadrunners, and coyotes (Stebbins 1944). *Uma n. notata* employs an escape behavior similar to its thermoregulatory behavior, it initially flees from a predator to a reasonably safe distance and then buries itself in the sand (Stebbins 1944).

Habitat: *Uma n. notata* is a habitat specialist that is totally restricted to habitats of aeolian sand (Norris 1958). Aeolian sand in which *U. n. notata* can be found has a grain size typically no coarser than 0.375 mm in diameter (averages 0.205 mm in diameter). As with *U. inornata* (Turner et al. 1984), increased sand penetrability (i.e., how easy the sand is to burrow into), is probably an important factor constraining the local distribution of *U. n. notata* The dominant plant in the associations in which *U. n. notata* is found include the following perennial shrubs: burro weed, creosote bush, croton *(Croton wigginsii)*, desert buckwheat *(Eriogonum deserticola)*, honey mesquite *(Prosopis glandulosa)*, mormon tea *(Ephedra californica)*, and the composite *(Helianthus tephrodes)*, none of which occur in very high density, giving the habitat an open sparse appearance (Stebbins 1944, Norris 1958, Mayhew 1966). Burrowing in sand on the lee side of desert shrubs has been noted by several authors (Stebbins 1944, Norris 1958), a selection that may be influenced by the differences in penetrability and grain size of the sand in those locations (see Turner et al. 1984). The location of oviposition sites is unknown, but they may be located at the base of perennial plants (see the flat-tailed horned lizard *(Phrynosoma mcallii)* account).

Status: Special Concern; although this species has a reasonably broad range in California, it is vulnerable because of its specialization for fragile sandy habitats that have been heavily impacted by off-road vehicles in the last 20 years (Busack and Bury 1974, Bury and Luckenbach 1983, Luckenbach and Bury 1983, Maes 1990). Although probably not as vulnerable as *P. mcallii*, most of the comments made under the status section for that species also apply to *U. n. notata*. The escape behavior of *U. n. notata* makes its vulnerable to injury from off-road vehicles, which continue to be used at high levels over the range of *U. n. notata* (Maes 1990, King and Robbins 1991b). As demonstrated for *U. inornata*, the surface stabilization and sand depletion that occur as a result of the placement of windbreaks (e.g., rows of salt cedar: Turner et al. 1984) and probably other structures, an increasing phenomenon over the range of *U. n. notata*, threatens to continue to decrease the amount of habitat available for this taxon.

Management Recommendations: Much of the ecology of *U. n. notata* is reasonably well-known, but several key aspects are not. In particular, the location of oviposition sites and the variation in their location, the movement and recolonization abilities of this taxon, and a better understanding of variation in habitat suitability with the vegetation association and the specific species consumed in the diet. Additionally, regular annual surveys conducted at fixed locations and at identical diel and seasonal intervals are needed to track long-term trends in this species (see Maes 1990). Sweeps surveys to estimate sand lizard track densities (see England and Nelson 1977) need further evaluation as a survey method. Long-term data are particularly important to couple to any measurements of habitat change for management purposes. Emphasis on preservation of large, unobstructed expanses of aeolian sand habitat is needed. The dynamics and variation in the natural maintenance of such habitats is poorly understood, and urgently needs study before definitive management recommendations regarding the size of areas needed for long-term persistence of this taxon.

MOJAVE FRINGE-TOED LIZARD
Uma scoparia Cope 1894

Description: A moderate-sized (69.0-112.0 mm SVL), pale-colored lizard with a dorsal reticulum of black-bordered spots with red centers (ocelli: Norris 1958, Stebbins 1985). Ocelli are irregularly arranged over the back. Undersurfaces are white except for crescent-shaped dark marking on the throat, dark bars on the tail, and a single, prominent dark spot on each side of the belly (Norris 1958). During breeding, a yellow-green ventral wash develops that becomes pink on the side of the body (Stebbins 1985). The iris is black.

Taxonomic Remarks: Remarks made regarding the taxonomic status of *Uma notata notata* generally also apply to *Uma scoparia*. It needs emphasis that determination of the systematic status of *U. scoparia* cannot be made without a comprehensive assessment of genetic variation across its range coupled to a morphological analysis of those same populations.

Distribution: The known distribution of this near-endemic to California extends from extreme southern Inyo County (Norris 1958) through most of San Bernardino County and barely into the northeast comer of Los Angeles County southward and eastward through the eastern half of Riverside County to the vicinity of Blythe (Figure 38). A single record exists for Parker, Yuma County, Arizona (Pough 1974). Its known elevational range extends from below sea level to ca. 1000 m in the vicinity of Kelso (San Bernardino County).

Life History: Many of the generalized comments that apply to the genus made in the *U. n. notata* account also apply to this species. *Uma scoparia* is sand-dwelling specialist that inhabits similar environments utilized by *U. notata* (Stebbins 1944, Norris 1958). Lizards emerge from hibernation sites in late March or early April (Mayhew 1964b). Adults begin to exhibit breeding colors during April and breeding continues through July (Norris 1958). Males actively defend territories against other rival males in addition to courting females. Females also maintain territories, but they do not show any aggression against other individuals (Kauffman 1982). Home ranges for adult males are estimated to average 0.10 ha, while home ranges for adult females averaged 0.034 ha and overlapped the territories of adult males (Kauffman 1982). Females deposit from 2-5 (average = 2-3) eggs in sandy hills or hummocks during the months of May through July (Stebbins 1954b, Kauffman 1982). Some adult females produce more than one clutch of eggs a year. Hatchlings first appear by September (Miller and Stebbins 1964), and grow rapidly over the next 2 years. Most males and females teach sexual maturity (70 mm and 65-70 mm SVL, respectively) two summers after hatching. Juveniles do not defend territories until they become subadults. Juveniles eat largely arthropods and only a small amount of plant material; in contrast, adult *U. scoparia* consumed more plant material than arthropods (Minnich and Shoemaker 1970, 1972). Foods consumed by these opportunistic feeders include dried seeds, grasses, ants, beetles, scorpions (Scorpionida), and occasionally conspecifics (Miller and Stebbins 1964, Minnich and Shoemaker 1970, 1972). Both juveniles and adults have daily activity patterns that are temperature dependent. From April to May, lizards are active during the mid-day. From May to September, they move about in the mornings and late afternoons, but retreat underground when temperatures are high (Miller and Stebbins 1964). Hibernation occurs from November to February (Mayhew 1964b). Known predators are the same animals listed for *U. n. notata* (see previous account), plus the burrowing owl (Miller and Stebbins 1964) and leopard lizard (*Crotaphytus wislizenii:* Gracie and Murphy 1986).

Habitat: The habitat characteristics of *U. scoparia* are essentially identical to those for *U. n. notata* except that some of the vegetation associates will differ because the range of the

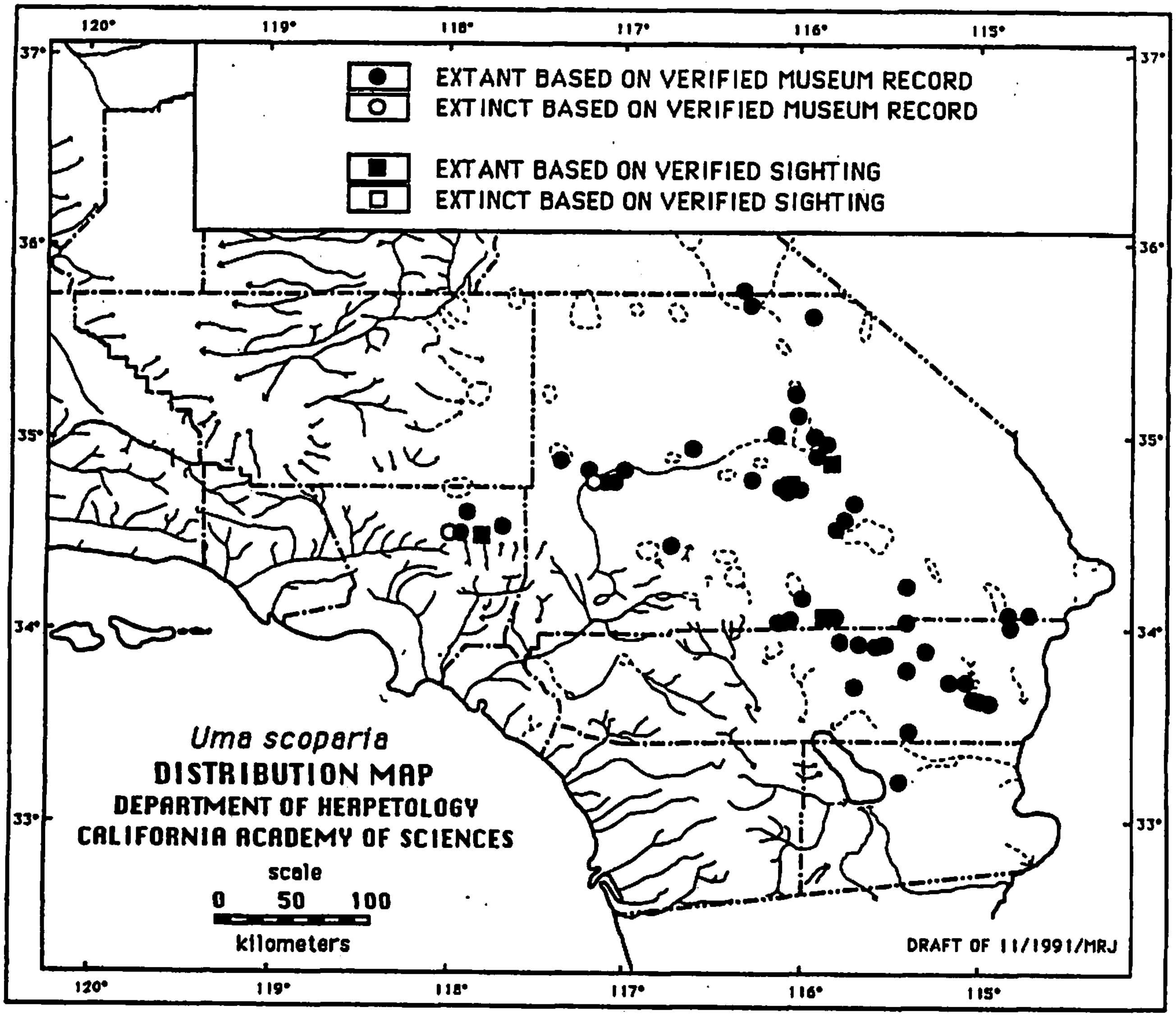


Figure 38. Historic and current distribution of the Mojave Desert fringe-toed lizard (*Uma scoparia*) in southern California based on 140 locations from 599 museum records and 8 records from other sources.

former is largely the Mojave desert region in California. The habitat section of the *U. n. notata* account should be referred to. Throughout most of its range, *U. scoparia* is found in creosote bush scrub (Kauffman 1982).

Status: Special Concern; most of the comments made for *U. n. notata* also apply to this species, although the importance of major impacts differ somewhat. Off-road vehicles seems to be the more important impact over most of the range of *U. scoparia,* whereas the influence of development is currently really significant in the western Mojave desert Several towns in the western Mojave (e.g., Hesperia, Lancaster, Palmdale, and Victorville) have sustained extraordinary levels of growth (up to over an order of magnitude) over the last 15 years. This level of growth has not only fragmented desert habitat, but markedly increased the local use of adjacent desert areas. The increase in landfills associated with such growth has resulted in a marked increase in selected generalized predators (e.g., common ravens; see King and Robbins 1991b and Camp et al. 1993), which are implicated in recruitment declines in other species such as desert tortoises (U.S. Fish and Wildlife Service 1990). Such predators may have similar negative effects on the Mojave fringe-toed lizard (King and Robbins 1991b).

Management Recommendations: Most of the comments made for *U. n. notata,* except that regarding oviposition sites, also apply to this species. The ability of fragments of sandy desert habitat to sustain populations of the Mojave fringe-toed lizard over the long-term needs to be determined. It is unclear what sort of use and what intensity of use desert habitats can sustain and still maintain Mojave fringe-toed lizards; Additionally, it needs to be determined whether the generalized predators currently on the increase have any significant effect on the recruitment or survivorship of Mojave fringe-toed lizards.

SANDSTONE NIGHT LIZARD
Xantusia henshawi gracilis Grismer and Galvan 1986

Description: A medium-sized (50-70 mm SVL), narrow-waisted, soft-skinned lizard with fine, granular scales; a flattened head; an enlarged temporal scale; gular folds; lidless eyes; and vertical elliptical pupils (Grismer and Galvan 1986). The dorsoventrally flattened, slender body is covered with a dense pattern of reduced dark brown spots on a light colored background (Grismer and Galvan 1986). The venter is white with minute amounts of black peppering present only on forepart of the body (Grismer and Galvan 1986). The iris is dark brown with dense iridiophores split by a vertical eye stripe (pers. observ.).

Taxonomic Remarks: This recently described night lizard is considered morphologically (Grismer and Galvan 1986) and biochemically distinct (Bezy and Sites 1987) from the granite night lizard *(X. h. henshawi).* Analysis of genetic variation across its highly restricted known geographic range has not yet been attempted.

Distribution: The known range of this California endemic is confined to the Truckhaven Rocks, a 1.3-km wide x 3-km long outcrop in the eastern part of Anza-Borrego State Park (Figure 39). The known elevational range of the sandstone night lizard extends from 240 m to 305 m.

Life History: Virtually nothing is known of sandstone night lizard life history. The morphology of *X. h. gracilis* is thought to facilitate survival in sandstone and mudstone habitat, a rocky substrate that undergoes constant local erosion (Grismer and Galvan 1986). These authors speculate that it may be excluded by other saxicolous lizards (e.g.

EXHIBIT 546

STATE OF CALIFORNIA B THE NATURAL RESOURCES AGENCY ARNOLD SCHWARZENEGGER, Governor

COLORADO RIVER BOARD OF CALIFORNIA
770 FAIRMONT AVENUE, SUITE 100
GLENDALE, CA 91203-1068
(818) 500-1625
(818) 543-4685 FAX

DOCKET
09-AFC-8
DATE JUL 02 2010
RECD. JUL 06 2010

July 2, 2010

Mr. Mike Monasmith
Project Manager
Siting, Transmission and Environmental
Protection Division
California Energy Commission
1516 Ninth Street, MS 15
Sacramento, CA 95814-5512

Dear Mr. Monasmith:

The Colorado River Board of California (Board), created in 1937, is the State agency charged with safeguarding and protecting the rights and interests of the State, its agencies and citizens, in the water and power resources of the seven-state Colorado River System.

The Board has reviewed the Staff Assessment and Environmental Impact Statement, Application for Certification for the Genesis Solar Energy Project in Riverside County, California. The applicant for the Genesis Solar Energy Project, Genesis Solar LLC, is seeking a right-of-way grant for approximately 4,640 acres of federal lands that are administered by the Bureau of Land Management (BLM). The Genesis Solar Energy Project proposes to use a wet cooling tower for power plant cooling. The total water consumption during the operational 30-year period and power purchase agreement with a California utility for the Genesis Solar Energy Project is estimated to be 1,644 acre-feet per year. In addition, the water use during the construction phase is estimated to be 2,440 acre-feet over the construction period. The water supply for the project will be pumped from on-site groundwater wells and stored on-site.

According to the Consolidated Decree of the Supreme Court of the United States in the case of *Arizona v. California, et al.* entered March 27, 2006, (547 U.S. 150, 2006), the consumptive use of water means "diversion from the stream less such return flow thereto as is available for consumptive use in the United States or in satisfaction of the Mexican treaty obligation" and consumptive use "includes all consumptive uses of water of the mainstream, including water drawn from the mainstream by underground pumping." Also, pursuant to the 1928 Boulder Canyon Project Act (BCPA) and the Consolidated Decree, no water shall be delivered from storage or used by any water user without a valid contract between the Secretary of the Interior and the water user for such use, i.e., through a BCPA Section 5 contract.

Within California, BCPA Section 5 contracts have previously been entered into between users of Colorado River mainstream water and the Secretary of the Interior for water from the Colorado River that exceeds California's basic entitlement to use Colorado River water as set forth in the Consolidated Decree. Thus, no additional Colorado River water is available for use by new project proponents along the Colorado River, except through the contract of an existing BCPA Section 5

PROOF OF SERVICE (REVISED 6/7/10) FILED WITH
ORIGINAL MAILED FROM SACRAMENTO ON 7/8/10
MS

contract holder, either by direct service or through an exchange of non-Colorado River water for Colorado River water.

The BLM lands proposed for the Genesis Solar Energy Project are currently located within the "Accounting Surface" area designated by U.S. Geological Survey Water Investigation Reports (i.e., WRI 94-4005 and WRI 00-4085). These reports indicates that the aquifer underlying lands located within the "Accounting Surface" is considered too be hydraulically connected to the Colorado River and groundwater withdrawn from wells located within the "Accounting Surface" would be replaced by Colorado River water, in part or in total. This means that if it is determined that these wells are, in fact, pumping Colorado River water, a contract with the Secretary of the Interior would be required before such a diversion and use is deemed to be a legally authorized use of this water supply.

As a result of discussions associated with two other solar power projects, including the Blythe and the Palen Solar Power Projects; and the Board has identified a preferred option for obtaining a legally authorized and reliable water supply for these projects. That option involves obtaining water through an existing BCPA Section 5 contract holder, The Metropolitan Water District of Southern California. Although other options may be available, it is the Board's assessment that they could not be implemented in a timely manner and address the requirement that water consumptively used from the Colorado River must be through a BCPA Section 5 contractual entitlement.

If you have any questions or require further information, please feel free to contact me at (818) 500-1625.

Sincerely,

CGray

for Gerald R. Zimmerman
Acting Executive Director

cc: Ms. Lorri Gray-Lee, Regional Director, U.S. Bureau of Reclamation
Ms. Holly Roberts, Associate Field Manager, Palm Springs-South Coast Field Office, BLM
Ms. Eileen Allen, California Energy Commission
Mr. William J. Hasencamp, The Metropolitan Water District of Southern California

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
1516 NINTH STREET, SACRAMENTO, CA 95814
1-800-822-6228 – WWW.ENERGY.CA.GOV

APPLICATION FOR CERTIFICATION FOR THE
GENESIS SOLAR ENERGY PROJECT

Docket No. 09-AFC-8

PROOF OF SERVICE
(Revised 6/7/10)

APPLICANT
Ryan O'Keefe, Vice President
Genesis Solar LLC
700 Universe Boulevard
Juno Beach, Florida 33408
E-mail service preferred
Ryan.okeefe@nexteraenergy.com

Scott Busa/Project Director
Meg Russel/Project Manager
Duane McCloud/Lead Engineer
NextEra Energy
700 Universe Boulvard
Juno Beach, FL 33408
Scott.Busa@nexteraenergy.com
Meg.Russell@nexteraenergy.com
Duane.mccloud@nexteraenergy.com
E-mail service preferred
Matt Handel/Vice President
Matt.Handel@nexteraenergy.com
Email service preferred
Kenny Stein,
Environmental Services Manager
Kenneth.Stein@nexteraenergy.com

Mike Pappalardo
Permitting Manager
3368 Videra Drive
Eugene, OR 97405
mike.pappalardo@nexteraenergy.com

Kerry Hattevik/Director
West Region Regulatory Affairs
829 Arlington Boulevard
El Cerrito, CA 94530
Kerry.Hattevik@nexteraenergy.com

APPLICANT'S CONSULTANTS
Tricia Bernhardt/Project Manager
Tetra Tech, EC
143 Union Boulevard, Ste 1010
Lakewood, CO 80228
Tricia.bernhardt@tteci.com

James Kimura, Project Engineer
Worley Parsons
2330 East Bidwell Street, Ste.150
Folsom, CA 95630
James.Kimura@WorleyParsons.com

COUNSEL FOR APPLICANT
Scott Galati
Galati & Blek, LLP
455 Capitol Mall, Ste. 350
Sacramento, CA 95814
sgalati@gb-llp.com

INTERESTED AGENCIES
California-ISO
e-recipient@caiso.com

Allison Shaffer, Project Manager
Bureau of Land Management
Palm Springs South Coast
Field Office
1201 Bird Center Drive
Palm Springs, CA 92262
Allison_Shaffer@blm.gov

INTERVENORS
California Unions for Reliable
Energy (CURE)
c/o: Tanya A. Gulesserian,
Rachael E. Koss,
Marc D. Joseph
Adams Broadwell Joesph
& Cardoza
601 Gateway Boulevard,
Ste 1000
South San Francisco, CA 94080
tgulesserian@adamsbroadwell.com
rkoss@adamsbroadwell.com

Tom Budlong
3216 Mandeville Cyn Rd.
Los Angeles, CA 90049-1016
tombudlong@roadrunner.com

*Mr. Larry Silver
California Environmental
Law Project
Counsel to Mr. Budlong
E-mail preferred
larrysilver@celproject.net

Californians for Renewable
Energy, Inc. (CARE)
Michael E. Boyd, President
5439 Soquel Drive
Soquel, CA 95073-2659
michaelboyd@sbcglobal.net

***Lisa T. Belenky, Senior Attorney**
Center for Biological Diversity
351 California St., Suite 600
San Francisco, CA 94104
lbelenky@biologicaldiversity.org

***Ileene Anderson**
Public Lands Desert Director
Center for Biological Diversity
PMB 447, 8033 Sunset Boulevard
Los Angeles, CA 90046
ianderson@biologicaldiversity.org

OTHER
Alfredo Figueroa
424 North Carlton
Blythe, CA 92225
lacunadeaztlan@aol.com

ENERGY COMMISSION
JAMES D. BOYD
Commissioner and Presiding
Member
jboyd@energy.state.ca.us

ROBERT WEISENMILLER
Commissioner and Associate Member
rweisenm@energy.state.ca.us

*indicates change

Kenneth Celli
Hearing Officer
kcelli@energy.state.ca.us

Mike Monasmith
Siting Project Manager
mmonasmi@energy.state.ca.us

Caryn Holmes
Staff Counsel
cholmes@energy.state.ca.us

Robin Mayer
Staff Counsel
rmayer@energy.state.ca.us

Jennifer Jennings
Public Adviser's Office
publicadviser@energy.state.ca.us

DECLARATION OF SERVICE

I, Maria Santourdjian declare that on July 8, 2010, I served and filed copies of the attached Comment Letter from Colorado River Board of California. The original document, filed with the Docket Unit, is accompanied by a copy of the most recent Proof of Service list, located on the web page for this project at: **[http://ww.energy.ca.gov/sitingcases/genesis_solar].**

The documents have been sent to both the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, in the following manner:

(Check all that Apply)

FOR SERVICE TO ALL OTHER PARTIES:

__x__ sent electronically to all email addresses on the Proof of Service list;

__x__ by personal delivery;

__x__ by delivering on this date, for mailing with the United States Postal Service with first-class postage thereon fully prepaid, to the name and address of the person served, for mailing that same day in the ordinary course of business; that the envelope was sealed and placed for collection and mailing on that date to those addresses **NOT** marked "email preferred."

AND

FOR FILING WITH THE ENERGY COMMISSION:

__x__ sending an original paper copy and one electronic copy, mailed and emailed respectively, to the address below (*preferred method*);

OR

____ depositing in the mail an original and 12 paper copies, as follows:

CALIFORNIA ENERGY COMMISSION
Attn: Docket No. 09-AFC-8
1516 Ninth Street, MS-4
Sacramento, CA 95814-5512
docket@energy.state.ca.us

I declare under penalty of perjury that the foregoing is true and correct, that I am employed in the county where this mailing occurred, and that I am over the age of 18 years and not a party to the proceeding.

Originally Signed by
Maria Santourdjian

*indicates change

EXHIBIT 547

PUBLIC UTILITIES COMMISSION
505 VAN NESS AVENUE
SAN FRANCISCO, CA 94102-3298

ID #9611
Draft Resolution E-4343
August 12 Commission Meeting

July 7, 2010

TO: PARTIES TO DRAFT RESOLUTION E-4343
Service Lists – R.08-08-009, R.08-02-007, R.06-02-012

Enclosed is Draft Resolution E-4343 of the Energy Division addressing Pacific Gas and Electric Company's advice letter (AL) 3546-E and supplemental AL 3546-E-A. It will be on the agenda at the August 12, 2010 Commission meeting. The Commission may then vote on this Draft Resolution or it may postpone a vote until later.

When the Commission votes on a Draft Resolution, it may adopt all or part of it as written, amend, modify or set it aside and prepare a different Resolution. Only when the Commission acts does the Resolution become binding on the parties.

Parties may submit comments on the Draft Resolution no later than Tuesday, July 27, 2010.

An original and two copies of the comments, with a certificate of service, should be submitted to:

Honesto Gatchalian and Maria Salinas
Energy Division
California Public Utilities Commission
505 Van Ness Avenue
San Francisco, CA 94102
jnj@cpuc.ca.gov; mas@cpuc.ca.gov

A copy of the comments should be submitted to:

Sean Simon
Energy Division
svn@cpuc.ca.gov

Those submitting comments and reply comments must serve a copy of their comments on 1) the entire service list attached to the Draft Resolution, 2) all Commissioners, and 3) the Director of the Energy Division, the Chief Administrative Law Judge and the General Counsel, on the same date that the comments are submitted to the Energy Division.

Comments may be submitted electronically.

Comments shall be limited to five pages in length plus a subject index listing the recommended changes to the Draft Resolution and an appendix setting forth the proposed findings and ordering paragraphs.

Comments shall focus on factual, legal or technical errors in the proposed Draft Resolution. Comments that merely reargue positions taken in the advice letter or protests will be accorded no weight and are not to be submitted.

Paul Douglas
Project and Program Supervisor
Energy Division

Enclosure:
Certificate of Service

CERTIFICATE OF SERVICE

I certify that I have by mail this day served a true copy of Draft Resolution E-4343 on all parties in these filings or their attorneys as shown on the attached list.

Dated July 7, 2010 at San Francisco, California.

____

Maria Salinas

NOTICE

Parties should notify the Energy Division, Public Utilities Commission, 505 Van Ness Avenue, Room 4002 San Francisco, CA 94102, of any change of address to insure that they continue to receive documents. You must indicate the Resolution number on the service list on which your name appears.

DRAFT

PUBLIC UTILITIES COMMISSION OF THE STATE OF CALIFORNIA

ENERGY DIVISION

ID #9611
RESOLUTION E-4343
August 12, 2010

REDACTED

RESOLUTION

Resolution E-4343. Pacific Gas and Electric Company (PG&E)

PROPOSED OUTCOME: This Resolution approves PG&E's request for approval of cost recovery for a power purchase agreement (PPA) resulting from PG&E's 2007 Renewables Portfolio Standard (RPS) solicitation between PG&E and Genesis Solar, LLC., pursuant to California's RPS program. The PPA is approved.

ESTIMATED COST: Actual costs are confidential at this time.

By Advice Letter 3546-E filed on October 26, 2009 and Supplemental Advice Letter filed 3546-E-A on June 14, 2010.

SUMMARY

Pacific Gas and Electric Company's renewable power purchase agreement complies with the Renewables Portfolio Standard procurement guidelines and is approved.

Pacific Gas and Electric Company (PG&E) filed Advice Letter (AL) 3546-E on October 26, 2009, requesting California Public Utilities Commission (Commission) approval of a renewable power purchase agreement (PPA) with Genesis Solar, LLC (Genesis Solar), an affiliate of NextEra Energy Resources, LLC, which is a subsidiary of FPL Group.

Under the proposed 25-year PPA, PG&E would procure renewable energy from the planned 250 megawatt Genesis Solar solar thermal parabolic trough facility to be located in Riverside County, California. The Genesis Solar PPA resulted from PG&E's 2007 Renewables Portfolio Standard (RPS) solicitation.

On June 14, 2010, PG&E filed supplemental AL 3546-E-A to amend the proposed PPA. Specifically, the amendment reduces the contract price if certain events occur and removes several contract price adjustment provisions. Supplement AL 3546-E-A also included a letter agreement clarifying Genesis Solar's efforts to obtain its application for certification for use of wet-cooling technology for the Project (vs. dry-cooling, which is also allowed pursuant to the PPA), and related terms and conditions in the PPA.

This resolution approves the PPA between PG&E and Genesis Solar because the PPA is consistent with PG&E's 2007 RPS Procurement Plan approved in Decision 07-02-011 and because the costs are reasonable with the contract prices approved here. The Commission approves specific contract prices set forth in the proposed PPA that are reasonable and will ensure that the Genesis Solar project provides the greatest value for PG&E's ratepayers. With the contract prices approved here, deliveries under the PPA are fully recoverable in rates over the life of the contract, subject to Commission review of PG&E's administration of the PPA.

The following tables summarize the Project specific features of the agreement:

Generating Facility	Genesis Solar
Technology	Solar Thermal (Trough)
Capacity	250 megawatts (MW)
Expected Deliveries	560 gigawatt hours per year (GWh/yr) (wet cooled) 524 GWh/yr (dry cooled)
Contract Term	25 years
Commercial Operation Date	Unit 1(125 MW): 11/30/2013 Unit 2 (125 MW): 11/30/2014
Project Location	Riverside County, CA

BACKGROUND

Overview of RPS Program

The California RPS Program was established by Senate Bill (SB) 1078, and has been subsequently modified by SB 107 and SB 1036.[1] The RPS program is codified in Public Utilities Code Sections 399.11-399.20.[2] The RPS program administered by the Commission requires each utility to increase its total procurement of eligible renewable energy resources by at least one percent of retail sales per year so that 20 percent of the utility's retail sales are procured from eligible renewable energy resources no later than December 31, 2010.[3] Additional background information about the Commission's RPS Program, including links to relevant laws and Commission decisions, is available at http://www.cpuc.ca.gov/PUC/energy/Renewables/overview.htm and http://www.cpuc.ca.gov/PUC/energy/Renewables/decisions.htm.

NOTICE

Notice of AL 3546-E and supplemental AL 3546-E-A was made by publication in the Commission's Daily Calendar. PG&E states that a copy of the Advice Letter was mailed and distributed in accordance with Section IV of General Order 96-B.

PROTESTS

On November 23, 2009, the Division of Ratepayer Advocates (DRA) submitted a late-filed protest with the Commission. DRA's protest to AL 3546-E was submitted as confidential and was fully redacted. Energy Division accepted DRA's late-filed protest. Accordingly, PG&E submitted a confidential response with the Commission on December 4, 2009.

---

[1] SB 1078 (Sher, Chapter 516, Statutes of 2002); SB 107 (Simitian, Chapter 464, Statutes of 2006); SB 1036 (Perata, Chapter 685, Statutes of 2007).

[2] All further references to sections refer to Public Utilities Code unless otherwise specified.

[3] *See* § 399.15(b)(1).

DISCUSSION

PG&E Requests Commission Approval of a New Renewable Energy Contract

On October 26, 2009, PG&E filed Advice Letter (AL) 3546-E requesting California Public Utilities Commission (Commission) review and approval of a renewable power purchase agreement (PPA) with Genesis Solar, LLC, (Genesis Solar or Project), an affiliate of NextEra Energy Resources, LLC, (NextEra) which is a subsidiary of the FPL Group. The Genesis Solar PPA resulted from PG&E's 2007 Renewables Portfolio Standard solicitation. Beginning in November 2013, generation from the 250 megawatt (MW) Genesis Solar project is expected to contribute an average of 560 gigawatt-hours (GWh) if wet cooling is used and 524 GWh if the facility is dry-cooled towards PG&E's Renewables Portfolio Standard (RPS) requirement.

Genesis Solar proposes to develop two 125 MW solar thermal parabolic trough facilities comprised of a field of single-axis tracking parabolically-curved mirrors to concentrate solar radiation onto a receiver tube located along the focal line of the trough-shaped mirrors. A heat transfer fluid flows through the receiver tube and absorbs the thermal energy to generate steam and produce electricity utilizing a standard Rankine cycle turbine-generator. According to AL 3546-E, Genesis Solar intends to use wet cooling for the project, but the PPA also includes pricing terms and conditions for dry cooling if permitting warrants it.[4]

On August 31, 2009, Genesis Solar filed an Application for Certification[5] (AFC) with the California Energy Commission (CEC).[6] Specifically, Genesis Solar requests authority to construct its Project on federal land managed by the Bureau of Land Management (BLM).[7] The CEC's AFC process, in conjunction with the

[4] A wet-cooled facility utilizes water to cool steam in order to maximize generation efficiency. Dry-cooled systems use approximately 90% less water than wet-cooled ones, but perform less efficiently.

[5] The Genesis Solar AFC filed with the CEC is available at: http://www.energy.ca.gov/sitingcases/genesis_solar/index.html

[6] The California Energy Commission is the lead agency (for licensing thermal power plants 50 megawatts and larger) under the California Environmental Quality Act (CEQA) and has a certified regulatory program under CEQA.

[7] Because the Project would be located on BLM administered land, the Project must also be compliant with the National Environmental Policy Act (NEPA).

BLM, and other agencies as necessary, will consider Best Management Practices that have been developed for solar energy projects in order to minimize or mitigate negative impacts on natural resources.[8]

On June 14, 2010, PG&E filed supplemental AL 3546-E-A to amend contract price terms and conditions. Specifically, the amendment reduces the contract price if certain events occur and removes several contract price adjustment provisions. The amendments result in lower expected costs to ratepayers. Supplement AL 3546-E-A also included a letter agreement between PG&E and Genesis Solar to clarify the parties' obligation under the PPA related to the permitting conditions set forth for the project as a wet- or dry-cooled facility.

PG&E requests that the Commission issue a resolution containing the following findings:

1. Approves the PPA in its entirety, including payments to be made by PG&E pursuant to the PPA, subject to the Commission's review of PG&E's administration of the PPA.
2. Finds that any procurement pursuant to the PPA is procurement from an eligible renewable energy resource for purposes of determining PG&E's compliance with any obligation that it may have to procure eligible renewable energy resources pursuant to the California Renewables Portfolio Standard (Public Utilities Code Section 399.11 et seq.) ("RPS"), Decision ("D.") 03-06-071 and D.06-10-050, or other applicable law.
3. Finds that all procurement and administrative costs, as provided by Public Utilities Code section 399.14(g), associated with the PPA shall be recovered in rates.
4. Adopts the following finding of fact and conclusion of law in support of CPUC Approval:
    a. The PPA is consistent with PG&E's 2008 RPS procurement plan.
    b. The terms of the PPA, including the price of delivered energy, are reasonable.

[8] The CEC's Best Management Practices are available at: http://www.energy.ca.gov/2009publications/CEC-700-2009-016/CEC-700-2009-016-SD-REV.PDF

5. Adopts the following finding of fact and conclusion of law in support of cost recovery for the PPA:
    a. The utility's cost of procurement under the PPA shall be recovered through PG&E's Energy Resource Recovery Account.
    b. Any stranded costs that may arise from the PPA are subject to the provisions of D.04-12-048 that authorize recovery of stranded renewables procurement costs over the life of the contract. The implementation of the D.04-12-048 stranded cost recovery mechanism is addressed in D.08-09-012.
6. Adopts the following findings with respect to resource compliance with the Emissions Performance Standard ("EPS") adopted in R.06-04-009:
    a. The PPA is not a covered procurement subject to the EPS because the generating facility has a forecast capacity factor of less than 60% and therefore is not baseload generation under paragraphs 1(a)(ii) and 3(2)(a) of the Adopted Interim EPS Rules.

Energy Division evaluated the proposed PPA on the following grounds:

- Consistency with PG&E's 2007 RPS Procurement Plan
- Consistency with Least-Cost, Best-Fit requirements and Independent Evaluator review
- Procurement Review Group participation
- Consistency with RPS standard terms and conditions
- Cost reasonableness
- Cost containment
- Project viability
- Compliance with the minimum quantity requirement for long-term/new facility contracts
- Compliance with the Interim Emissions Performance Standard

Consistency with PG&E's 2007 RPS Procurement Plan

California's RPS statute requires that the Commission review the results of a renewable energy resource solicitation submitted for approval by a utility.[9] PG&E's 2007 RPS procurement plan (Plan) was approved by D.07-02-011 on February 15, 2007. Pursuant to statute, PG&E's Plan included an assessment of supply and demand to determine the optimal mix of renewable generation resources, consideration of flexible compliance mechanisms established by the Commission, and a bid solicitation protocol setting forth the need for renewable generation of various operational characteristics.[10] The stated goal of PG&E's 2007 RPS Plan was to procure approximately 1-2 percent of PG&E's retail sales volume or between 750 and 1,500 GWh per year.

PG&E states that the Genesis Solar PPA is consistent with its 2007 Plan because it was solicited, negotiated and executed according to PG&E's solicitation protocols.

The Genesis Solar project will not contribute to PG&E's 2010 20% RPS target due to the project's expected fourth quarter, 2013 online date. However, the project is valuable for maintaining PG&E's RPS target in subsequent years, particularly given the projected increase in PG&E's load and expiration of shorter-term RPS contracts. Therefore, the Genesis Solar project fits PG&E's identified renewable resource needs because it will contribute to maintaining PG&E's long-term RPS goal.

<u>The PPA is consistent with PG&E's 2007 RPS Procurement Plan, including PG&E's RPS resource needs, approved by D.07-02-011.</u>

Consistency with PG&E's Least-Cost, Best-Fit (LCBF) requirements and Independent Evaluator review

The Commission's least-cost, best-fit (LCBF) decision directs the utilities to use certain criteria in their bid ranking.[11] The decision offers guidance regarding the process by which the utility ranks bids in order to select or "shortlist" the bids with which it will commence negotiations. PG&E's 2007 RPS solicitation protocol included an explanation of its LCBF methodology, which includes

---

[9] Pub. Util. Code, § 399.14

[10] Pub. Util. Code, § 399.14(a)(3)

[11] *See* D.04-07-029

quantitative and qualitative analysis focusing on four primary areas: 1) determination of a bid's market value; 2) calculation of transmission adders and integration costs; 3) evaluation of portfolio fit; and 4) consideration of non-price factors such as project viability.

Fundamentally, the decision to shortlist a project is based on its net market value (contract price plus any adder for future transmission costs, less resource adequacy value and the forward energy price for a comparable quantity of energy) and project viability. For example a project is shortlisted if the project's net market value is above some threshold, such as the fourth quartile of all bids. Because shortlisting provides the utility with an opportunity to negotiate a more competitive price, in some cases it may be prudent for a utility to shortlist a relatively high-priced project that demonstrates high indicia of viability.

PG&E employed an independent evaluator (IE) to oversee its 2007 RPS solicitation, as required by the Commission.[12] AL 3546-E included an IE report which in part noted that PG&E was inclusive in developing its 2007 RPS shortlist, adding projects that were evaluated as highly viable that would not have otherwise been shortlisted due to low market valuation (high price).

Consistent with D.06-05-039, an independent evaluator oversaw PG&E's 2007 RPS solicitation and subsequent negotiations with Genesis Solar.

The IE verified that PG&E's decision to shortlist Genesis Solar was consistent with PG&E's solicitation protocols, including its least cost, best fit methodology set forth in its 2007 RPS Plan and the IE supported PG&E's decision to shortlist the Genesis Solar project.[13]

Procurement Review Group participation

The Procurement Review Group (PRG) was initially established in D.02-08-071 as an advisory group to review and assess the details of the IOUs' overall procurement strategy, solicitations, specific proposed procurement contracts and other procurement processes prior to submitting filings to the Commission.[14]

---

[12] *See* D.06-05-039

[13] AL 3546-E, Appendix I.

[14] The PRG for PG&E includes representatives of the California Department of Water Resources, the Commission's Energy Division and Division of Ratepayer Advocates,

Footnote continued on next page

PG&E provided its PRG updates on the Genesis Solar negotiations on May 15, 2009, June 12, 2009, and August 14, 2009.

Pursuant to D.02-08-071, PG&E's Procurement Review Group participated in the review of the Genesis Solar PPA.

Consistency with RPS standard terms and conditions

The Genesis Solar PPA is based on PG&E's 2008 RPS pro forma contract and complies with D.08-04-009, as modified by D.08-08-028.[15] As a result, the PPA contains the required non-modifiable standard terms and conditions.

The Genesis Solar PPA includes the Commission adopted RPS "non-modifiable" standard terms and conditions.

Cost Reasonableness

In AL 3546-E, PG&E determined that the costs of the Genesis Solar PPA were reasonable compared to proposals received in response to PG&E's 2008 solicitation (the most recent market data at the time AL 3546-E was filed). PG&E filed work papers with AL 3546-E illustrating how the Genesis Solar PPA compared to bids received in PG&E's 2008 RPS solicitation and PG&E's 2008 shortlist. The Commission's reasonableness review for RPS PPA costs also includes a comparison to other proposed RPS projects from PG&E's 2009 RPS solicitation, as well as recent Commission-approved projects. Because of the challenges facing renewable project development, in addition to price, Energy Division considers project viability when comparing the costs of RPS contracts.

In its protest to AL 3546-E, DRA noted particular concern over the costs of the Genesis Solar PPA. PG&E in its reply to DRA's protest asserted that the price of the Genesis Solar PPA is reasonable given its technology and the high viability of the project.

Union of Concerned Scientists, The Utility Reform Network, the California Utility Employees, and Jan Reid, as a PG&E ratepayer.

[15] While the Genesis Solar PPA resulted from PG&E's 2007 RPS solicitation, PG&E based the Genesis Solar PPA on its 2008 RPS pro forma because it reflected the most recent Commission required standard terms and conditions and included other refinements accepted by the Commission.

The Commission recognizes that the costs of complying with the RPS program are not insignificant and moreover that the instant advice letter concerning the Genesis Solar PPA will impose a long-term commitment on PG&E's ratepayers. The Commission will only approve a PPA if it is necessary and if the costs are reasonable. While PG&E has entered into numerous RPS contracts, many of these projects will require new transmission infrastructure and may face challenges obtaining permits and/or financing. In light of this, it is a common assumption that some of the renewable generation under contract will be delayed. Therefore, it is imperative that the utilities continue to build and diversify their renewable portfolios with viable projects that may be contracted for at reasonable costs. For this reason, the Commission directed the utilities and Energy Division staff to develop tools to ensure that projects which demonstrate high viability are given appropriate weight in the procurement selection process.[16] Approval of the Genesis Solar PPA will add a highly viable solar thermal project to PG&E's RPS portfolio.

While DRA's makes a valid argument that the Genesis Solar project is a relatively high-priced project, the IE report offers some comfort concerning the reasonableness of the costs. Specifically, the IE noted that PG&E and Genesis Solar have negotiated the Genesis Solar project under various contract structures, including a joint ownership proposal. Because of this, the IE stated that PG&E was afforded significant access to project cost information and that, "PG&E should be comfortable with the costs of the project and related development activities."[17]

Moreover, on June 14, 2010, PG&E submitted supplemental AL 3546-E-A which included a reduction in the contract price if certain events occur. Therefore, while the Genesis Solar PPA may be a relatively high priced PPA, on balance the Commission finds that the costs of the Genesis Solar PPA, as amended by supplemental AL 3546-E, are reasonable in light of the specified contract prices approved by this resolution, the project's benefits and comments from the IE discussed above. As set forth in Confidential Appendix B, we only approve specified contract prices to ensure that PG&E and Genesis Solar are sufficiently motivated to cause the project to be developed in a manner that provides the

---

[16] *See* February 3, 2009, Assigned Commission's Ruling R.08-08-009.

[17] AL 3546-E, Appendix I at 30.

greatest value for PG&E's ratepayers. Confidential Appendix B includes a detailed discussion of the contractual pricing terms, including PG&E's estimate of the total contract costs under the PPA and the approved contract prices for the Genesis Solar PPA.

With the prices approved by this resolution, the costs of the approved Genesis Solar PPA are reasonable compared to PG&E's 2009 solicitation and other comparable PPAs.

With the prices approved by this resolution, payments made by PG&E under the PPA are fully recoverable in rates over the life of the PPA, subject to Commission review of PG&E's administration of the PPA.

Cost Containment

Pursuant to statute, the Commission calculates a market price referent (MPR) to assess above-market costs of individual RPS contracts and the RPS program in general.[18] Contracts that meet certain criteria are eligible for above-MPR funds (AMF).[19] Based on a 2014 guaranteed commercial online date for the Project, the 25-year PPA exceeds the 2008 MPR[20] and therefore has above-market costs associated with it.[21]

---

[18] *See* § 399.15(c)

[19] SB 1036 codified in § 399.15(d)(2) the following criteria: the contract was selected through a competitive solicitation, the contract covers a duration of no less than 10 years, the contracted project is a new facility that will commence commercial operations after January 1, 2005, the contract is not for renewable energy credits, and the above-market costs of a contract do not include any indirect expenses including imbalance energy charges, sale of excess energy, decreased generation from existing resources, or transmission upgrades.

[20] *See* Resolution E-4214.

[21] The $/MWh portion of the contract price that exceeds the MPR, multiplied by the expected generation throughout the contract term, represents the total "above-market costs" for a given PPA.

The PPA meets the eligibility criteria for AMFs. However, PG&E has exhausted its AMFs provided by statute.[22] Therefore, PG&E will voluntarily incur the above-MPR costs of the PPA.

Because there are above-market costs associated with this contract, which is subject to the cost limitation of Pub. Utils. Code § 399.15(d), and PG&E has exhausted its above-MPR funds, PG&E is voluntarily entering into the Genesis Solar PPA as permitted under the Pub. Util. Code.

Project viability assessment and development status

PG&E believes that the Genesis Solar project is viable and will be developed according to the terms and conditions in the PPA. PG&E's project viability assessment includes key criteria for renewable project development such as developer experience, commercialization of the technology, site control and permitting status and access to transmission.

Energy Division staff reviewed the project development information provided in the advice letter and concurs with PG&E that the Genesis Solar project is viable relative to other RPS projects. The viability of the Genesis Solar project is reasonable compared to other projects offered to PG&E.

Developer experience and creditworthiness

The Genesis Solar project is being developed by NextEra, a subsidiary of the FPL Group. Through its subsidiaries, NextEra, operates more than 17,000 MW nationwide and is the largest seller in North America of solar and wind generated energy, including a 310 MW solar thermal plant in California's Mojave Desert.

Technology

PG&E explains that the Genesis Solar project will utilize "standard" solar thermal parabolic trough technology that been commercially demonstrated for over 20 years at the Solar Energy Generating Systems (SEGS) operating in California's Mojave Desert. This technology is the most widely commercially deployed type of utility-scale solar thermal technology.

---

[22] On May 28, 2009, the Director of the Energy Division notified PG&E that it had exhausted its AMF account.

Site control and permitting status

As discussed above, the Genesis Solar project is pursuing its AFC from the CEC and site control from the BLM. The Genesis Solar project has been identified by the BLM as a "fast-track" project.[23] Fast-track designated projects are considered advanced enough in the permitting process that they could obtain approval by December 2010, therefore making them eligible for economic stimulus funding under the American Recovery and Reinvestment Act of 2009.

Interconnection and transmission

Genesis Solar is pursuing an interconnection agreement with Southern California Edison Company through the California Independent System Operator interconnection process. Transmission upgrade studies for the project are underway and any necessary transmission build-out is expected to be completed in time for the project to deliver under the terms of the PPA.

Contribution to minimum quantity requirement for long-term/new facility contracts

D.07-05-028 established a "minimum quantity" condition on the ability of utilities to count an eligible contract of less than 10 years duration for compliance with the RPS program.[24] In the calendar year that a short-term contract with an existing facility is executed, the utility must also enter into long-term contracts or contracts with new facilities equivalent to at least 0.25% of the utility's previous year's retail sales.

As a new facility, delivering pursuant to a long-term contract, the Genesis Solar PPA will contribute to PG&E's minimum quantity requirement established in D.07-05-028.

---

[23] A list of the BLM's renewable energy "fast-track" projects is available at: http://www.blm.gov/wo/st/en/prog/energy/renewable_energy/fast-track_renewable.html

[24] For purposes of D.07-05-028, contracts of less than 10 years duration are considered "short-term" contracts and facilities that commenced commercial operations prior to January 1, 2005 are considered "existing".

Compliance with the Interim Greenhouse Gas Emissions Performance Standard (EPS)

California Pub. Util. Code § 8340 and 8341 require that the Commission consider emissions costs associated with new long-term (five years or greater) power contracts procured on behalf of California ratepayers.

D.07-01-039 adopted an interim EPS that establishes an emission rate quota for obligated facilities to levels no greater than the greenhouse gas (GHG) emissions of a combined-cycle gas turbine power plant. The EPS applies to all energy contracts for baseload generation that are at least five years in duration.[25]

Generating facilities using certain renewable resources are deemed compliant with the EPS, although contracts with intermittent resources are subject to the limitation that total purchases under the contract do not exceed the expected output from the facility over the term of the contract.

The PPA complies with the EPS established in D.07-01-039 because it concerns an in-state RPS-eligible facility with a capacity factor less than 60 percent.

DRA filed a confidential protest to PG&E's advice letter

On November 23, 2009, DRA submitted a confidential protest to AL 3546-E with the Commission. Because DRA's protest was submitted to the Commission as confidential the details of DRA's protest cannot be discussed. In general, DRA argues against Commission approval of the PPA for reasons that concern cost and whether PG&E's selection and negotiation of the Genesis Solar PPA followed RPS procurement protocols.

PG&E asserted that it adhered to its RPS solicitation protocols and that the costs of the PPA are reasonable for a highly viable renewable project.

For the reasons discussed above, and with the approved prices, we find that the costs of the Genesis Solar PPA, as amended by supplemental AL 3546-E-A, are reasonable and that the PPA was selected and executed consistent with PG&E's Commission approved 2007 RPS procurement plan. Accordingly, we deny DRA's protest in its entirety. (See Confidential Appendix A for a summary of DRA's protest and PG&E's response.)

---

[25] "Baseload generation" is electricity generation at a power plant "designed and intended to provide electricity at an annualized plant capacity factor of at least 60%." Pub. Utils. Code § 8340 (a).

RPS Eligibility and CPUC Approval

Pursuant to Pub. Util. Code § 399.13, the CEC certifies eligible renewable energy resources. Generation from a resource that is not CEC-certified cannot be used to meet RPS requirements. To ensure that only CEC-certified energy is procured under a Commission-approved RPS contract, the Commission has required standard and non-modifiable "eligibility" language in all RPS contracts. That language requires a seller to warrant that the project qualifies and is certified by the CEC as an "Eligible Renewable Energy Resource," that the project's output delivered to the buyer qualifies under the requirements of the California RPS, and that the seller uses commercially reasonable efforts to maintain eligibility should there be a change in law affecting eligibility.[26]

The Commission requires a standard and non-modifiable clause in all RPS contracts that requires "CPUC Approval" of a PPA to include an explicit finding that "any procurement pursuant to this Agreement is procurement from an eligible renewable energy resource for purposes of determining Buyer's compliance with any obligation that it may have to procure eligible renewable energy resources pursuant to the California Renewables Portfolio Standard (*Public Utilities Code Section 399.11 et seq.*), Decision 03-06-071, or other applicable law."[27]

Notwithstanding this language, the Commission has no jurisdiction to determine whether a project is an eligible renewable energy resource, nor can the Commission determine prior to final CEC certification of a project, that "any procurement" pursuant to a specific contract will be "procurement from an eligible renewable energy resource."

Therefore, while we include the required finding here, this finding has never been intended, and shall not be read now, to allow the generation from a non-RPS-eligible resource to count towards an RPS compliance obligation. Nor shall such finding absolve the seller of its obligation to obtain CEC certification, or the utility of its obligation to pursue remedies for breach of contract. Such contract enforcement activities shall be reviewed pursuant to the Commission's authority to review the utilities' administration of contracts.

---

26 *See, e.g.* D. 08-04-009 at Appendix A, STC 6, Eligibility.

27 *See, e.g.* D. 08-04-009 at Appendix A, STC 1, CPUC Approval.

Confidential information

The Commission, in implementing Pub. Util. Code § 454.5(g), has determined in D.06-06-066, as modified by D.07-05-032, that certain material submitted to the Commission as confidential should be kept confidential to ensure that market sensitive data does not influence the behavior of bidders in future RPS solicitations. D.06-06-066 adopted a time limit on the confidentiality of specific terms in RPS contracts. Such information, such as price, is confidential for three years from the date the contract states that energy deliveries begin, except contracts between IOUs and their affiliates, which are public.

The confidential appendices, marked "[REDACTED]" in the public copy of this resolution, as well as the confidential portions of the advice letter, should remain confidential at this time.

COMMENTS

Public Utilities Code section 311(g)(1) provides that this resolution must be served on all parties and subject to at least 30 days public review and comment prior to a vote of the Commission. Section 311(g)(2) provides that this 30-day period may be reduced or waived upon the stipulation of all parties in the proceeding.

The 30-day comment period for the draft of this resolution was neither waived nor reduced. Accordingly, this draft resolution was mailed to parties for comments, and will be placed on the Commission's agenda no earlier than 30 days from today.

FINDINGS AND CONCLUSIONS

1. The Genesis Solar, LLC power purchase agreement is consistent with Pacific Gas and Electric Company's 2007 Renewables Portfolio Standard Procurement Plan and resource needs, approved by Decision 07-02-011.
2. The selection of the Genesis Solar, LLC power purchase agreement is consistent with Pacific Gas and Electric Company's 2007 Renewables Portfolio Standard Procurement solicitation least-cost, best-fit protocols and renewable resource needs, approved by Decision 07-02-011.
3. Consistent with Decision 06-05-039, an independent evaluator oversaw Pacific Gas and Electric Company's negotiations with Genesis Solar, LLC and

concurs with Pacific Gas and Electric Company's decision to execute the agreement and that the proposed Genesis Solar, LLC power purchase agreement merits Commission approval.

4. Pursuant to Decision 02-08-071, Pacific Gas and Electric Company's Procurement Review Group participated in the review of the Genesis Solar, LLC power purchase agreement.
5. Pacific Gas and Electric Company submitted a supplemental advice letter to reduce the contract price of the Genesis Solar, LLC power purchase agreement if certain events occur and to remove several contract price adjustment provisions.
6. With the prices approved by this resolution and identified in Confidential Appendix B, the total all-in costs of the Genesis Solar, LLC power purchase agreement, are reasonable based on their relation to contract price and viability of bids received in response to Pacific Gas and Electric Company's 2009 solicitation for renewable resources.
7. All of the prices set forth in the Genesis Solar, LLC power purchase agreement exceed the applicable 2008 market price referent.
8. Pursuant to Public Utilities Code § 399.15(d), PG&E will voluntarily procure energy under the Genesis Solar, LLC power purchase agreement at a price that exceeds the applicable market price referent.
9. Consistent with the prices approved by this resolution and identified in Confidential Appendix B, payments made by Pacific Gas and Electric Company under the Genesis Solar, LLC power purchase agreement are fully recoverable in rates over the life of the agreement, subject to Commission review of Pacific Gas and Electric Company's administration of the agreement.
10. The viability of the Genesis Solar, LLC project is reasonable compared to other projects offered to Pacific Gas and Electric Company.
11. The Genesis Solar, LLC power purchase agreement will contribute to Pacific Gas and Electric Company's minimum quantity requirement established in Decision 07-05-028.
12. The Genesis Solar, LLC power purchase agreement complies with the Emissions Performance Standard because it meets the conditions established in Decision 07-01-039.
13. The Division of Ratepayer Advocate's protest is denied.

14. Procurement pursuant to the Genesis Solar, LLC power purchase agreement is procurement from eligible renewable energy resources for purposes of determining Pacific Gas and Electric Company's compliance with any obligation that it may have to procure eligible renewable energy resources pursuant to the California Renewables Portfolio Standard (Public Utilities Code Section 399.11 et seq.), Decision 03-06-071 and Decision 06-10-050, or other applicable law.
15. The immediately preceding finding shall not be read to allow generation from a non-RPS eligible renewable energy resource under the power purchase agreement to count towards an RPS compliance obligation. Nor shall that finding absolve Pacific Gas and Electric Company of its obligation to enforce compliance with this agreement.
16. The confidential appendices, marked "[REDACTED]" in the public copy of this Resolution, as well as the confidential portions of the advice letter, should remain confidential at this time.
17. Advice Letter 3546-E and supplemental Advice Letter 3546-E-A should be approved effective today.

THEREFORE IT IS ORDERED THAT:

1. Pacific Gas and Electric Company's Advice Letter 3546-E and supplemental Advice Letter 3546-E-A, requesting Commission approval of a power purchase agreement with Genesis Solar, LLC is approved, consistent with the prices approved by this resolution and identified in Confidential Appendix B.
2. This Resolution is effective today.

I certify that the foregoing resolution was duly introduced, passed and adopted at a conference of the Public Utilities Commission of the State of California held on August 12, 2010; the following Commissioners voting favorably thereon:

PAUL CLANON
Executive Director

Confidential Appendix A

Summary of Confidential Protest from the Division of Ratepayer Advocates

[REDACTED]

Confidential Appendix B

Summary of PPA terms and conditions

[REDACTED]

Confidential Appendix C

Excerpt from the Independent Evaluator Report

[REDACTED]