Headquarters U.S. Air Force

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Monitoring Program Design for Mohave Ground Squirrels at Edwards AFB

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Environmental Management – Edwards AFB

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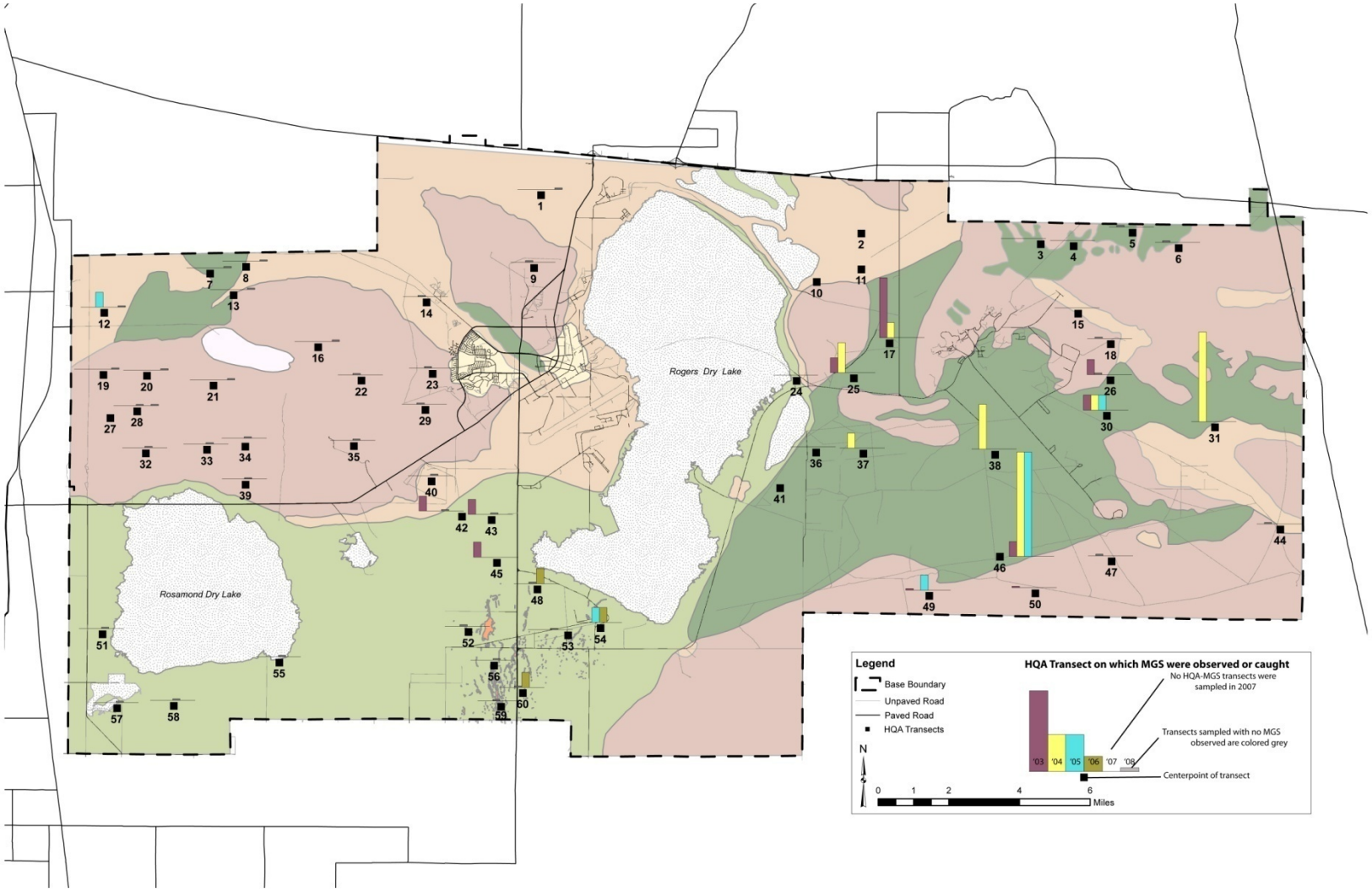
Presentation Overview

- Existing Monitoring Program
- Project Objectives
- Survey Design
  - Occupancy Samples
    - Footprints
    - Track transects
  - Quantitative Samples
    - Trapping webs
- Estimation of Mohave ground squirrel abundance
- Conclusions
- Recommendations

Existing Monitoring Program

- 60 fixed long-term monitoring locations
- 10 to 15 locations sampled on rotating basis each year
- Grid design (4 x 25 traps at 35 m spacing; 8.8 ha)
- Trapped for 5 days (500 trap-days)
- Provides numbers of animals caught and locations

Historic Distribution on Edwards AFB



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Project Objectives

- Develop a scientifically defensible monitoring program for the Mohave ground squirrel that can:
  - Detect and monitor population sizes
  - Cost effective
  - Acceptable to regulatory agencies

- Considers alternative techniques and approaches

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Project Tasks

- Conduct Literature Review
  - Mohave ground squirrel biology
  - Small mammal trapping designs
  - Survey and statistical methods
- Develop Preliminary Survey Design
  - Trapping techniques
  - Analytical techniques
- Validate Survey Design
  - Spring 2009
- Finalize Survey Design

Survey Design

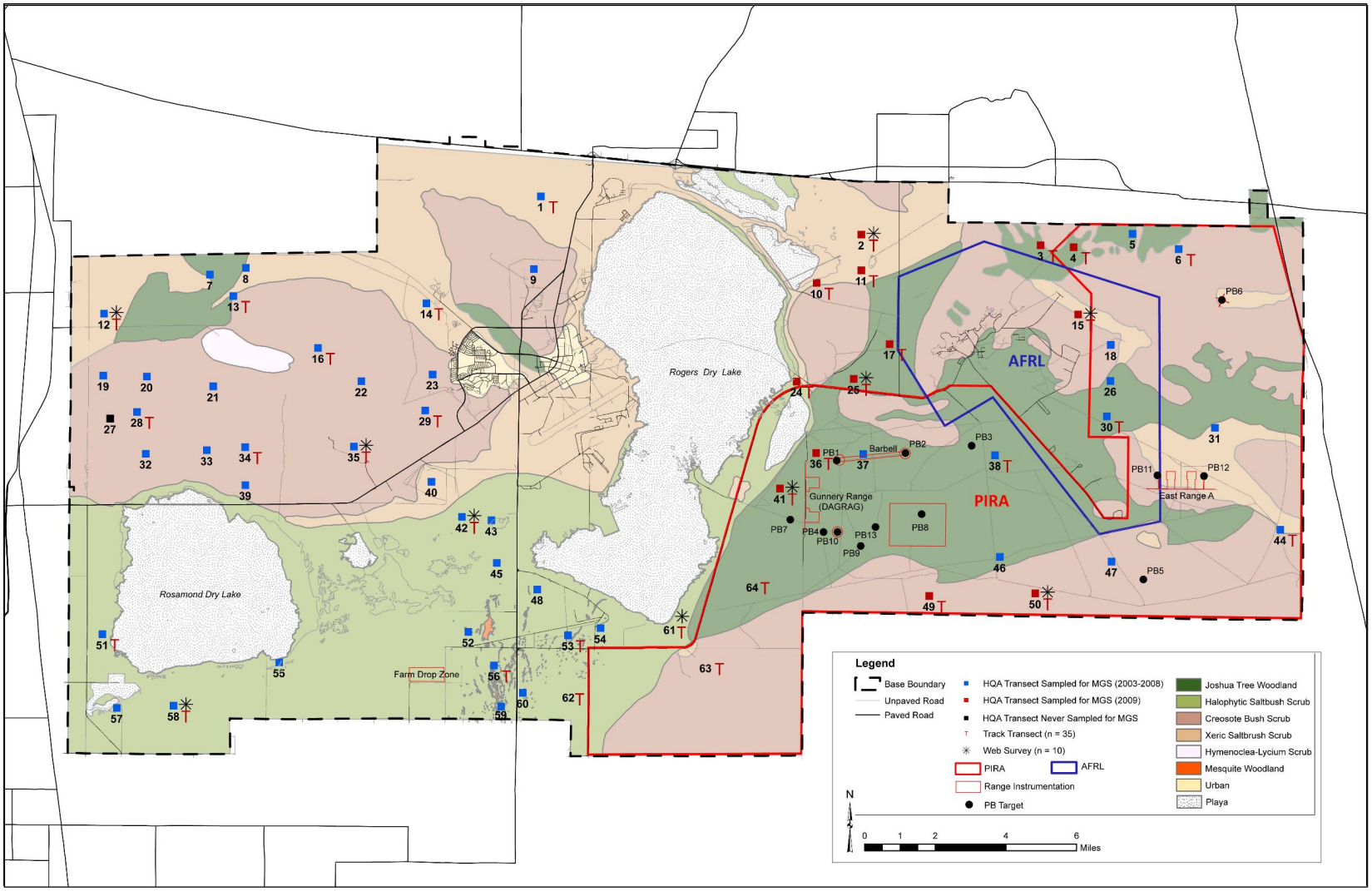
- Two Phase Design
  - Occupancy – measure of relative presence/absence of Mohave ground squirrels
    - Track stations (low cost, widely dispersed)
  - Quantitative – direct estimates of density
    - Trapping web
    - 500 trap-days (similar effort to existing efforts)
  - Stratified by habitat

- Concurrent with 2009 long-term monitoring survey

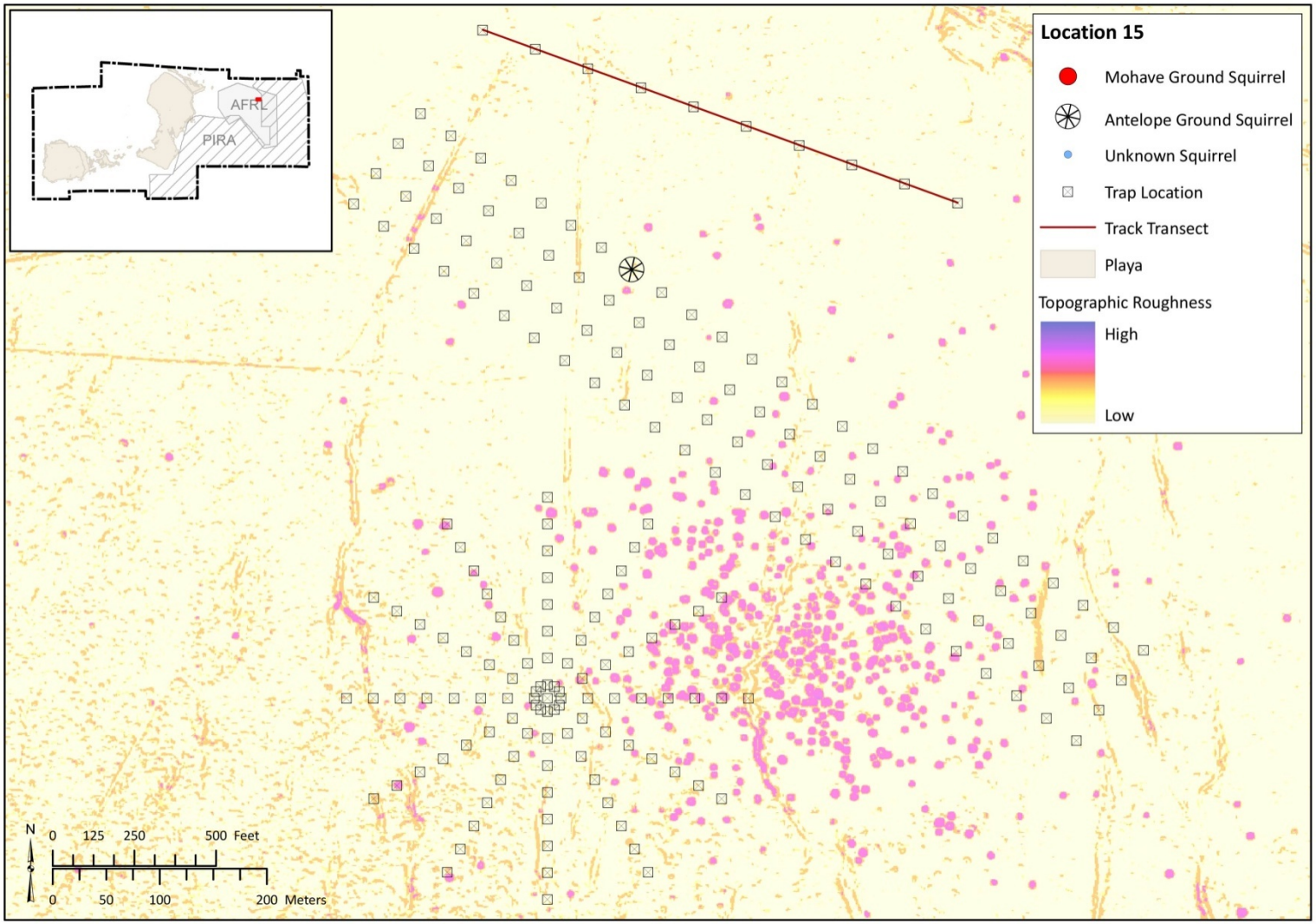
Allocation of Transects and Webs to Habitats

Habitat	Area (acres)	# Track Transects	# Webs
Creosote Bush Scrub	102,816	11	3
Halophytic Saltbush Scrub	56,268	7	3
Joshua Tree Woodland	52,756	9	2
Xeric Saltbush Scrub	45,282	7	2

Survey Locations



Sampling Layout



Occupancy - Track Identification

Track Collection from Known Individuals

Print Measurements

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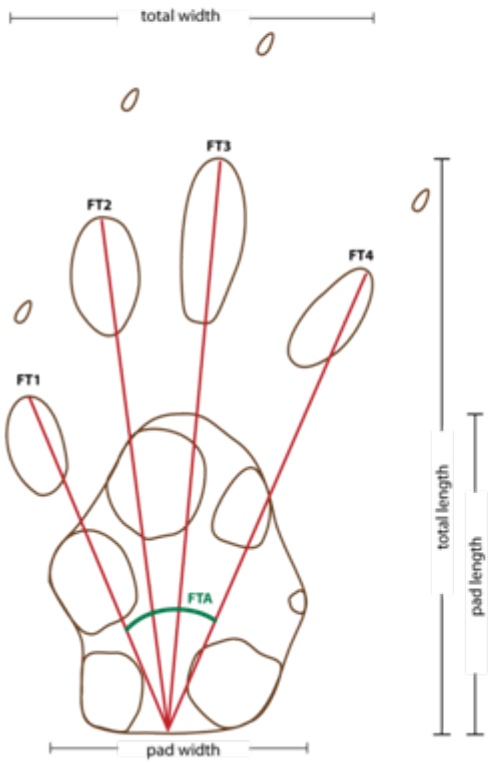
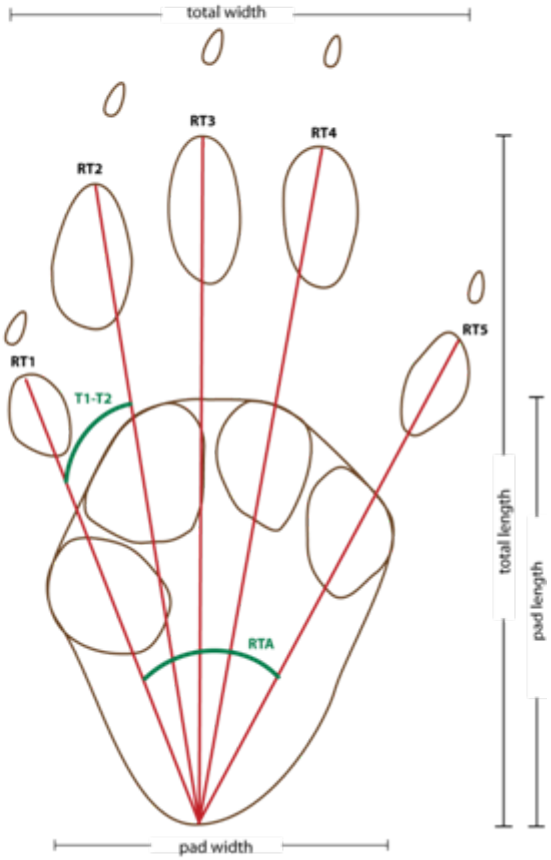
Ground Squirrels (Spermophilus spp.)



Left Front



Left Rear

2008 Track Study

- 17 Mohave ground squirrels
- 17 antelope ground squirrels
- Analyzed using linear discriminant analysis

Species ~ total length + pad length + toe 3 length			
Species	**AGS (predict)**	**MGS (predict)**	**Correct Prediction Rate**
AGS (Actual)	12	5	71%
MGS (Actual)	2	15	88%
Species ~ total length + pad length			
Species	**AGS (predict)**	**MGS (predict)**	**Correct Prediction Rate**
AGS (Actual)	13	4	76%
MGS (Actual)	3	14	82%
Species ~ pad length + pad width + ratio (pad width/pad length)			
Species	**AGS (predict)**	**MGS (predict)**	**Correct Prediction Rate**
AGS (Actual)	12	5	71%
MGS (Actual)	3	14	82%
Species ~ total length + total width+ (total width/total length)			
Species	**AGS (predict)**	**MGS (predict)**	**Correct Prediction Rate**
AGS (Actual)	12	5	71%
MGS (Actual)	3	14	82%

2009 Track Verification Study

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- Evaluation of 2008 models to predict 2009 identities
- 12 Mohave ground squirrels
- 10 antelope ground squirrels
- Front foot measurements

Prediction of 2009 data based on 2008 models			
Species ~ total length + pad length + toe 3 length			
Species	**AGS (predict)**	**MGS (predict)**	**Correct Prediction Rate**
AGS (Actual)	8	2	80%
MGS (Actual)	3	9	75%
Species ~ total length + pad length			
Species	**AGS (predict)**	**MGS (predict)**	**Correct Prediction Rate**
AGS (Actual)	8	2	80%
MGS (Actual)	2	10	83%
Species ~ pad length + pad width + ratio (pad width/pad length)			
Species	**AGS (predict)**	**MGS (predict)**	**Correct Prediction Rate**
AGS (Actual)	8	2	80%
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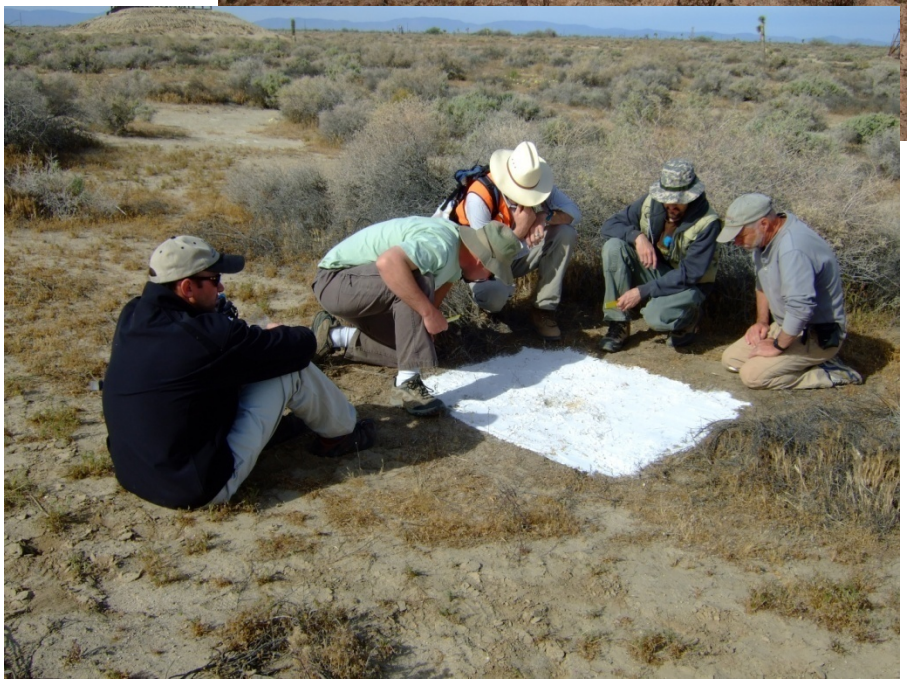
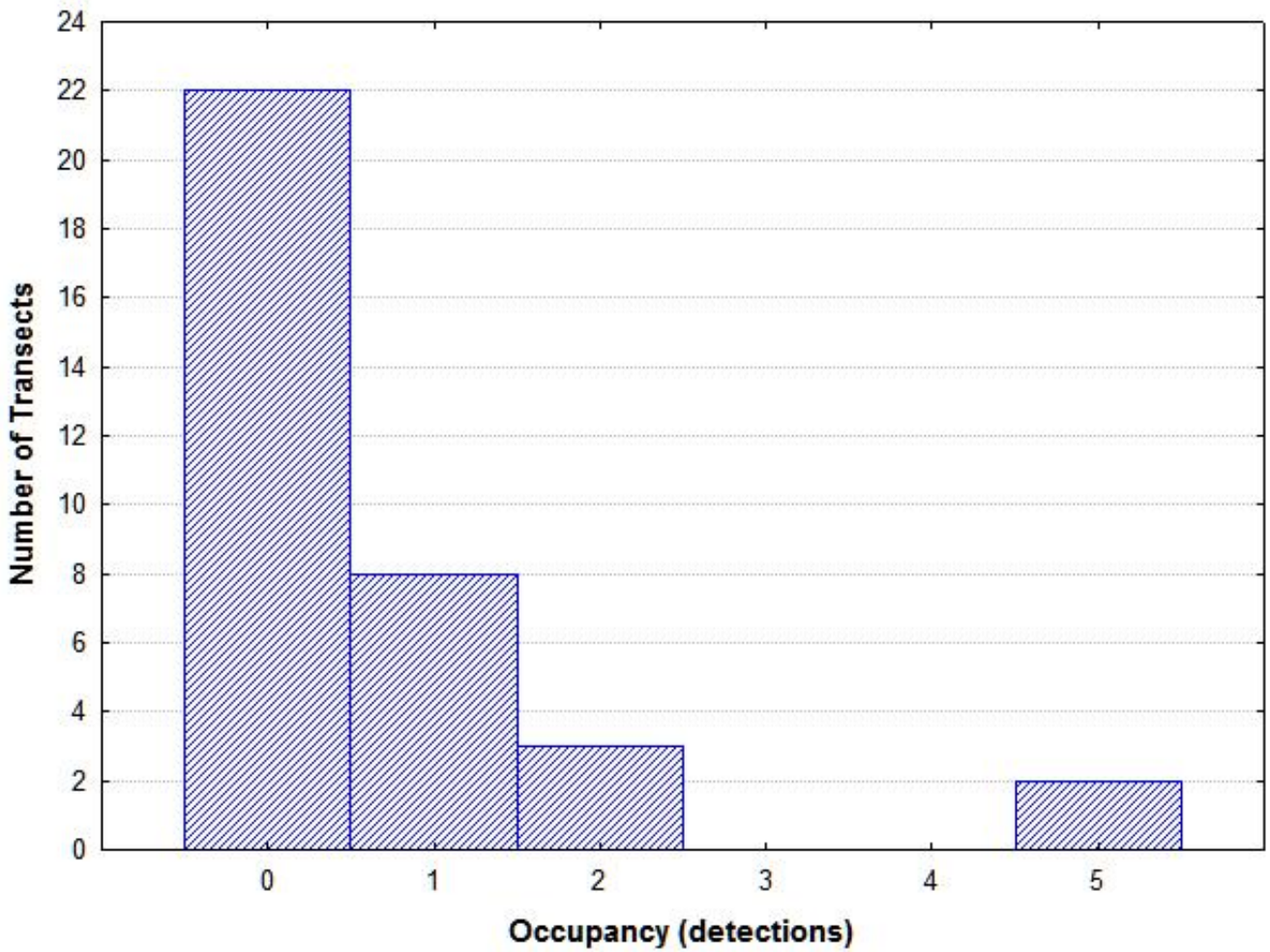
Species ~ total length + total width+ (total width/total length)			
Species	**AGS (predict)**	**MGS (predict)**	**Correct Prediction Rate**
AGS (Actual)	8	2	80%
MGS (Actual)	2	10	83%

Occupancy - Track Station Transects

- 35 Transects: 10 stations spaced at 50 m intervals
- Each transect was read twice
- Measured multiple squirrel trails at each station
- Five predetermined measurements per footprint
- Photographs of tracks
- Expert guidance

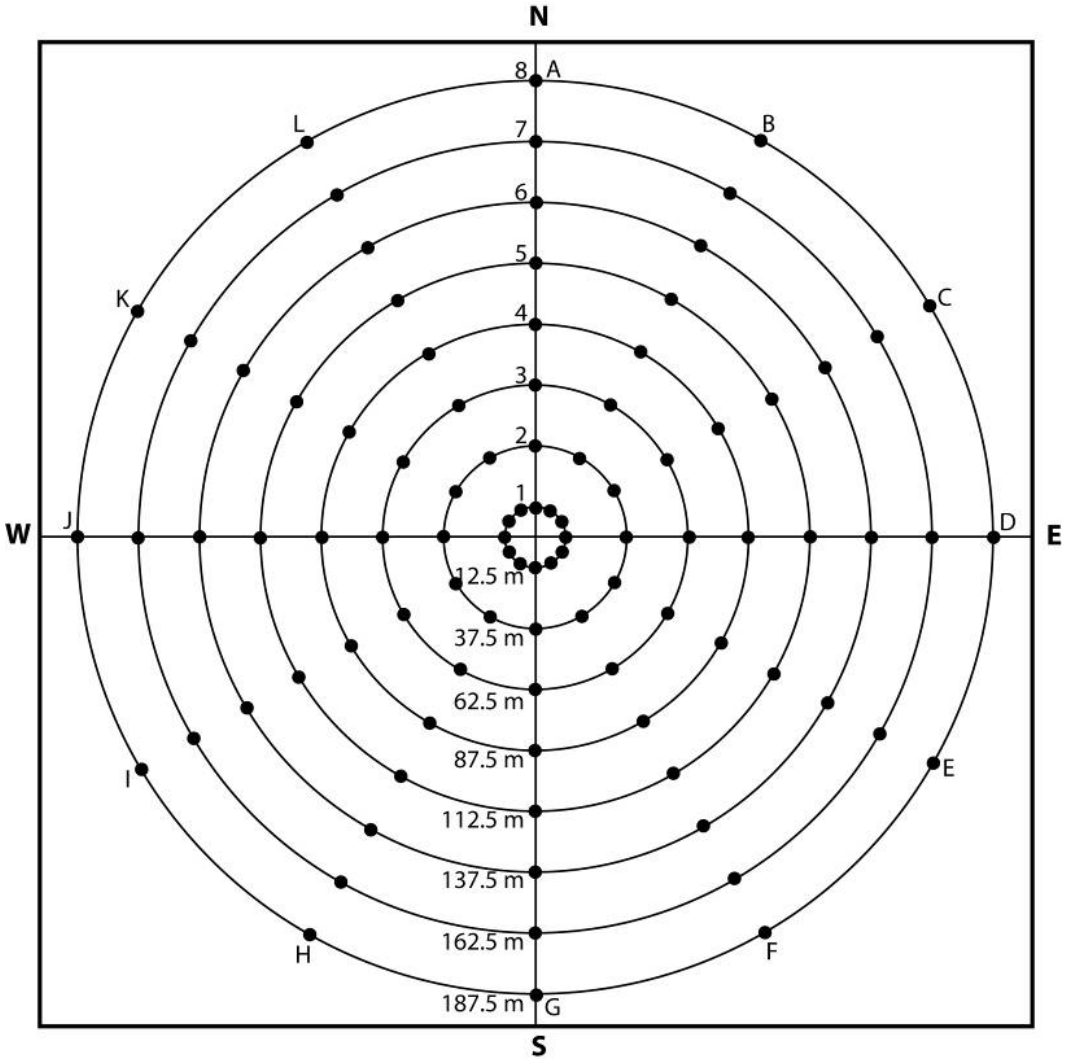


Occupancy - Track Transects



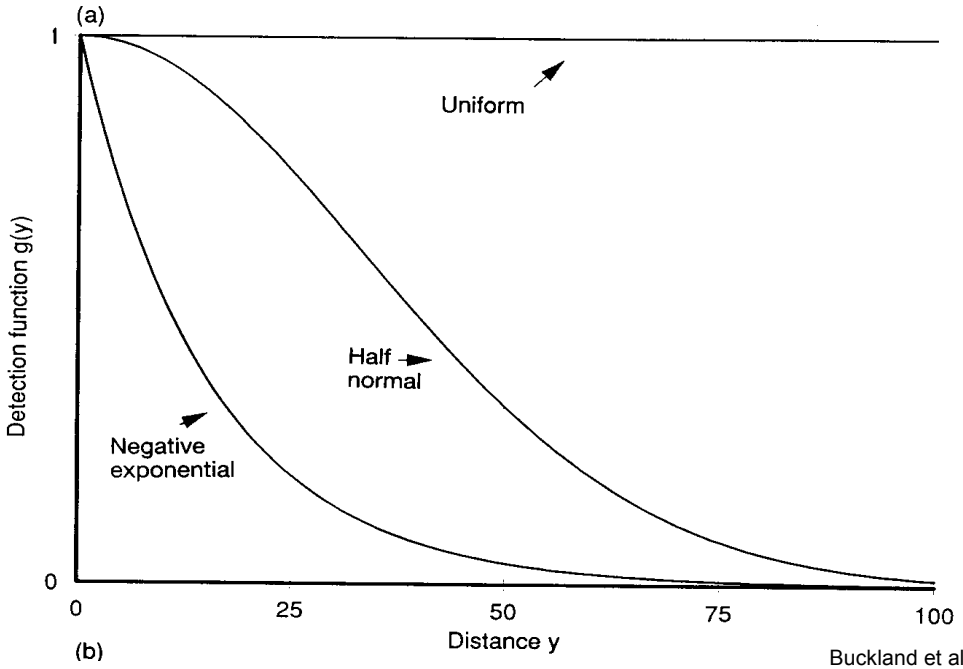
Quantitative - Trapping Webs

- 10 webs
- 12 radii
- 8 traps per radius
- 25 m trap spacing
- 187.5 m radius
- Sampled for 5 days (500 trap days)
- Captured animals were uniquely marked
- 9.6 ha/web



Quantitative - Distance Sampling

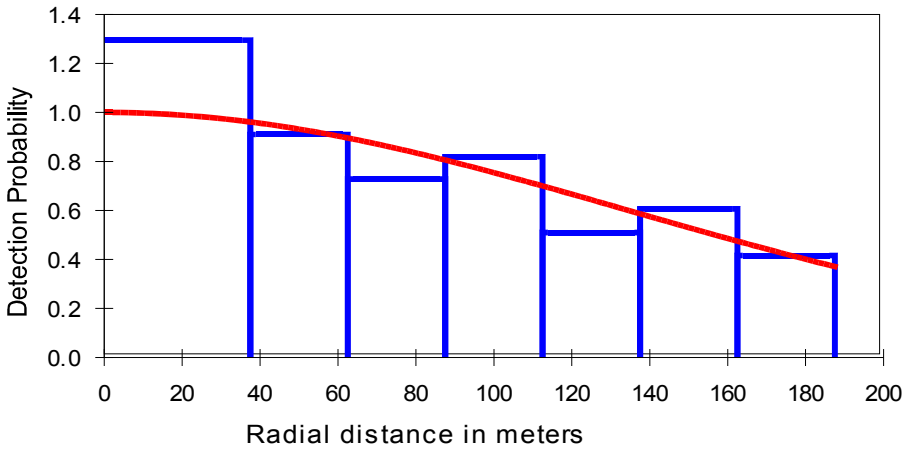
- Animals at center of web were captured with certainty
- Animal movement is stable
- Trap distances are measured accurately
- Sufficient animals are collected to estimate the detection function



Buckland et al. 2001

DISTANCE results

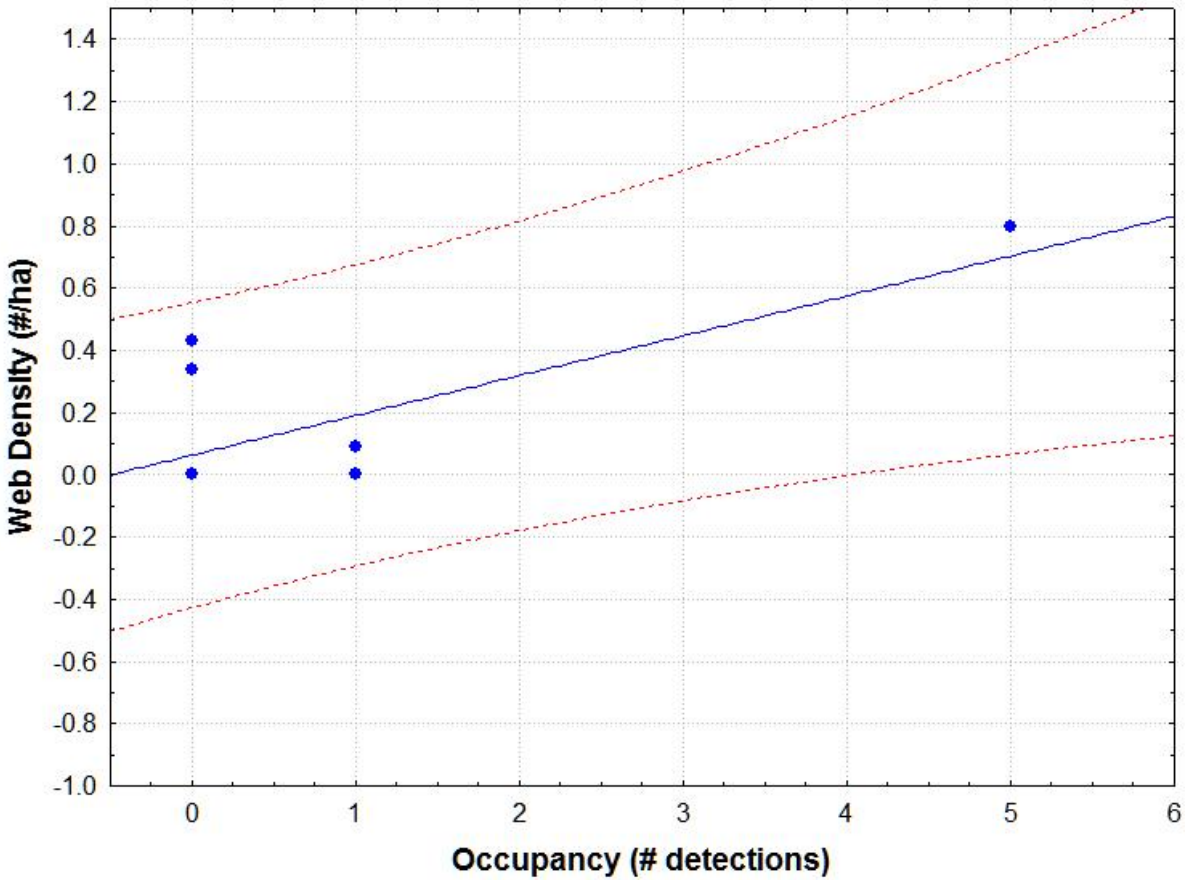
- 34 unique individuals
- 15 recaptures
- 6 webs with 0 captures



Web	Density (#/ha)	D (LCL)	D (UCL)	D CV	Probability of Detection	Effective Detection Radius (m)
2	0.09	0.06	0.13	0.22	0.63	149.33
25	0.34	0.22	0.53	0.22	0.63	149.33
41	0.43	0.28	0.66	0.22	0.63	149.33
61	0.80	0.52	1.23	0.22	0.63	149.33
Average	**0.41**	**0.27**	**0.64**	**0.22**	**0.63**	**149.33**

Density – Occupancy Relationship

- Assumes that Occupancy is proportional to Density



Preliminary Estimate of MGS Abundance

- Estimated densities at each transect location
- Calculated average density by habitat
- Multiplied densities by habitat area
- Order of magnitude results

Habitat	Area (ha)	Average density (#/ha)	Total number
Creosote Bush Scrub	41,608	0.14 (0-0.35)	5,800 (0-14,600)
Halophytic Saltbush Scrub	22,770	0.25 (0.11-0.47)	5,700 (2,500-10,700)
Joshua Tree Woodland	21,349	0.11 (0.01–0.32)	2,300 (200-6,800)
Xeric Saltbush Scrub	18,325	0.11 (0.01-0.33)	2,000 (180-6,000)
Total	104,054	0.15 (0.03-0.37)	15,900 (2,900-38,100)

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Conclusions

- Demonstrated the applicability of the two-phase design to estimate densities and total numbers of Mohave ground squirrels throughout the Base.
  - Track transects provide measure of relative abundance
    - Does not require animals to be handled
    - Distinguishes species based on footprints
    - Cost effective
  - Trapping webs allow direct estimation of animal density with few assumptions
- Optimization of sampling design is required to reduce variation

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Design Recommendations

- Increase sample size
  - Increase the number of times the track transects are visited from 2 to 3, thereby increasing the accuracy of the occupancy sample.
  - Increase the number of webs that are trapped.
  - Allocate proportionately more transects and webs to habitats that are more likely to support Mohave ground squirrel.
- Decrease trap spacing to 10 to 15 m
- Stratify samples based on potential plant associations (soils), slope, topography