

Headquarters U.S. Air Force

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Monitoring Program Design for Mohave Ground Squirrels at 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

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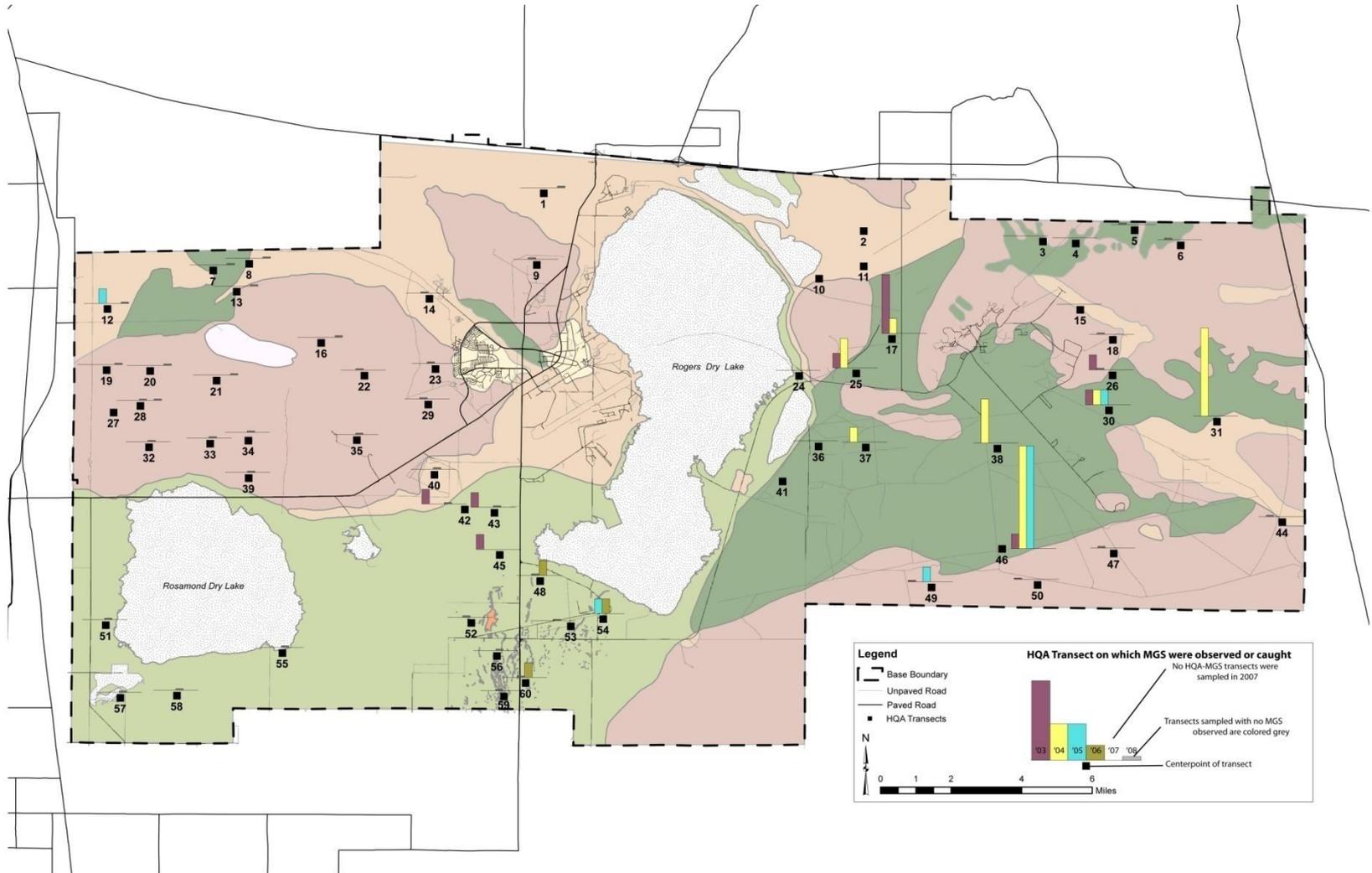
- 60 fixed long-term monitoring locations
- 10 to 15 locations sampled on rotating basis each year
- Grid design (4 x 25 traps at 35 m spacing; 8.8 ha)
- Trapped for 5 days (500 trap-days)
- Provides numbers of animals caught and locations





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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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





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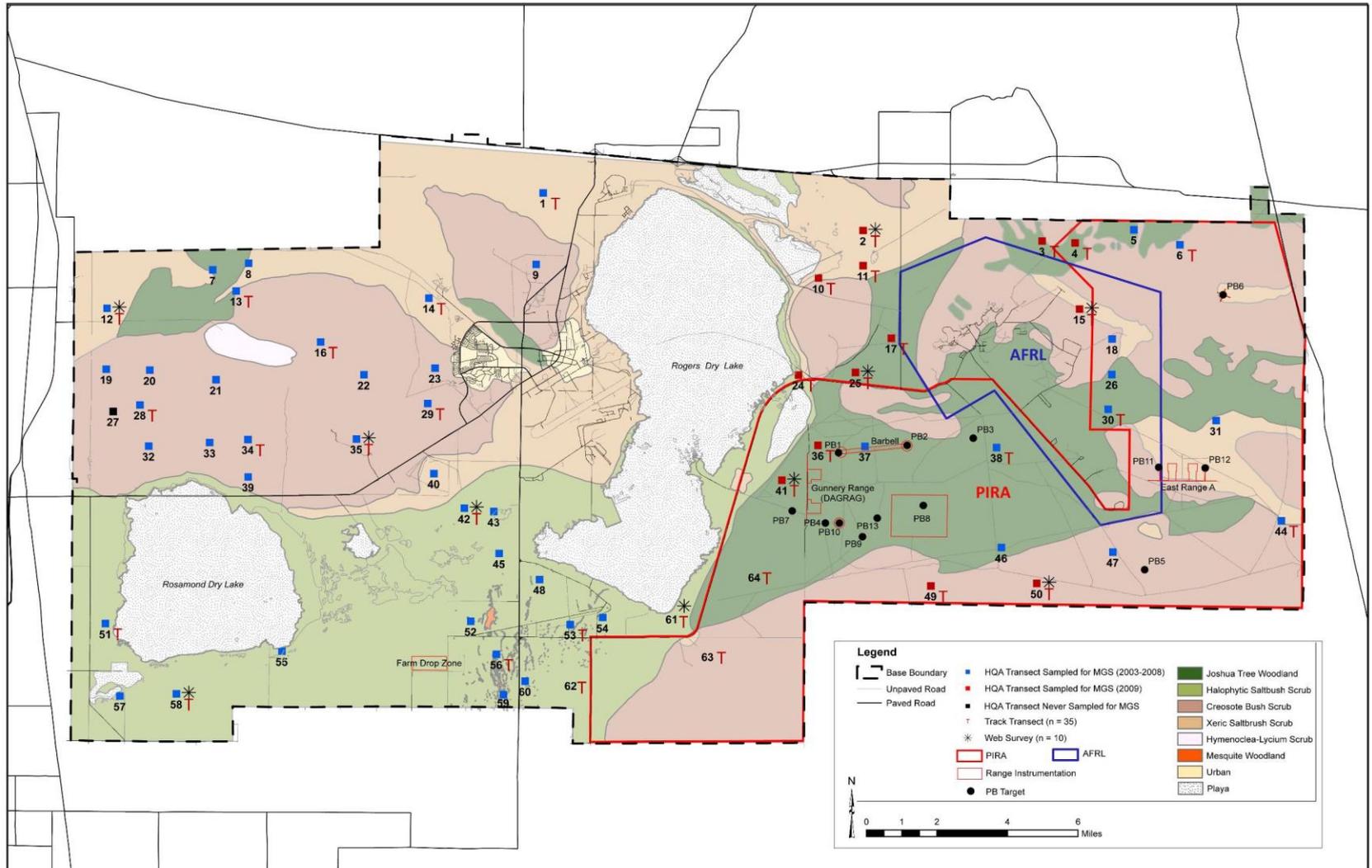
Allocation of Transects and Webs to Habitats

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

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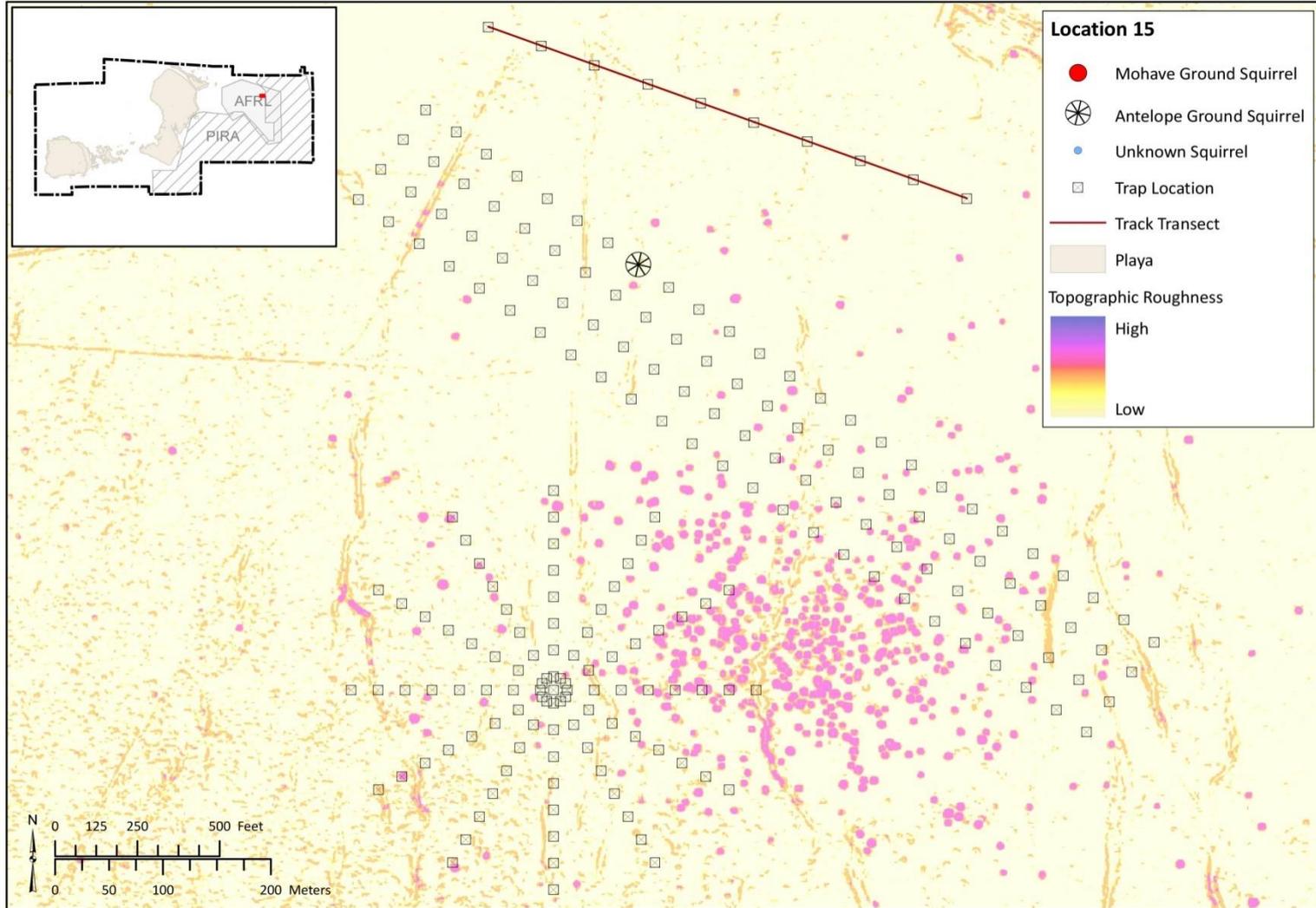


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Sampling Layout



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Occupancy - Track Identification



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Track Collection from Known Individuals



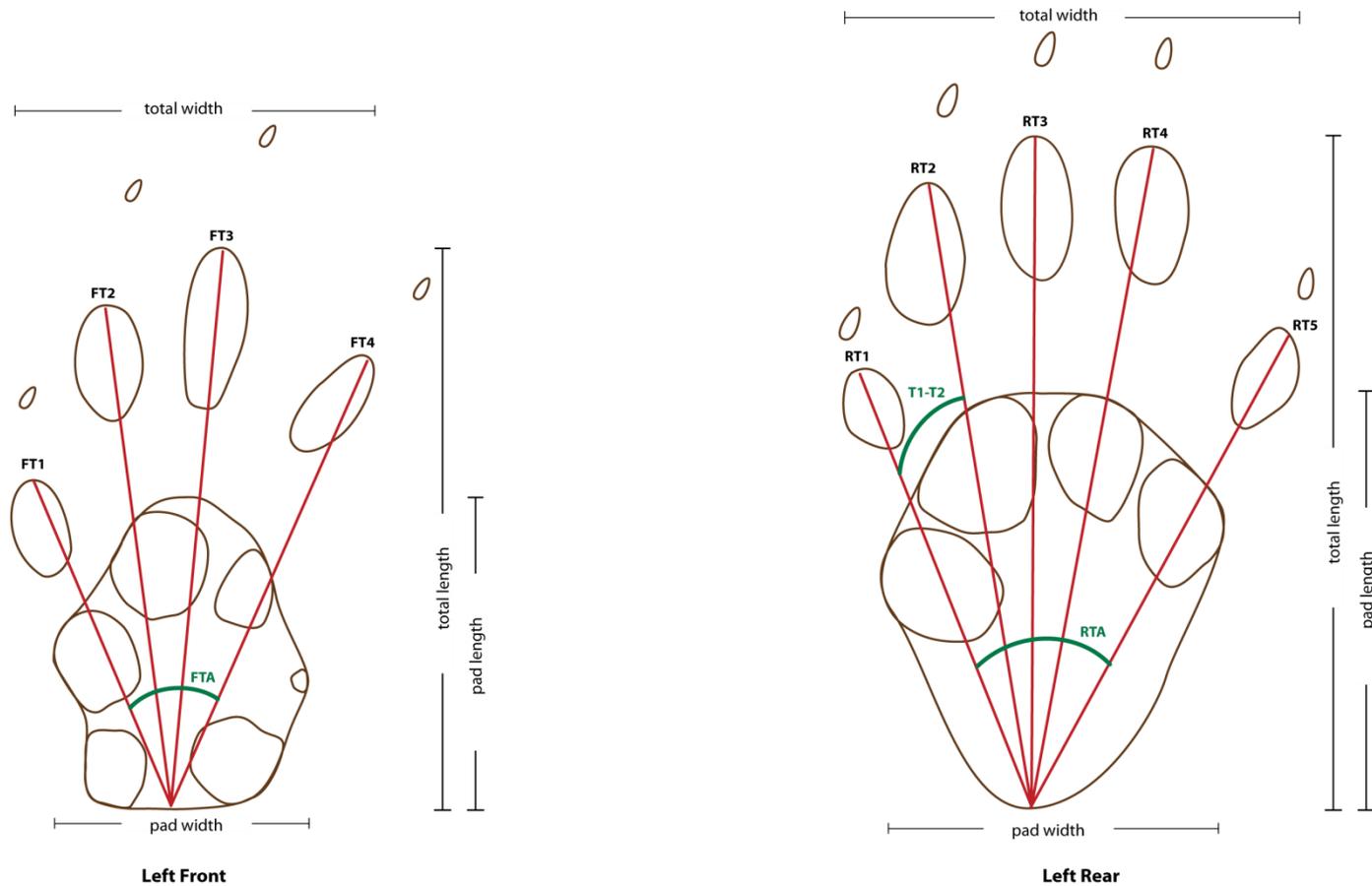
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Print Measurements

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Ground Squirrels (*Spermophilus* spp.)





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%
MGS (Actual)	2	10	83%
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

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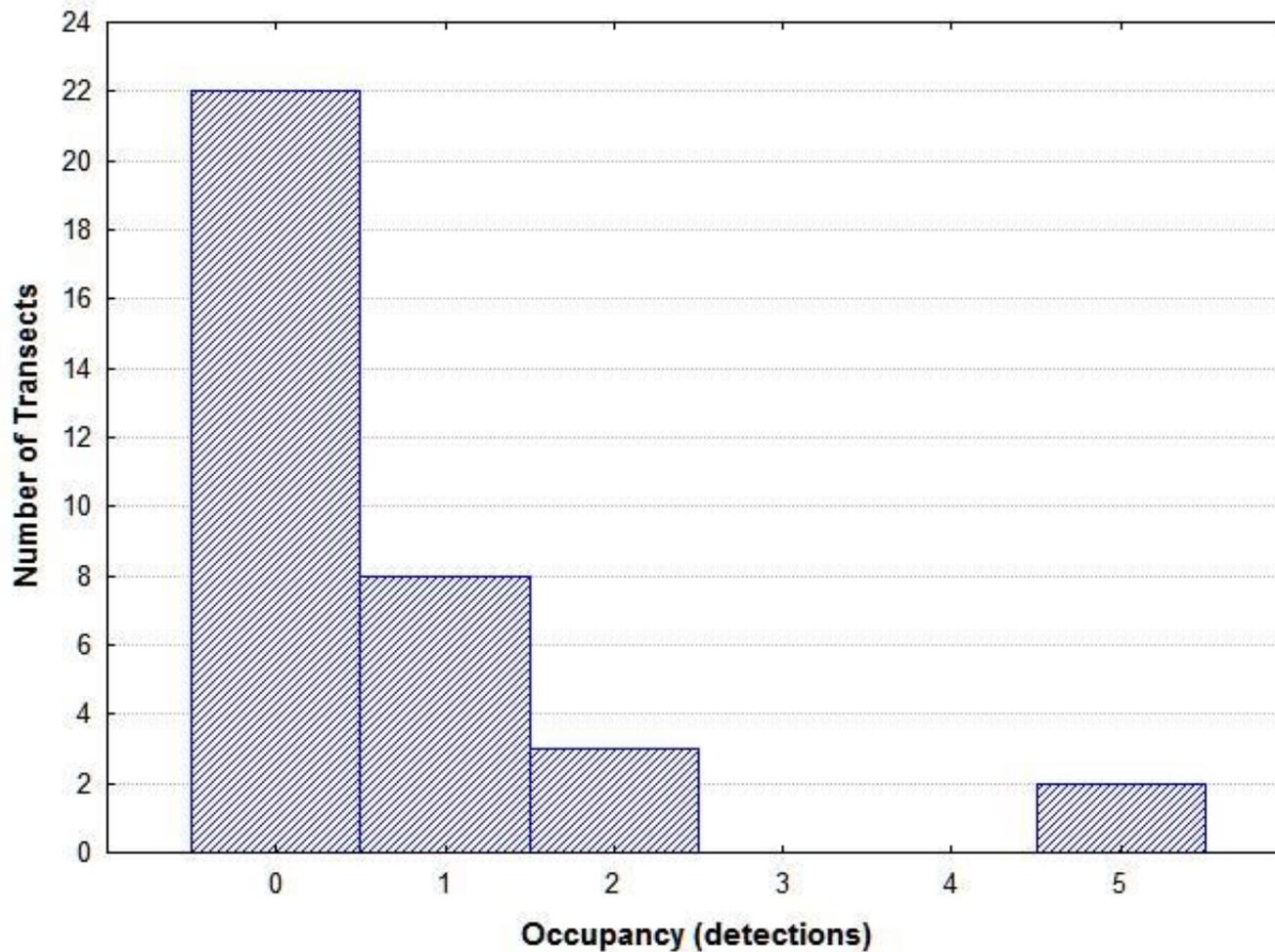
- 35 Transects: 10 stations spaced at 50 m intervals
- Each transect was read twice
- Measured multiple squirrel trails at each station
- Five predetermined measurements per footprint
- Photographs of tracks
- Expert guidance





Occupancy - Track Transects

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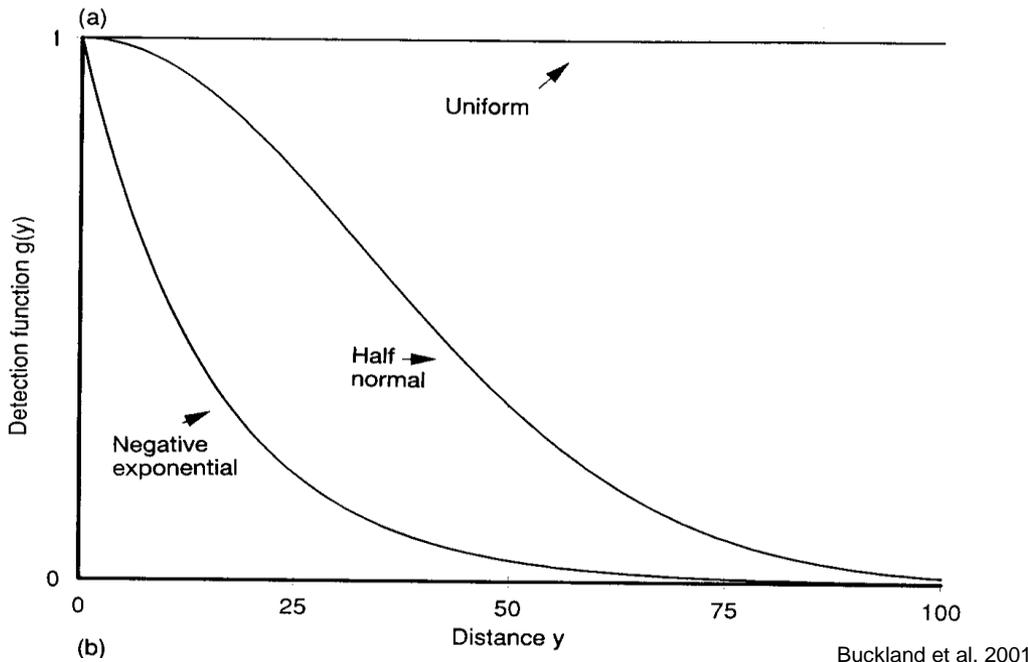


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Quantitative - Distance Sampling

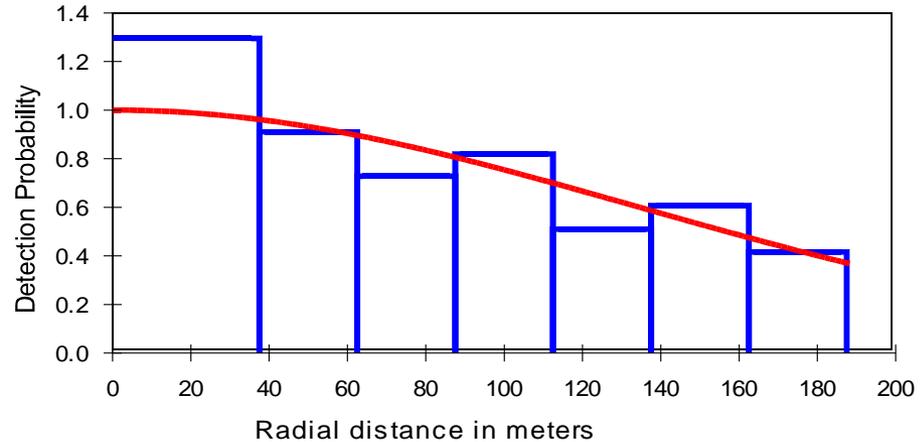
- Animals at center of web were captured with certainty
- Animal movement is stable
- Trap distances are measured accurately
- Sufficient animals are collected to estimate the detection function





DISTANCE results

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

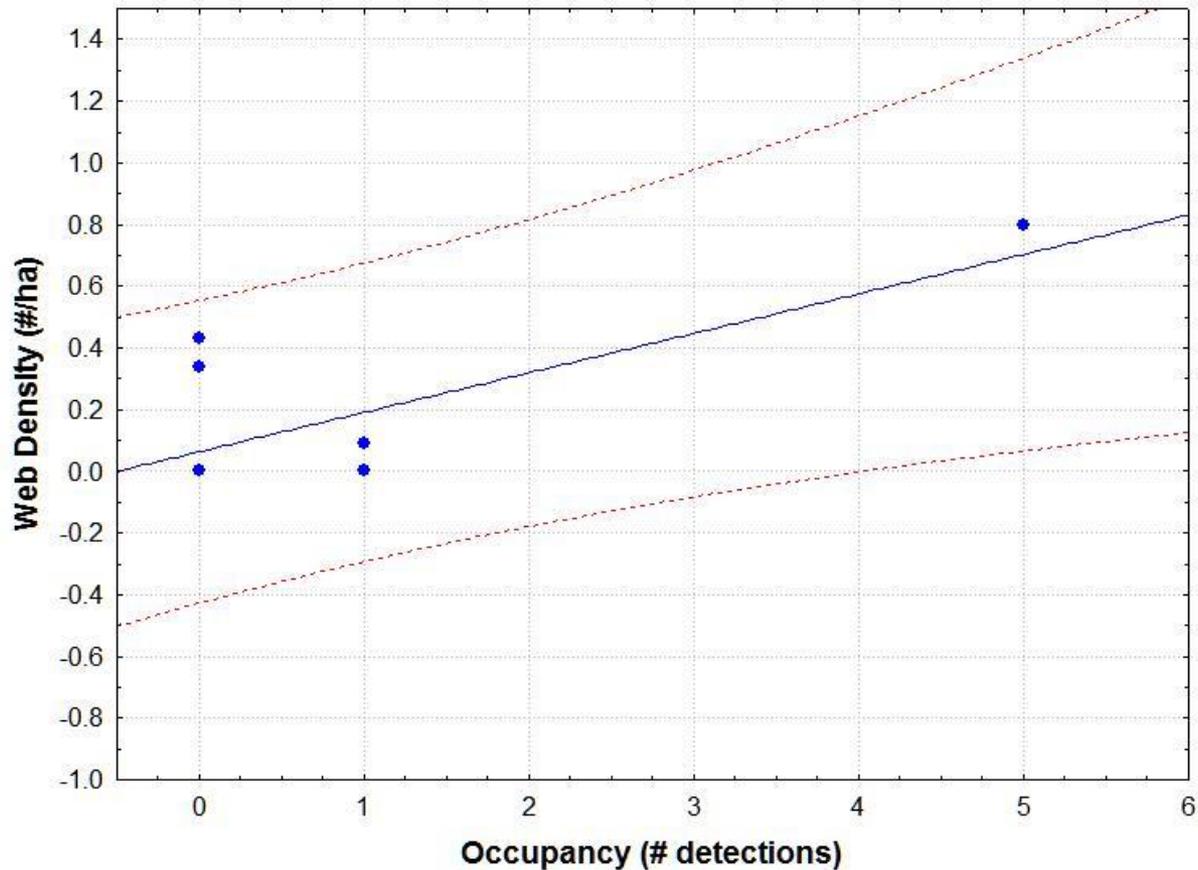


Web	Density (#/ha)	D (LCL)	D (UCL)	D CV	Probability of Detection	Effective Detection Radius (m)
2	0.09	0.06	0.13	0.22	0.63	149.33
25	0.34	0.22	0.53	0.22	0.63	149.33
41	0.43	0.28	0.66	0.22	0.63	149.33
61	0.80	0.52	1.23	0.22	0.63	149.33
Average	0.41	0.27	0.64	0.22	0.63	149.33



Density – Occupancy Relationship

- Assumes that Occupancy is proportional to Density





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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)



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
 - Do not require animals to be handled
 - Distinguish 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



Design Recommendations

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- 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.
 - Pre-bait transects
 - Increase the number of webs trapped.
 - Allocate proportionately more transects and webs to habitats that are more likely to support Mohave ground squirrel.
- Stratify samples based on potential plant associations (soils), slope, topography
- Re-evaluate trap spacing on webs
- Consider temporal spacing of trapping efforts