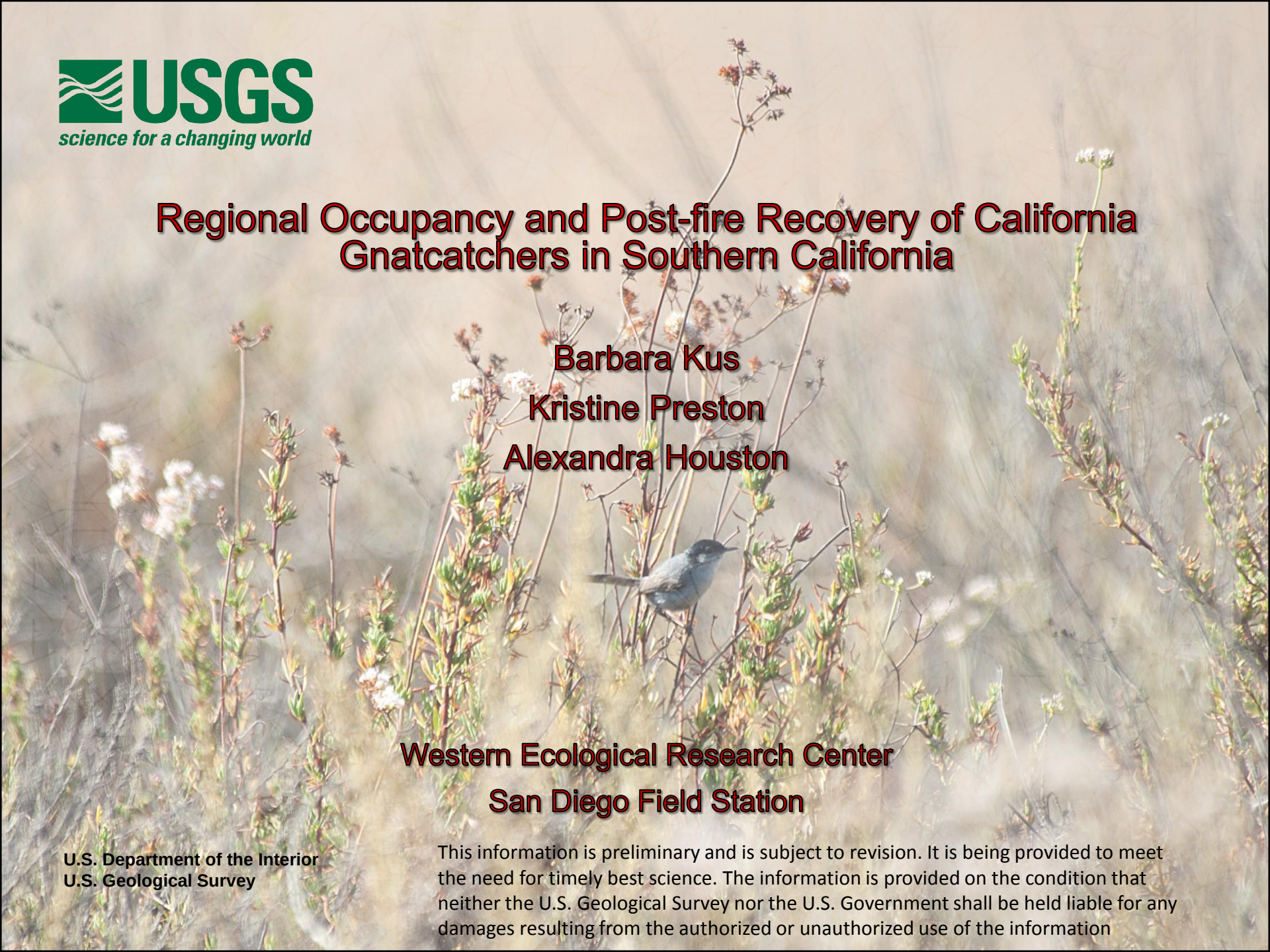


Regional Occupancy and Post-fire Recovery of California Gnatcatchers in Southern California

Barbara Kus

Kristine Preston

Alexandra Houston

Western Ecological Research Center

San Diego Field Station

U.S. Department of the Interior
U.S. Geological Survey

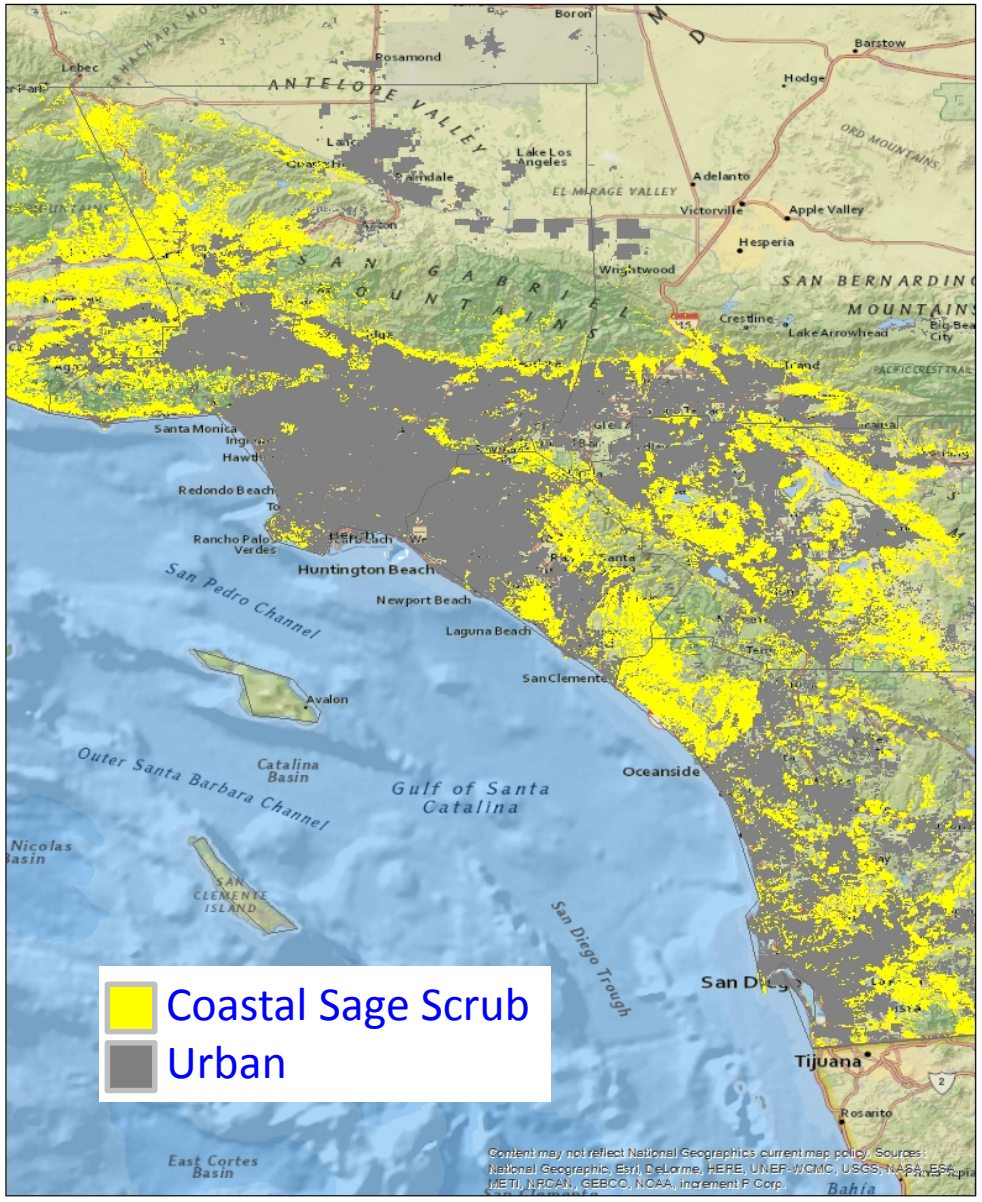
California Gnatcatcher

USGS

Preliminary Information-Subject to Revision.
Not for Citation

Threats:

- Habitat fragmentation
- Urbanization

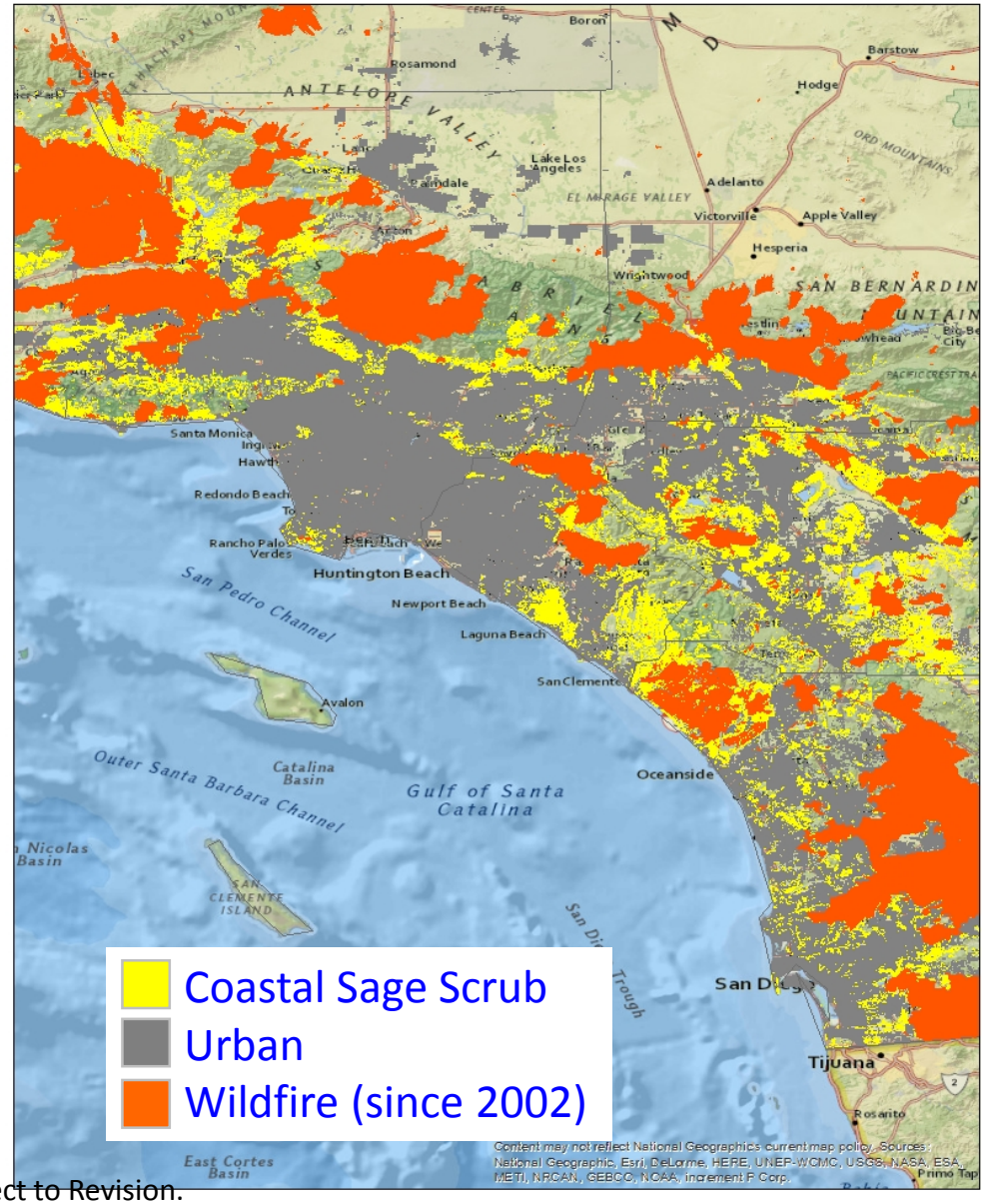


USGS

Preliminary Information-Subject to Revision.
Not for Citation

Threats:

- Habitat fragmentation
- Urbanization
- Wildfire



Preliminary Information-Subject to Revision.
Not for Citation

Outline of Presentation

- Brief history of project
- Methods
- Results
  - Gnatcatcher occupancy
  - Vegetation influences
- Summary and applications

Technical Workshop

Research and Monitoring Priorities for the California Gnatcatcher in the San Diego MSCP

July 18, 2013

San Diego, CA

Participants

Barbara Kus	USGS
Kristine Preston	SDMMP
Ron Rempel	SDMMP
Jon Atwood	Antioch University
Clark Winchell	USFWS
Paul Doherty	Colorado State Univ.

GOALS:

- Review findings of past studies
- Identify future research and monitoring priorities

Research Priorities

Primary Stressors:

- Fire: temporary loss of habitat
- Habitat degradation/conversion

Focus research on:

- Effect of fire on habitat and birds, with the goal of informing management before, during, and after fire

- How and where to rehabilitate CSS

- How to predict and detect response of CAGN to climate change

Workshop Recommendations

- Design a post-fire study to address habitat and CAGN recovery

- Continue occupancy monitoring -> **Regional**

- Improve habitat suitability model by integrating vegetation variables

- Improve efficiency of survey methods

Workshop Recommendations

- Design a post-fire study to address habitat and CAGN recovery

- Continue occupancy monitoring -> **Regional**

- Improve habitat suitability model by integrating vegetation variables

→ New Tool: Revised model

- Improve efficiency of survey methods

New Tool

New CAGN Habitat Suitability Model (Kris Preston, SDMMP)

Need: Existing model worked well for San Diego County, but not for other counties and more inland areas

- Partitioned Mahalanobis D2 statistical model for southern California
- Created in GIS using PRISM environmental (climate, topography) covariate data and the most recent available vegetation and land use layers and CAGN presence data (1,063 calibration points; USGS)
- 150 x 150m spatial scale
- Validated with 3,195 USFWS gnatcatcher locations
- Includes burn perimeters and attributes (time since fire, etc.) to guide post-fire monitoring at regional scale

Workshop Recommendations

- Design a post-fire study to address habitat and CAGN recovery → USGS, SDMMP

- Continue occupancy monitoring -> **Regional**

- Improve habitat suitability model by integrating vegetation variables → New Tool: Revised model

- Improve efficiency of survey methods → USGS, SDMMP, FWS, NCC

Post-fire Study

Goals:

- Evaluate recovery of CAGN and CSS habitat as a function of time since fire (2003, 2007, 2014)
- Relate CAGN occurrence to vegetation structure and composition
- Relate recovery of vegetation structure and composition to time since burn, previous land use, geographic location, and environmental conditions

Workshop Recommendations

- Design a post-fire study to address habitat and CAGN recovery → USGS, SDMMP
- Continue occupancy monitoring -> **Regional** → Workshop: Interest in Regional Monitoring (July 2014)
- Improve habitat suitability model by integrating vegetation variables → New Tool: Revised model
- Improve efficiency of survey methods → USGS, SDMMP, FWS, NCC

Workshop Recommendations

- Design a post-fire study to address habitat and CAGN recovery → USGS, SDMMP

- Continue occupancy monitoring -> **Regional** → Workshop: Interest in Regional Monitoring (July 2014); Workshop: Results of July 2014 workshop (Dec 2014)

- Improve habitat suitability model by integrating vegetation variables → New Tool: Revised model

- Improve efficiency of survey methods → USGS, SDMMP, FWS, NCC

Workshop Recommendations

- Design a post-fire study to address habitat and CAGN recovery → USGS, SDMMP → 

- Continue occupancy monitoring -> **Regional** → Workshop: Interest in Regional Monitoring (July 2014) → Workshop: Results of July 2014 workshop (Dec 2014) → Workshop: Protocol for Regional Monitoring (Jul 2015)

- Improve habitat suitability model by integrating vegetation variables → New Tool: Revised model → Workshop: Protocol for Regional Monitoring (Jul 2015)

- Improve efficiency of survey methods → USGS, SDMMP, FWS, NCC → Workshop: Protocol for Regional Monitoring (Jul 2015)

Workshop Recommendations

- Design a post-fire study to address habitat and CAGN recovery → USGS, SDMMP → 

- Continue occupancy monitoring -> **Regional** → Workshop: Interest in Regional Monitoring (July 2014) → Workshop: Results of July 2014 workshop (Dec 2014) → Workshop: Protocol for Regional Monitoring (Jul 2015) → Workshop: Training on data collection (Mar 2016)

- Improve habitat suitability model by integrating vegetation variables → New Tool: Revised model → Workshop: Protocol for Regional Monitoring (Jul 2015)

- Improve efficiency of survey methods → USGS, SDMMP, FWS, NCC → Workshop: Protocol for Regional Monitoring (Jul 2015)

Workshop Recommendations

- Design a post-fire study to address habitat and CAGN recovery → USGS, SDMMP

- Continue occupancy monitoring -> **Regional**

Workshop: Interest in Regional Monitoring (July 2014) → Workshop: Results of July 2014 workshop (Dec 2014) → Workshop: Protocol for Regional Monitoring (Jul 2015) → Workshop: Training on data collection (Mar 2016)

- Improve habitat suitability model by integrating vegetation variables → New Tool: Revised model

- Improve efficiency of survey methods → USGS, SDMMP, FWS, NCC

Regional Survey

Partners

4-S Ranch HOA
Angeles National Forest
Audubon California Starr Ranch
California Department of Fish and Wildlife
California Department of Parks and Recreation
Caltrans
Center for Natural Lands Management (CNLM)
City of Anaheim
City of Carlsbad
City of Chino Hills
City of Chula Vista
City of Escondido
City of Irvine
City of Laguna Niguel
City of Oceanside
City of Poway
City of San Diego - Parks Department
City of San Diego - Public Utilities
City of Thousand Oaks
City of Vista
City of Whittier
Conejo Open Space Conservation Agency
County of Los Angeles
County of Orange
County of San Diego
Endangered Habitats Conservancy
Fallbrook Land Conservancy
Fallbrook Public Utility
FED
Fond Land Preservation Foundation
Helix Water District
HG Fenton Environmental Lands LLC
Irvine Ranch Water District
Lakeview at Highlands Ranch HOA
Manzanita Partners LLC
Matt Witman
Mountains Recreation & Conservation Authority
Native Habitat Preservation Authority
Nature Reserves of Orange County (NCC)
Olivenhain Municipal Water District
Orange County Transportation Authority
Otay Ranch POM
Otay Water District
Palos Verdes NCCP
Ramona Municipal Water District
Rancho Mission Viejo
Rancho Santa Fe Lakes HOA
Rancho Simi Recreation and Park District
Riverside County Habitat Conservation Agency
Riverside County Parks
San Dieguito River Park
Sanitation Districts of Los Angeles County
Santa Monica Mountains Conservancy
Sweetwater Authority
The Environmental Trust
The Nature Conservancy
UC San Diego
US Bureau of Land Management
US Department of Defense
US National Park Service
US Forest Service
US Fish and Wildlife Service
US Geological Survey
Vallecitos Water District
WashPlan HCP Property
Western Riverside Co. Regional Conservation Authority
Western Riverside Co. Multi-Species Reserve

USGS

Partners

4-S Ranch HOA
Angeles National Forest
Audubo
Californ
Californ
Caltrans
Center f
City of A
City of C
City of C
City of C
City of E
City of Irvine
City of Laguna Niguel
City of Oceanside
City of Poway
City of San Diego - Parks Department
City of San Diego - Public Utilities
City of Thousand Oaks
City of Vista
City of Whittier
Conejo Open Space Conservation Agency
County of Los Angeles
County of Orange
County of San Diego
Endangered Habitats Conservancy
Fallbrook Land Conservancy
Fallbrook Public Utility
FED
Olivenhain Municipal Water District
Orange County Transportation Authority
Otay Ranch POM
Otay Water District
Palos Verdes NCCP
Ramona Municipal Water District
Rancho Mission Viejo
Rancho Santa Fe Lakes HOA
Rancho Simi Recreation and Park District
Riverside County Habitat Conservation Agency
Riverside County Parks
San Dieguito River Park
Sanitation Districts of Los Angeles County
Santa Monica Mountains Conservancy
Sweetwater Authority
The Environmental Trust
Conservancy
Land Management
ent of Defense
Park Service
rvice
Wildlife Service
l Survey
ater District
CP Property
Western Riverside Co. Regional Conservation Authority
Western Riverside Co. Multi-Species Reserve

Funding:

San Diego Association of Governments (Sandag)
California Department of Fish and Wildlife
U.S. Fish and Wildlife Service
Natural Communities Coalition


Alex Houston

USGS

Preliminary Information-Subject to Revision.
Not for Citation

Methods

Point Selection:

- Based on revised CAGN habitat suitability model
- Number of points based on analysis of sample sizes needed to detect change in occupancy (30%)
- Located on conserved and military lands
- Spatially balanced design
- Survey plots 150 x 150m
- Plots at least 600m apart (regional); 450 m (fire)

Methods

Number of Points:

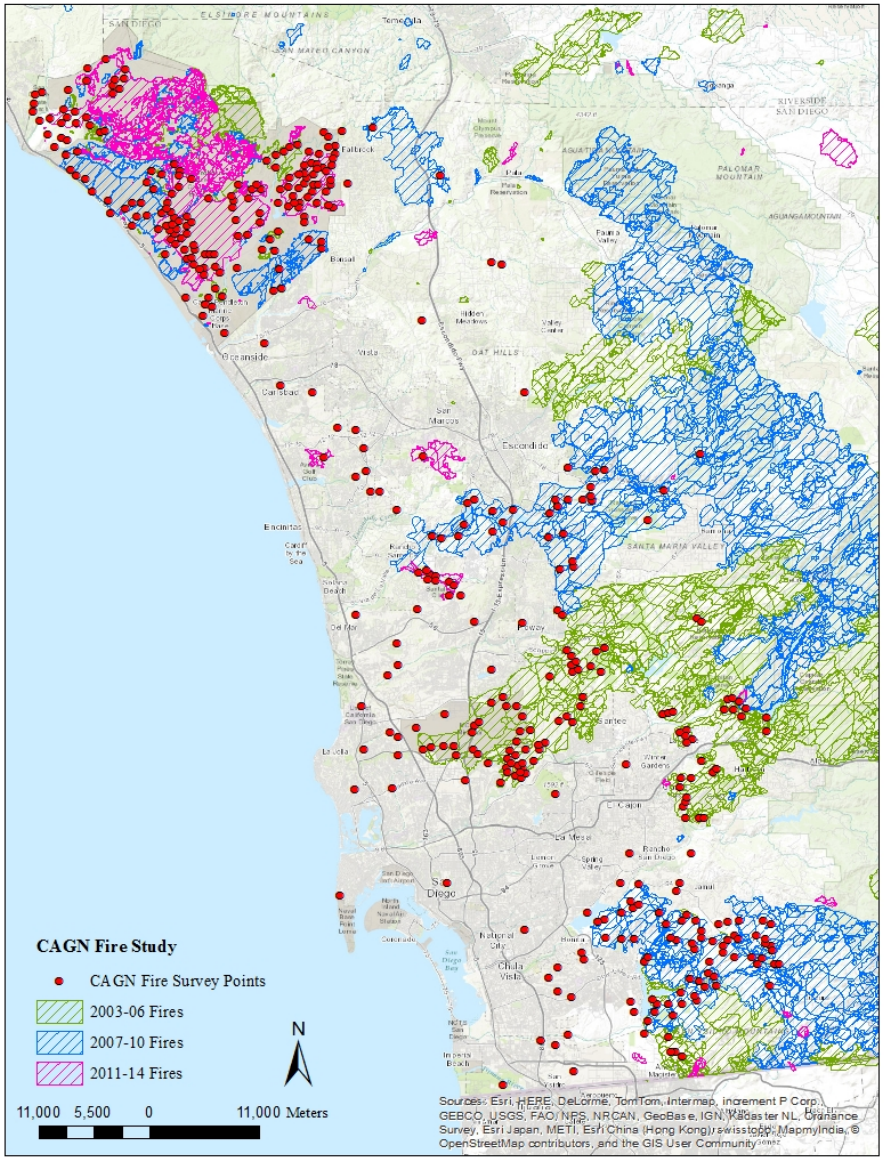
Fire Study (San Diego County)

	Fire Category				
	2003-2006	**2007**-2010	2011-**2014**	<2002 "unburned"	Total
2015	106	111	107		324
2016	107	111	106	103	427

Regional Occupancy Monitoring

	County						
	SD	OC	RV	LA	SB	VN	Total
2016	177	77	38	17	8	21	338

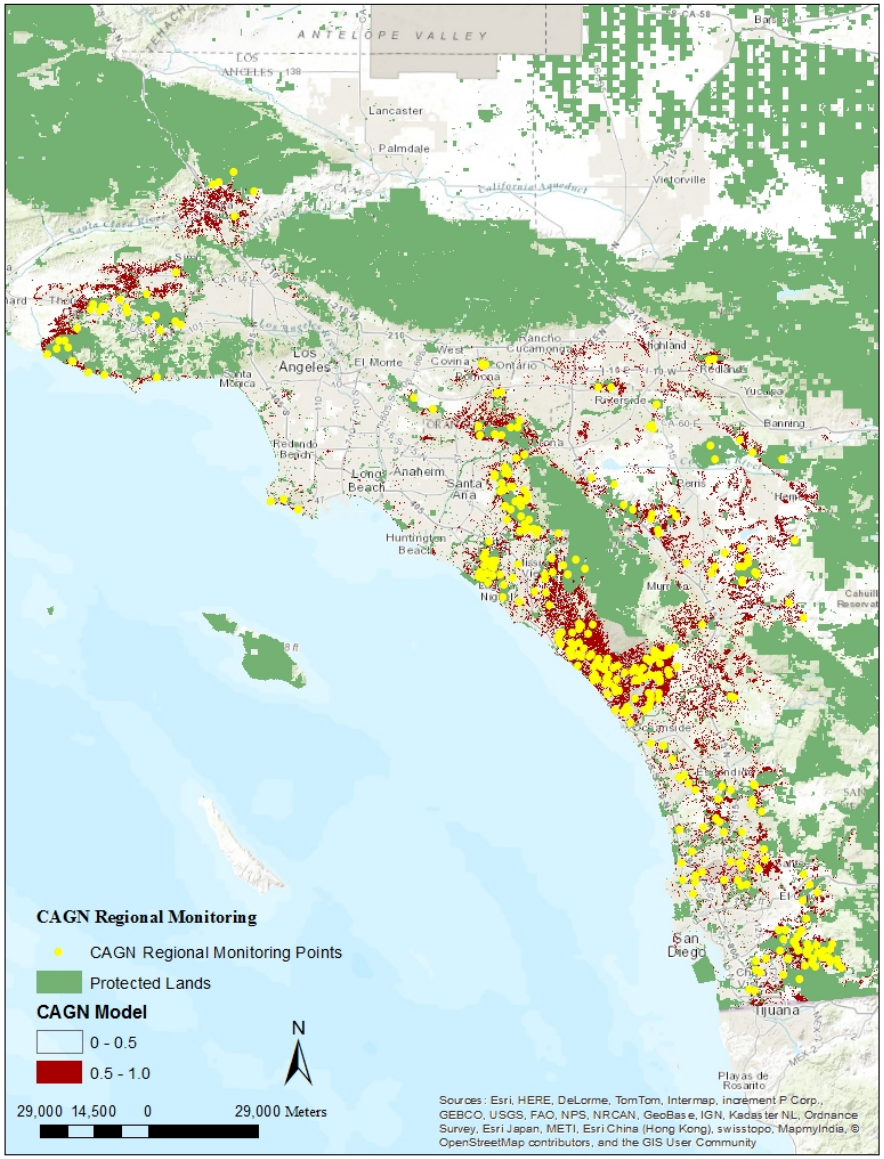
Post-fire Points



USGS

Preliminary Information-Subject to Revision.
Not for Citation

Regional Points



USGS

Preliminary Information-Subject to Revision.
Not for Citation

Overall Objectives

Use occupancy framework to calculate:

- Percent area occupied (PAO)
- Extinction rates
- Colonization rates

→ Bird Survey Protocol

Analyze effect of covariates:

- Vegetation variables
- Others

→ Vegetation Sampling Protocol

Standardized

Bird Survey Protocol

Timing and number of visits:

- 3 visits to each point
- Survey periods:
  - 15 – 31 March
  - 1-15 April
  - 16-30 April

Survey method:

- Area searches
- Broadcast CAGN song
- Survey length up to 45 minutes

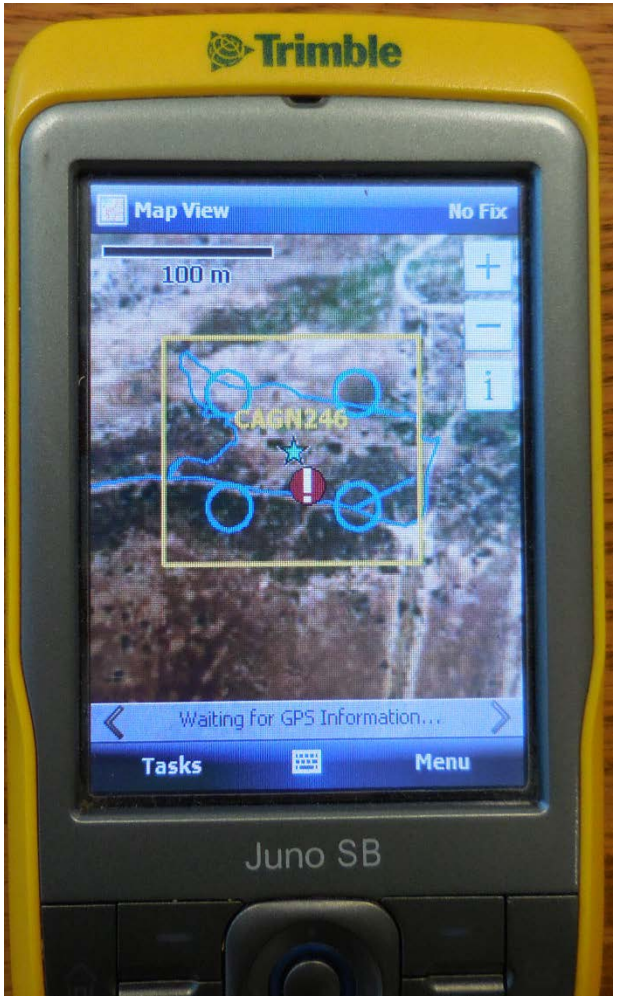
Vegetation Sampling Protocol

Timing:

- One visit per plot
- 1 May – 15 June

Sampling:

- Veg sampled in each of 4 circular plots
- Point-intercept method
- Hits at 2-m intervals along 2 30-m transects
- 32 points/circle x 4 =
- 128 points/plot



Vegetation Species

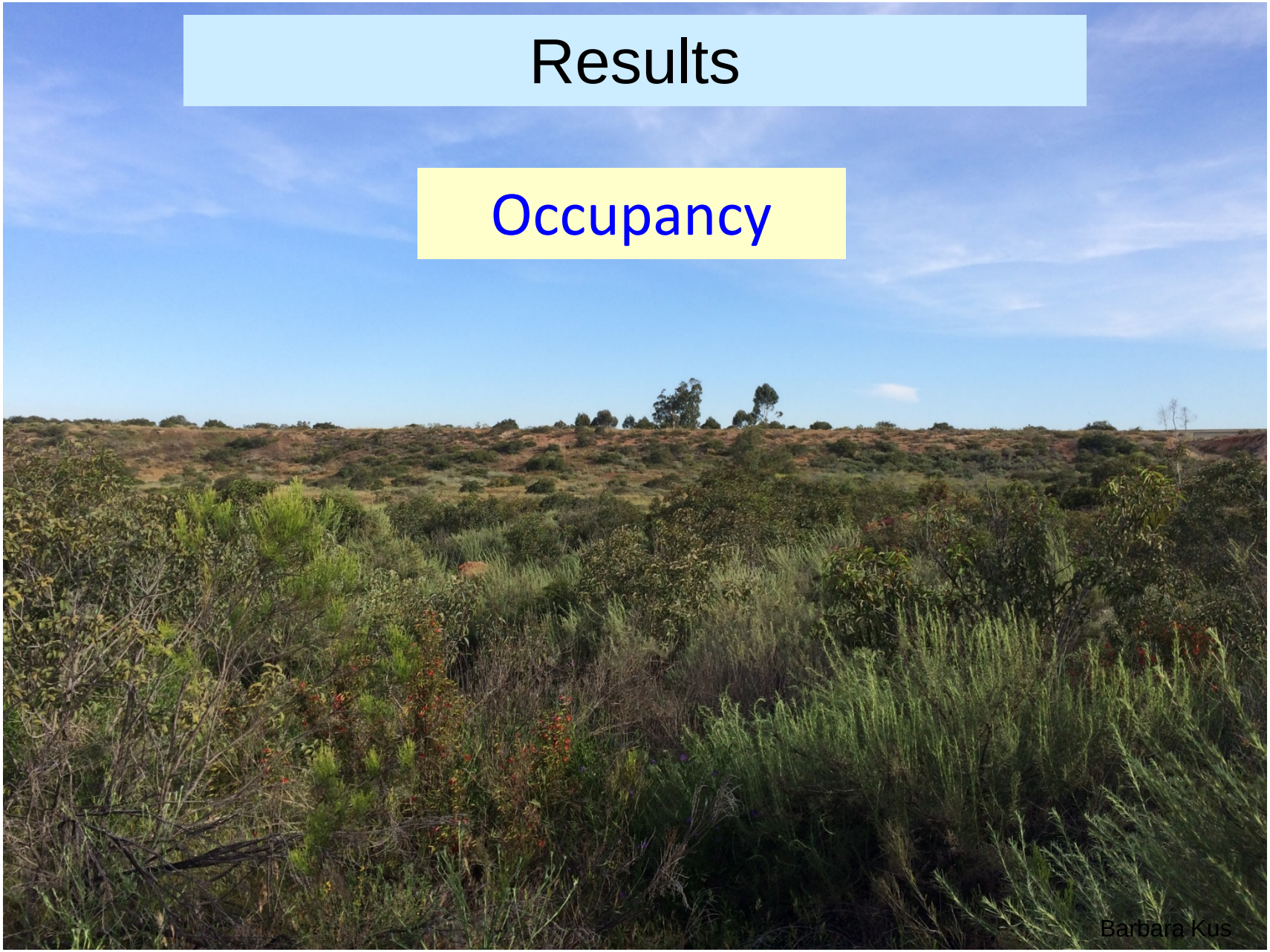
QUER	*Quercus spp.* (Oak species)
MALA	*Malosma laurina* – Laurel sumac
SAMX	*Sambucus mexicana* - Elderberry
RHIN	*Rhus integrifolia* – Lemonadeberry
CEAN	*Ceanothus spp* – Lilac species
ARCA	*Artemisia California* – California sagebrush
ERFA	*Eriogonum fasciculatum* – California buckwheat
ENCA	*Encelia californica* – Bush sunflower or California Encelia
ENFA	*Encelia farinosa* – Brittlebush
BALA	*Bahiopsis laciniata* - San Diego Sunflower
MAFA	*Malacothamnus fasciculatus* – Bushmallow
OPUN	*Opuntia/Cylindropuntia* spp. – Prickly pear/Cholla cactus species
SAAP	*Saliva apiana* – White sage
SAME	*Salvia mellifera* – Black sage
BAPI	*Baccharis pilularis* – Coyote bush
ACGL	*Acmispon glaber* – Deerweed
YUCC	*Hesperoyucca whipplei* – Our Lord's Candle – or *Yucca* spp.
DEAD	Dead shrub – entire shrub is dead
BRNI	*Brassica nigra* – Black mustard
CEME	*Centaurea melitensis* – Tocalote
CYCA	*Cynara cardunculus* – Artichoke thistle
FOVU	*Foeniculum vulgare* – Fennel
Grass	Non-native grasses
OTHER	**Other species not on list**

TREE: ≥ 2 m tall
SHRUB: < 2 m tall

USGS

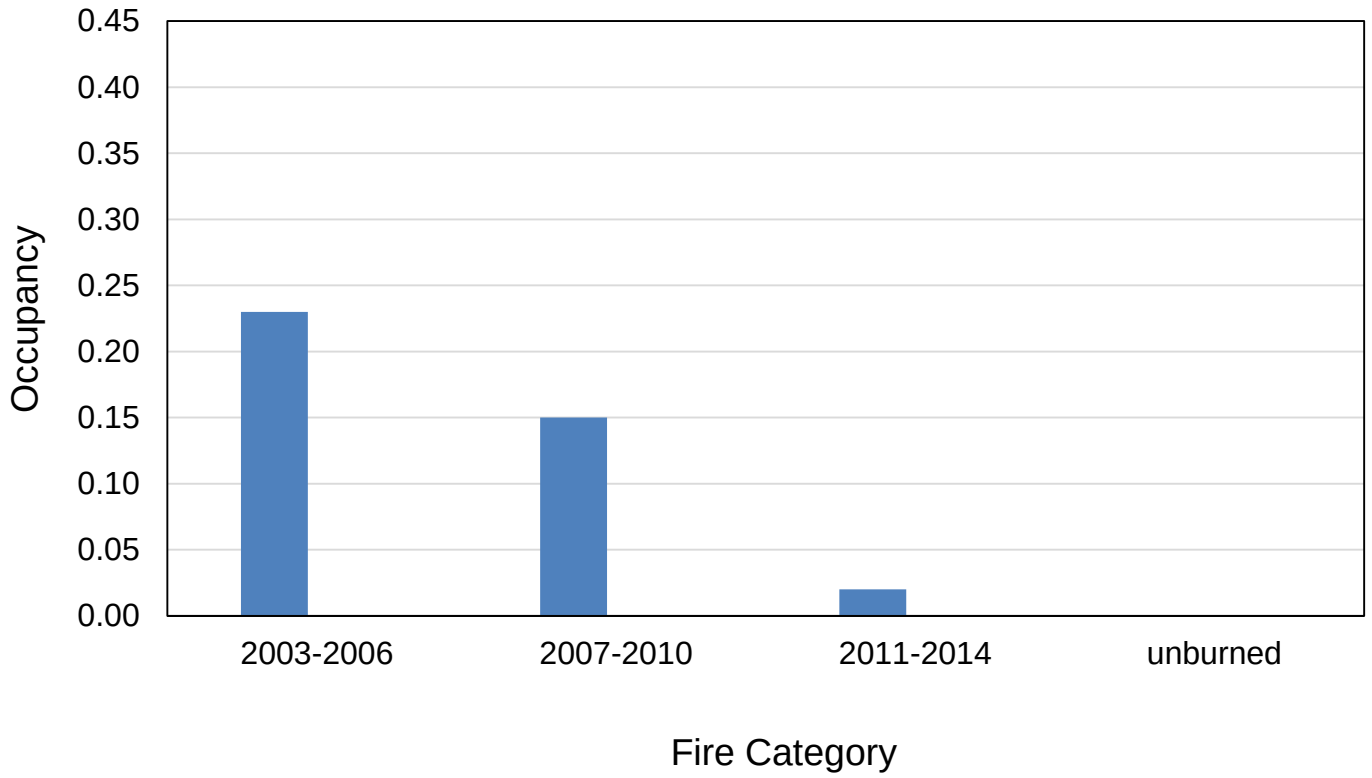
Results

Occupancy



Post-fire Occupancy 2015

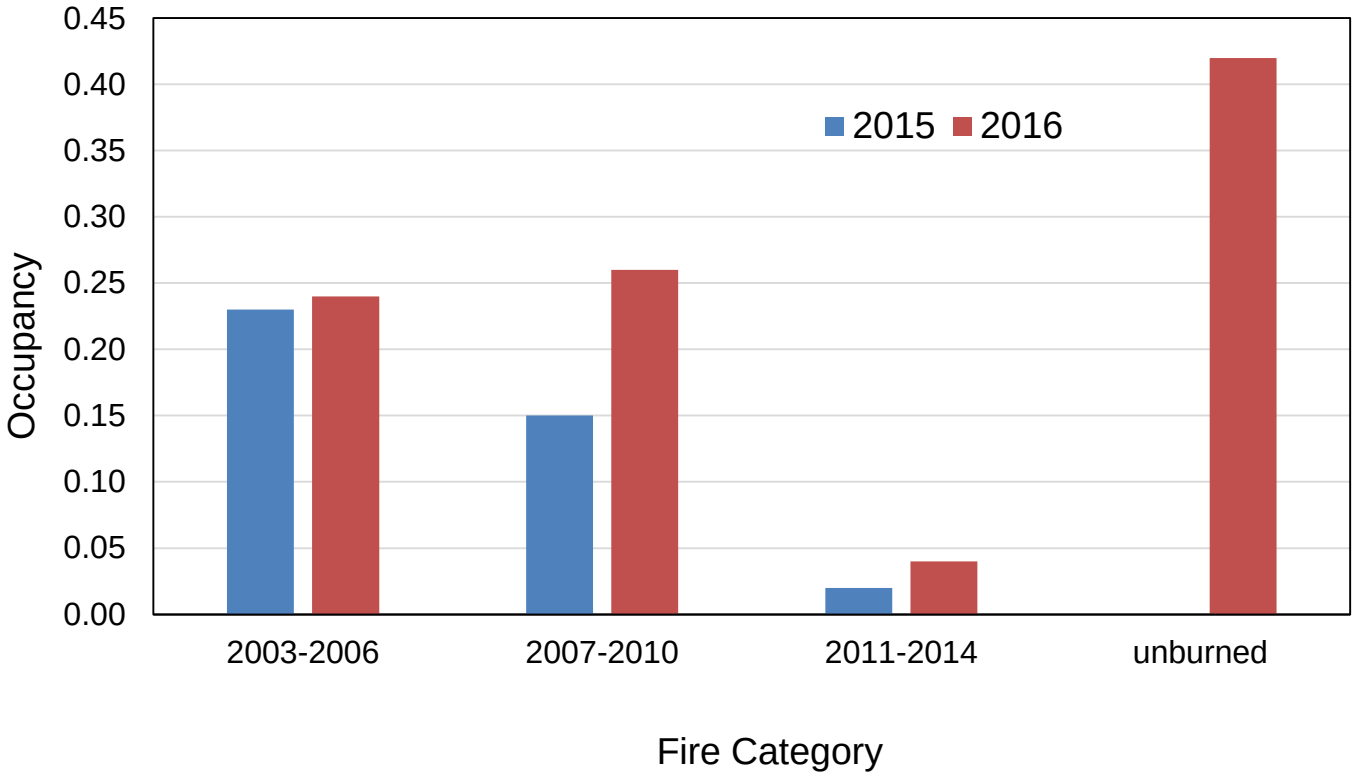
2015:
- Detectability = 0.66
- Occupancy = 0.14



Post-fire Occupancy 2015-2016

2015:
- Detectability = 0.66
- Occupancy = 0.14

2016:
- Detectability = 0.71
- Occupancy = 0.24



Regional Occupancy 2016

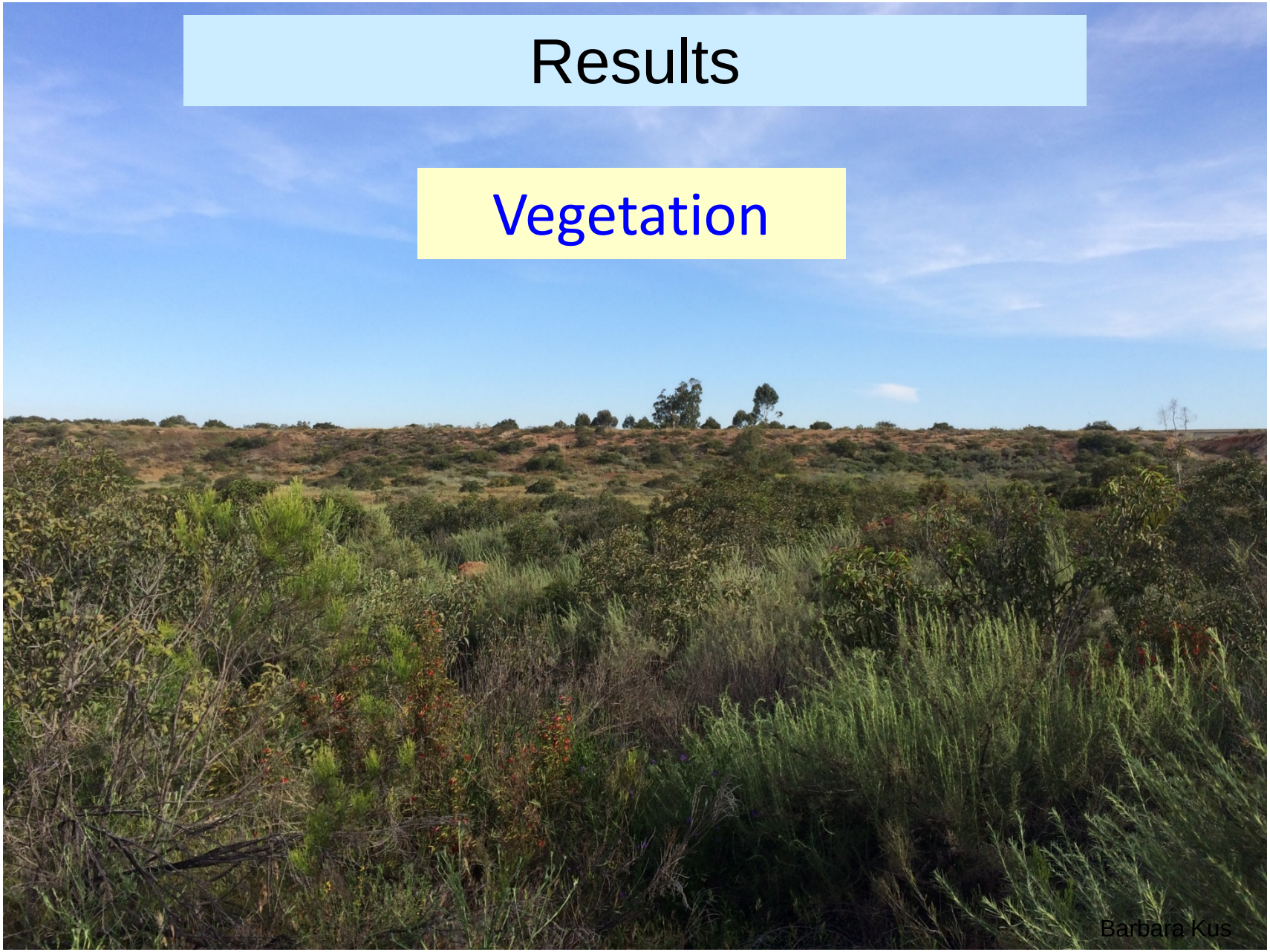
2016:

- Detectability: V1 = 0.60 V2 = 0.78 V3 = 0.59
- Occupancy = 0.23

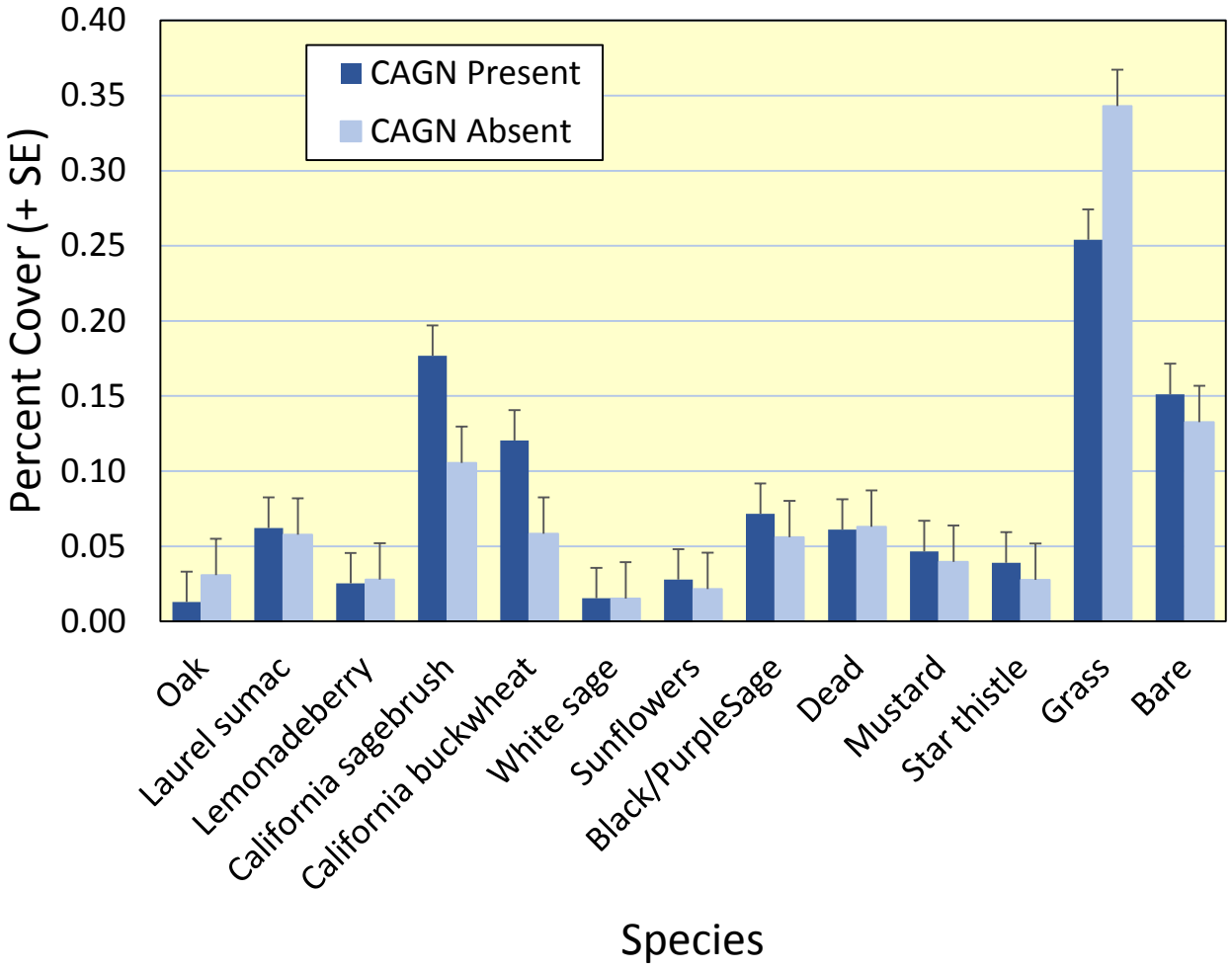
What factors influence occupancy?

Results

Vegetation



Vegetation Composition



18 variables:
cover ≤ 0.01

13 variables:
cover > 0.01

USGS

Preliminary Information-Subject to Revision.
Not for Citation

Principal Components Analysis

	RC1	RC2	RC3	RC4	RC5
Deerweed	-0.17	0.03	0.10	0.20	0.35
Chamise	0.02	0.04	0.06	-0.15	0.41
California sagebrush	0.23	0.25	0.41	0.37	-0.07
San Diego sunflower	-0.15	0.00	0.02	0.78	-0.13
Coyote bush	0.01	0.33	-0.20	-0.04	-0.22
Bare	0.09	-0.45	-0.39	-0.12	0.4
Sage spp.	0.85	0.00	0.04	-0.09	-0.10
Boulder	0.01	-0.32	-0.29	0.14	0.22
Mustard spp.	-0.24	0.07	-0.07	-0.06	-0.09
Cactus	0.05	0.12	0.07	0.02	0.04
Lilac spp.	0.06	-0.04	0.51	-0.08	0.22
Star thistle	-0.12	-0.08	0.64	0.03	0.00
Artichoke thistle	-0.14	0.06	-0.07	-0.10	-0.18
Dead	-0.15	0.12	0.15	0.48	0.28
California sunflower	0.27	-0.08	-0.08	0.10	-0.04
Brittlebush	0.01	-0.42	-0.37	0.32	0.27
California buckwheat	0.23	-0.05	0.19	0.54	-0.13
Fennel	-0.14	-0.02	0.05	-0.09	-0.33
Goldenbush	0.04	-0.01	0.06	-0.08	0.29
Non-native grasses	-0.61	-0.17	0.38	-0.03	-0.42
Bushmallow	0.25	0.07	0.10	-0.04	0.12
Laurel sumac	0.23	0.16	0.46	0.35	-0.04
Other Herb	-0.49	-0.17	0.21	0.06	-0.34
OtherTree/Shrub	0.08	0.62	0.02	-0.04	0.32
Pavement	-0.02	0.12	-0.24	-0.07	-0.07
Oak spp.	-0.08	0.50	-0.10	-0.08	0.20
Lemonadeberry	0.33	0.24	-0.11	0.03	-0.09
White sage	-0.07	-0.04	0.63	0.03	0.16
Purple sage	0.21	-0.04	0.08	-0.06	-0.06
Black sage	0.82	0.02	0.02	-0.07	-0.08
Mexican elderberry	-0.03	0.39	-0.18	0.11	-0.11
Shrub Height	0.36	0.48	0.12	0.12	0.01
Sunflowers	-0.01	-0.33	-0.26	0.79	0.11
Total Herb	-0.75	-0.19	0.30	-0.05	-0.44
Total Tree/Shrub	0.56	0.55	0.26	0.44	0.23
Tree Height	-0.11	0.60	-0.19	-0.17	0.06
Yucca spp.	-0.09	0.06	0.08	0.04	0.53
Variance	**0.10**	**0.07**	**0.07**	**0.07**	**0.06**

37%

USGS

Preliminary Information-Subject to Revision.
Not for Citation

Principal Components Analysis

RC1	RC2	RC3	RC4	RC5
+ black sage				
+ total shrub/tree				
- grass				
- total herb				
tall shrubs				

Principal Components Analysis

RC1	RC2	RC3	RC4	RC5
+ black sage	+ oak			
+ total shrub/tree	+ Mexican elderberry			
- grass	+ tree			
- total herb	+ total shrub/tree			
tall shrubs	tall shrub			
	tall tree			
	- California sunflower			
	- bare			

Principal Components Analysis

RC1	RC2	RC3	RC4	RC5
+ black sage	+ oak	+ California sagebrush		
+ total shrub/tree	+ Mexican elderberry	+ lilac spp.		
- grass	+ tree	+ star thistle		
- total herb	+ total shrub/tree	+ laurel sumac		
tall shrubs	tall shrub	+ white sage		
	tall tree	+ grass		
	- California sunflower	- brittlebush		
	- bare	- bare		

Principal Components Analysis

RC1	RC2	RC3	RC4	RC5
+ black sage	+ oak	+ California sagebrush	+ California sagebrush	
+ total shrub/tree	+ Mexican elderberry	+ lilac spp.	+ California buckwheat	
- grass	+ tree	+ star thistle	+ laurel sumac	
- total herb	+ total shrub/tree	+ laurel sumac	+ sunflower spp.	
tall shrubs	tall shrub	+ white sage	+ dead	
	tall tree	+ grass	+ total shrub/tree	
	- California sunflower	- brittlebush		
	- bare	- bare		

Principal Components Analysis

RC1	RC2	RC3	RC4	RC5
+ black sage	+ oak	+ California sagebrush	+ California sagebrush	+ chamise
+ total shrub/tree	+ Mexican elderberry	+ lilac spp.	+ California buckwheat	+ deerweed
- grass	+ tree	+ star thistle	+ laurel sumac	+ yucca spp.
- total herb	+ total shrub/tree	+ laurel sumac	+ sunflower spp.	+ bare
tall shrubs	tall shrub	+ white sage	+ dead	- grass
	tall tree	+ grass	+ total shrub/tree	- total herb
	- California sunflower	- brittlebush		
	- bare	- bare		

Principal Components Analysis

RC1	RC2	RC3	RC4	RC5
+ black sage	+ oak	+ California sagebrush	+ California sagebrush	+ chamise
+ total shrub/tree	+ Mexican elderberry	+ lilac spp.	+ California buckwheat	+ deerweed
- grass	+ tree	+ star thistle	+ laurel sumac	+ yucca spp.
- total herb	+ total shrub/tree	+ laurel sumac	+ sunflower spp.	+ bare
tall shrubs	tall shrub	+ white sage	+ dead	- grass
	tall tree	+ grass	+ total shrub/tree	- total herb
	- California sunflower	- brittlebush		
	- bare	- bare		

Physical Variables

- Distance to coast
- Elevation
- Slope
- Last fire

AIC Model Selection

Model	AICc	Delta AICc	AICc Weights	Model Likelihood	Number Parameters	Deviance
{psi(erfa+arca+tothrb+tottre+tottre2+lastfire+lastfire2) p(.)}	550.4821	0	0.25488	1	9	531.9071
{psi(erfa+arca+tothrb+tottre+tottre2+shrbht+lastfire+lastfire2) p(.)}	551.0877	0.6056	0.18829	0.7387	10	530.3826
{psi(erfa+arca+tothrb+tothrb2+tottre+tottre2+lastfire+lastfire2) p(.)}	552.1305	1.6484	0.11179	0.4386	10	531.4254
{psi(erfa+arca+tothrb+tottre+tottre2+shrbht+lastfire) p(.)}	552.2265	1.7444	0.10655	0.418	9	533.6515
{psi(erfa+arca+tothrb+tottre+tottre2+lastfire) p(.)}	552.3366	1.8545	0.10084	0.3956	8	535.878
{psi(erfa+arca+tothrb+tothrb2+tottre+tottre2+shrbht+lastfire+lastfire2) p(.)}	552.6567	2.1746	0.08593	0.3371	11	529.8078
{psi(erfa+arca+tothrb+tottre+shrbht+lastfire) p(.)}	553.5233	3.0412	0.05571	0.2186	8	537.0647
{psi(erfa+arca+tothrb+tottre+lastfire) p(.)}	554.4466	3.9645	0.03511	0.1378	7	540.0911
{psi(erfa+arca+tothrb+tottre+shrbht+dead+lastfire) p(.)}	555.1404	4.6583	0.02482	0.0974	9	536.5653
{psi(erfa+sunfl+arca+tothrb+tottre+lastfire) p(.)}	555.5042	5.0221	0.02069	0.0812	8	539.0456
[Plus 50 more models]						

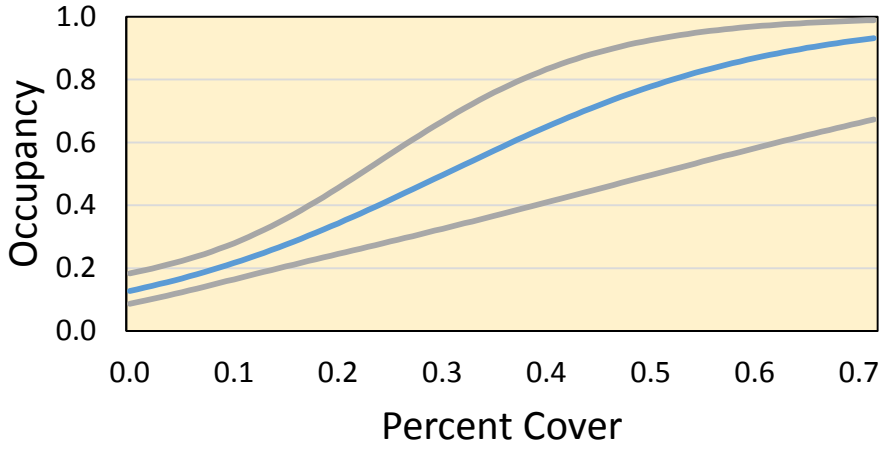
AIC Model Selection

Model	AICc	Delta AICc	AICc Weights	Model Likelihood	Number Parameters	Deviance
{psi(erfa+arca+tothrb+tottre+tottre2+lastfire+lastfire2) p(.)}	550.4821	0	0.25488	1	9	531.9071
{psi(erfa+arca+tothrb+tottre+tottre2+shrbht+lastfire+lastfire2) p(.)}	551.0877	0.6056	0.18829	0.7387	10	530.3826
{psi(erfa+arca+tothrb+tothrb2+tottre+tottre2+lastfire+lastfire2) p(.)}	552.1305	1.6484	0.11179	0.4386	10	531.4254
{psi(erfa+arca+tothrb+tottre+tottre2+shrbht+lastfire) p(.)}	552.2265	1.7444	0.10655	0.418	9	533.6515
{psi(erfa+arca+tothrb+tottre+tottre2+lastfire) p(.)}	552.3366	1.8545	0.10084	0.3956	8	535.878
{psi(erfa+arca+tothrb+tothrb2+tottre+tottre2+shrbht+lastfire+lastfire2) p(.)}	552.6567	2.1746	0.08593	0.3371	11	529.8078
{psi(erfa+arca+tothrb+tottre+shrbht+lastfire) p(.)}	553.5233	3.0412	0.05571	0.2186	8	537.0647
{psi(erfa+arca+tothrb+tottre+lastfire) p(.)}	554.4466	3.9645	0.03511	0.1378	7	540.0911
{psi(erfa+arca+tothrb+tottre+shrbht+dead+lastfire) p(.)}	555.1404	4.6583	0.02482	0.0974	9	536.5653
{psi(erfa+sunfl+arca+tothrb+tottre+lastfire) p(.)}	555.5042	5.0221	0.02069	0.0812	8	539.0456
[Plus 50 more models]						

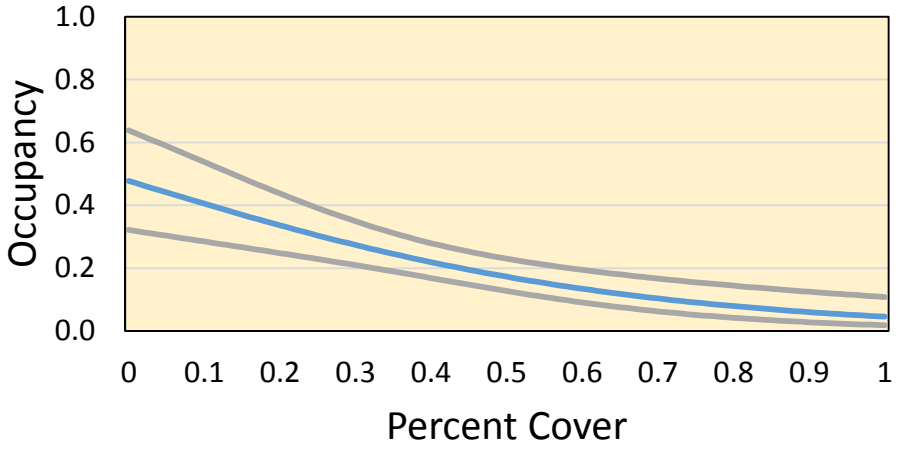
Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Total herbaceous (-)
- Shrub height (+)
- Total shrub/tree (+)
- Time since last fire (+)

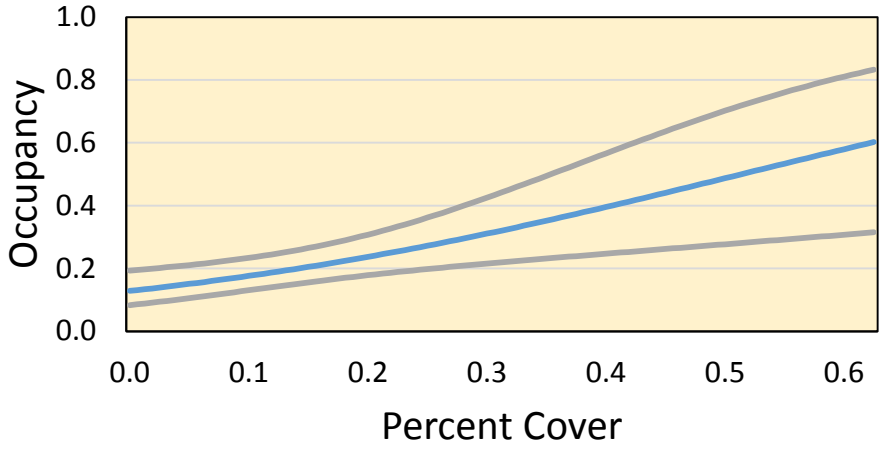
California Buckwheat



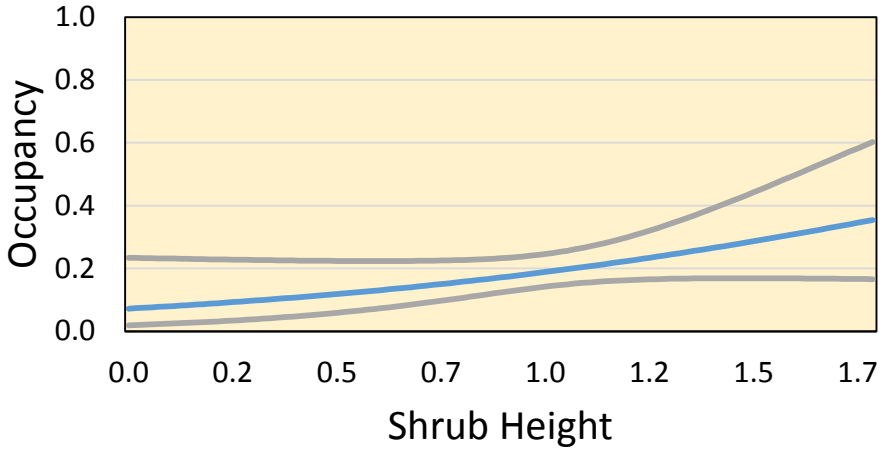
Total Herbaceous Cover



California Sagebrush

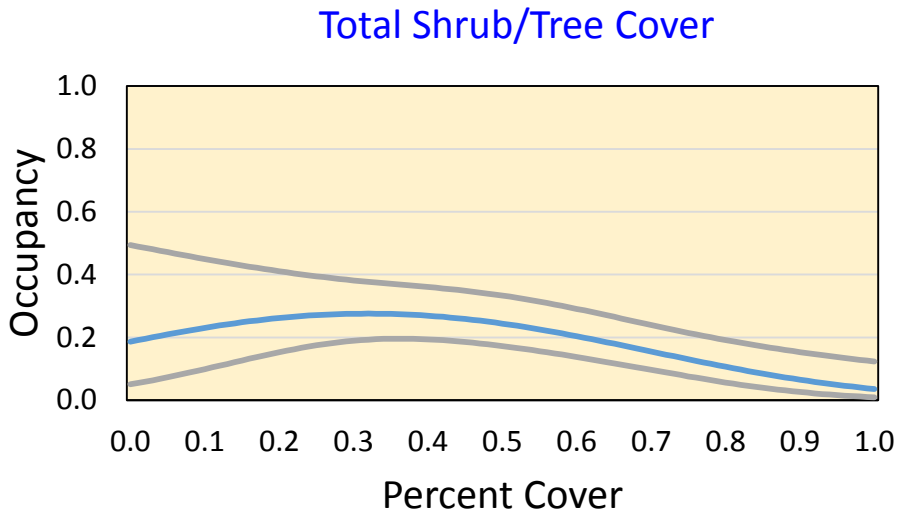


Shrub Height

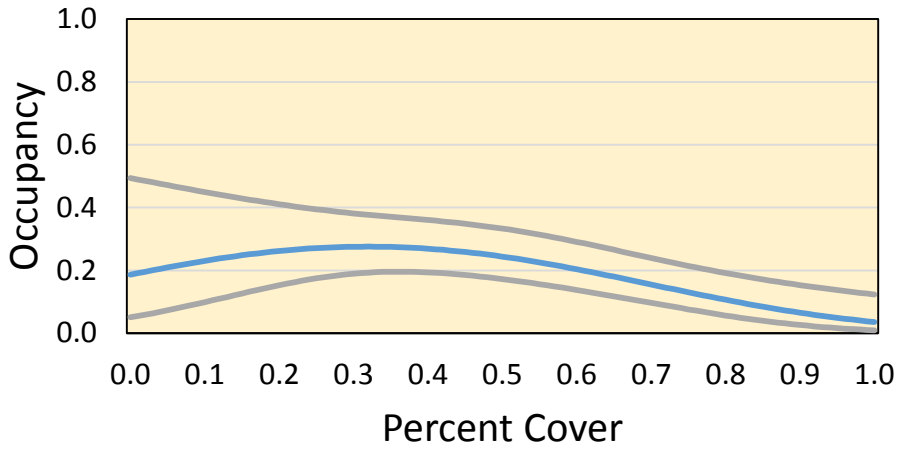


USGS

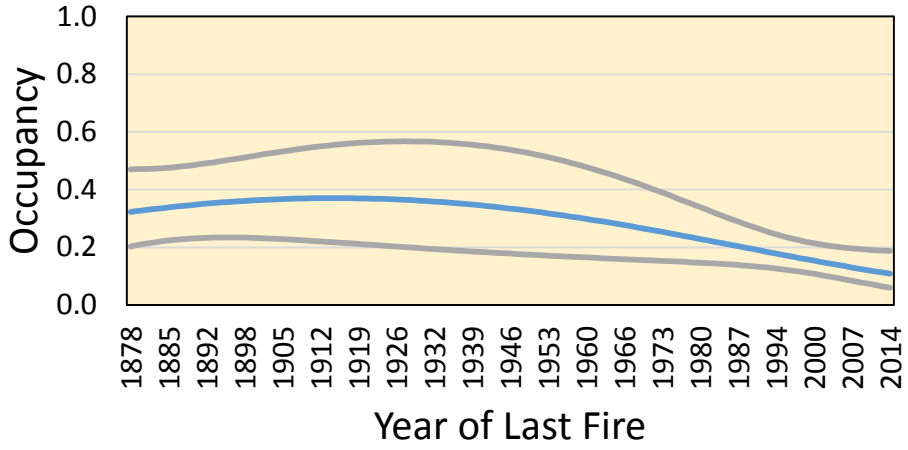
Preliminary Information-Subject to Revision.
Not for Citation



Total Shrub/Tree Cover



Last Fire



Models without Physical Variables

Occupancy a function of:

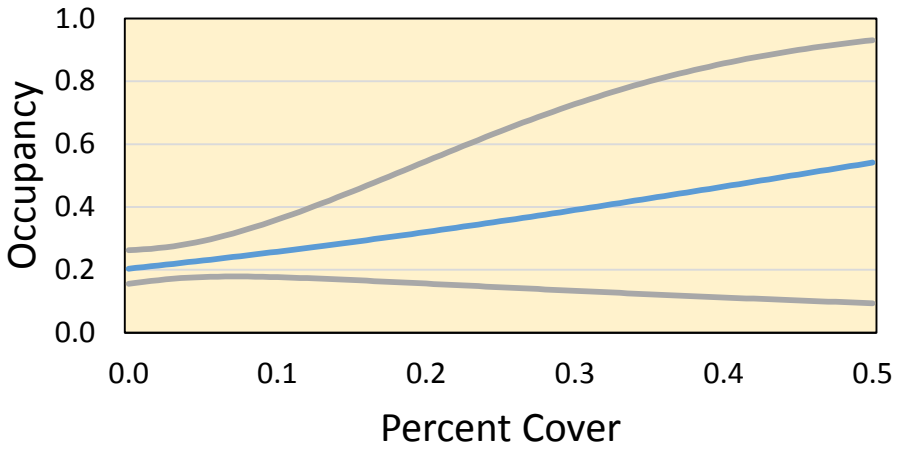
- California sagebrush (+)
- California buckwheat (+)
- Total shrub/tree (+)
- Sunflower (+)
- Laurel sumac (-)
- Dead (-)

Models without Physical Variables

Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Total shrub/tree (+)
- Sunflower (+)
- Laurel sumac (-)
- Dead (-)

Sunflower spp.

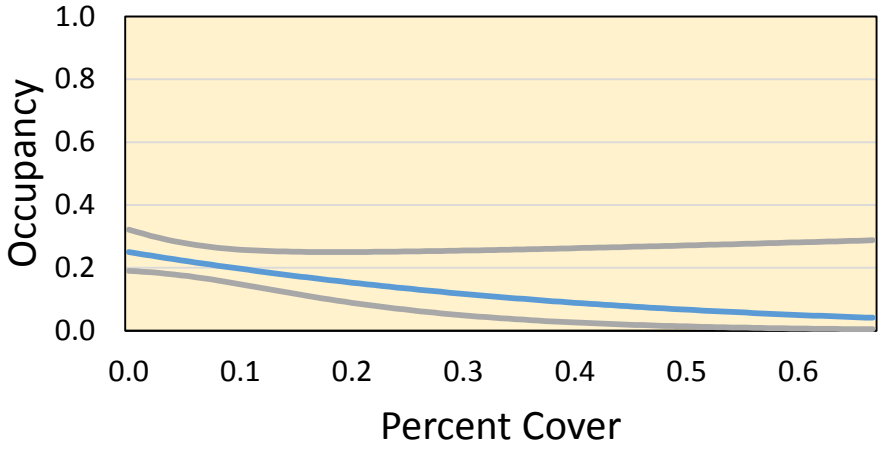


Models without Physical Variables

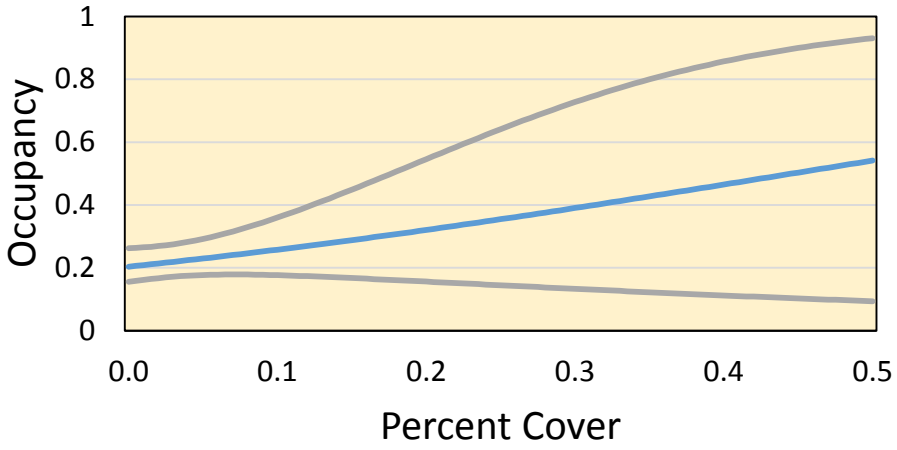
Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Total shrub/tree (+)
- Sunflower (+)
- Laurel sumac (-)
- Dead (-)

Laurel Sumac



Sunflower spp.

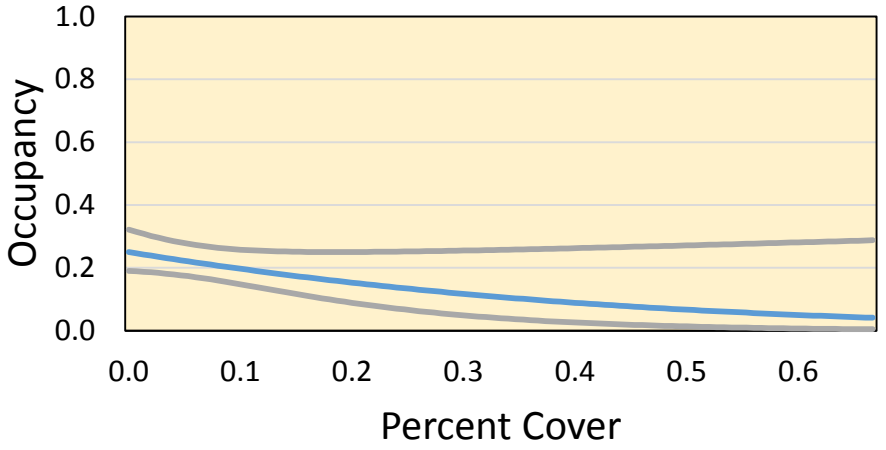


Models without Physical Variables

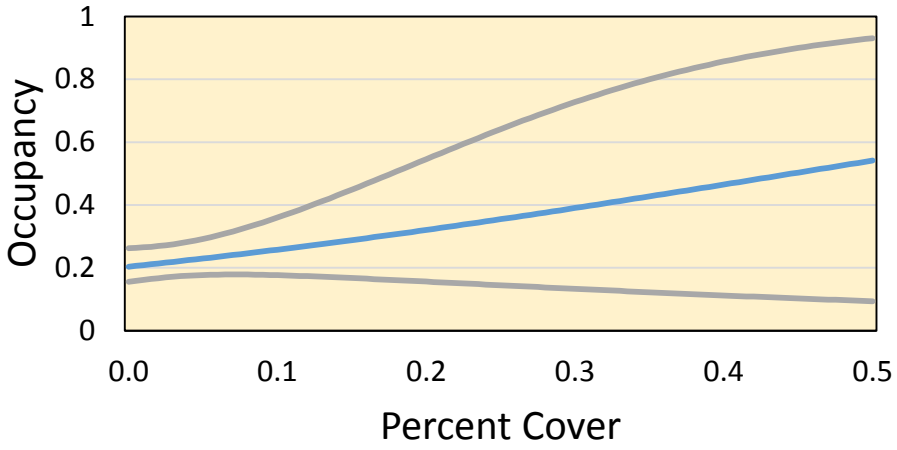
Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Total shrub/tree (+)
- Sunflower (+)
- Laurel sumac (-)
- Dead (-)

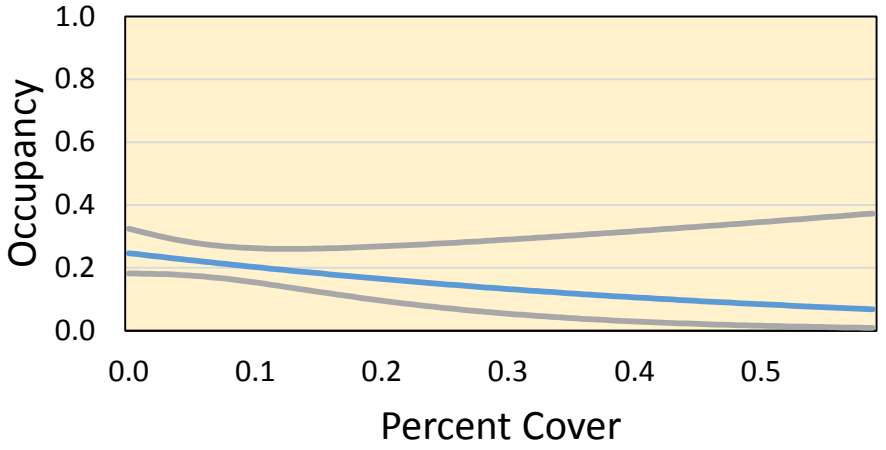
Laurel Sumac



Sunflower spp.



Dead



USGS

Preliminary Information-Subject to Revision.
Not for Citation

Summary

We now have:

- A standardized, question-based protocol for monitoring California gnatcatchers and CSS habitat region-wide
- A large, engaged partner base
- Baseline for analyzing trends in occupancy, colonization and extinction
- Data from which targets for habitat restoration and management can be derived and applied


Thank-you!