

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

Barbara Kus  
Kristine Preston  
Alexandra Houston

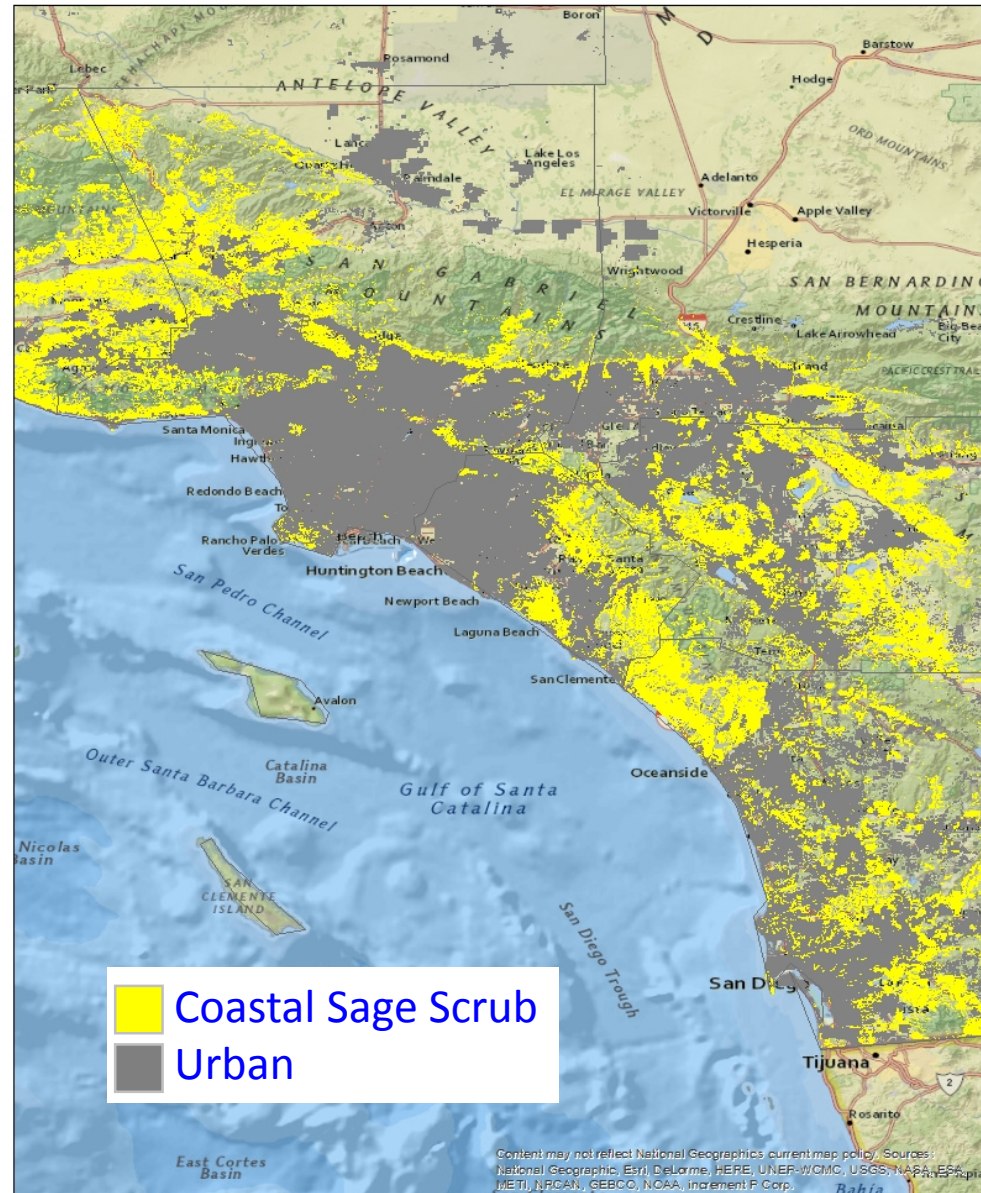
Western Ecological Research Center  
San Diego Field Station





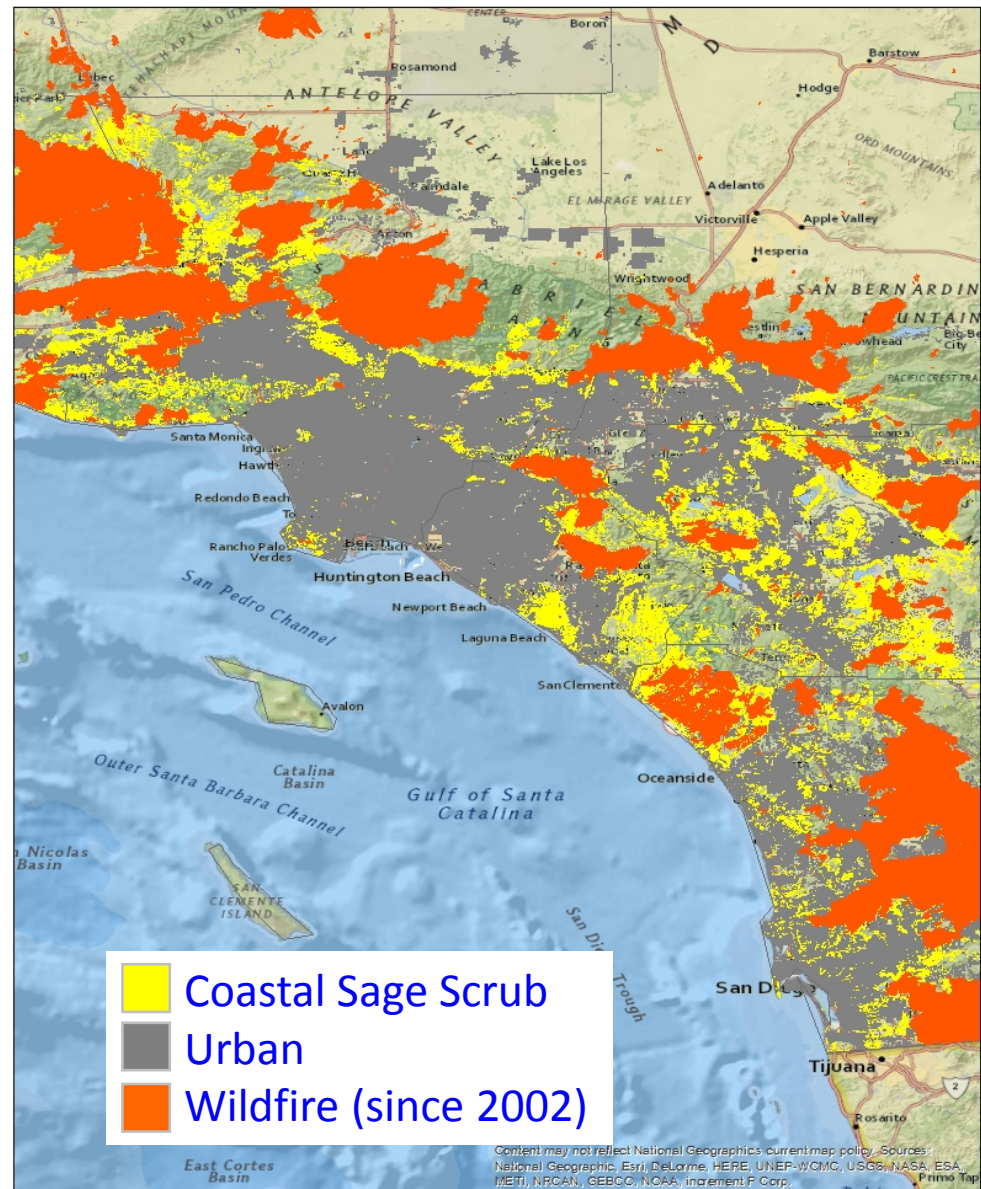
## Threats:

- Habitat fragmentation
- Urbanization



## Threats:

- Habitat fragmentation
- Urbanization
- Wildfire



# Outline of Presentation

- Brief history of project
- Methods
- Results
  - Gnatcatcher occupancy
    - Post-fire
    - Regional, subregional
  - 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





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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

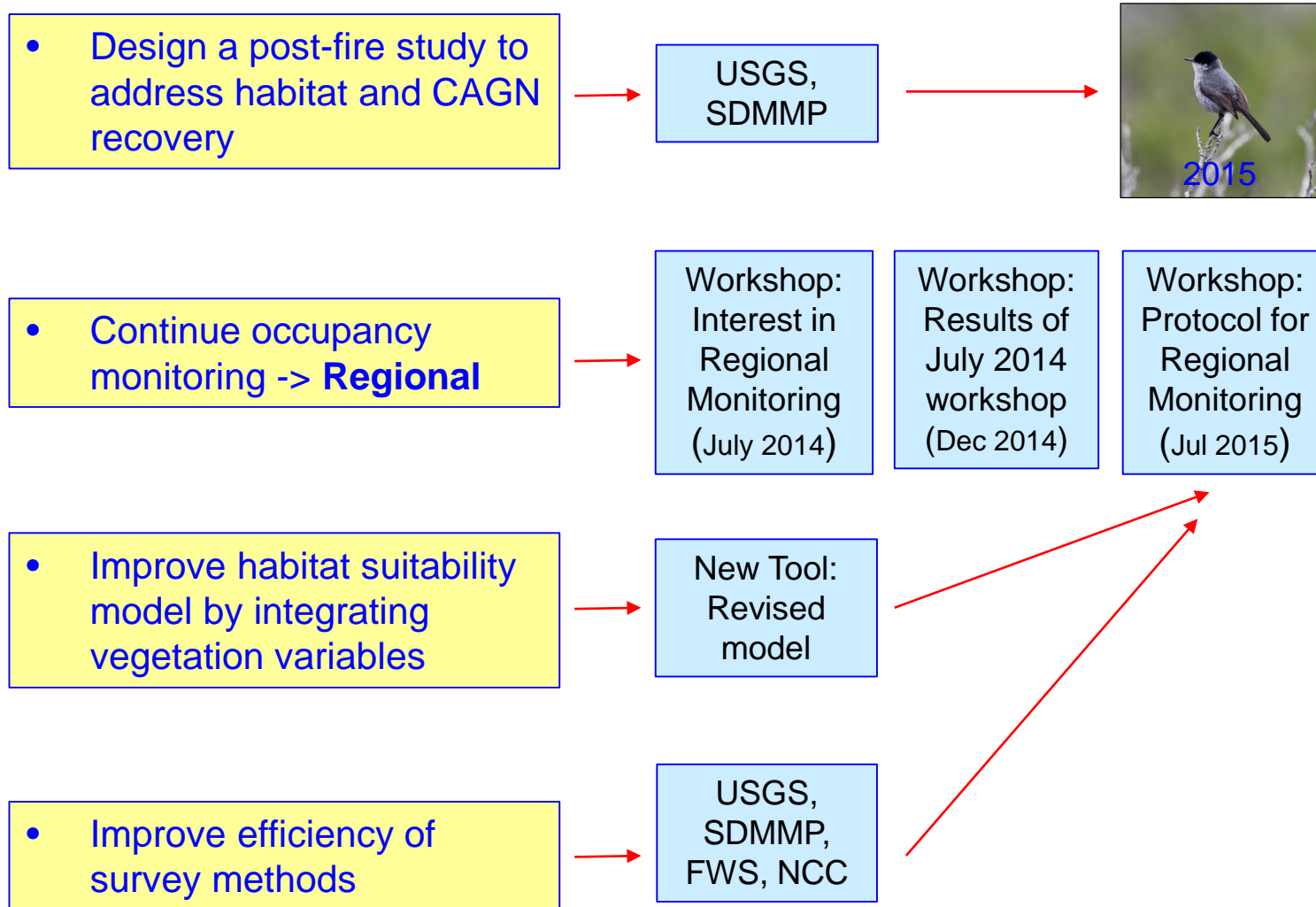
New Tool:  
Revised  
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- Improve efficiency of survey methods

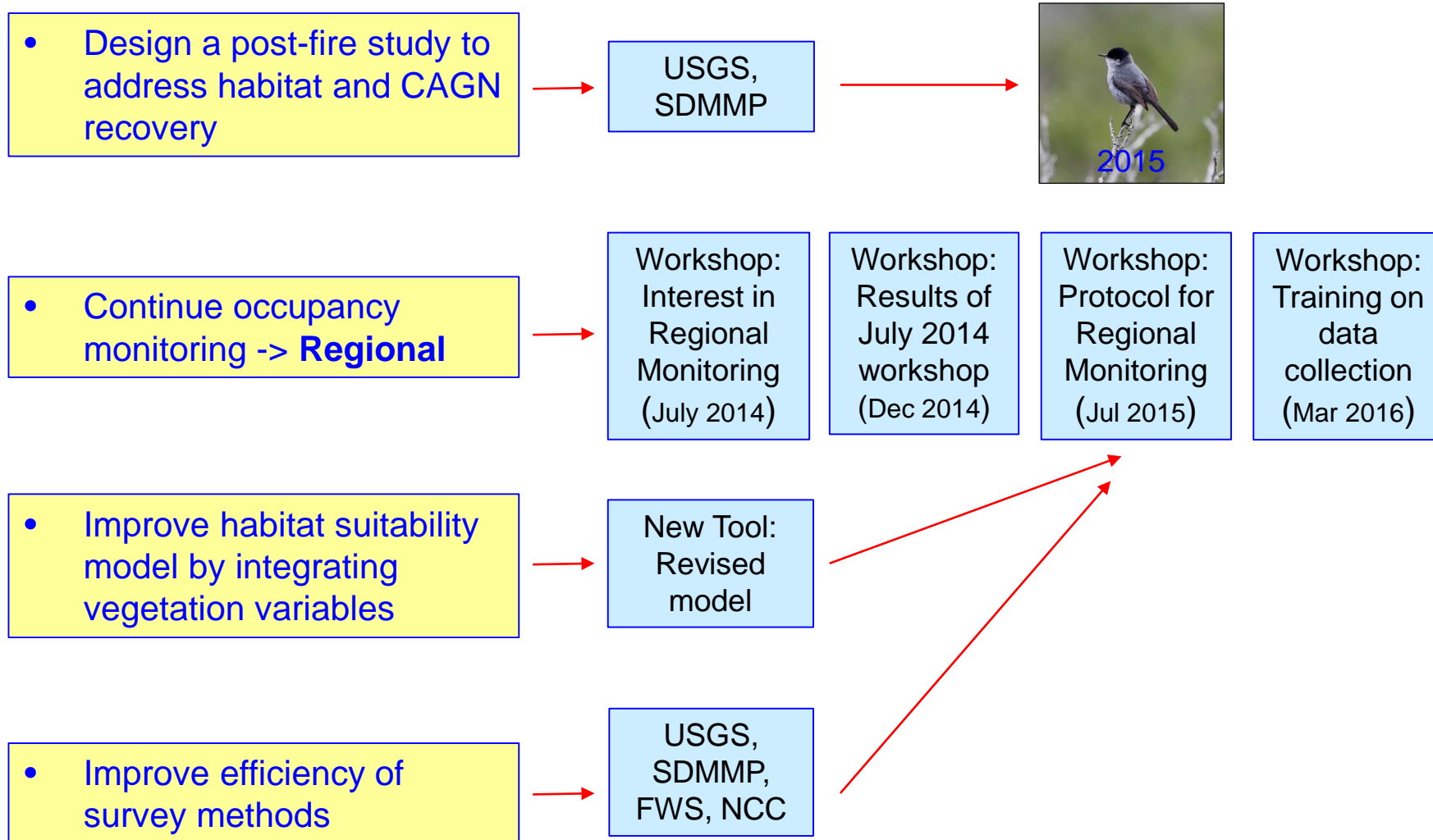
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SDMMP,  
FWS, NCC



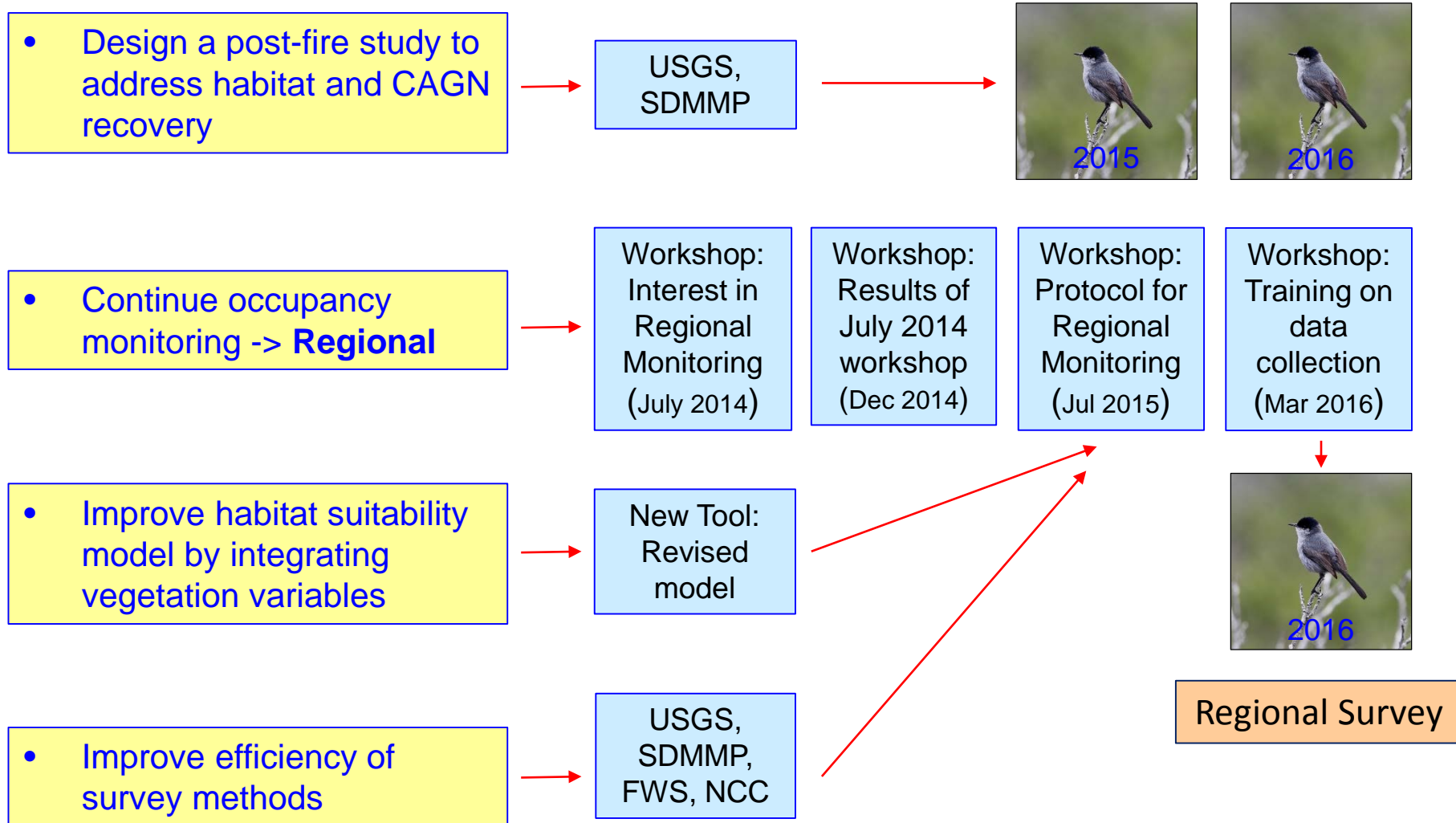
# Workshop Recommendations



# Workshop Recommendations



# Workshop Recommendations





# Partners

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



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Not for Citation

# Partners

4-S Ranch HOA  
Angeles National Forest

Fallbrook Public Utility  
FED

Sweetwater Authority  
The Environmental Trust

Audubon

California

California

Caltrans

Center for

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

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

Conservancy

D

Land Management

ent of Defense

Park Service

Service

Wildlife Service

l Survey

Water 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



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# 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



# Methods

## Number of Points:

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### Regional Occupancy Monitoring

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

180

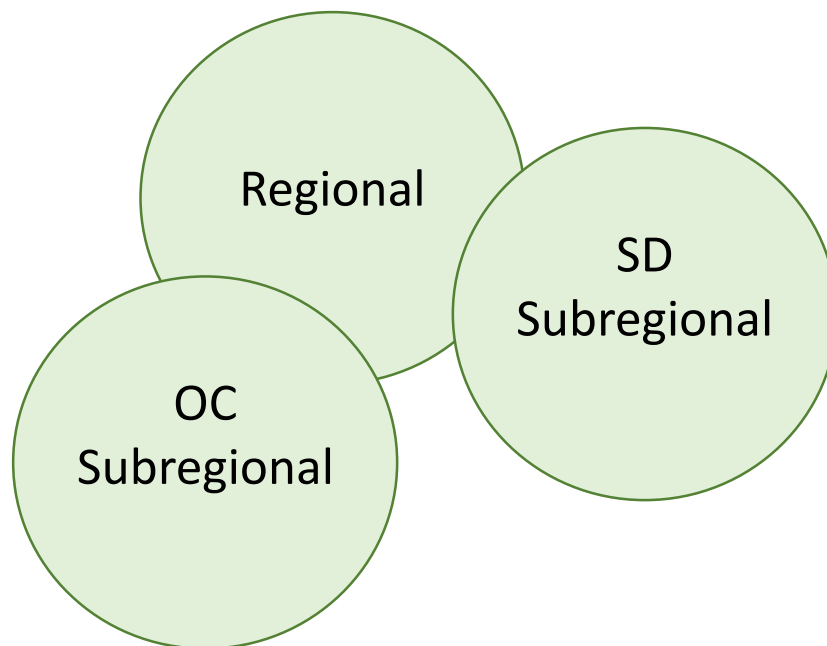
179

### Sub-regional Occupancy Monitoring

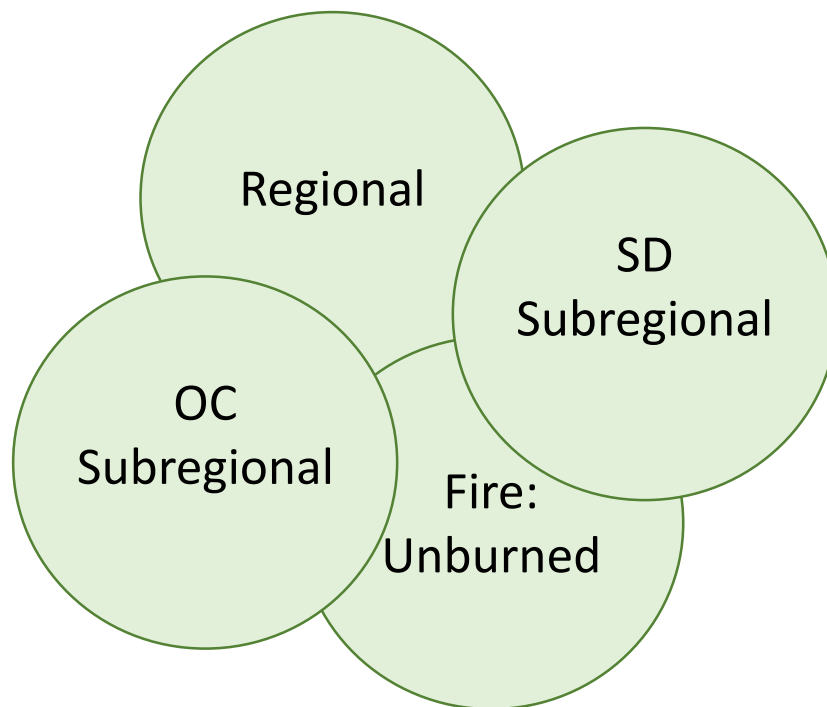


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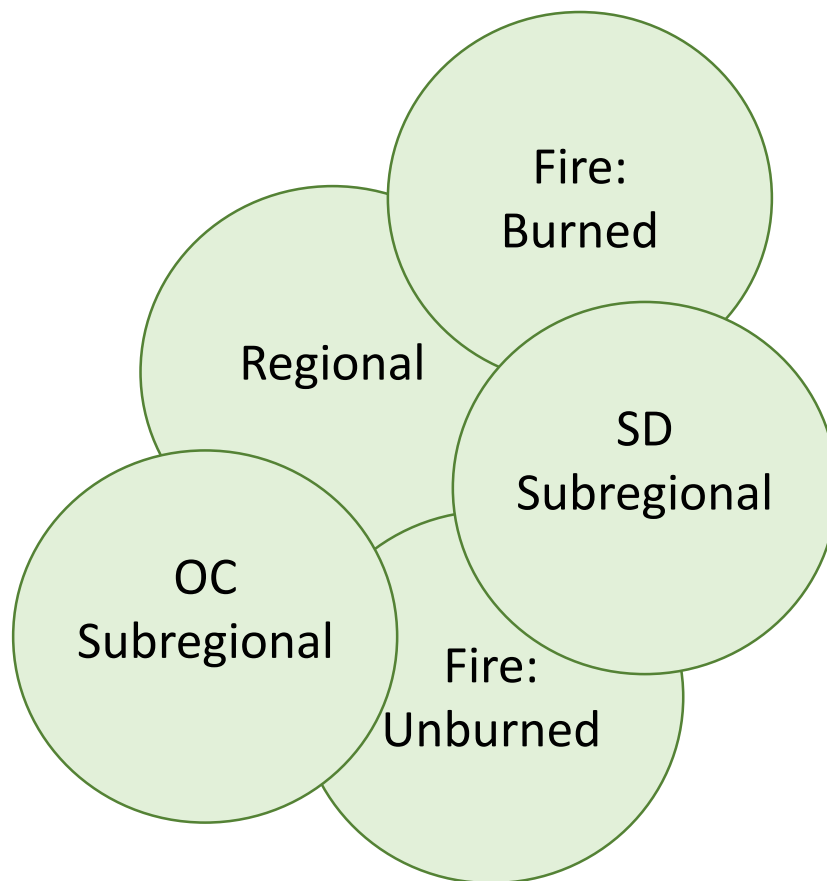
# Methods



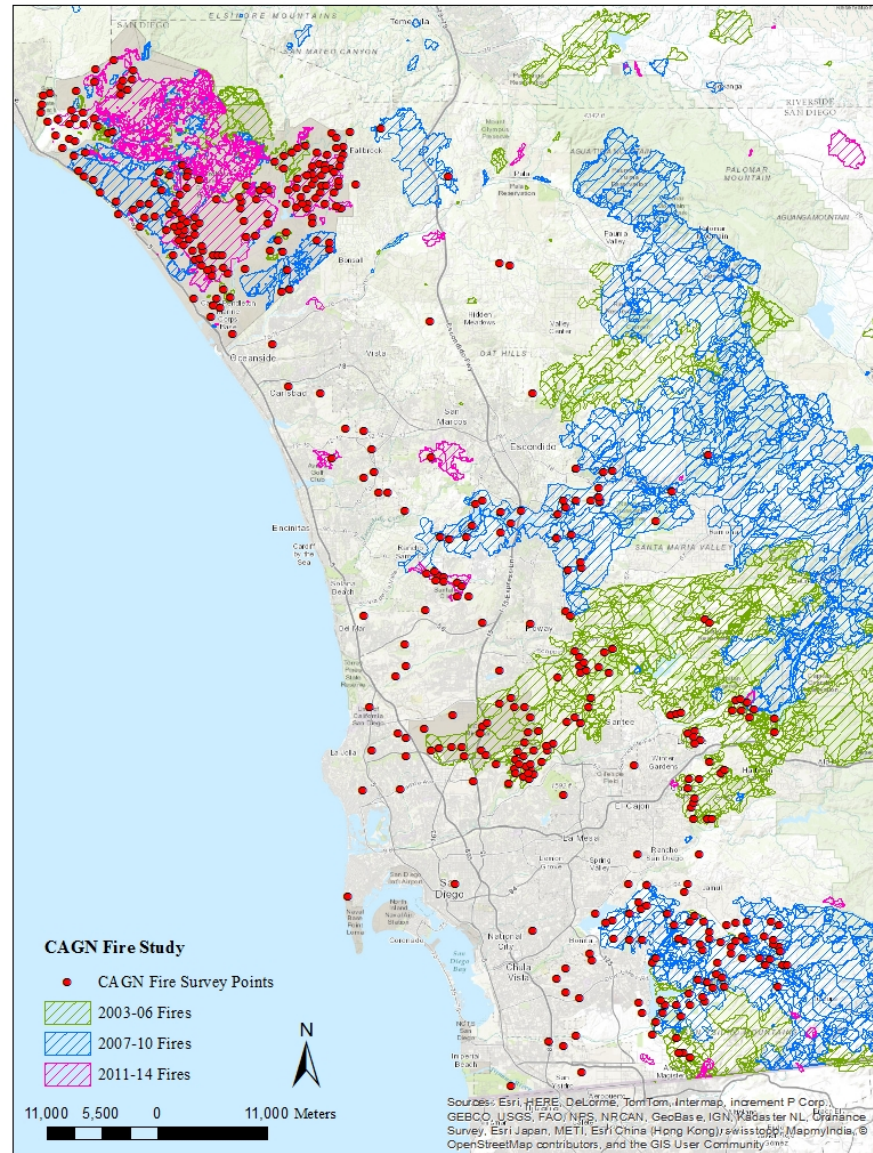
# Methods



# Methods



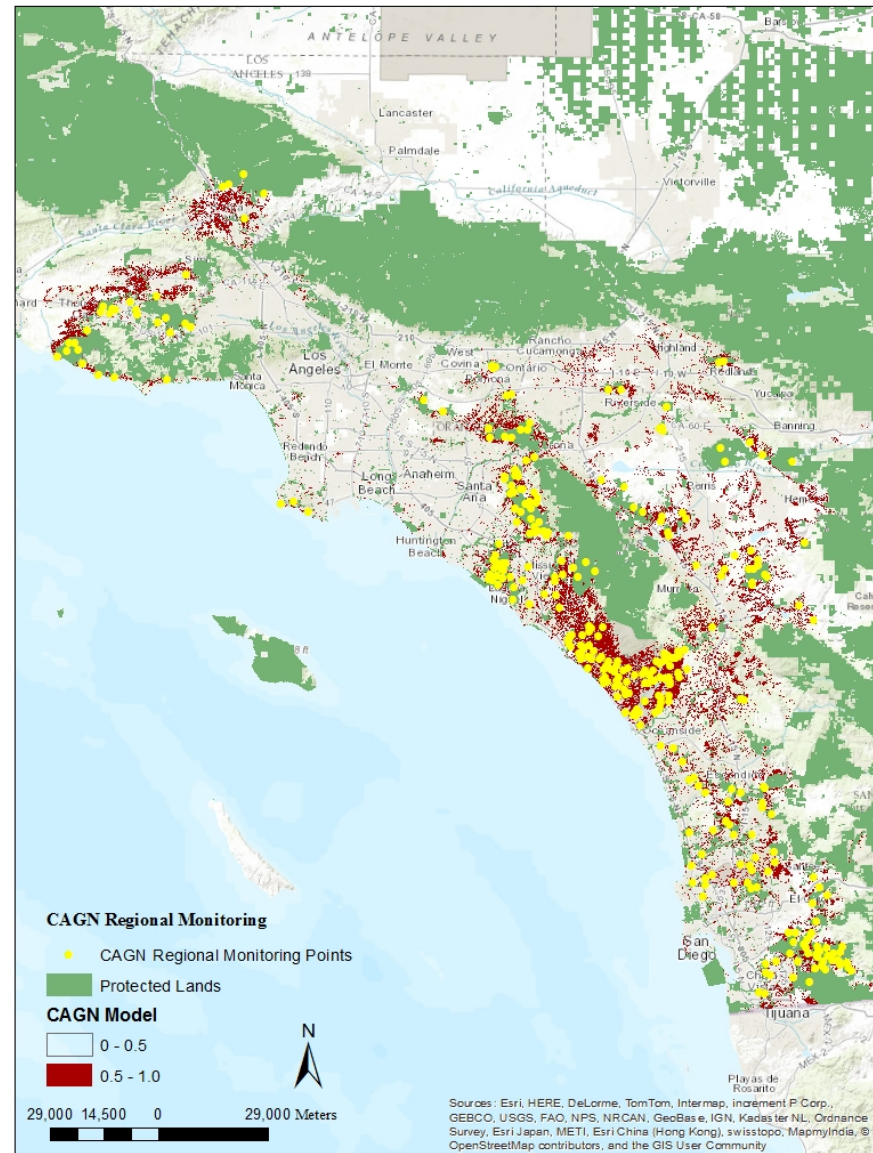
# Post-fire Points



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# Regional Points

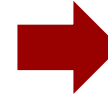


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# Overall Objectives

Use occupancy framework to calculate:

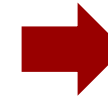
- Percent area occupied (PAO)
- Extinction rates
- Colonization rates



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



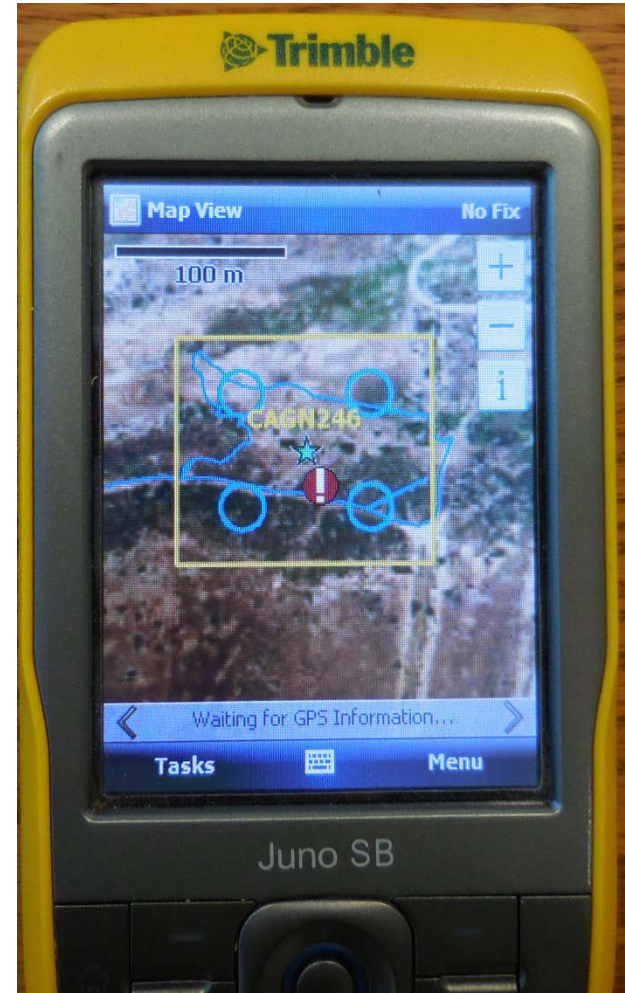
# Vegetation Sampling Protocol

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

**TREE:  $\geq 2$  m tall**  
**SHRUB:  $< 2$  m tall**



# Results

## Occupancy



Barbara Kus



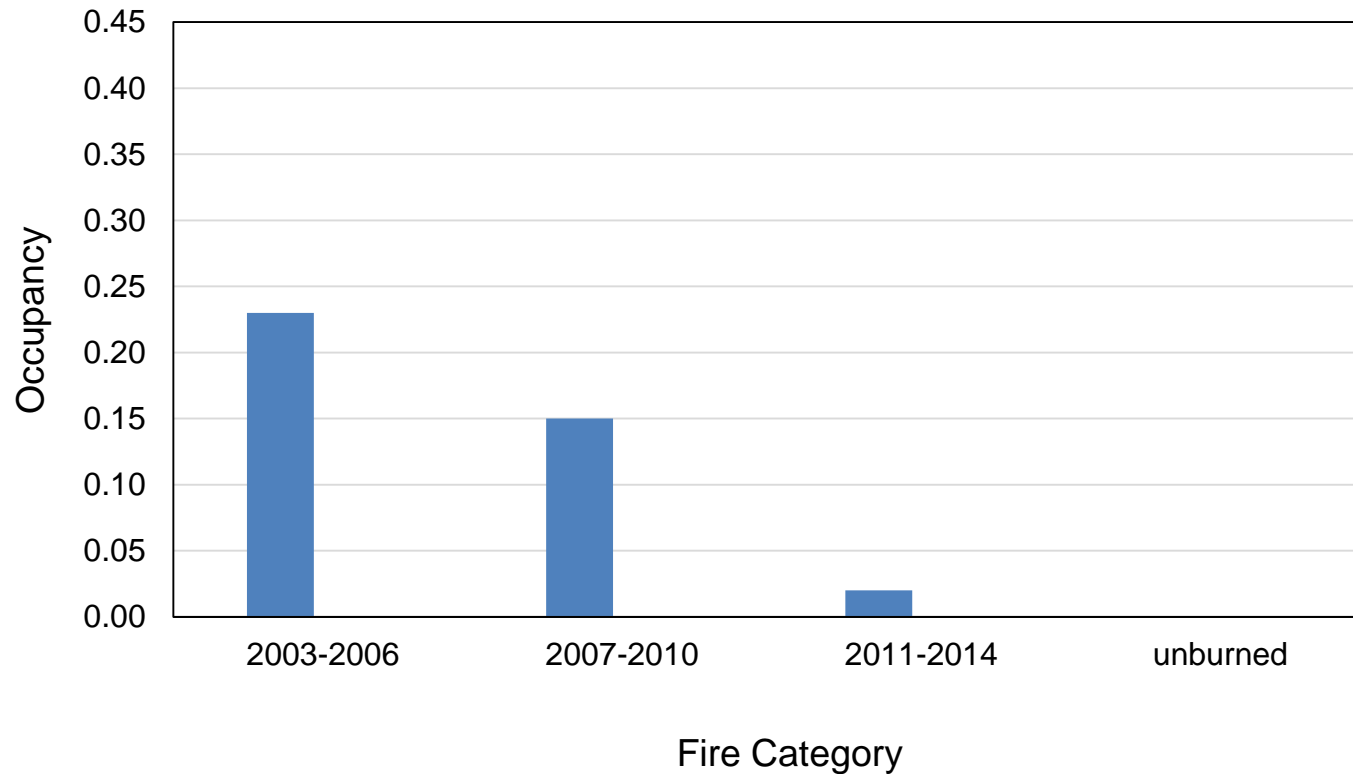
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# Post-fire Occupancy 2015

2015:

- Detectability = 0.66
- Occupancy = 0.14



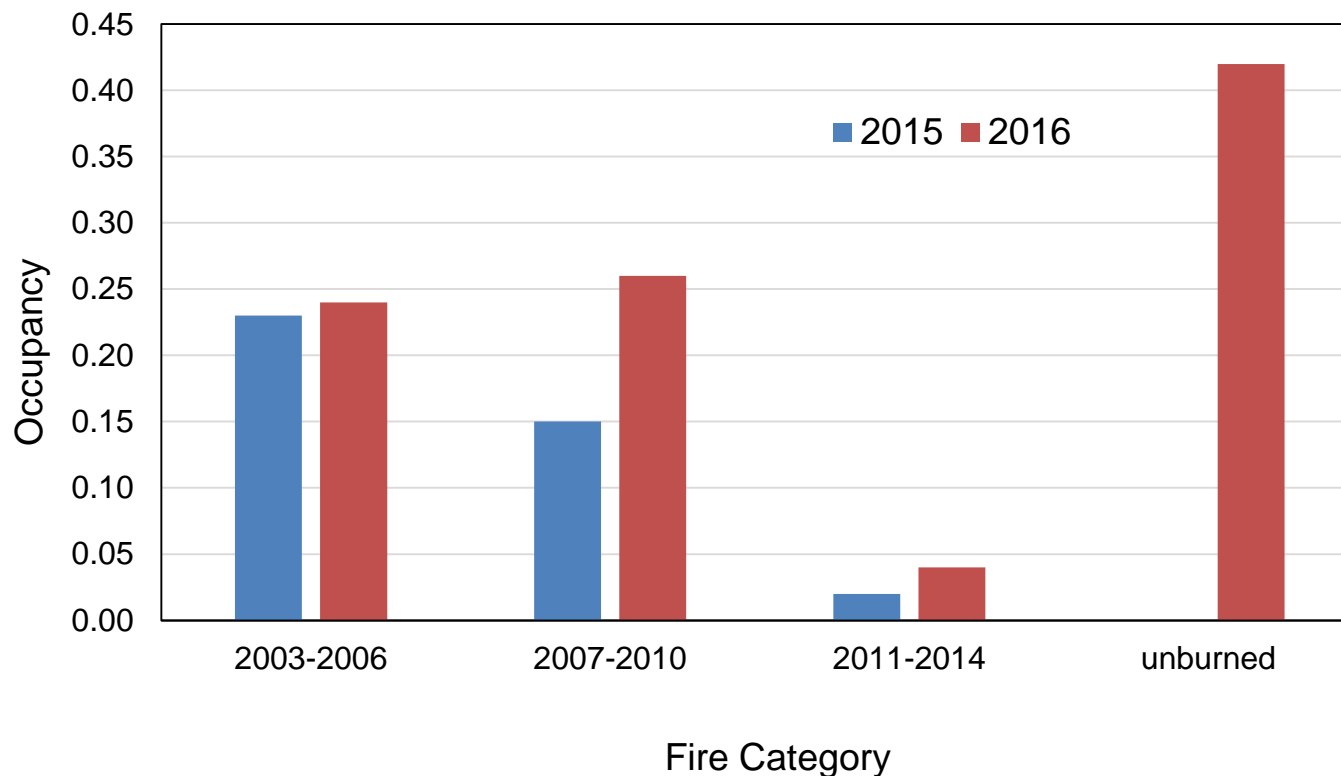
# Post-fire Occupancy 2015-2016

2015:

- Detectability = 0.66
- Occupancy = 0.14

2016:

- Detectability = 0.71
- Occupancy = 0.24



# Overall Occupancy 2016

Regional

- Detectability = 0.66
- Occupancy = 0.23

# Overall Occupancy 2016

Regional

- Detectability = 0.66
- Occupancy = 0.23

SD Subregional

- Detectability = 0.66
- Occupancy = 0.20

# Overall Occupancy 2016

Regional

- Detectability = 0.66
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SD Subregional

- Detectability = 0.66
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OC Subregional

- Detectability = 0.69
- Occupancy = 0.30

# Overall Occupancy 2016

Regional

- Detectability = 0.66
- Occupancy = 0.23

SD Subregional

- Detectability = 0.66
- Occupancy = 0.20

OC Subregional

- Detectability = 0.69
- Occupancy = 0.30

What factors influence occupancy?



# Results

## Vegetation

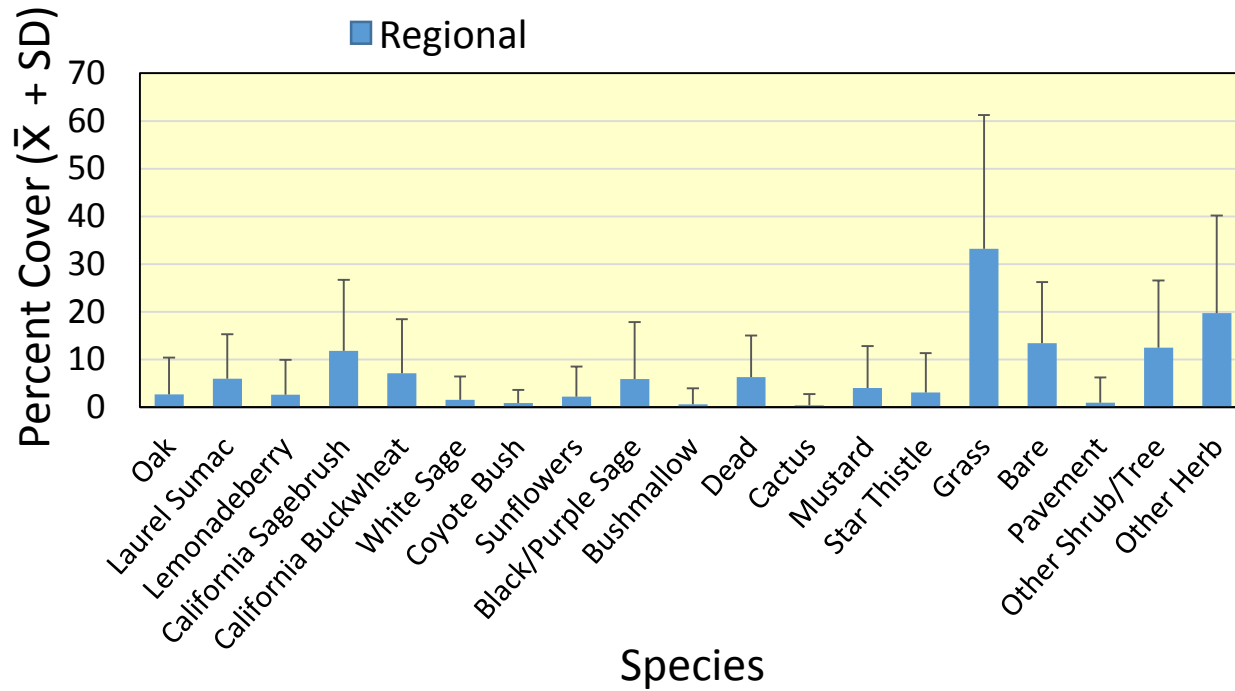


Barbara Kus



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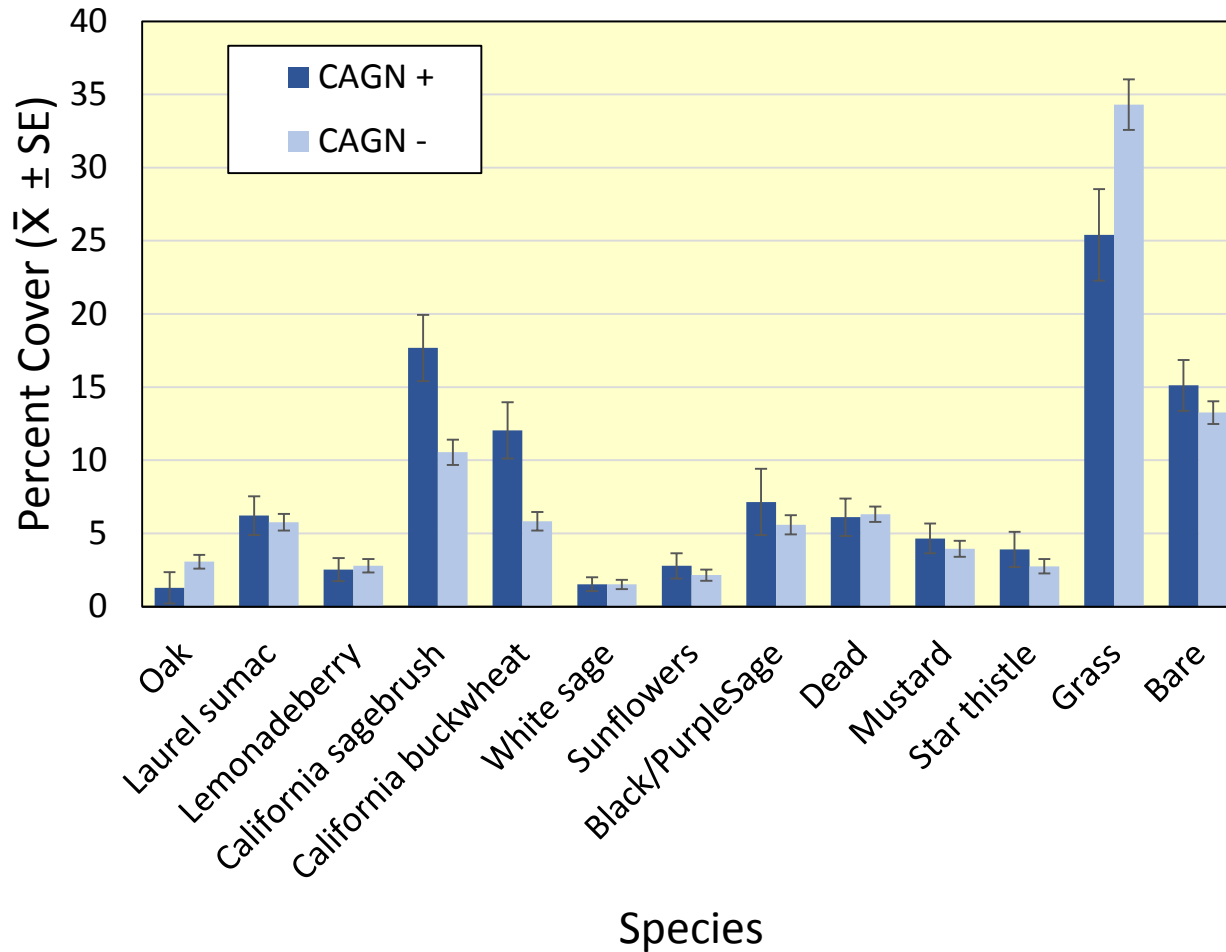
# Vegetation Composition



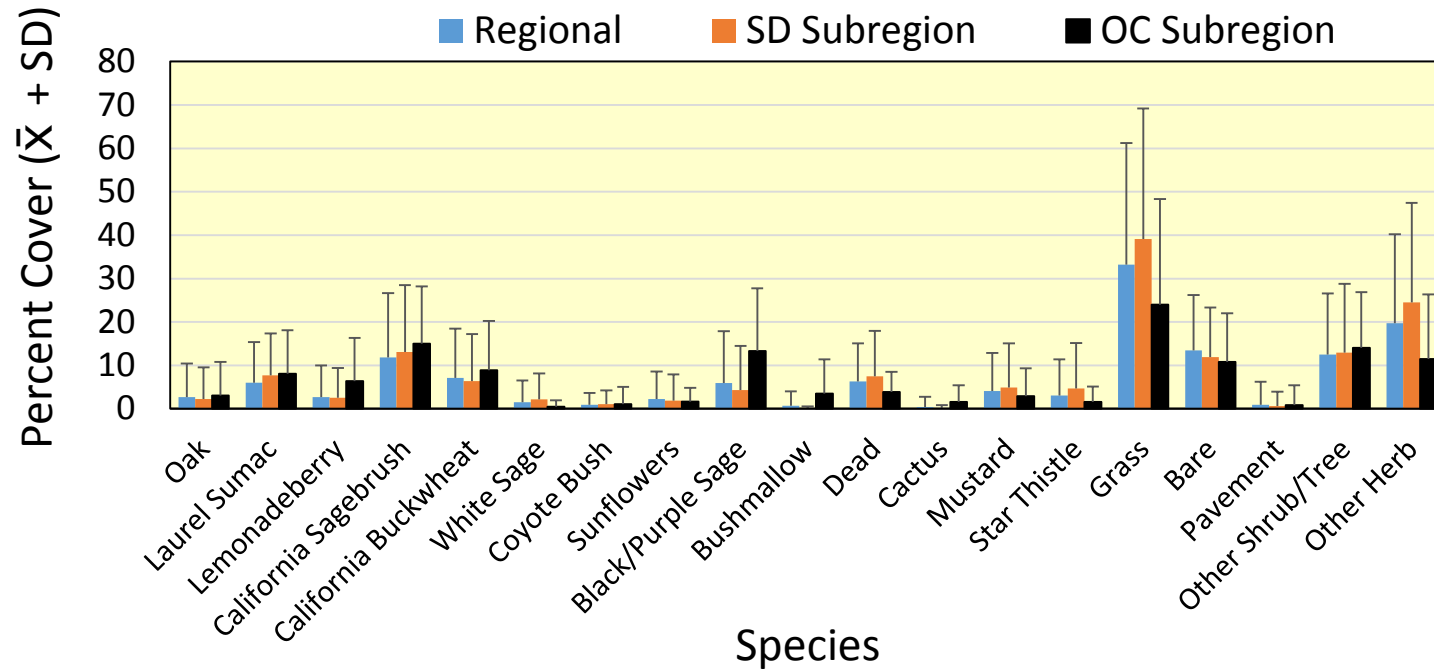
12 variables:  
cover  $\leq 0.01$

17 variables:  
cover  $> 0.01$

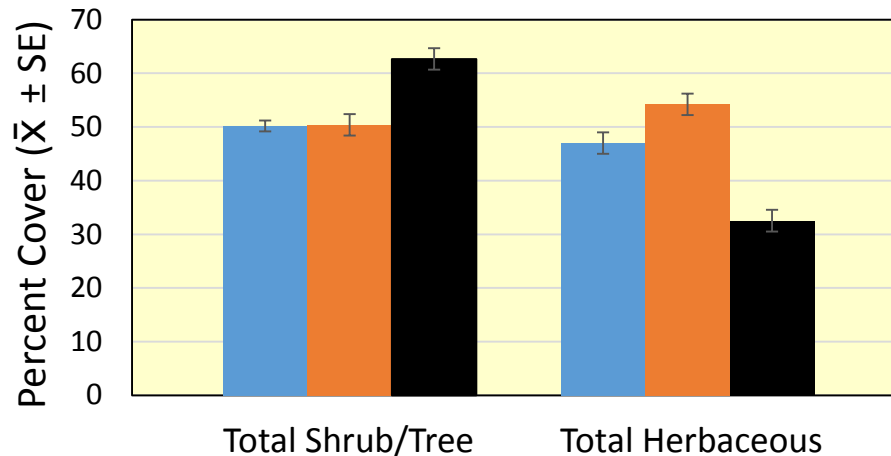
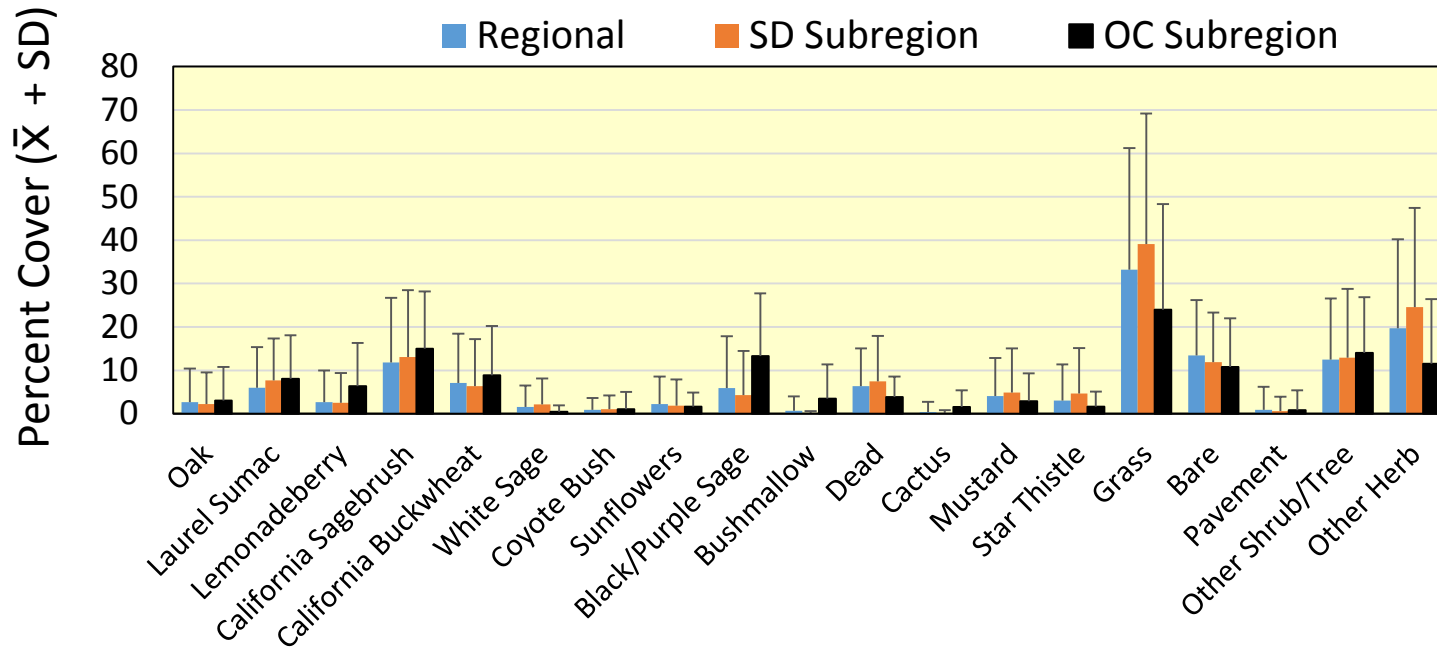
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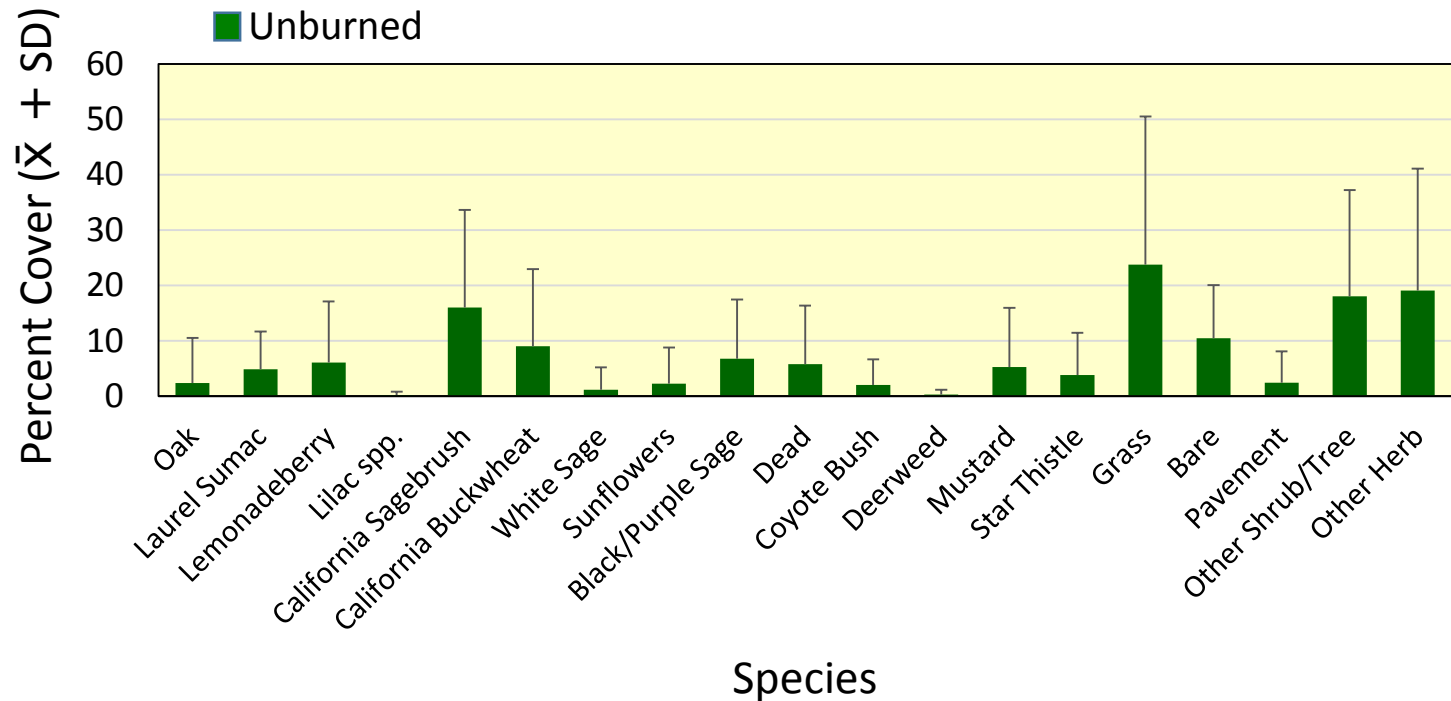
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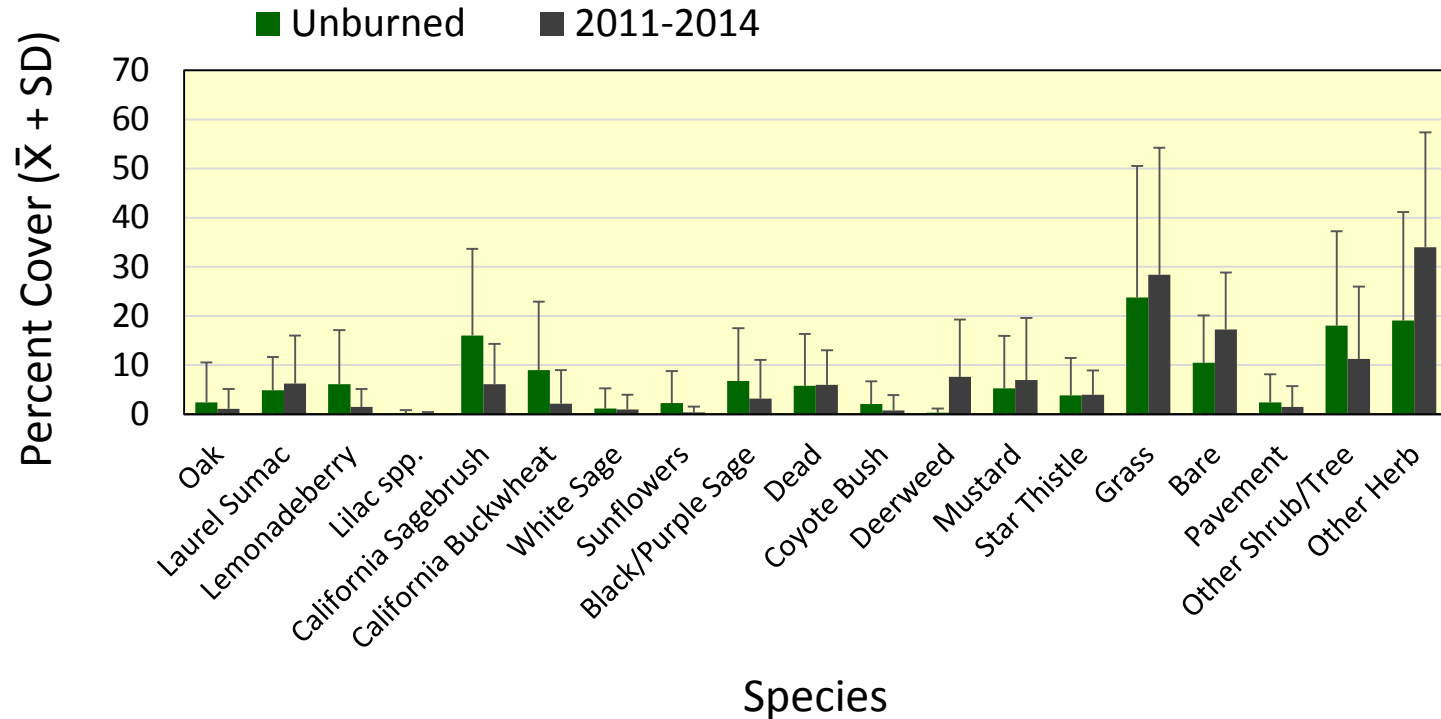


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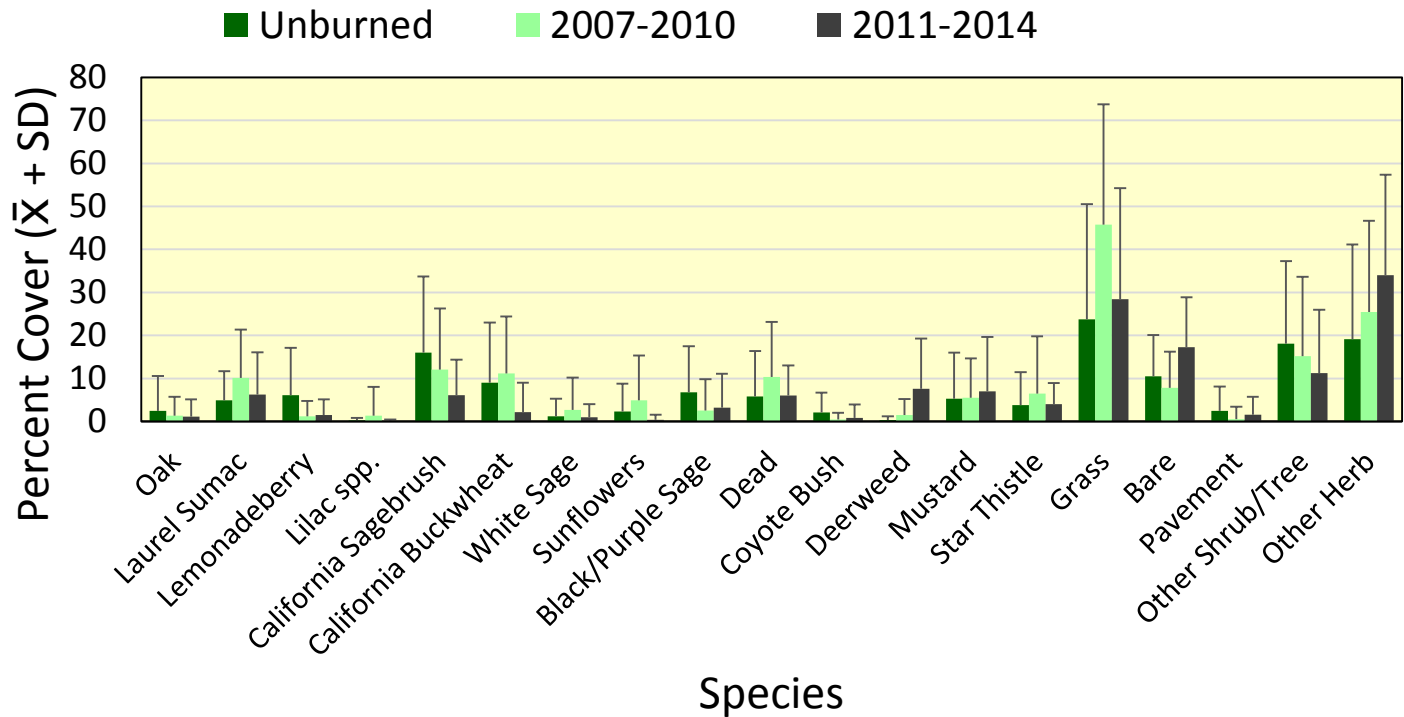




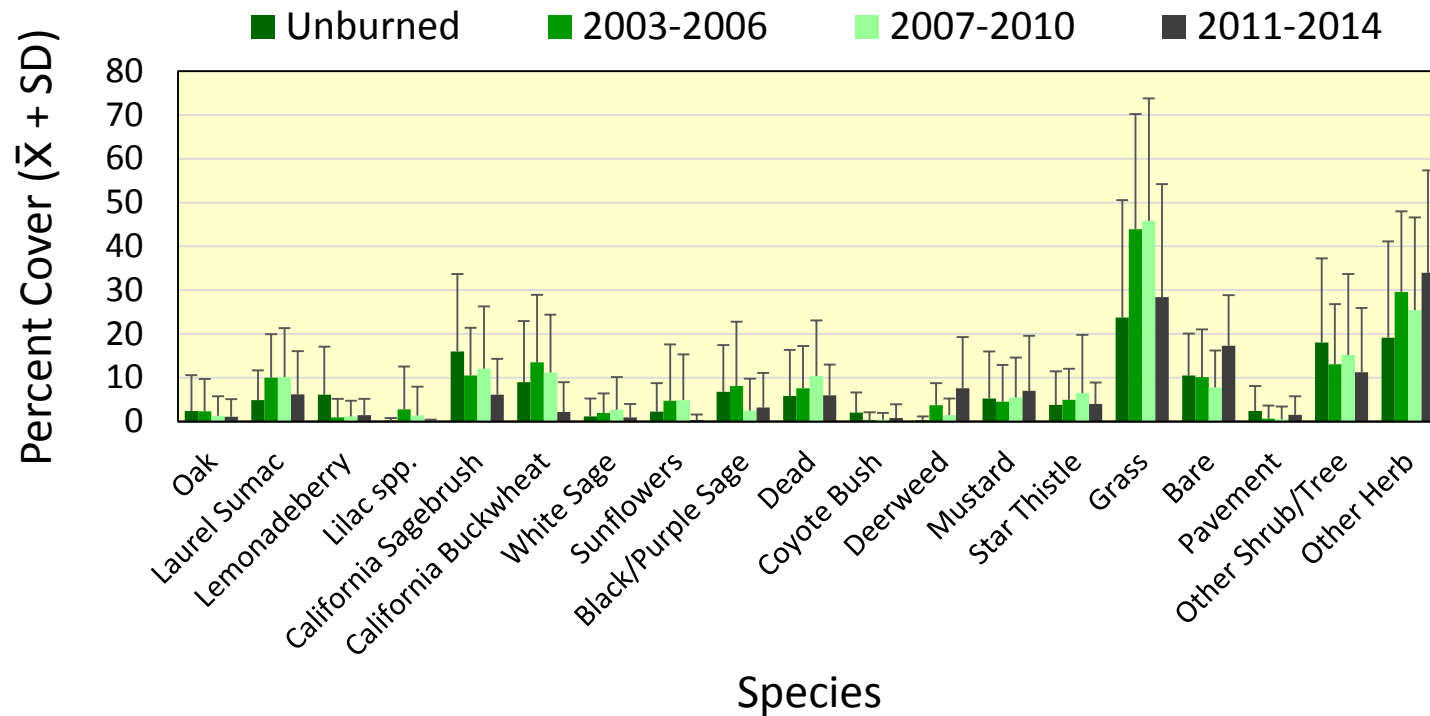
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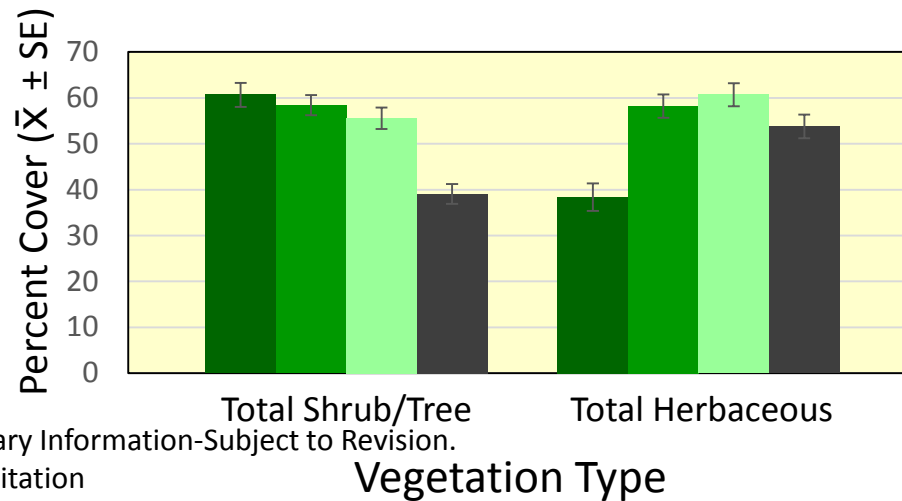
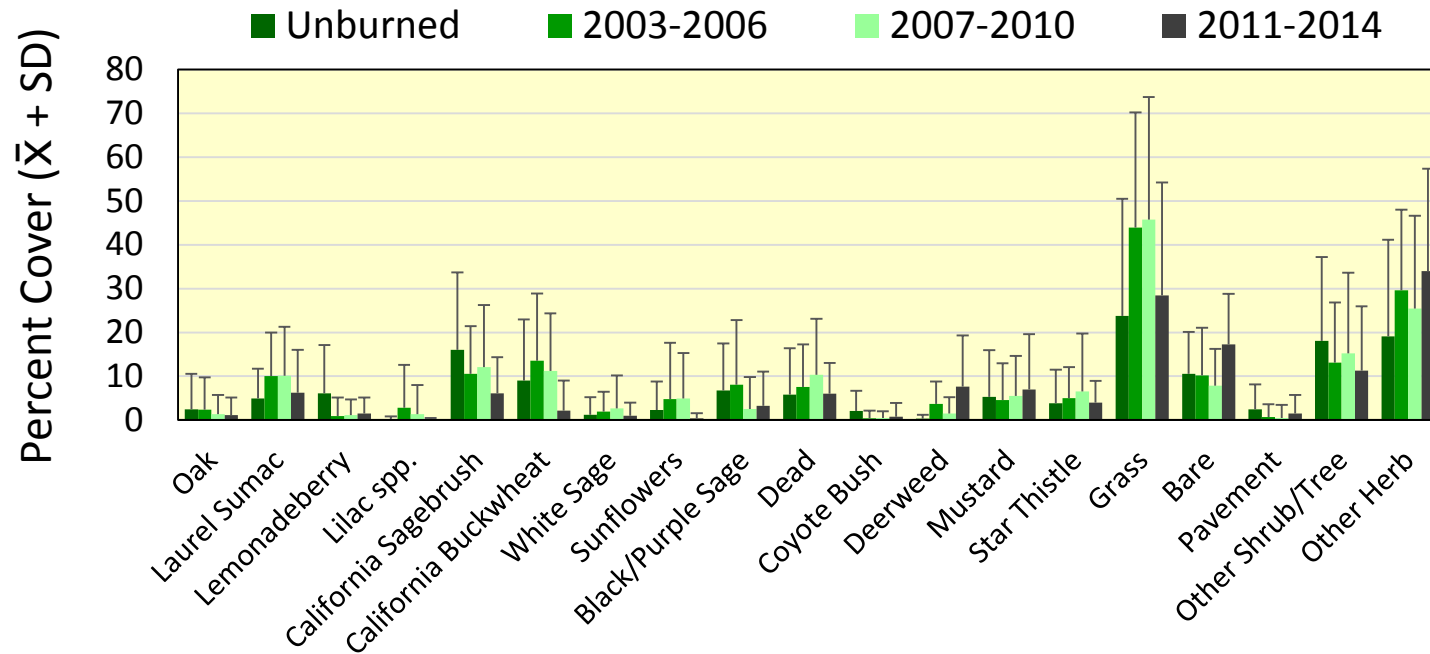
# Vegetation Composition



# Vegetation Composition



# Vegetation Composition



# 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



Preliminary Information-Subject to Revision.

Not for Citation

37%

# 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		

# 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+TOTTRE2+TOTHRB+LASTFIRE2) p(.)}	550.4821	0	0.2673	1	9	531.9071
{psi(ERFA+ARCA+SHRBHT+TOTTRE2+TOTHRB+LASTFIRE2) p(.)}	551.0877	0.6056	0.19747	0.7387	10	530.3826
{psi(BARE+ERFA+ARCA+TOTTRE2+TOTHRB+LASTFIRE2) p(.)}	551.2566	0.7745	0.18148	0.6789	10	530.5515
{psi(ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+LASTFIRE) p(.)}	553.5233	3.0412	0.05843	0.2186	8	537.0647
{psi(ERFA+SUNFL+ARCA+SHRBHT+TOTTRE+TOTHRB+LASTFIRE) p(.)}	553.7216	3.2395	0.05291	0.1979	9	535.1465
{psi(BARE+ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+LASTFIRE) p(.)}	553.759	3.2769	0.05193	0.1943	9	535.1839
{psi(ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+LASTFIRE2) p(.)}	553.8357	3.3536	0.04998	0.187	9	535.2606
{psi(BARE+ERFA+ARCA+TOTTRE+TOTHRB+LASTFIRE2) p(.)}	554.2454	3.7633	0.04072	0.1523	9	535.6704
{psi(ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+SLOPE+LASTFIRE) p(.)}	554.4533	3.9712	0.0367	0.1373	9	535.8782
{psi(ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+ELEV+LASTFIRE) p(.)}	555.5742	5.0921	0.02095	0.0784	9	536.9991
[Plus 47 more models]						

# AIC Model Selection

## Regional

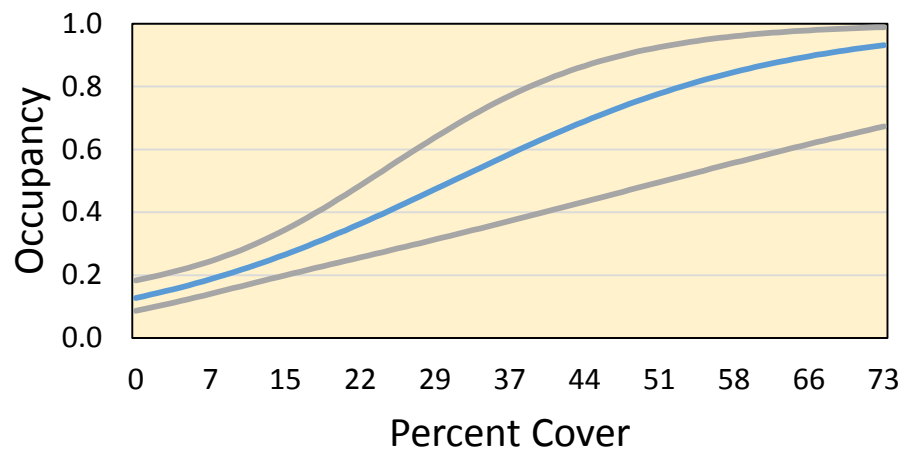
Model	AICc	Delta AICc	AICc Weights	Model Likelihood	Number Parameters	Deviance
{psi(ERFA+ARCA+TOTTRE2+TOTHRB+LASTFIRE2) p(.)}	550.4821	0	0.2673	1	9	531.9071
{psi(ERFA+ARCA+SHRBHT+TOTTRE2+TOTHRB+LASTFIRE2) p(.)}	551.0877	0.6056	0.19747	0.7387	10	530.3826
{psi(BARE+ERFA+ARCA+TOTTRE2+TOTHRB+LASTFIRE2) p(.)}	551.2566	0.7745	0.18148	0.6789	10	530.5515
{psi(ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+LASTFIRE) p(.)}	553.5233	3.0412	0.05843	0.2186	8	537.0647
{psi(ERFA+SUNFL+ARCA+SHRBHT+TOTTRE+TOTHRB+LASTFIRE) p(.)}	553.7216	3.2395	0.05291	0.1979	9	535.1465
{psi(BARE+ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+LASTFIRE) p(.)}	553.759	3.2769	0.05193	0.1943	9	535.1839
{psi(ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+LASTFIRE2) p(.)}	553.8357	3.3536	0.04998	0.187	9	535.2606
{psi(BARE+ERFA+ARCA+TOTTRE+TOTHRB+LASTFIRE2) p(.)}	554.2454	3.7633	0.04072	0.1523	9	535.6704
{psi(ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+SLOPE+LASTFIRE) p(.)}	554.4533	3.9712	0.0367	0.1373	9	535.8782
{psi(ERFA+ARCA+SHRBHT+TOTTRE+TOTHRB+ELEV+LASTFIRE) p(.)}	555.5742	5.0921	0.02095	0.0784	9	536.9991
[Plus 47 more models]						

Occupancy a function of:

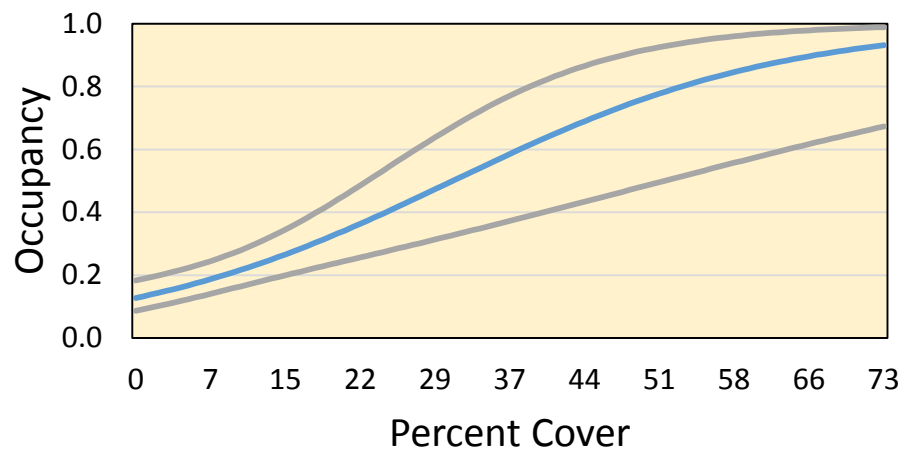
- California sagebrush (+)
- California buckwheat (+)
- Total herbaceous (-)
- Total shrub/tree (+)
- Shrub height (+)
- Bare (+)
- Time since last fire (+)



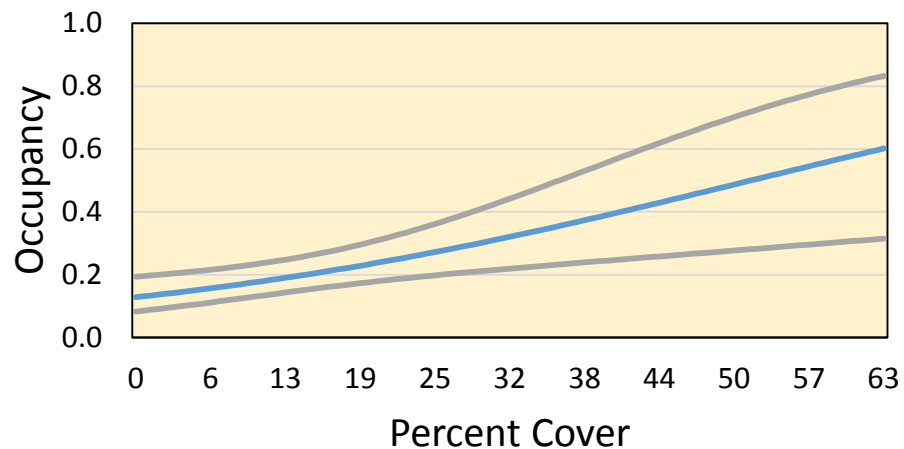
## California Buckwheat



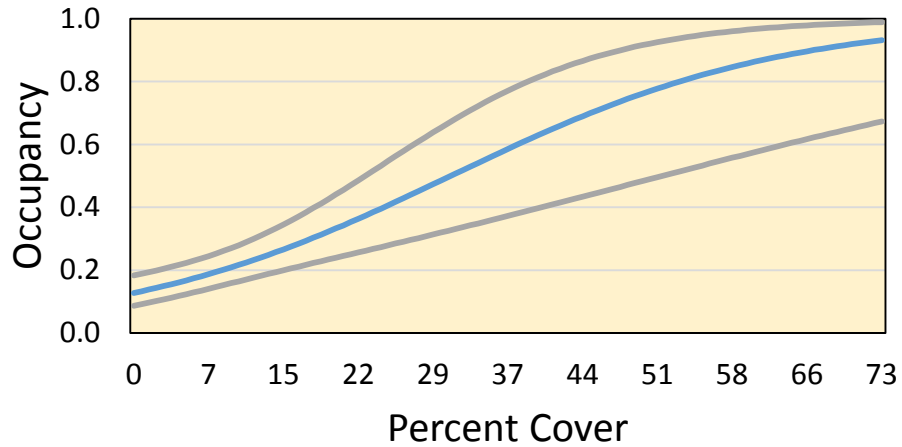
### California Buckwheat



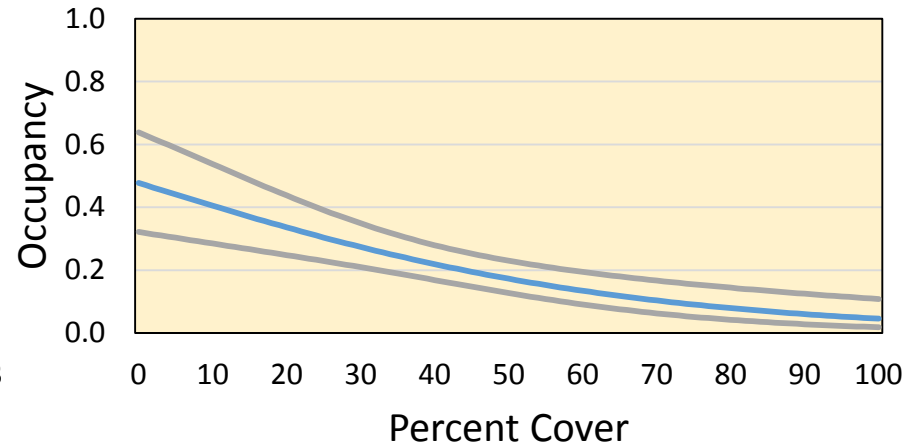
### California Sagebrush



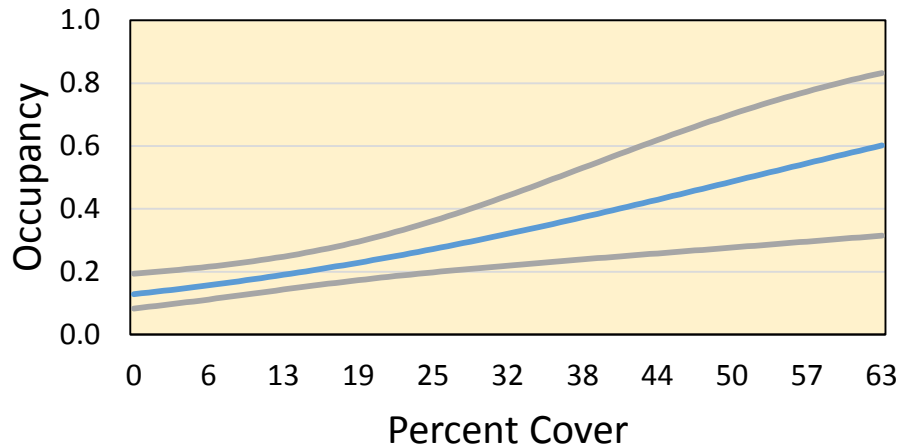
California Buckwheat



Total Herbaceous

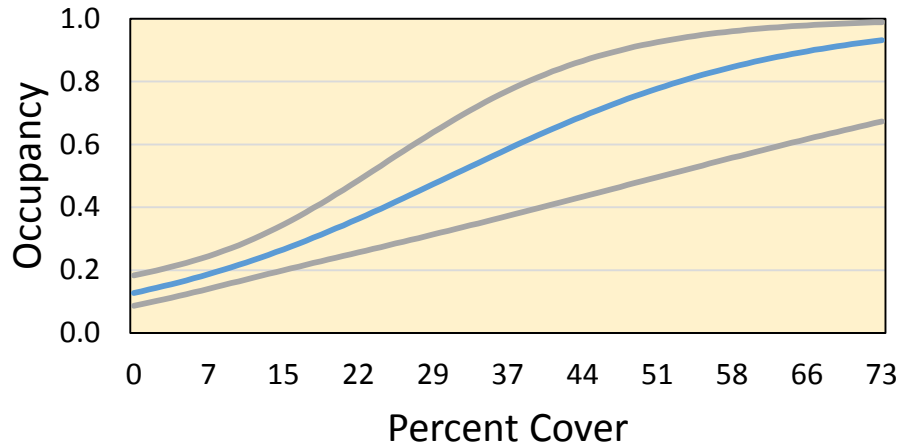


California Sagebrush

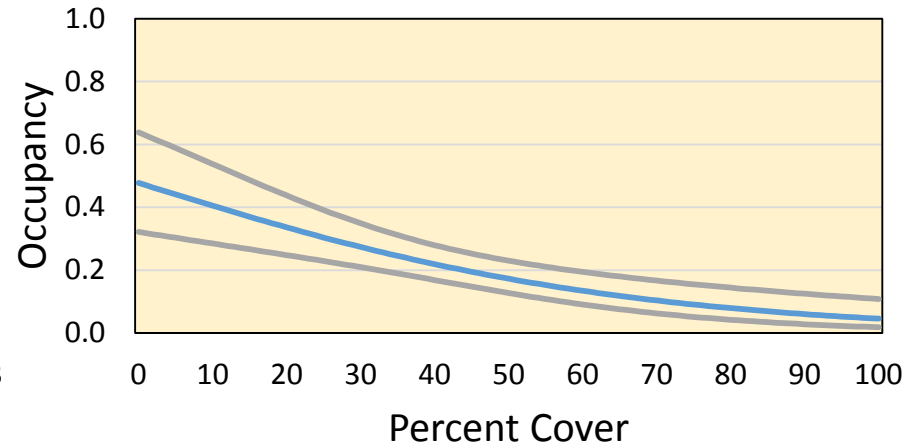




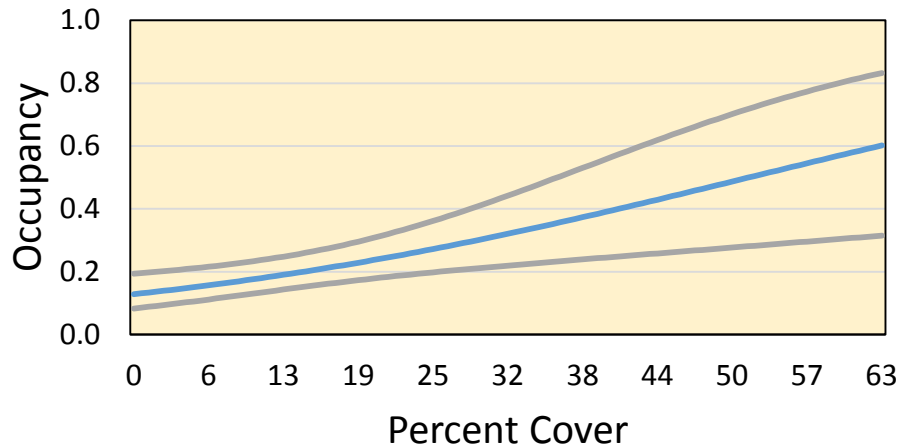
California Buckwheat



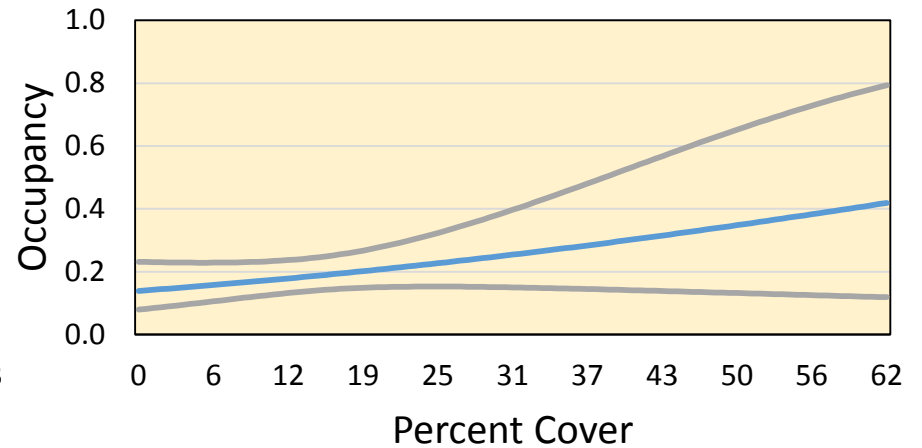
Total Herbaceous



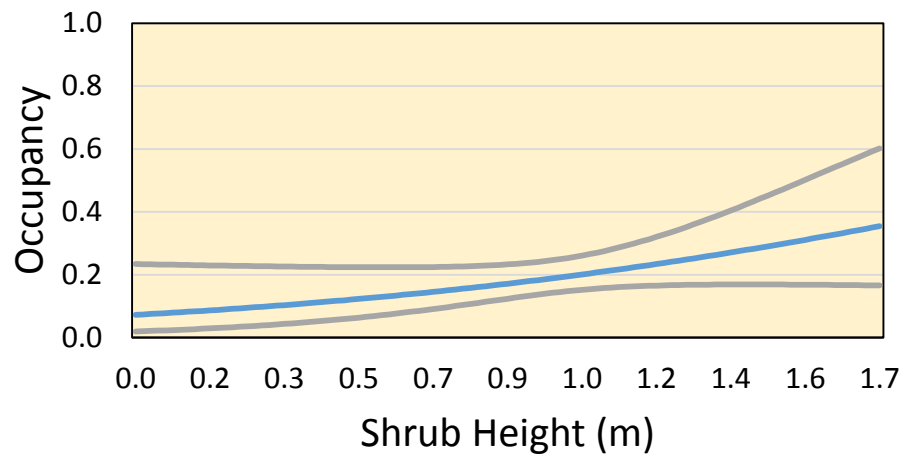
California Sagebrush



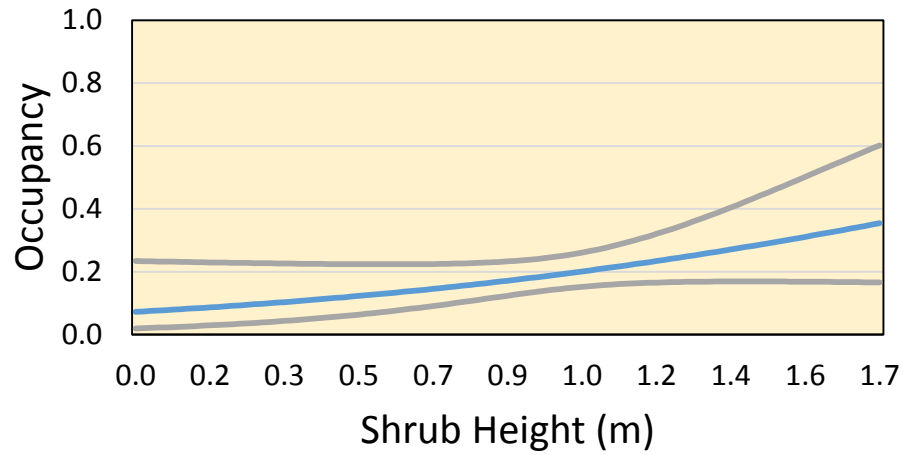
Bare Ground



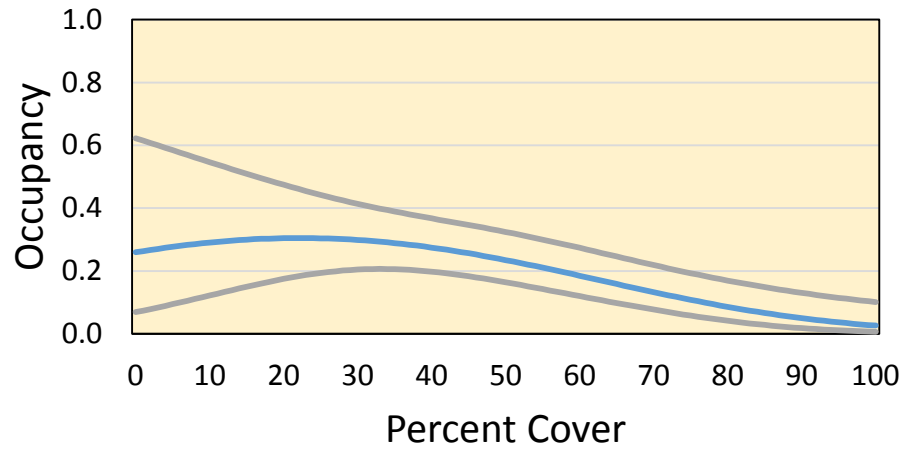
## Shrub Height



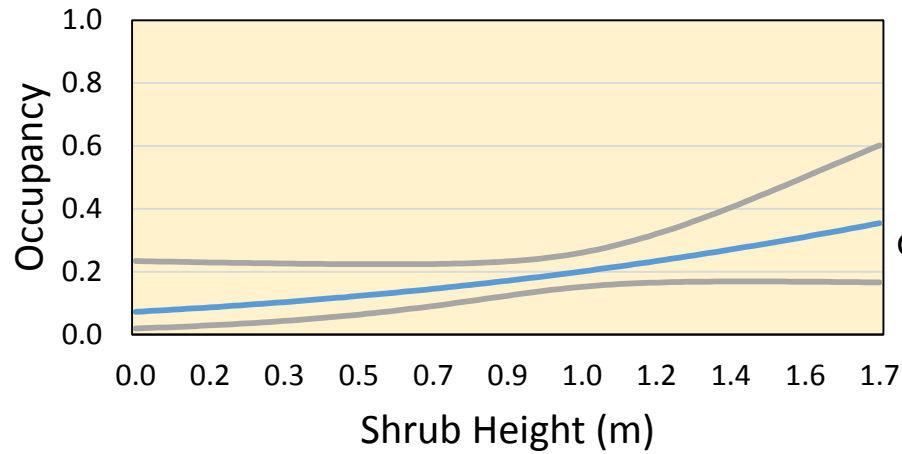
### Shrub Height



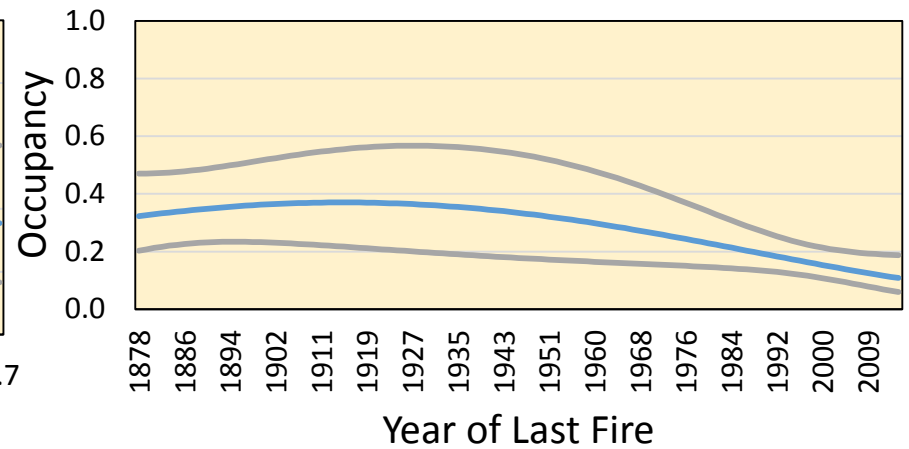
### Total Shrub/Tree



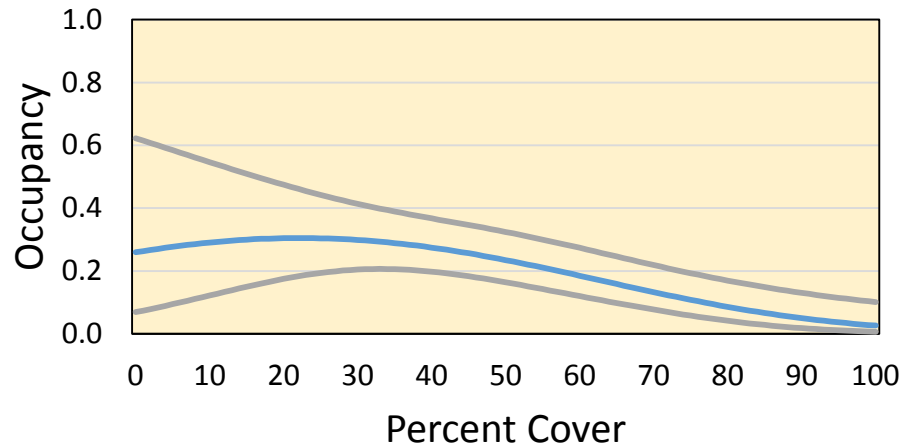
Shrub Height



Last Fire



Total Shrub/Tree



# Comparisons of Models

Variable	Regional	SD Subregion	OC Subregion	Unburned
California Sagebrush	+	+	+	+
California Buckwheat	+	+	+	
Total Shrub/Tree	+			
Total Herbaceous	-			
Bare	+		+	+
Shrub Height	+	+		+
Last Fire	+	+		
Laurel Sumac		-		-
Sunflowers		+	+	+
Distance to Coast		(-)		
Elevation		(-)	-	-
Grass				-
Star Thistle				+
Other Tree				-
Slope				-

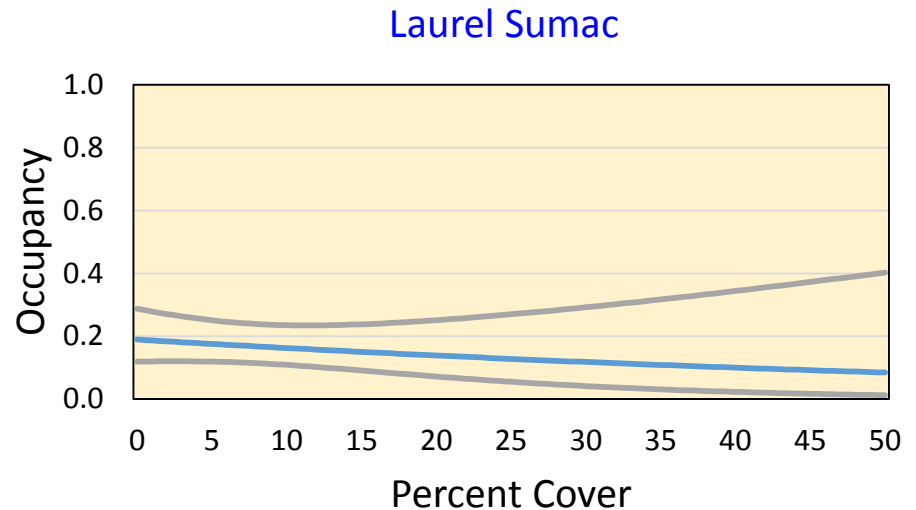


Preliminary Information-Subject to Revision.  
Not for Citation

# SD Subregional Models

Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Shrub Height (+)
- Time since last fire (+)
- Laurel sumac (-)
- Sunflowers (+)
- Distance to coast (-)
- Elevation (-)

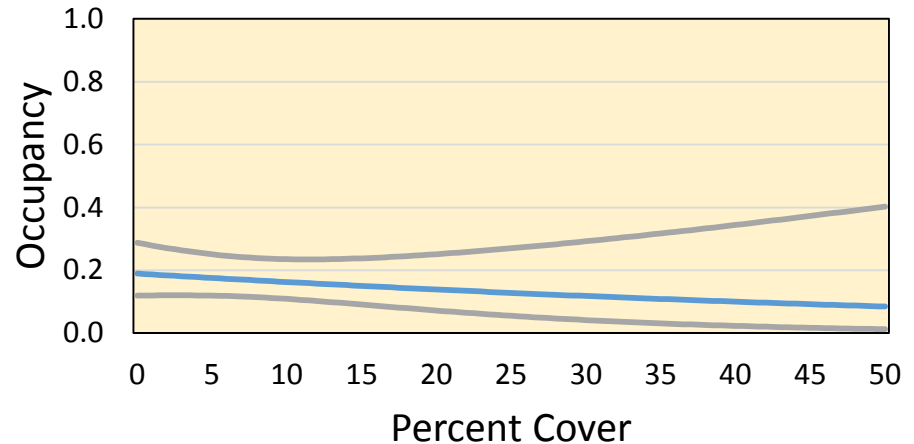


# SD Subregional Models

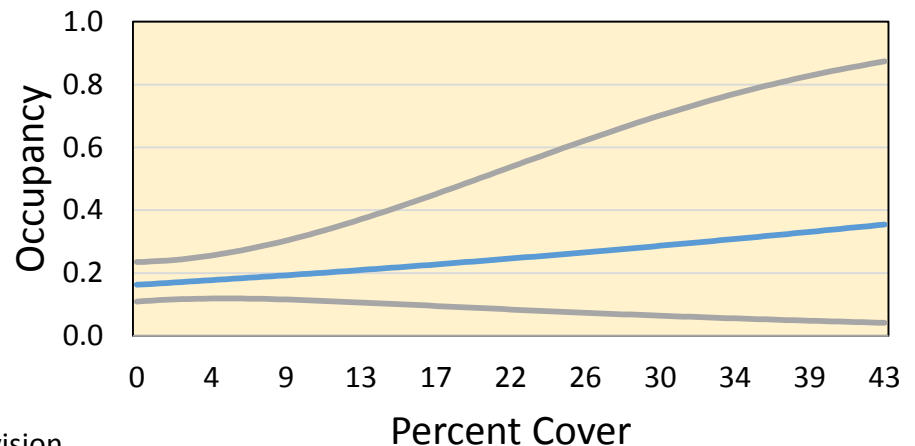
Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Shrub Height (+)
- Time since last fire (+)
- Laurel sumac (-)
- Sunflowers (+)
- Distance to coast (-)
- Elevation (-)

Laurel Sumac



Sunflowers



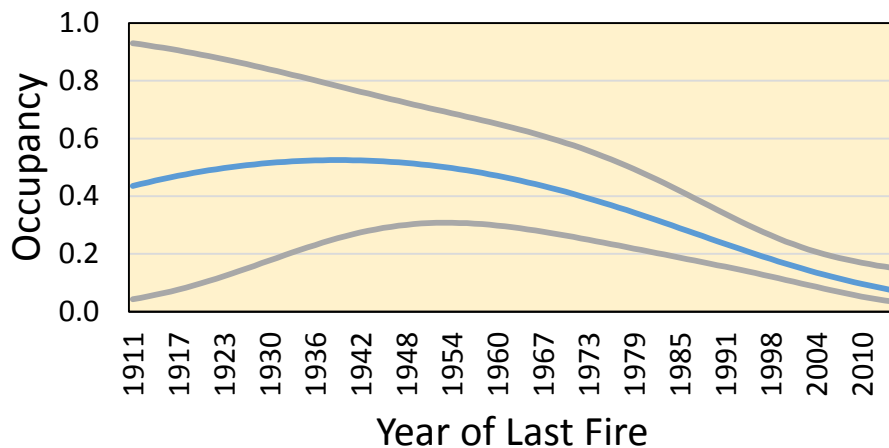


# SD Subregional Models

Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Shrub Height (+)
- Time since last fire (+)
- Laurel sumac (-)
- Sunflowers (+)
- Distance to coast (-)
- Elevation (-)

Last Fire



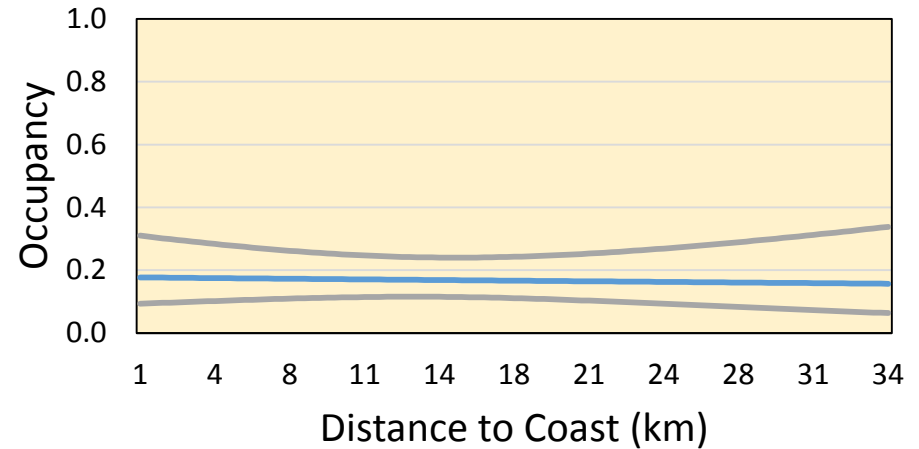
Preliminary Information-Subject to Revision.  
Not for Citation

# SD Subregional Models

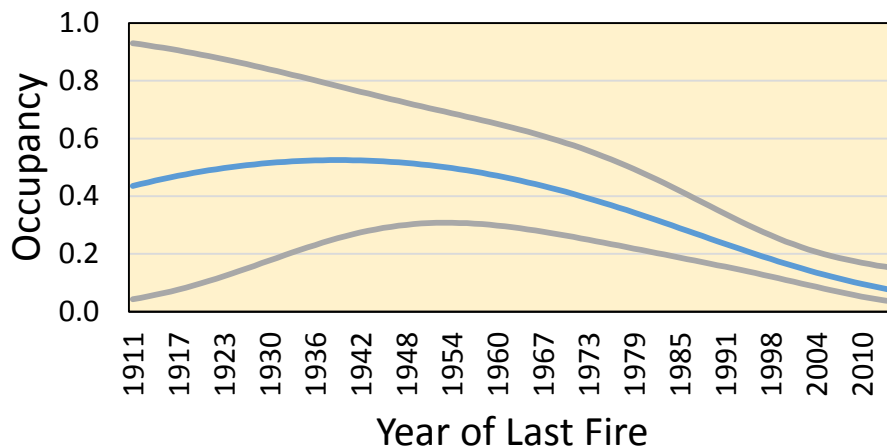
Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Shrub Height (+)
- Time since last fire (+)
- Laurel sumac (-)
- Sunflowers (+)
- Distance to coast (-)
- Elevation (-)

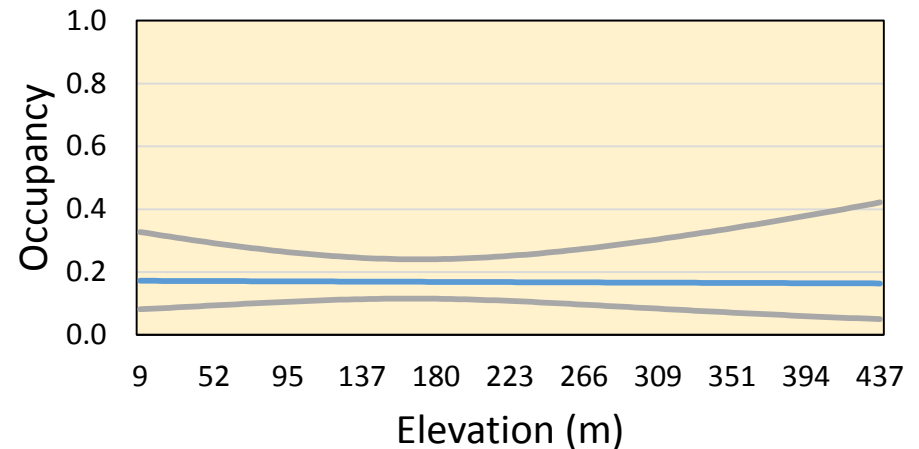
Distance to Coast



Last Fire



Elevation



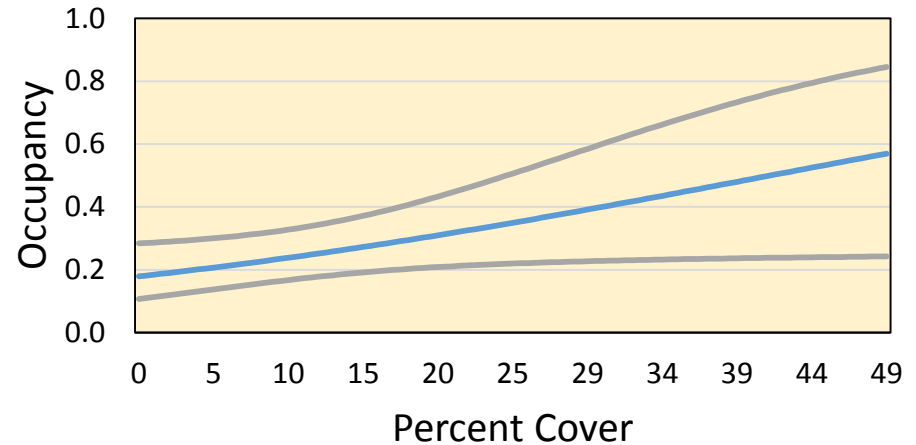
Preliminary Information-Subject to Revision.  
Not for Citation

# OC Subregional Models

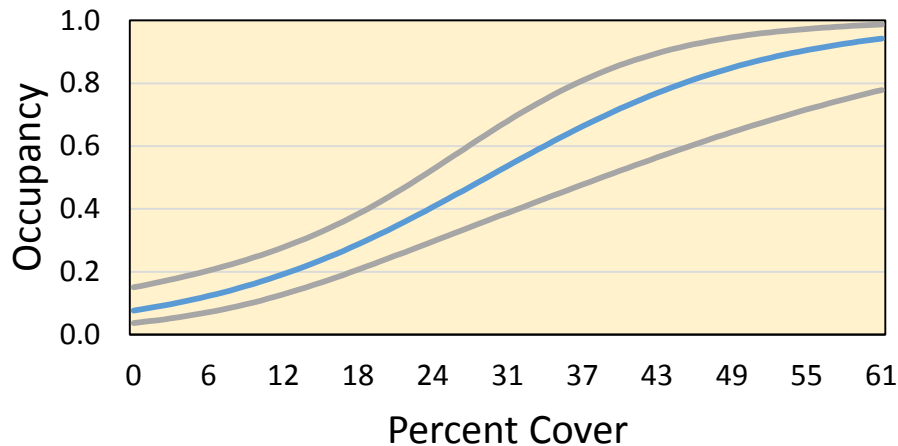
Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Bare(+)
- Sunflowers (+)
- Elevation (-)

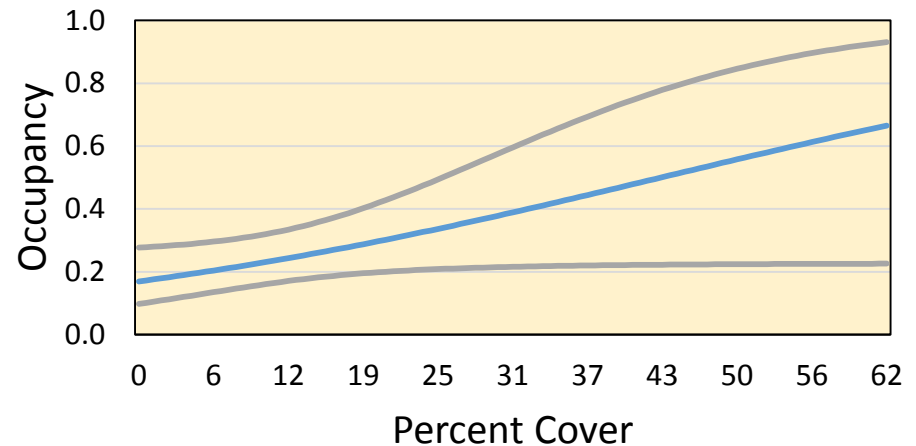
California Buckwheat



California Sagebrush



Bare Ground

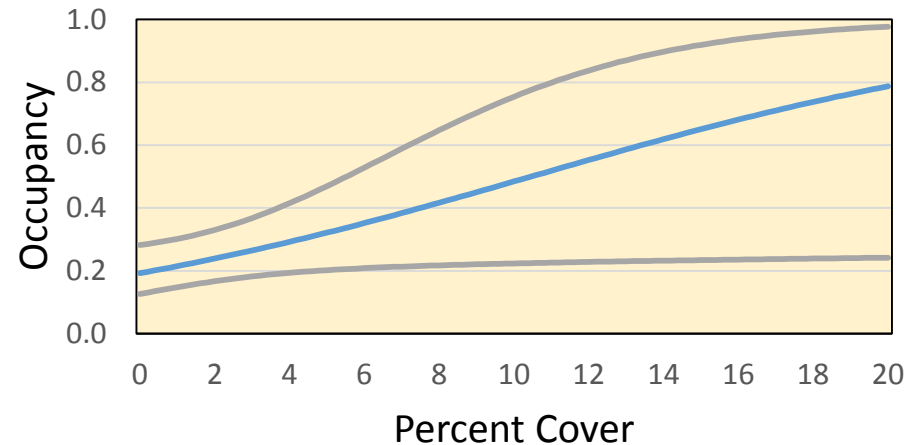


# OC Subregional Models

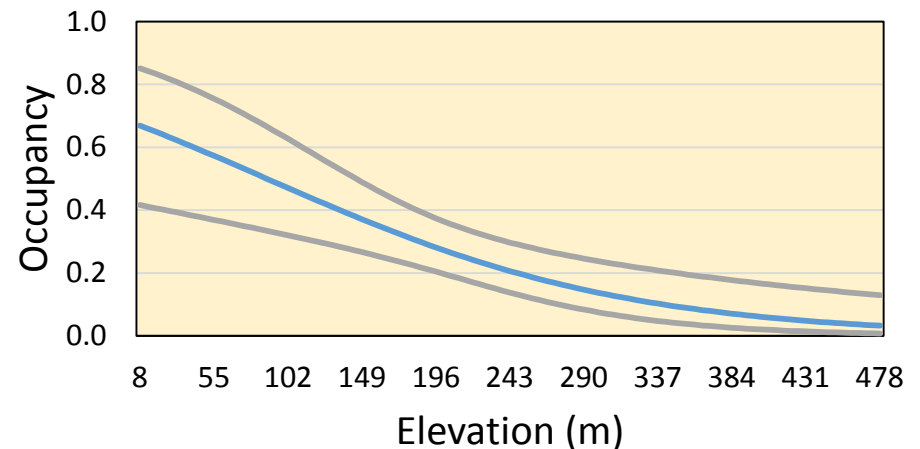
Occupancy a function of:

- California sagebrush (+)
- California buckwheat (+)
- Bare(+)
- Sunflowers (+)
- Elevation (-)

Sunflowers



Elevation

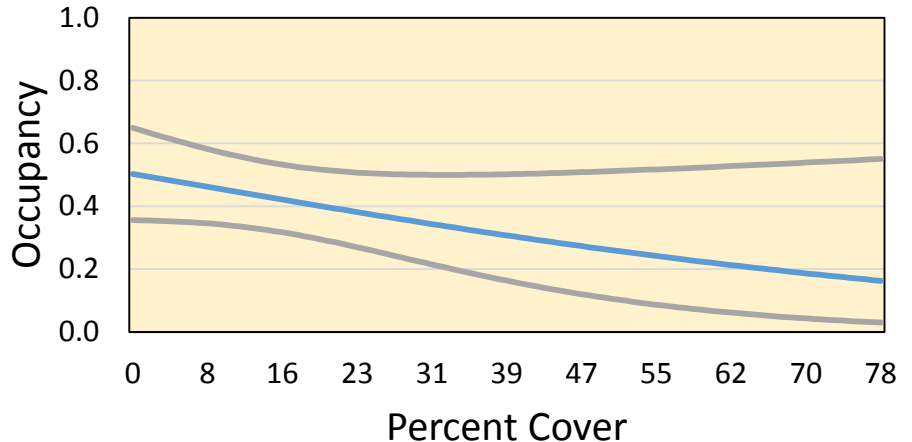


# Unburned Models

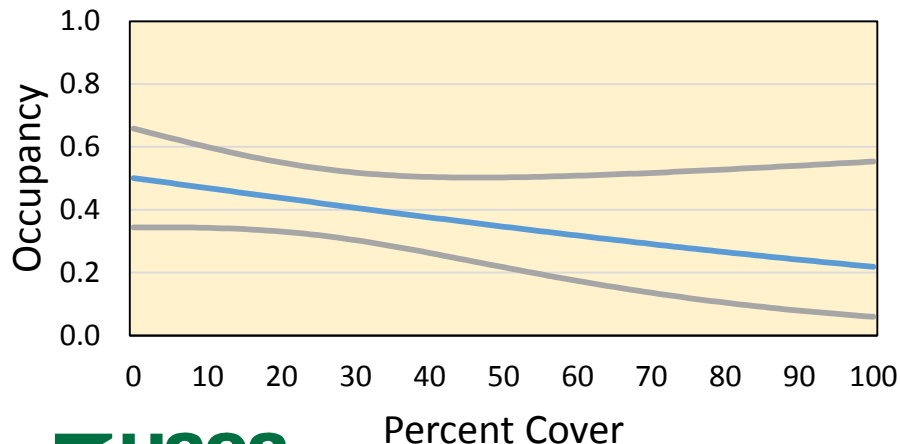
Occupancy a function of:

- California sagebrush (+)
- Bare(+)
- Shrub Height (+)
- Laurel Sumac (-)
- Sunflowers (+)
- Elevation (-)
- Grass (-)
- Star Thistle (+)
- Other Trees (-)
- Slope (-)

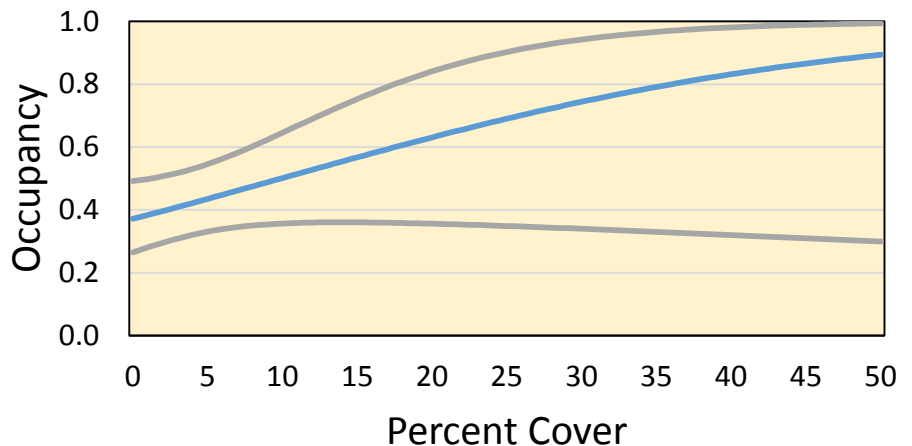
Other Trees



Grass



Star Thistle

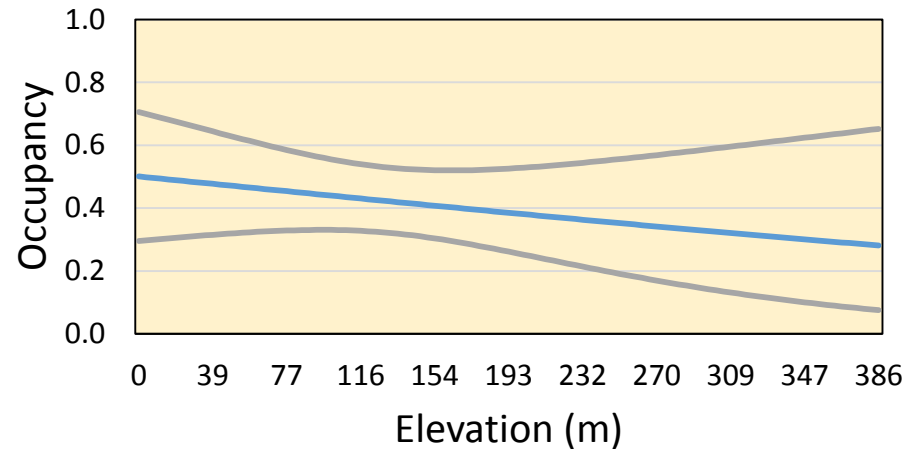


# Unburned Models

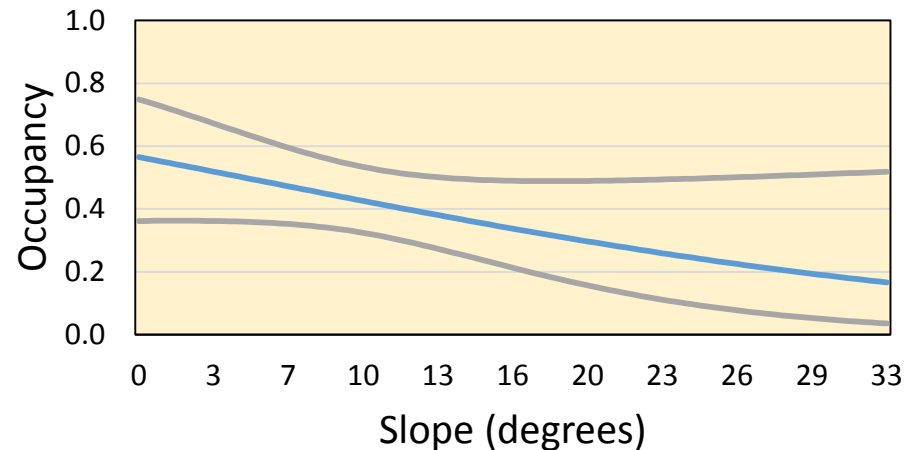
Occupancy a function of:

- California sagebrush (+)
- Bare(+)
- Shrub Height (+)
- Laurel Sumac (-)
- Sunflowers (+)
- Elevation (-)
- Grass (-)
- Star Thistle (+)
- Other Trees (-)
- Slope (-)

Elevation



Slope



# Comparisons of Models

Variable	Unburned	2003-2006	2007-2010
California Sagebrush	+		+
California Buckwheat		+	+
Dead		-	-
Total Herbaceous			-
Bare	+		+
Shrub Height	+	+	+
White Sage			-
Black Sage		+	
Laurel Sumac	-	-	(-)
Sunflowers	+		+
Distance to Coast			-
Elevation	-	-	-
Grass	-		(-)
Star Thistle	+	+	
Other Tree	-		
Slope	-	-	



Preliminary Information-Subject to Revision.  
Not for Citation



# Summary

## Positive effect on CAGN occupancy:

- California sagebrush
- California buckwheat
- Sunflower spp.
- Bare ground
- Shrub height

## Negative effect on CAGN occupancy:

- Grass
- Total herbaceous
- Laurel sumac
- (Time since fire)

# Summary

## Following wildfire:

- Grass/total herbaceous increases and remains high
- Laurel sumac increases and remains high
- California sagebrush and buckwheat increase gradually
- California buckwheat appears to recover more quickly than California sagebrush
- Black sage may be a surrogate for California sagebrush during recovery
- Post-fire recovery may take 6-7 decades

# 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!