Science as it Relates to Fisher and Marten Management: Public Lands

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Overview

1. Role of carnivores in ecosystems: why do we care?

2. What has science contributed to the goal of fisher and marten conservation (esp. public lands)?

   i.e. the ‘easy’ questions.

3. What are the next generation of information needs?

   i.e. the ‘hard’ questions.

Carnivores

1. Ecosystem ‘services’
   - transfer energy via predation, cycle nutrients
   - influence evolution of prey, disperse seeds

2. Role in structuring communities

Mesopredator release and avifaunal extinctions in a fragmented system

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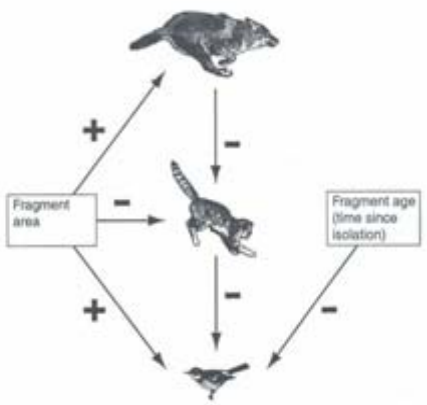


Figure 1 Model of the combined effects of trophic cascades and island biogeographical processes on top predators (for example, coyote), mesopredators (domestic cat) and prey (scrub-breeding birds) in a fragmented system. Direction of the interaction is indicated with a plus or minus.

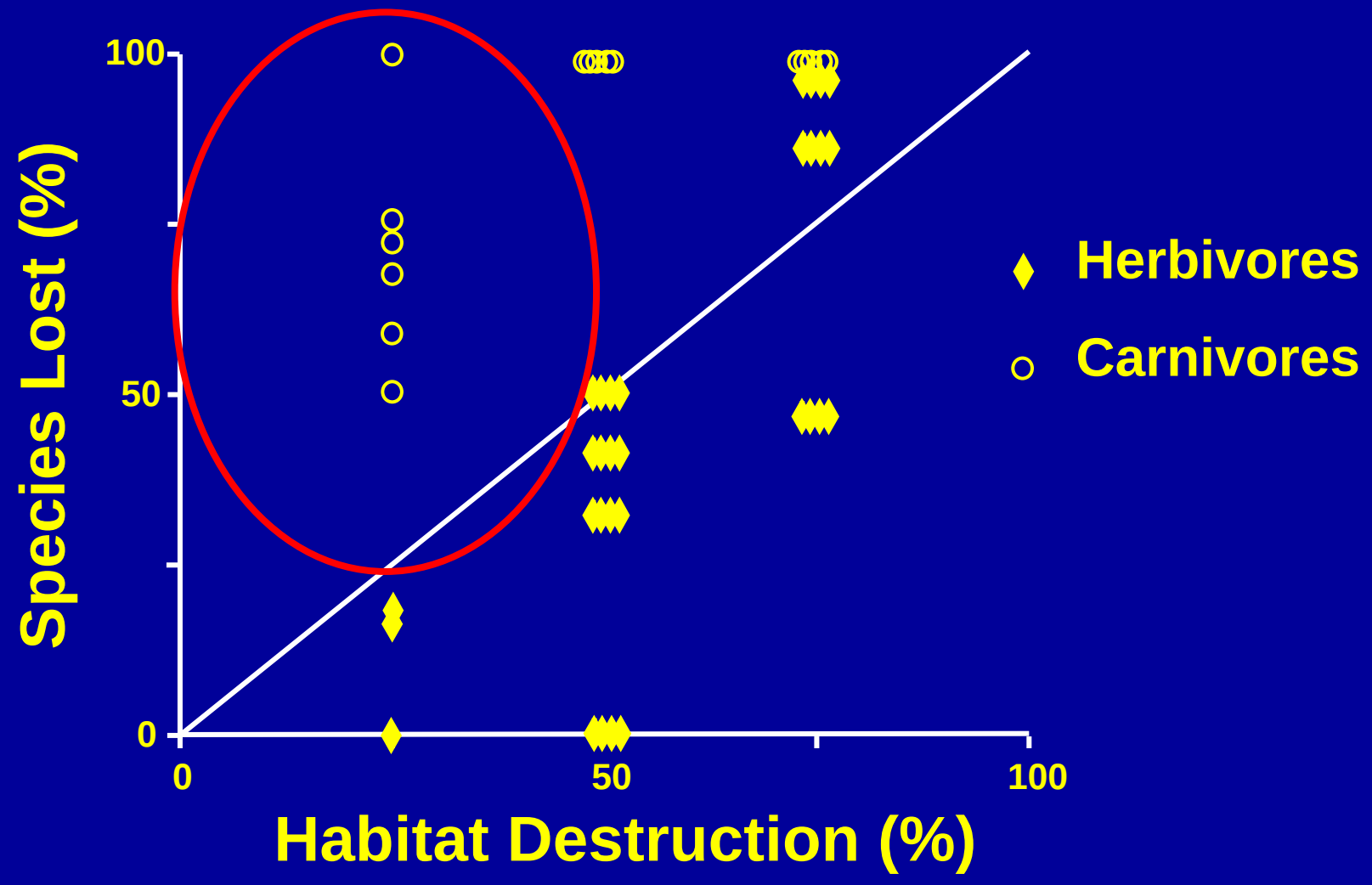
Ecological Meltdown in Predator-Free Forest Fragments

John Terborgh,[1*] Lawrence Lopez,[2] Percy Nuñez V.,[3] Madhu Rao,[4,5] Ghazala Shahabuddin,[6] Gabriela Orihuela,[7] Mailen Riveros,[8] Rafael Ascanio,[9] Greg H. Adler,[11] Thomas D. Lambert,[10] Luis Balbas[12]

The manner in which terrestrial ecosystems are regulated is controversial. The "top-down" school holds that predators limit herbivores and thereby prevent them from overexploiting vegetation. "Bottom-up" proponents stress the role of plant chemical defenses in limiting plant depredation by herbivores. A set of predator-free islands created by a hydroelectric impoundment in Venezuela allows a test of these competing world views. Limited area restricts the fauna of small (0.25 to 0.9 hectare) islands to predators of invertebrates (birds, lizards, anurans, and spiders), seed predators (rodents), and herbivores (howler monkeys, iguanas, and leaf-cutter ants). Predators of vertebrates are absent, and densities of rodents, howler monkeys, iguanas, and leaf-cutter ants are 10 to 100 times greater than on the nearby mainland, suggesting that predators normally limit their populations. The densities of seedlings and saplings of canopy trees are severely reduced on herbivore-affected islands, providing evidence of a trophic cascade unleashed in the absence of top-down regulation.

3. Vulnerability to extinction

3. Vulnerability to extinction



Wennergren et al. 1995

Characteristics that increase vulnerability to extinction

- Secondary or tertiary consumers
- Low densities
- Large home ranges
- Low mobility
- Relatively low genetic diversity

Especially Habitat Specialists: Marten & Fisher

Increased Risk from Habitat - Altering Activities

General Comparisons: *Martes* in California

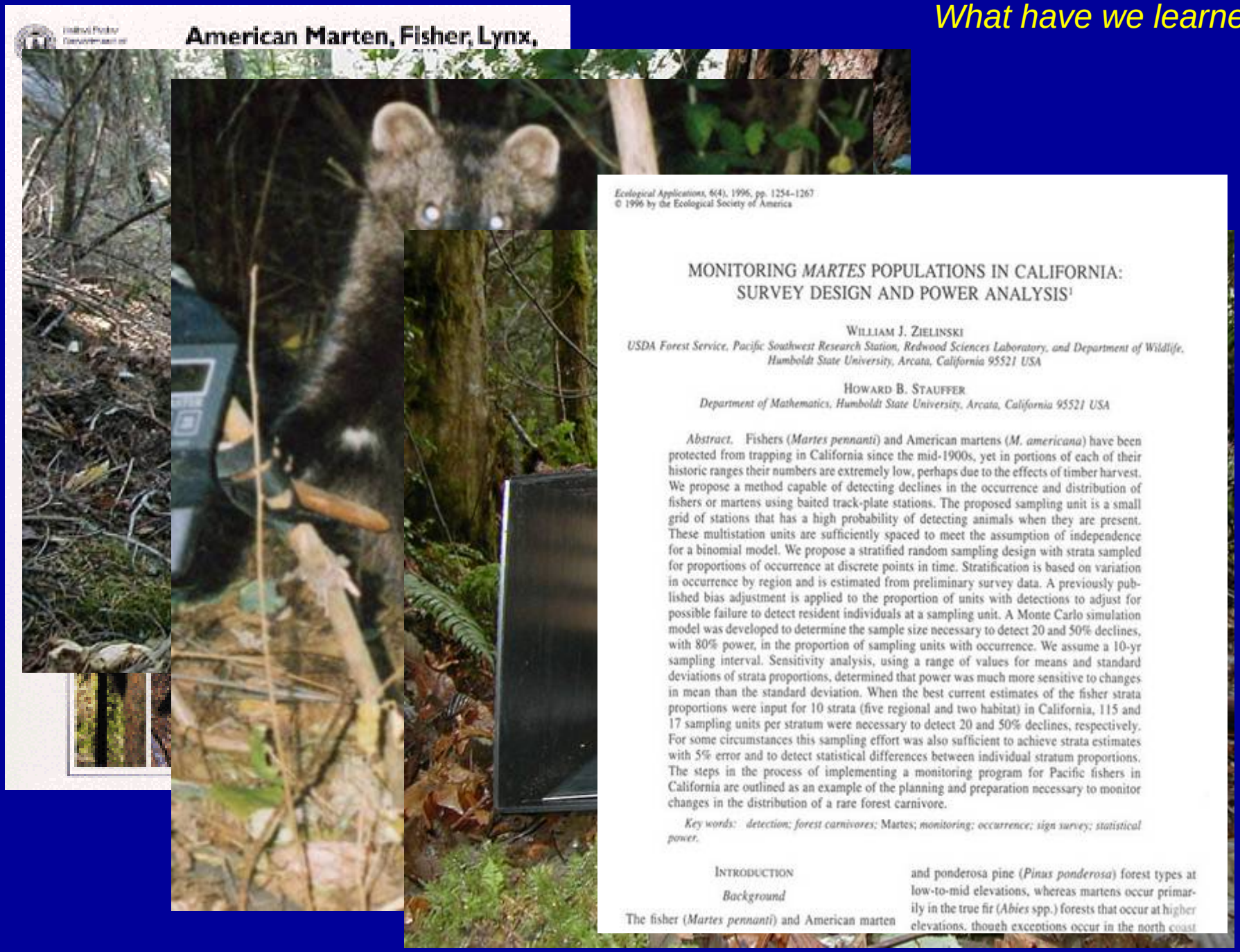
	M. americana	*M. pennanti*
Body size	0.5 - 1 kg	2 - 5 kg
Home range size	2 – 10 km^2	15 – 40 km^2
Forest types	Conifer	Mixed
Elevation	Higher	Lower
Paleohistory in western US	Pleistocene refugia	Holocene arrival

What we've learned from research on public lands in California:

SURVEY AND DETECTION METHODS

	Fisher	**Marten**
Track plates and cameras	●	●
Snow tracking	•	•
Noninvasive genetic sampling		
• fecal	•	•
•hair	●	●

What have we learned?



Ecological Applications, 6(4), 1996, pp. 1254–1267
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MONITORING *MARTES* POPULATIONS IN CALIFORNIA: SURVEY DESIGN AND POWER ANALYSIS[1]

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Abstract. Fishers (*Martes pennanti*) and American martens (*M. americana*) have been protected from trapping in California since the mid-1900s, yet in portions of each of their historic ranges their numbers are extremely low, perhaps due to the effects of timber harvest. We propose a method capable of detecting declines in the occurrence and distribution of fishers or martens using baited track-plate stations. The proposed sampling unit is a small grid of stations that has a high probability of detecting animals when they are present. These multistation units are sufficiently spaced to meet the assumption of independence for a binomial model. We propose a stratified random sampling design with strata sampled for proportions of occurrence at discrete points in time. Stratification is based on variation in occurrence by region and is estimated from preliminary survey data. A previously published bias adjustment is applied to the proportion of units with detections to adjust for possible failure to detect resident individuals at a sampling unit. A Monte Carlo simulation model was developed to determine the sample size necessary to detect 20 and 50% declines, with 80% power, in the proportion of sampling units with occurrence. We assume a 10-yr sampling interval. Sensitivity analysis, using a range of values for means and standard deviations of strata proportions, determined that power was much more sensitive to changes in mean than the standard deviation. When the best current estimates of the fisher strata proportions were input for 10 strata (five regional and two habitat) in California, 115 and 17 sampling units per stratum were necessary to detect 20 and 50% declines, respectively. For some circumstances this sampling effort was also sufficient to achieve strata estimates with 5% error and to detect statistical differences between individual stratum proportions. The steps in the process of implementing a monitoring program for Pacific fishers in California are outlined as an example of the planning and preparation necessary to monitor changes in the distribution of a rare forest carnivore.

Key words: detection; forest carnivores; Martes; *monitoring; occurrence; sign survey; statistical power.*

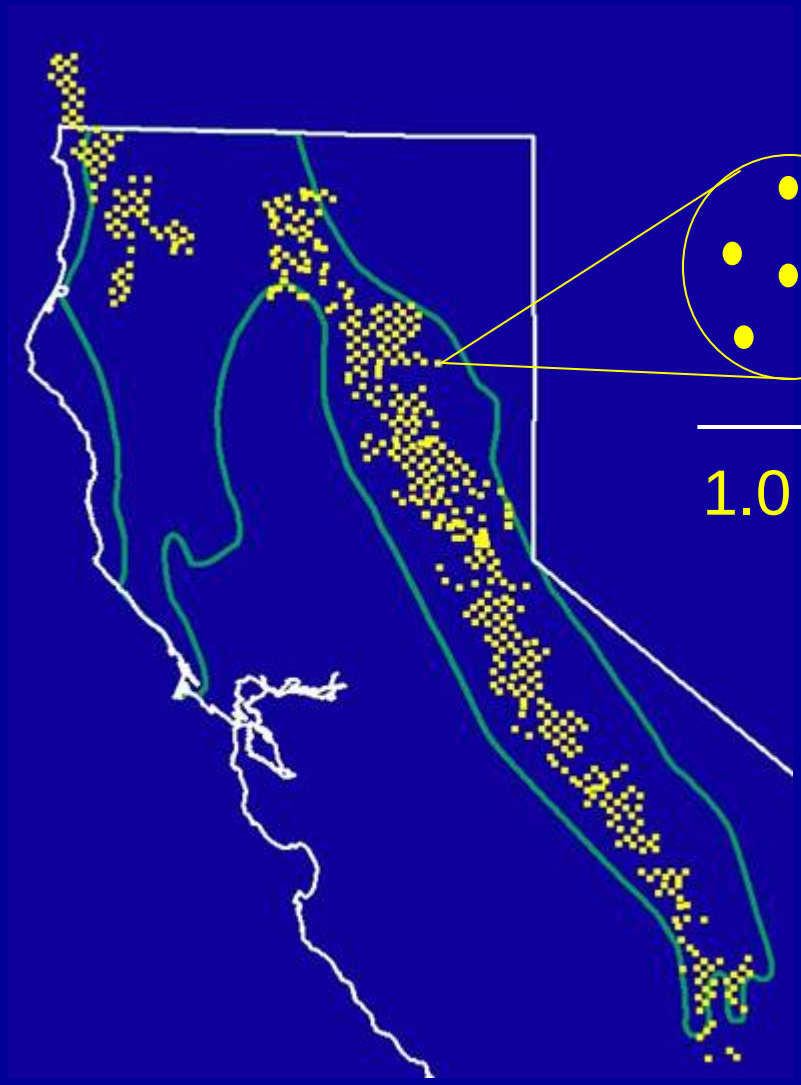
INTRODUCTION

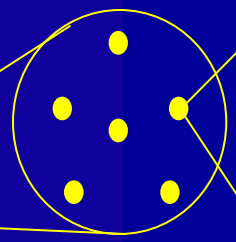
Background

The fisher (*Martes pennanti*) and American marten

and ponderosa pine (*Pinus ponderosa*) forest types at low-to-mid elevations, whereas martens occur primarily in the true fir (*Abies* spp.) forests that occur at higher elevations, though exceptions occur in the north coast

Systematic Surveys (1996- 2002)





1.0 km

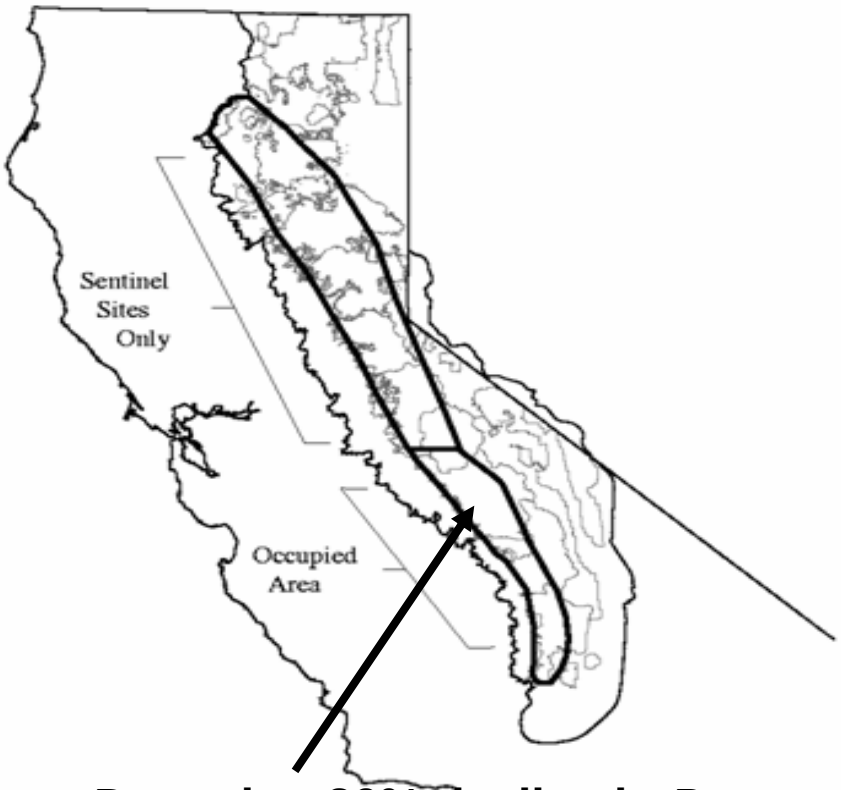
- n = 459 sample units
- systematic sampling
- 10-km spacing
- sample unit = 6 stations
- 8 visits

What have we learned?

Monitoring the Sierra Nevada Fisher Population (2002 -)

Developed as part of the Sierra Framework Adaptive Management Plan
(Zielinski and Mori 2001)

- Occupied v. unoccupied areas
- Index = P =proportion of units with detection
- Designed to detect 20% decline



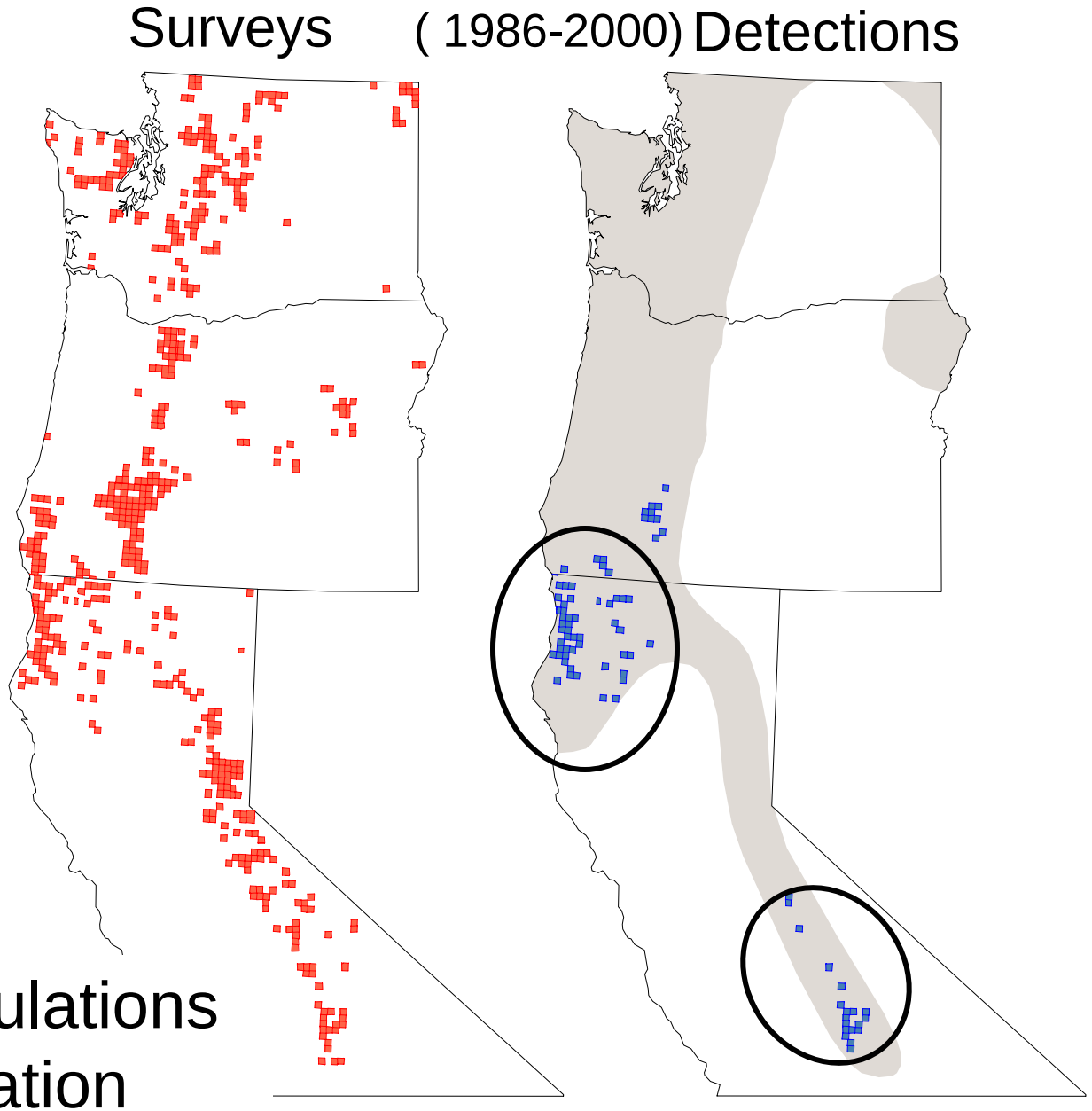
Detecting 20% decline in *P* requires ≥ 288 sample units.

What we've learned: BASIC ECOLOGY

	Fisher	Marten
Geographic Range	●	●
Microhabitat Selection (esp.resting)	●	●
Landscape Habitat Suitability	•	•
Home Range - size - composition	● •	●
Diet	●	●
Population Ecology Population Genetics Demography Fitness and Habitat Relations	• ● •	• •
Dispersal Behavior		
Community Ecology Disease and Parasites	• •	• •

What have we learned?

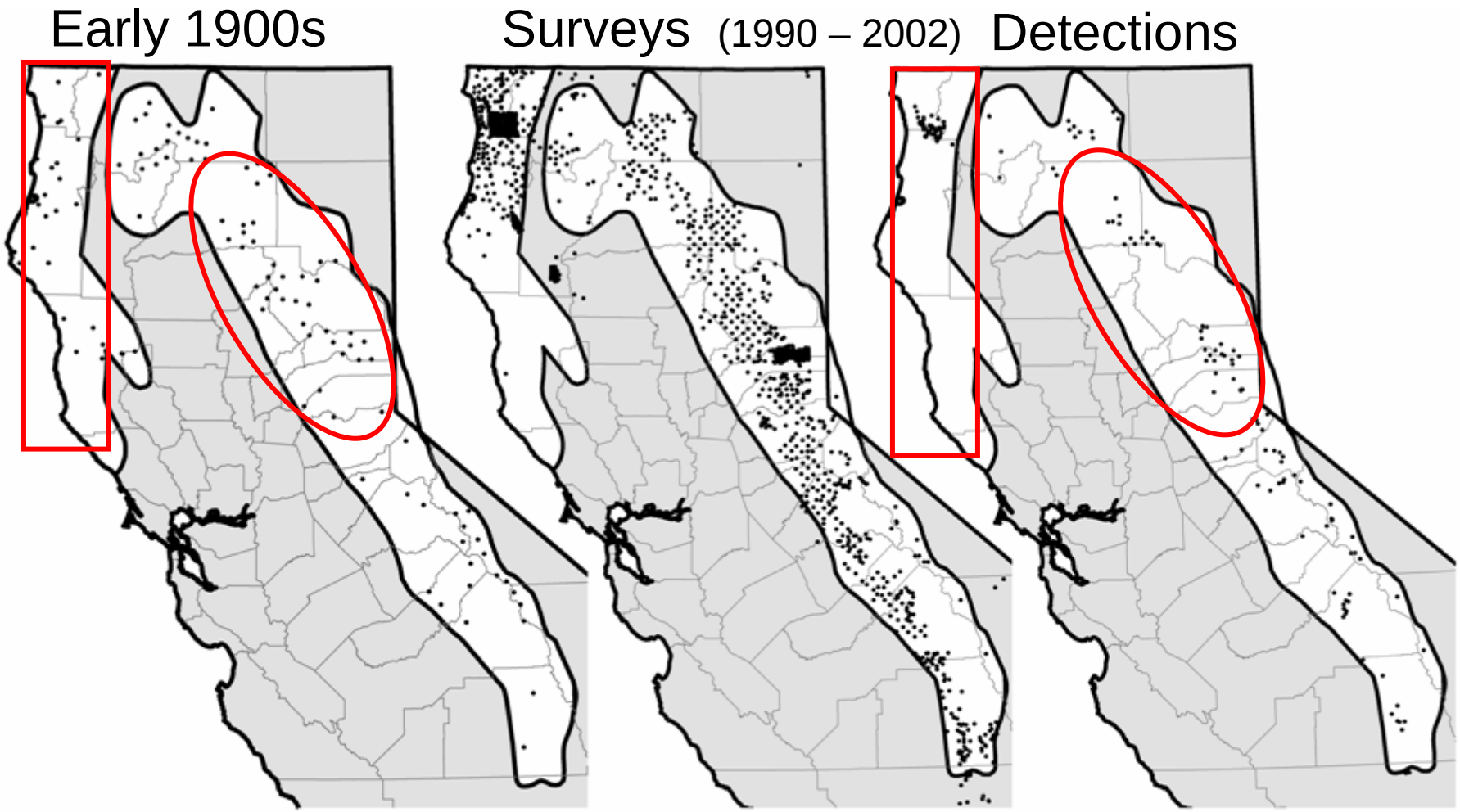
Fisher Distribution



- 2 California populations
- ~ 400 km separation

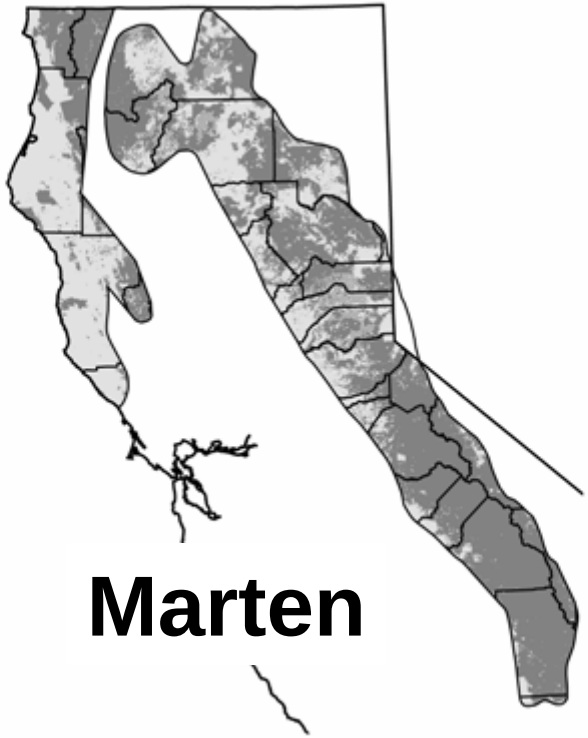
Aubry and Lewis (2003)

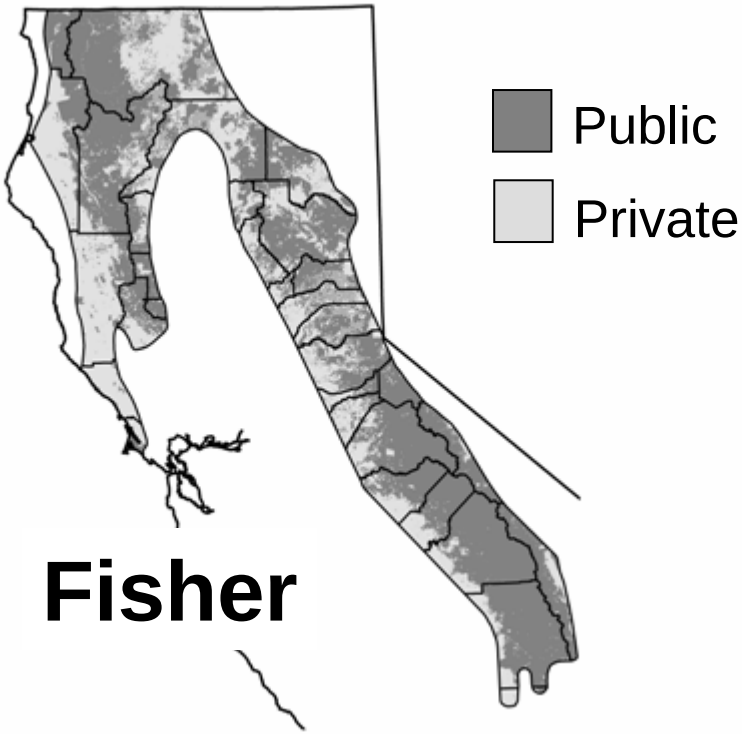
Marten Distribution



- Severe reduction: *M. a. humboldtensis*
- Apparent pop. fragmentation: Cascades/Northern Sierra

Land Ownership: Public v. Private





	Public	Private
Humboldt	**35%**	**65%**
Sierra	**68%**	**32%**
Both	**60%**	**40%**

Public	Private
62%	**38%**

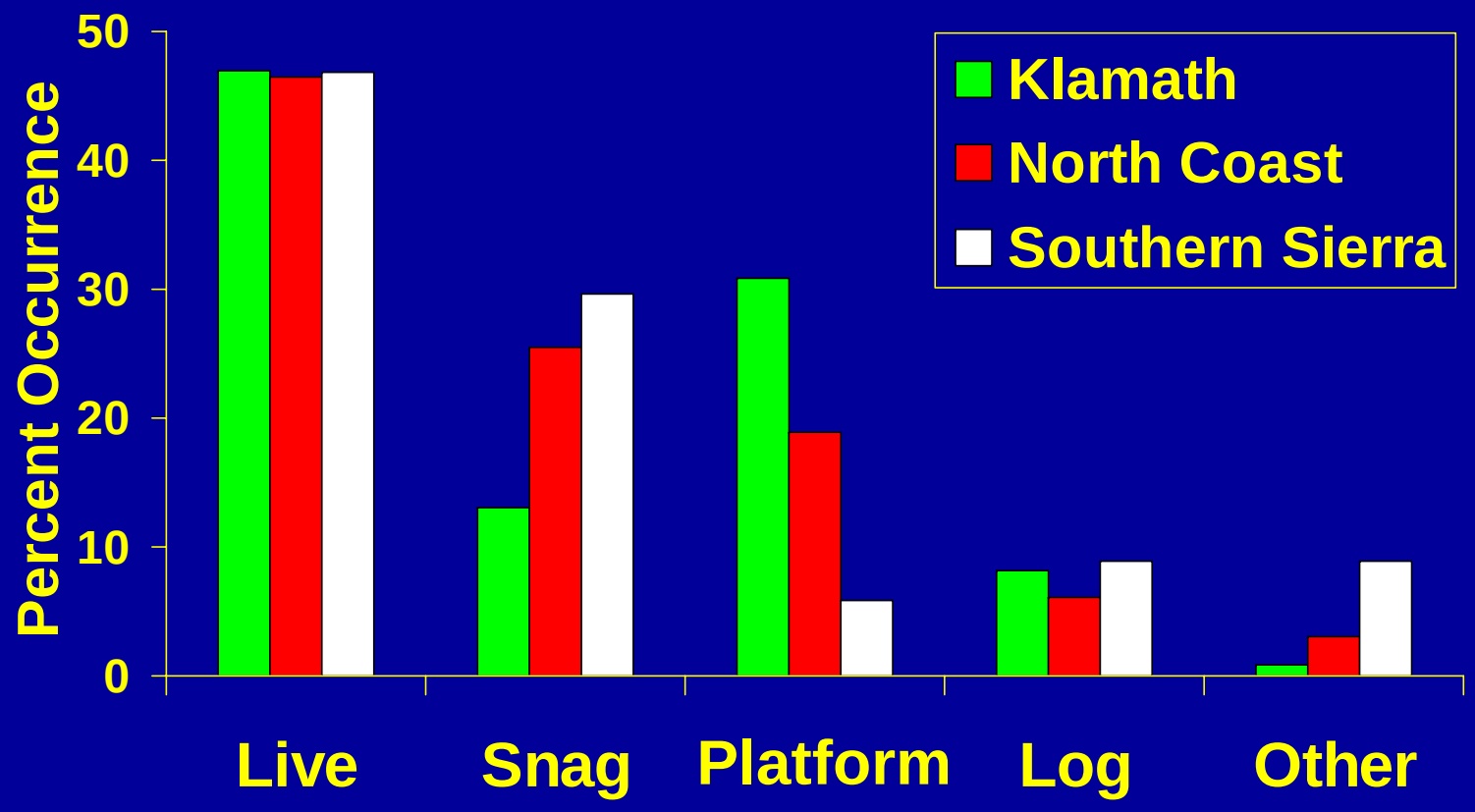
Fishers:
Two Important Microhabitat Elements

1. **Large Woody Structures**
2. **Dense Overhead Cover**

What have we learned?

Large Woody Structures

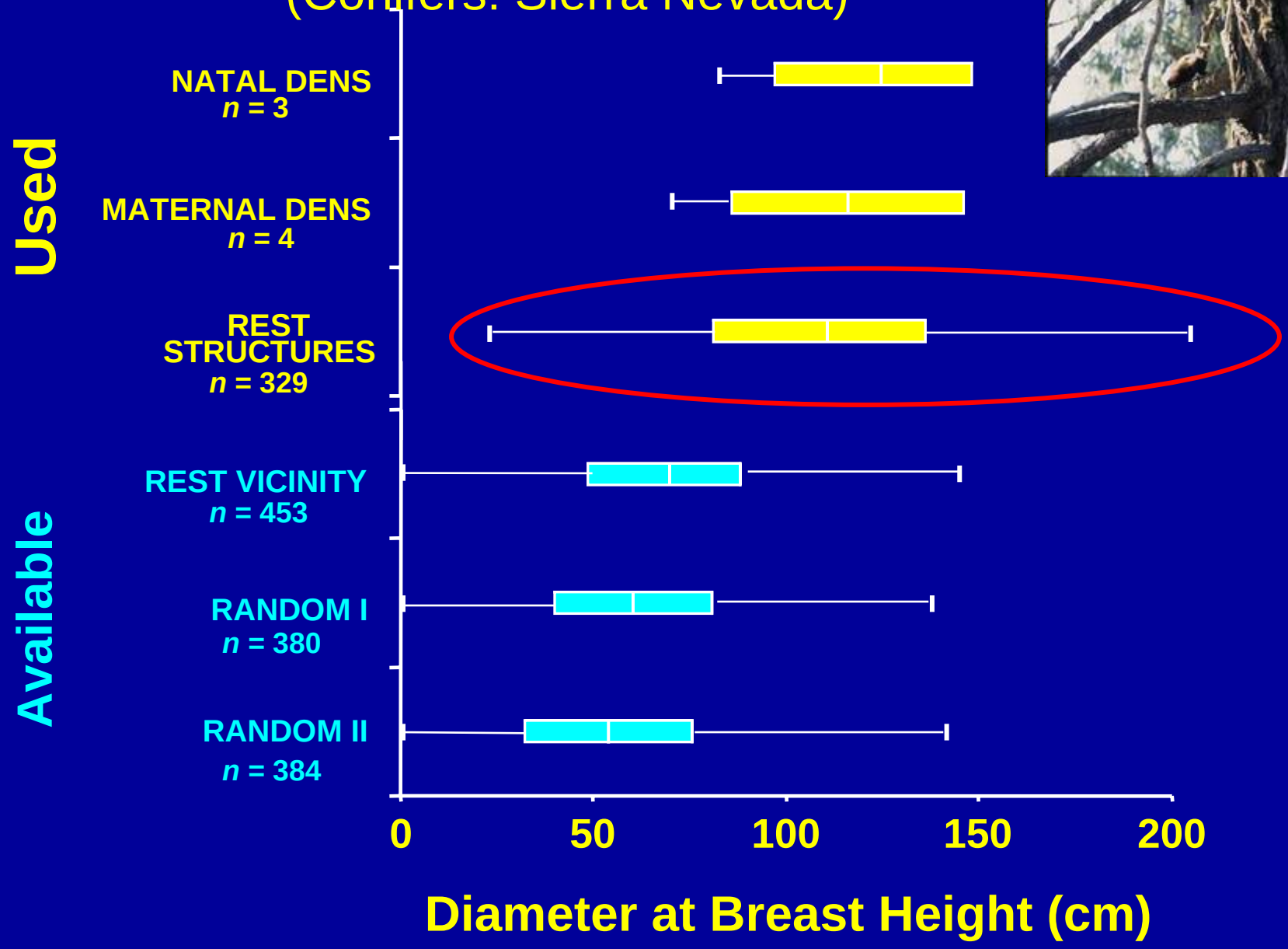
Fisher Rest Structures



What have we learned?

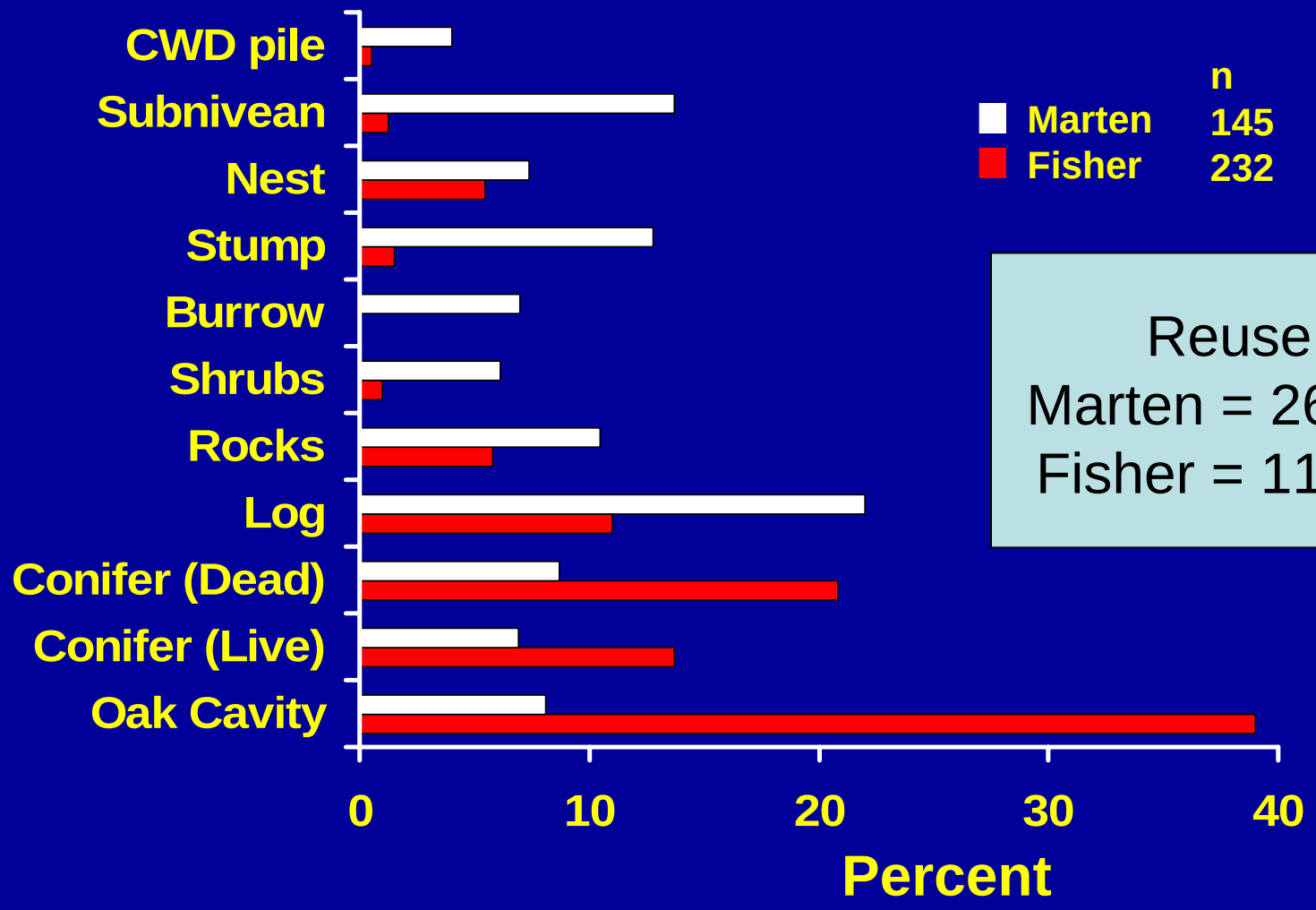
Fisher Rest Structure Size

(Conifers: Sierra Nevada)



Rest Structures: Fisher vs. Marten

Southern Sierra Nevada



Reuse
Marten = 26.2%
Fisher = 11.8%

Martes Rest Structures and Sites: Generalizations

- **structure more important than tree species**
- **size is necessary but age is required**
- **many suitable structures necessary per unit area**
- **logs important, but not as substitutes for trees/snags**
- **the structure's context (the 'site')is important**
- **reproductive dens likely to be similar to rest structures**

Dense Overhead Cover

Predictor Variables: Fisher Habitat Models

Model	Tree ***Canopy Closure***	Shrub ***Canopy Closure***	Max. Tree dbh	Average dbh Hardwood	Conifer Snags
Resting: 'Fisher' Model	**X**		X	X	X
Resting: Female Model	**X**		X		X
Resting: Southern Sierra Model			X	X	X
'Foraging' Model	**X**	**X**			

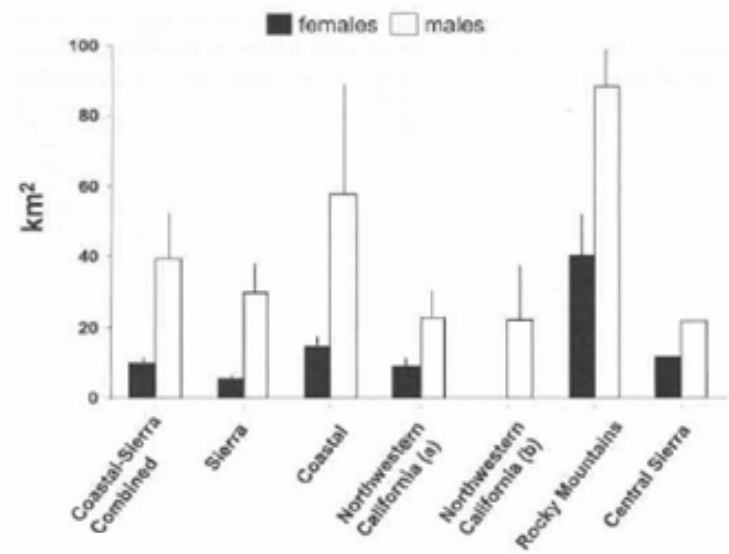
What have we learned?

Home Range Characteristics

Journal of Mammalogy, 85(4):649-657, 2004

HOME RANGE CHARACTERISTICS OF FISHERS IN CALIFORNIA

WILLIAM J. ZIELINSKI,* RICHARD L. TRUEX , GREGORY A. SCHMIDT, FREDRICK V. SCHLEXER, KRISTIN N. SCHMIDT, AND REGINALD H. BARRETT



Composition too…..

TABLE 2.-Percentage composition of vegetation type and seral stage classes in home ranges of all focal fishers in the Coastal study area, California, and for females (n = 7) and males (n = 2) separately.

Douglas-fir-early-seral	
Douglas-fir-mid-seral	24
Douglas-fir-late-seral	1
True fir-early-seral	
True fir-mid-seral	1
True fir-late-seral	1
Oak-Pine-early-seral	
Oak-Pine-mid-seral	
Oak-Pine-late-seral	
White oak-early-seral	
White oak-mid-seral	
White oak-late-seral	
Grassland	

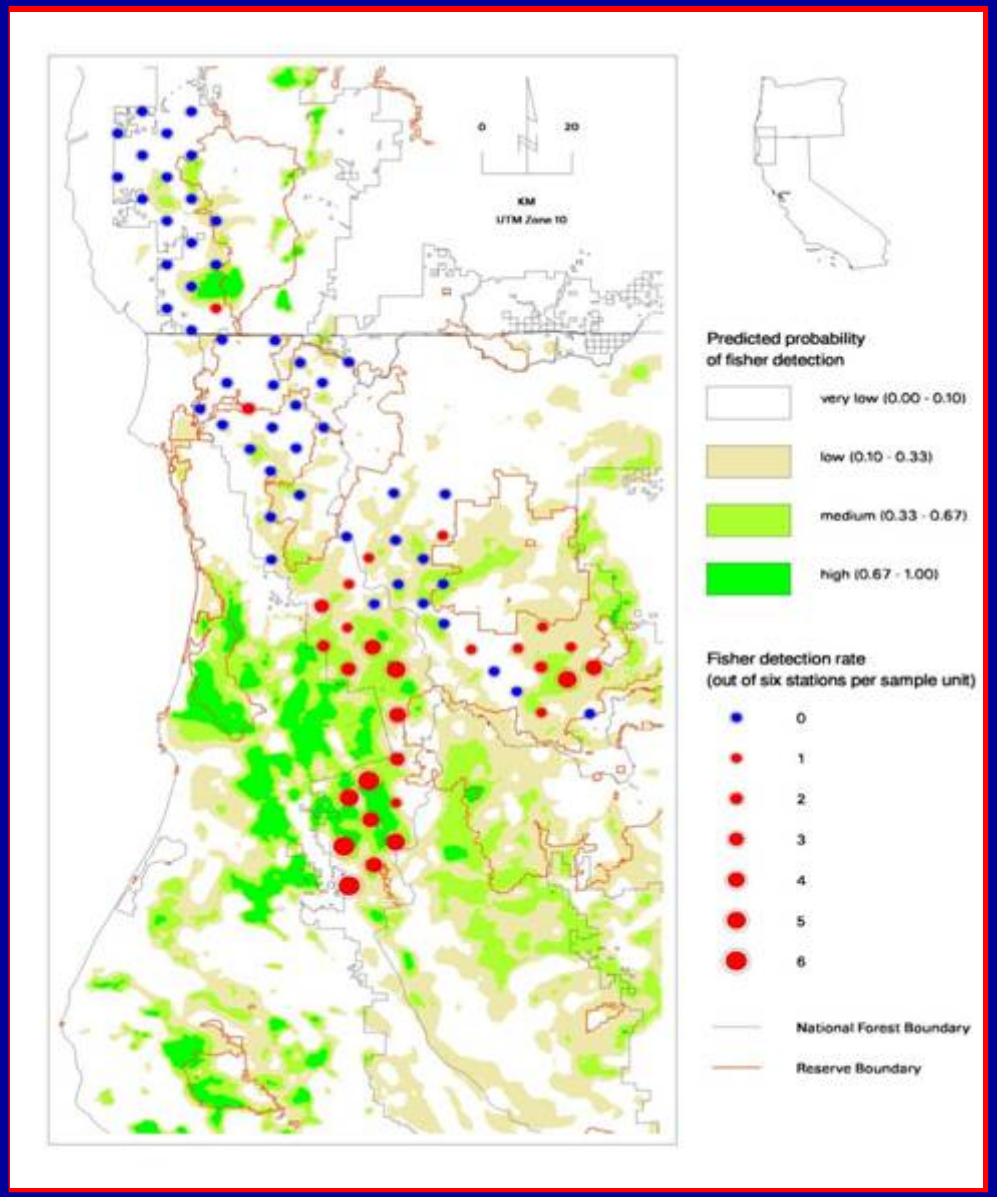
TABLE 3.-Percentage composition of California Wildlife Habitat Relations system types, size classes, and canopy closure classes in home ranges of all focal fishers in the Sierra study area, Ca[illegible] for females (n = 8) and males (n = 4) separately.

	Total		Female		Male	
	%	SD		SD		SD
Type						
Sierran Mixed Conifer	40.36	25.43	38.53	29.03	44.02	19.47
Ponderosa Pine	32.94	26.32	40.15	26.89	18.53	20.90
Montane Hardwood	12.27	12.53	13.98	14.65	8.85	7.16
Red Fir	7.30	16.63	0.01	0.04	21.86	24.28
Montane Hardwood Conifer	4.44	3.81	5.73	4.12	1.85	0.40
Montane Chaparral	1.82	1.97	1.16	1.33	3.15	2.56
Barren	0.47	0.87	0.16	0.32	1.09	1.34
Lodgepole Pine	0.21	0.51	0.00	0.00	[illegible]	[illegible]
Mixed Chaparral	0.16	0.34	0.24	0.41	0.00	0.00
Urban	0.03	0.09	0.04	0.11	0.00	0.00
Size Class (cm dbh)						
Not determined	2.78	2.62	1.81	1.54	4.72	3.48
1: seedling tree, <2.5 cm	0.30	0.44	0.34	0.52	0.24	0.28
2: sapling tree, 2.6-15.2 cm	1.63	1.66	1.61	1.94	1.67	1.12
3: pole tree, 15.3-28.9 cm	21.84	25.56	22.15	27.81	21.22	24.29
4: small tree, 29.0-61.0 cm	60.68	19.88	61.22	21.04	59.59	20.33
5: medium/large tree, >61.0 cm	12.77	10.93	12.88	13.47	12.56	3.83
Canopy Closure						
X: Not determined	1.44	2.17	0.99	1.57	2.34	3.14
Sparse: 10-24%	1.06	1.27	0.5	0.99	2.18	1.07
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Zielinski et al. 2004b

What have we learned?

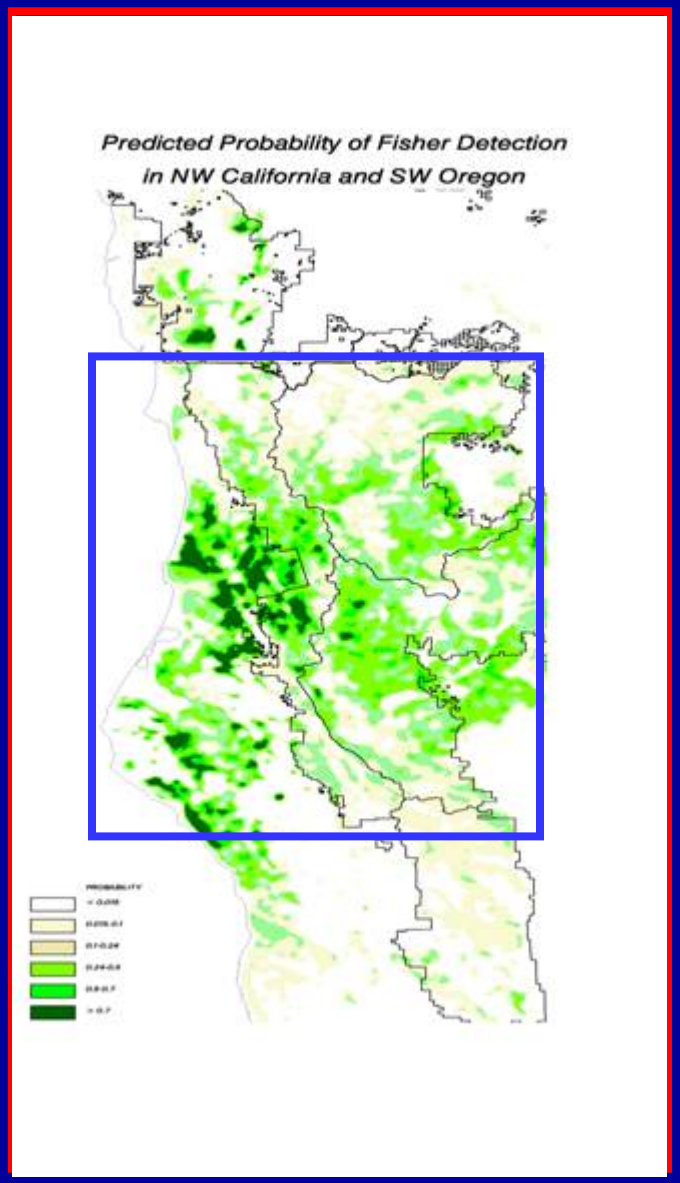
Landscape Models:
Regional Fisher Habitat is Differentially Distributed

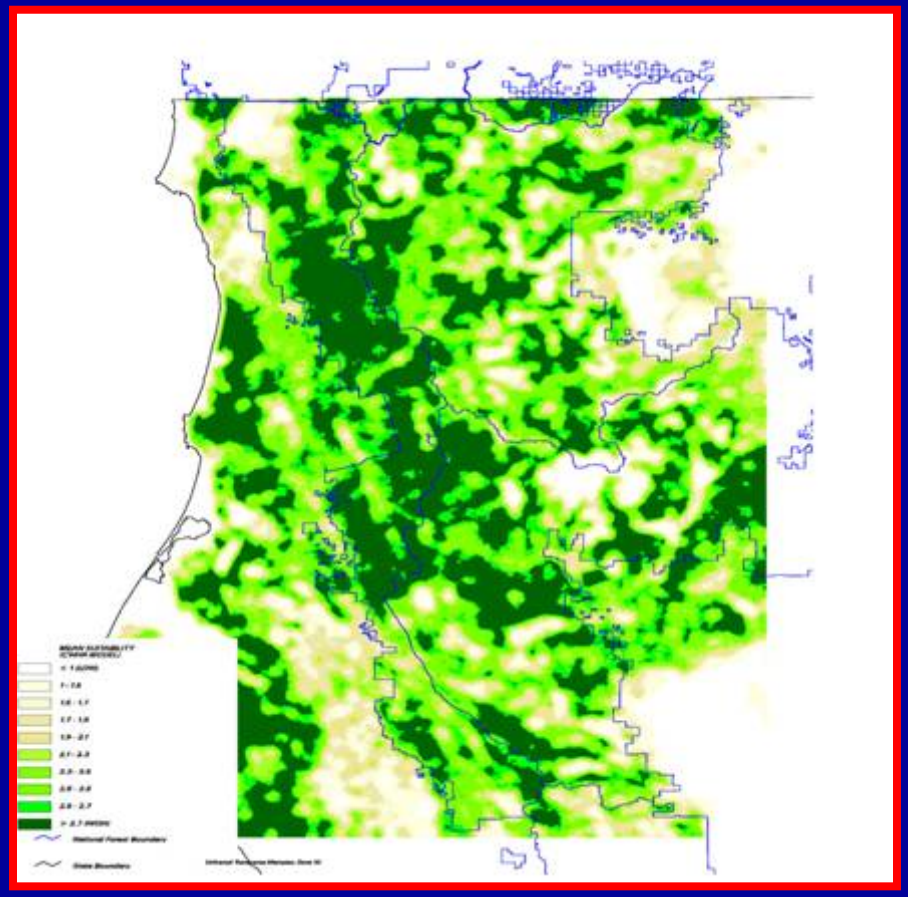


Carroll et al. (2004)

Empirical Model vs. Conceptual Model

[Cal. Wild. Hab. Relations]

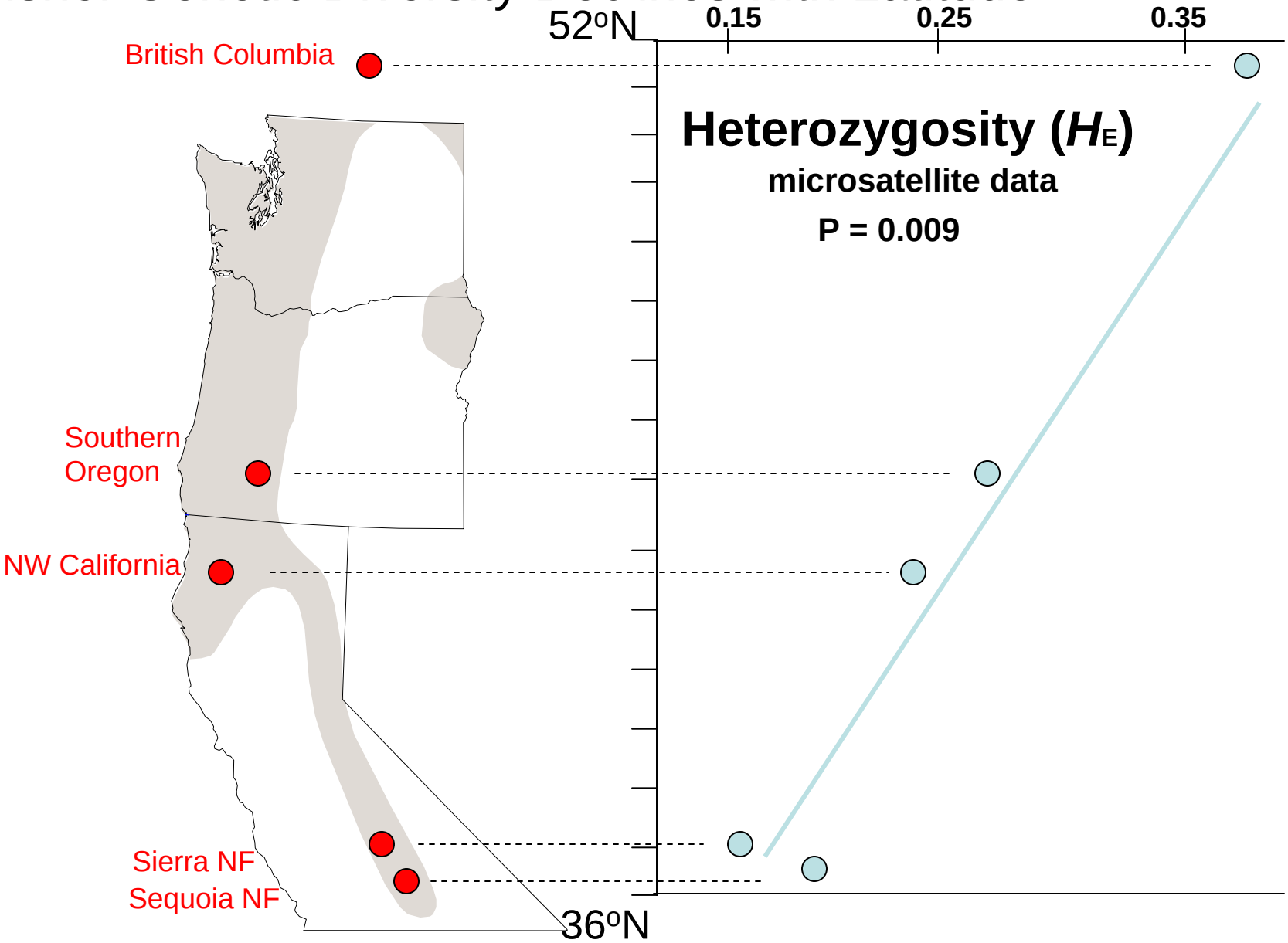




……overestimation of suitable habitat

Fisher Genetic Diversity Declines with Latitude

What have we learned?



Wisely et al. (2004)

Fisher Populations Demonstrate Restricted Gene Flow

- Wright's F_{ST} = 0.42 (0.07)
- Highest reported for mammalian carnivore
  - higher than for fishers in Canada (F_{ST}= 0.14)
  - higher than wolverine and marten
- Suggests population fragmentation and isolation

Genetic Diversity: Martens >> Fishers

	n	Haplotype Diversity (Nei 1987)	Nucleotide Diversity (Nei 1987)
Fisher	44	0.33	0.0008 + 0.03
Marten	29	0.73	0.0021 + 0.05

Excluding *M. a. humboldtensis*

D-loop mtDNA sequences (Koepf 1998)

What we've learned from research on public lands

BASIC ECOLOGY	Fisher	Marten
Geographic Range- Monitoring Distribution	●	●
Microhabitat Selection (esp.resting)	●	●
Landscape Habitat Suitability	●	
Home Range -size -composition	● ●	●
Diet	●	●
Population Ecology Population Genetics Demography Fitness and Habitat Relations	● ●	● ●
Dispersal Behavior		
Community Ecology Disease and Parasites	● ●	● ●

Descriptive

What we've learned from research on public lands in California: APPLIED ECOLOGY

	Fisher	Marten
Effects of Timber Harvest • clearcutting • other methods	●	●
Effects of Fuels Treatment • on habitat elements • on home range suitability	•	
Effects of OHV Recreation and Ski Areas		●
Effects of Land Allocation and Regional Conservation Planning	•	
Scale-Specific Effects Analysis • projects (THPs, BEs) • watershed	•	•

What we've learned from research on public lands in California: APPLIED ECOLOGY

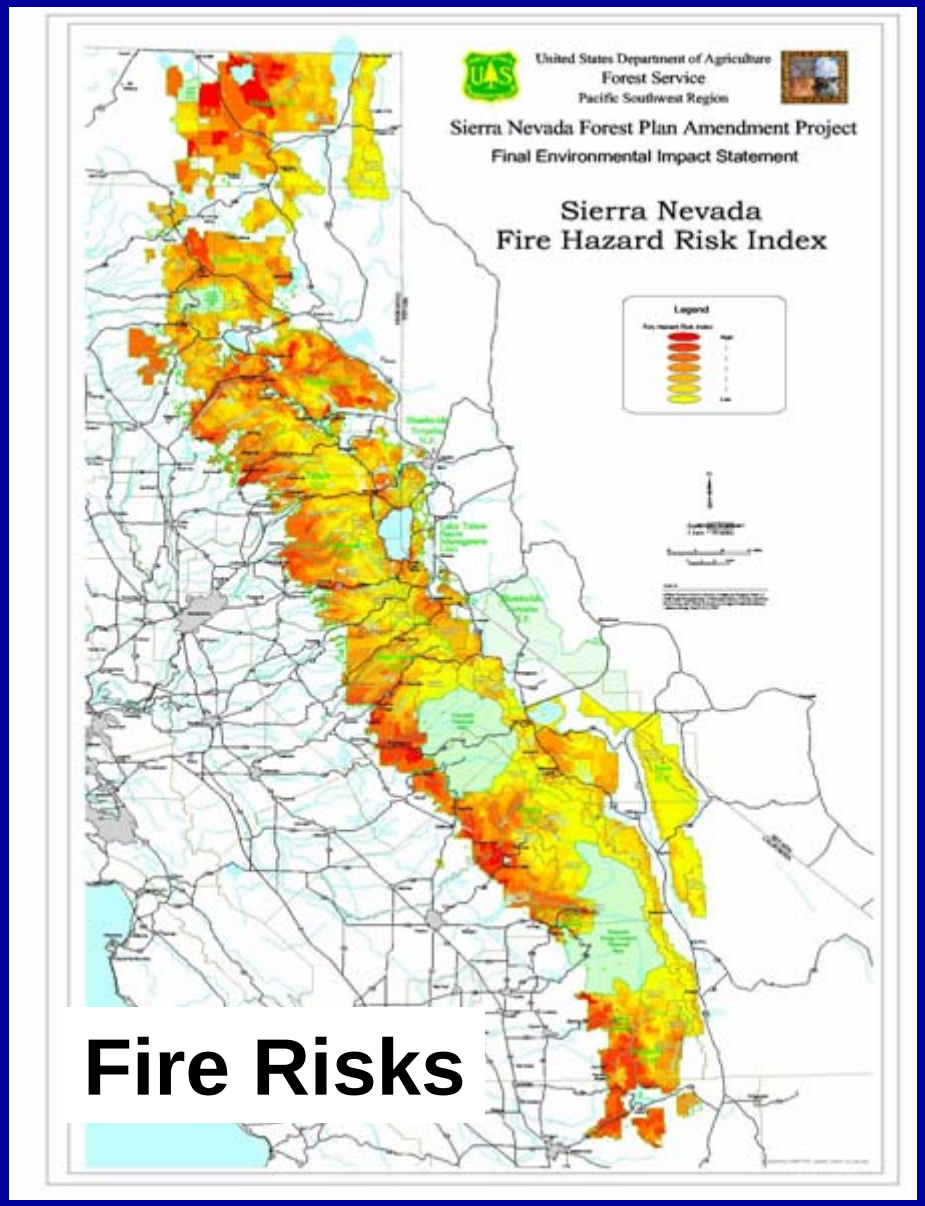
	Fisher	Marten
Effects of T • clearcu • other methods		●
Effects of F • on hab • on home range suitability		
Effects		●
Effects		
Scale-specific Habitat Guidelines • projects (THPs, BEs) • watershed	●	●

Urgent Need:
Fisher - Effects of Fuels Treatments

Urgent Need:
Marten - Effects of Recreation

Urgent Need:
Fisher & Marten - Conservation Planning and Effects Analysis

Fisher: Fire & Fuels Treatments



Fuels Treatment Options

Mechanical Treatment

Prescribed Fire

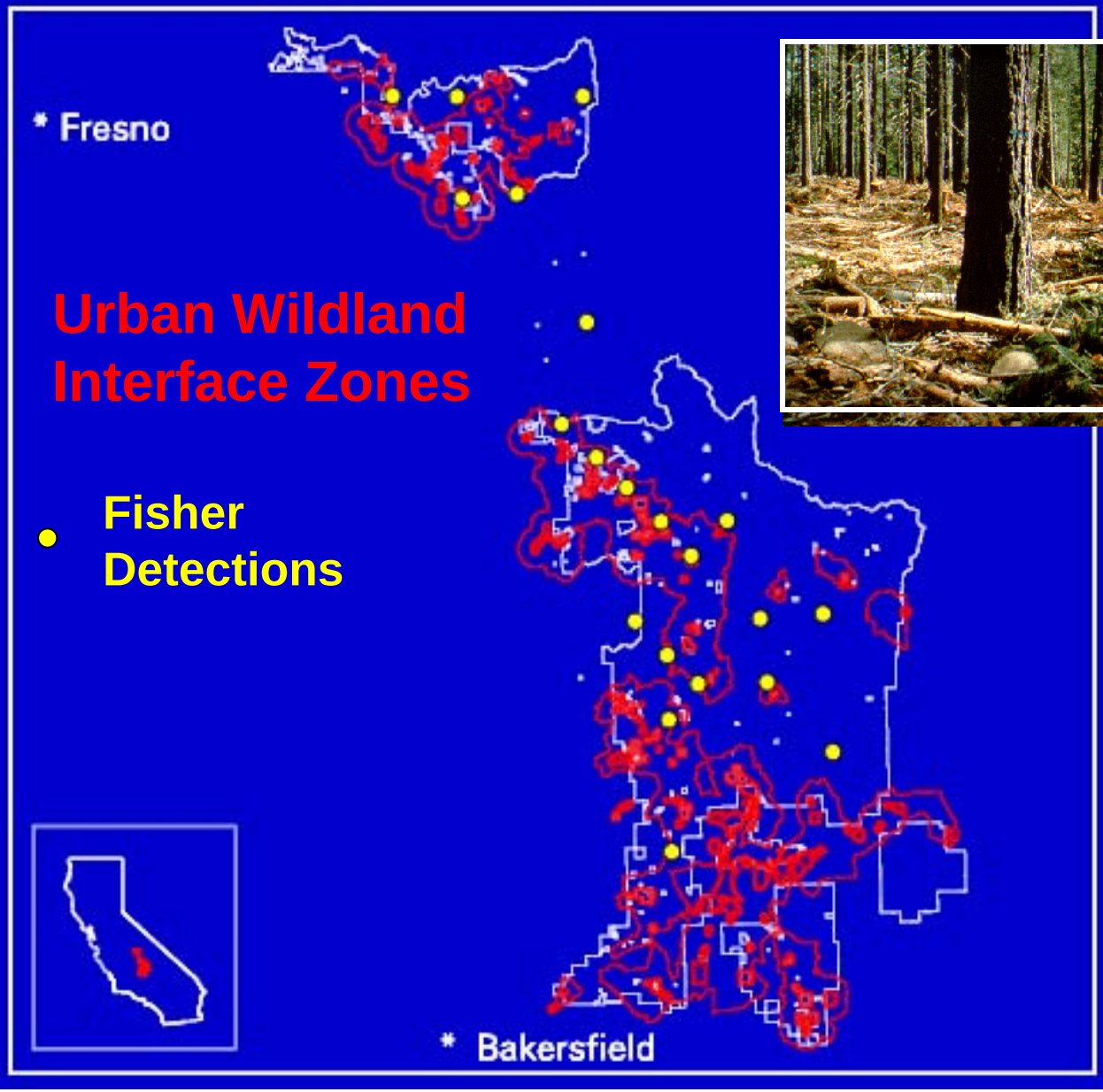
Fuels Treatments:
Fisher Habitat Risks

Potential short-term effects:

Decrease in….

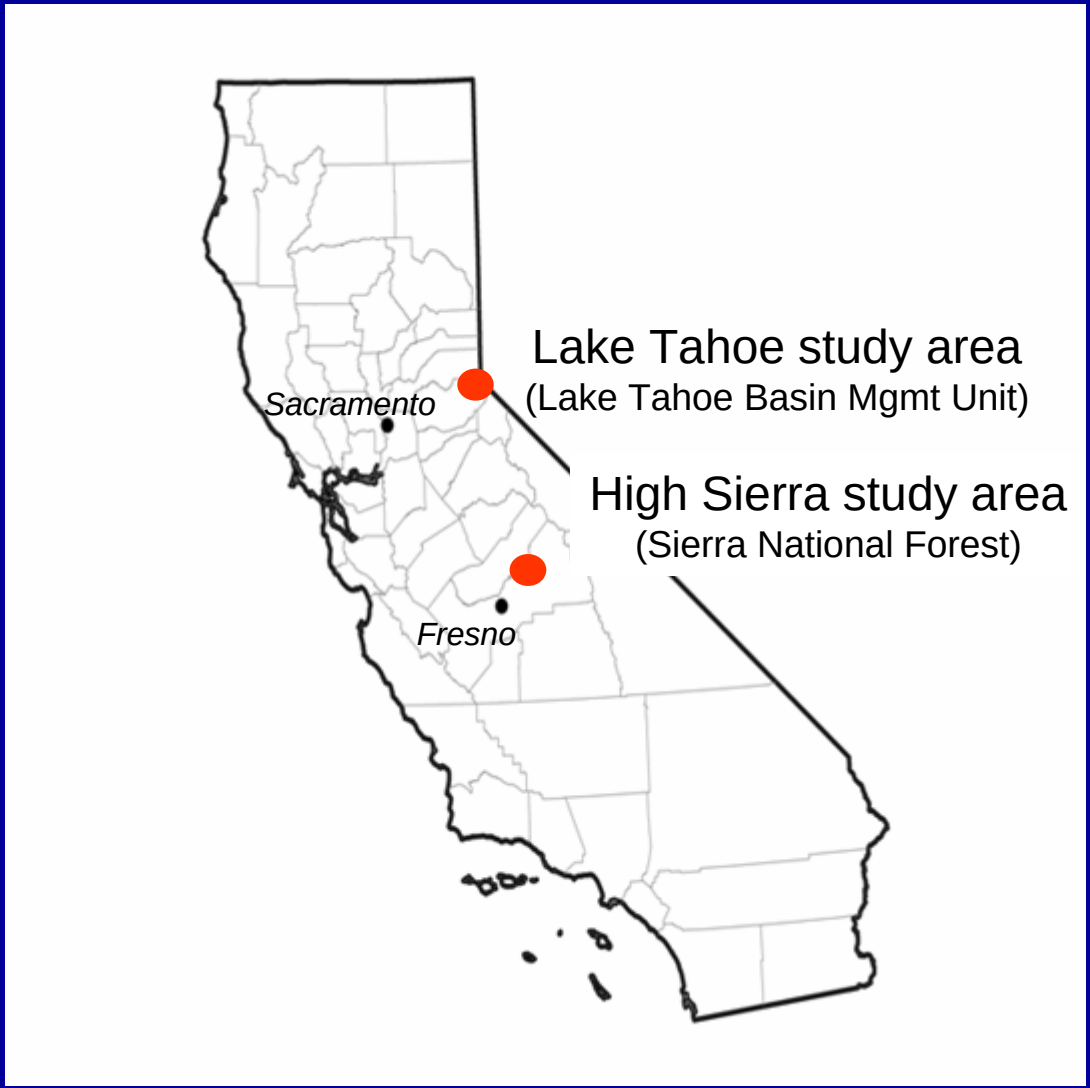
- large live trees
- large diameter snags and logs
- canopy closure
- canopy layers

The Challenge



OHV and Developed Recreation:
Effects on Martens

The Effects of OHVs on Martens



Zielinski and Slauson (in prep.)

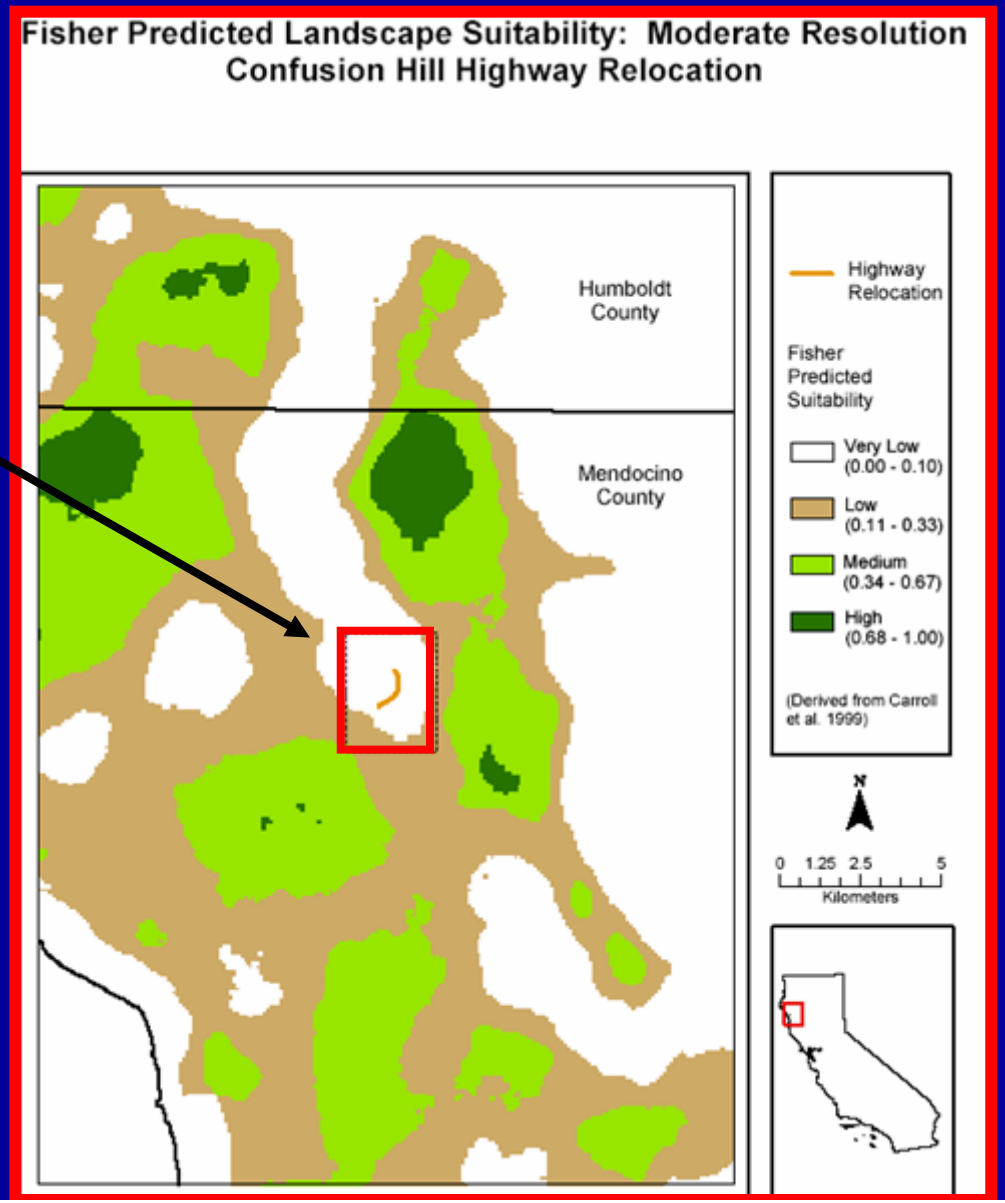
‘Effects Analysis’: Using Available Science

Project-level Questions:

- Landscape Models → Context
- Microhabitat Models → Evaluate Effects of Projects

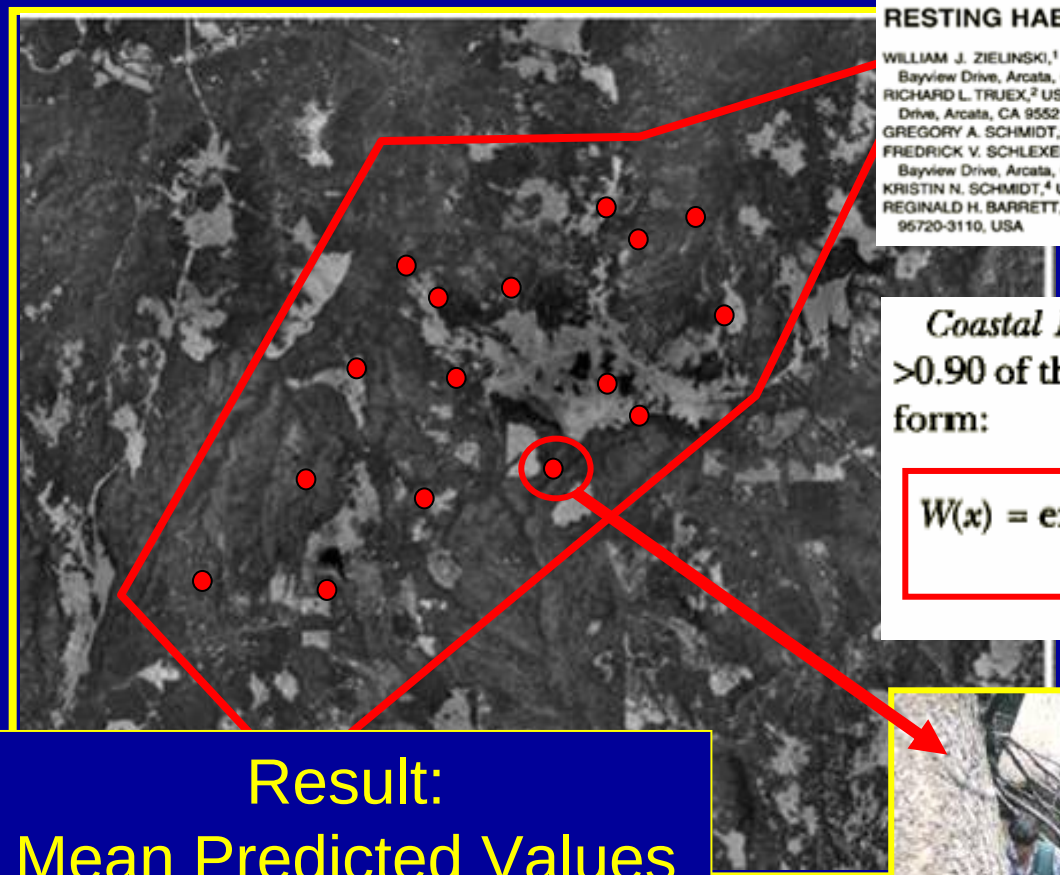
Landscape Models: Context for Projects

Highway Relocation



Microhabitat Models: Assessing Project Effects

(e.g., Resting Habitat Model; Zielinski et al. 2004)



RESTING HABITAT SELECTION BY FISHERS IN CALIFORNIA

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Coastal Models.—A single model accounted for >0.90 of the Akaike weight (Table 4) and took the form:

$$W(x) = \exp(0.06496*\text{CANAVE} + 0.01437*\text{DBH-MAX} + 0.8692*\text{CONSNAG}).$$

Result:
Mean Predicted Values
-Before and After-

Effects Analysis: Using Available Science

Project-level Questions:

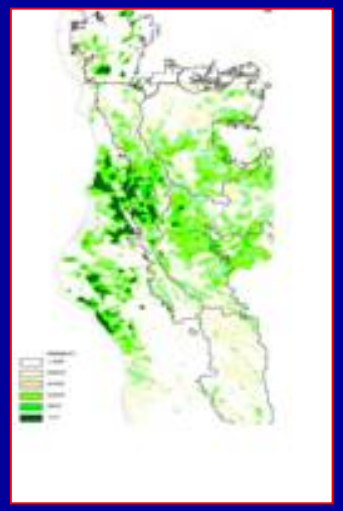
- Landscape Models → Context
- Microhabitat Models → Evaluate Effects of Projects

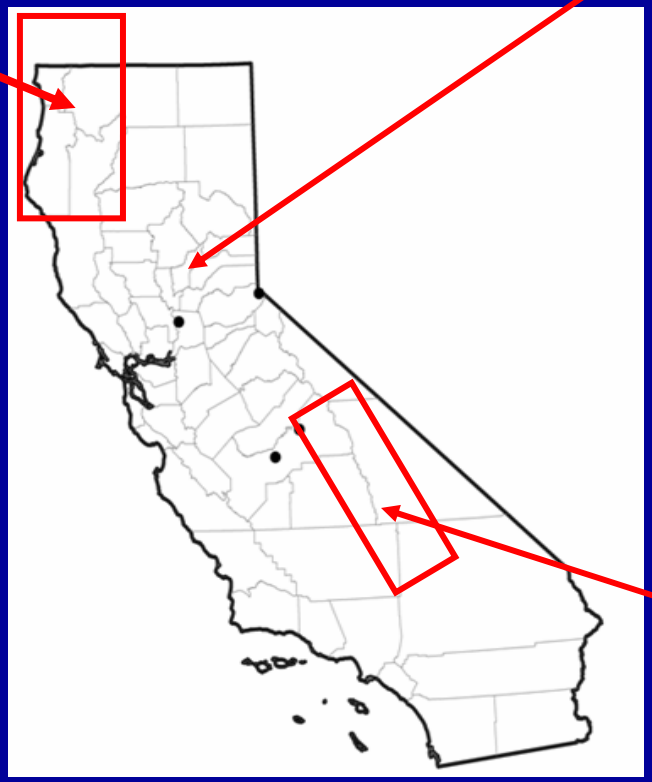
Landscape / Regional Conservation questions:

- Landscape models → source habitat / ‘bottlenecks’
- Landscape models → Conservation planning;
    - land allocations; reserve design
    - inform land exchanges [e.g., ‘checkerboard’].

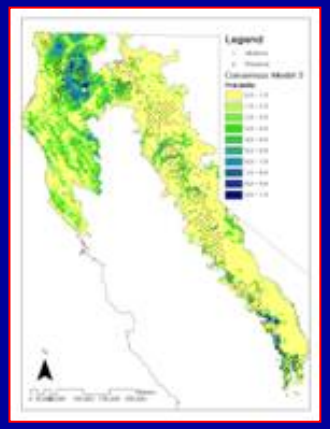
Conservation Planning: Using Regional Habitat Models

Carroll et al.
(1999; 2005)

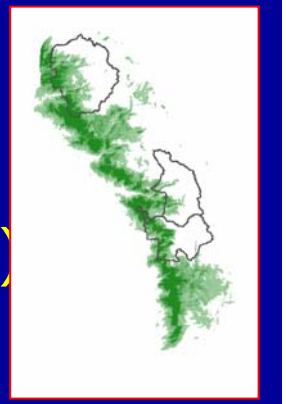




Seo et al.
(in prep.)



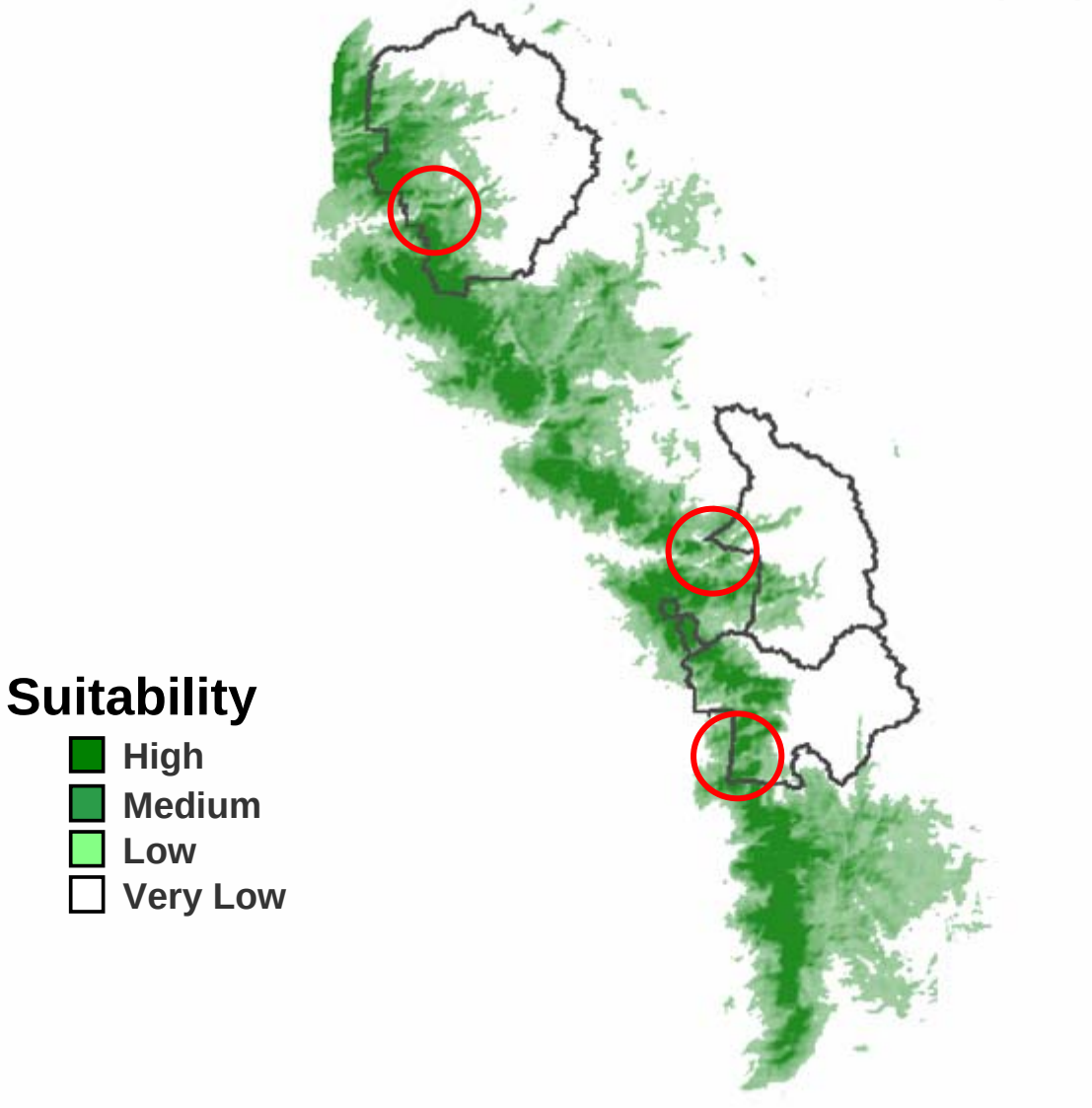
Truex
(in prep.)



Bottleneck – Corridor Identification

Landscape Habitat Suitability

Fisher Southern Sierra (Truex, in prep.)



The informed use of habitat models makes fisher and marten conservation a quantitative and a proactive process.

- Defensible and Responsible -

Conservation & Information Goals: *Realistic*

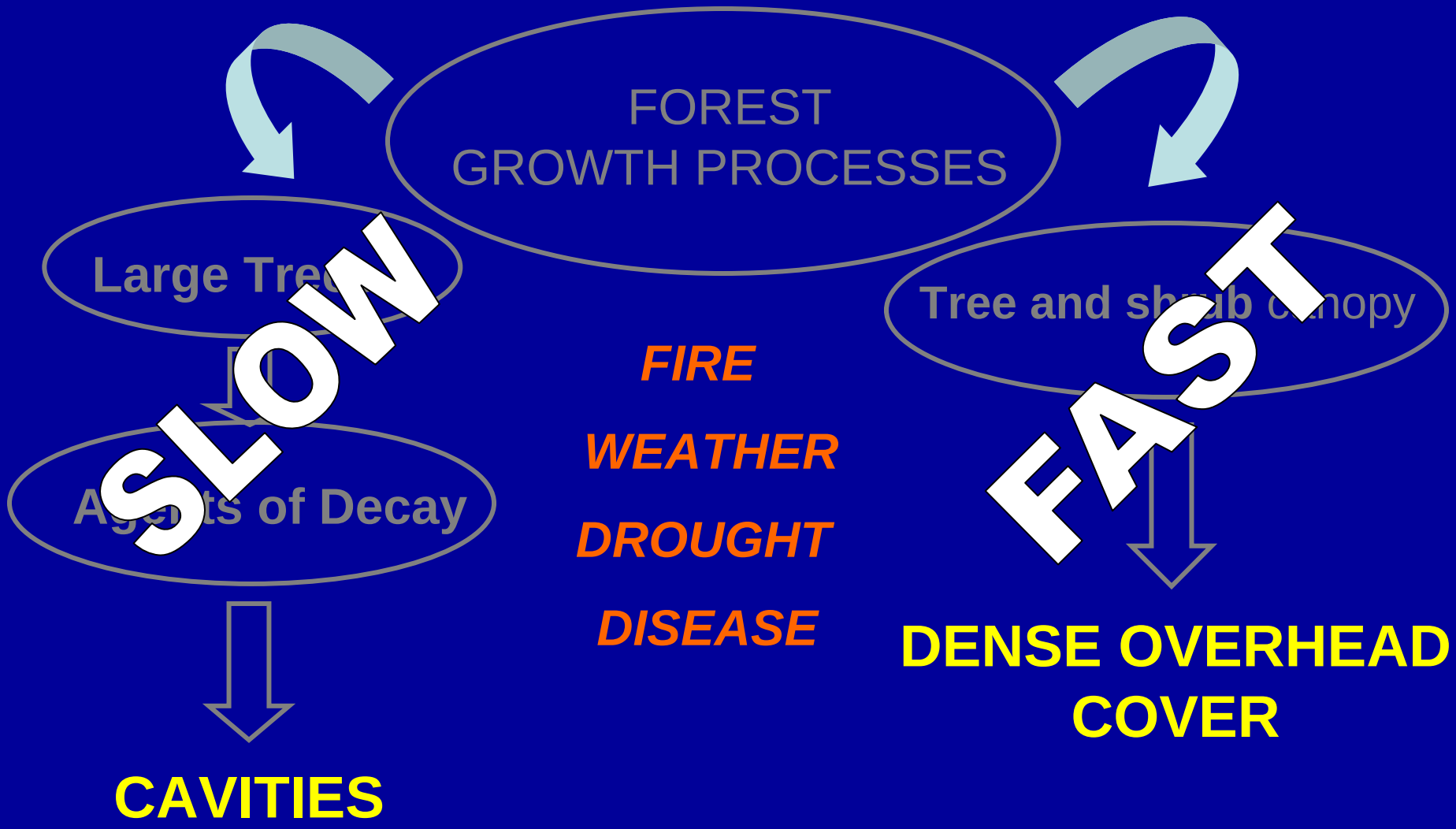
1. Comprehensive monitoring program: populations and habitats

2. Replicated studies of effects of land management activities on habitat use.

3. Overlooked aspects of ecology: e.g., dispersal, disease, reproductive den structures.

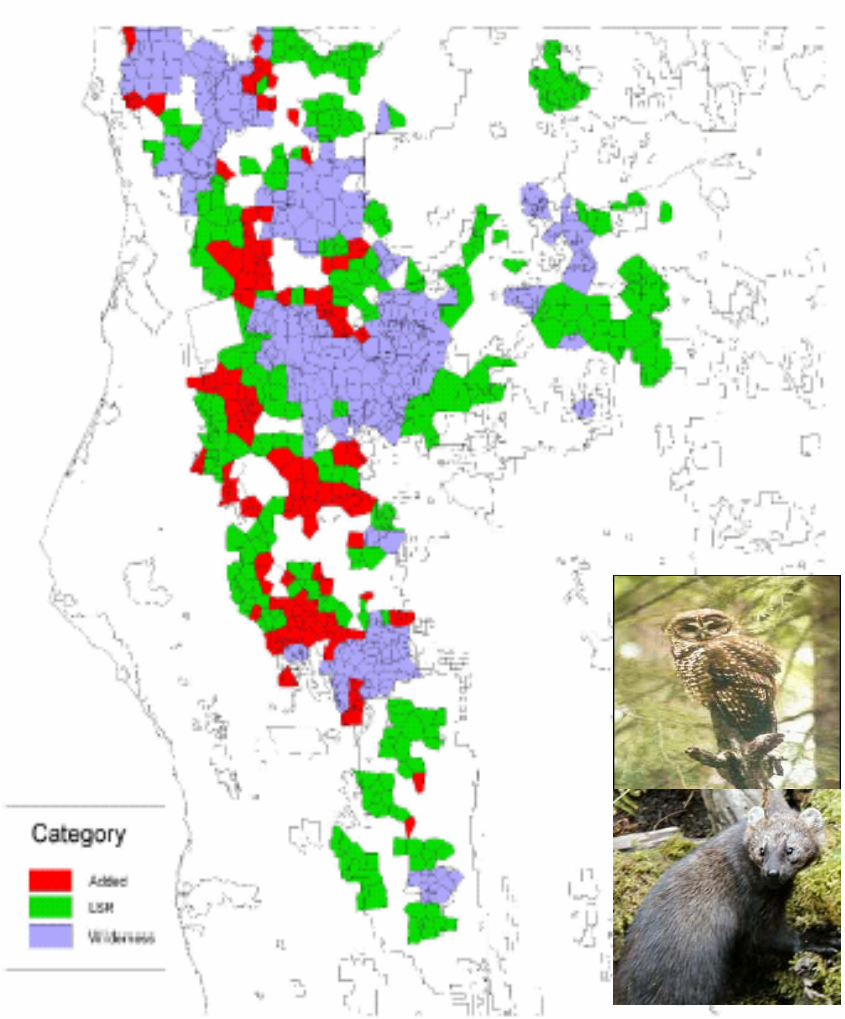
4. Integrate fisher/ marten management with ecosystem management

Ecosystem Mgmt: Sensitivity to Renewal Rates of Key Processes

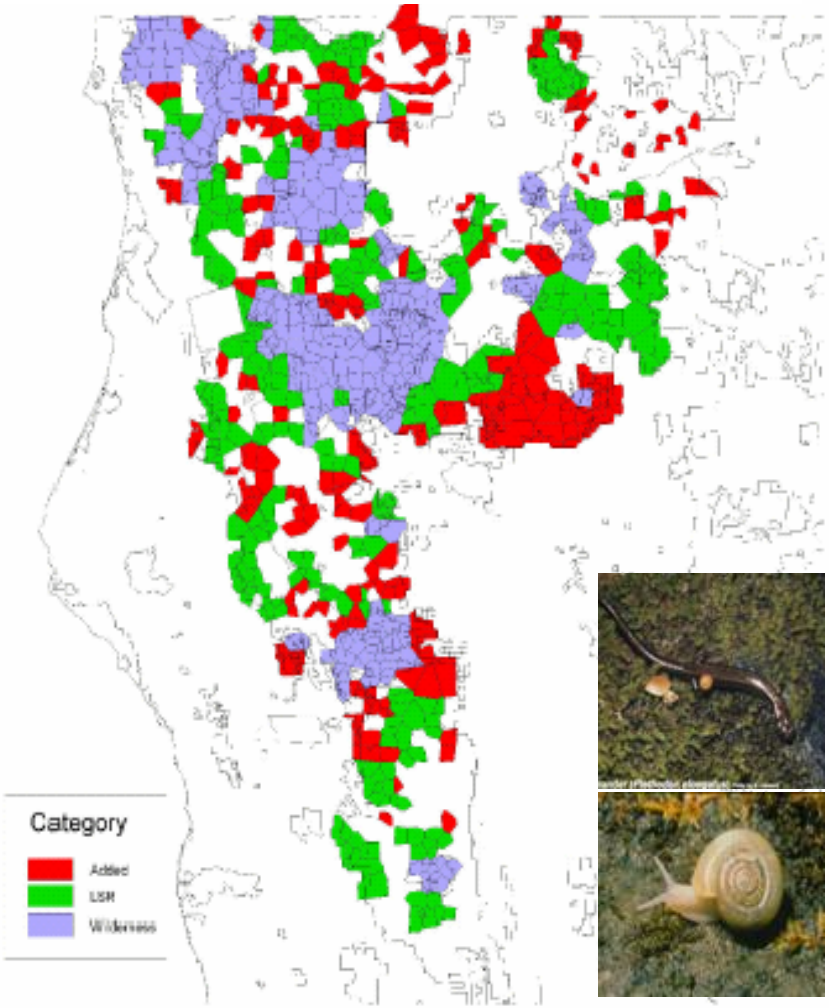


Ecosystem Mgmt: Integrate *Martes* & Other Late-Seral Species in Conservation Plans

Fisher + Owl



Mollusks and Salamanders



Dream Goals

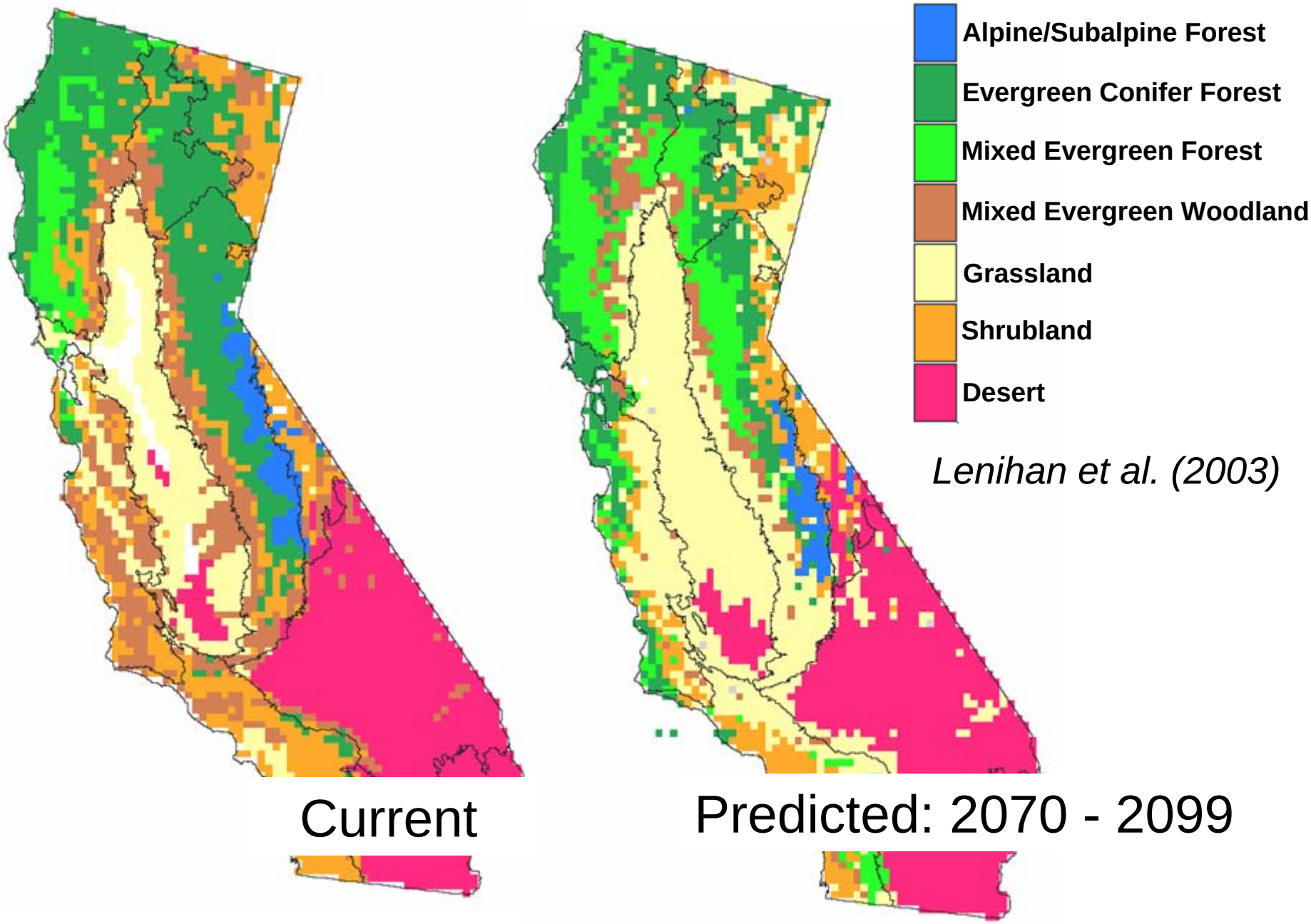
1. Discover habitat thresholds…
   …for occupancy and for reproduction.

2. Region-specific estimates of reproduction and survival.

3. Develop ‘fitness landscapes’ and viability consequences

4. Understand and prepare for effects of climate change on habitats.

Climate Change Predictions: Forests



Sue Morse

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