DISTRIBUTION, SITE OCCUPANCY, AND HABITAT SELECTION BY PACIFIC FISHERS IN THE SIERRA NATIONAL FOREST, CALIFORNIA

SIERRA NEVADA ADAPTIVE MANAGEMENT PROJECT

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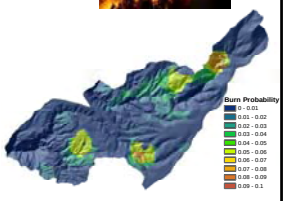
Sierra Nevada Adaptive Management Project

http://snamp.cnr.berkeley.edu

Independent 3rd Party Research Program to Assess How Forest Vegetation Treatments (SPLATS) Designed to Prevent Wildfires & Protect Forests & Homes Affect:

1. Wildlife Populations Focusing on Pacific Fisher & Spotted Owl

2. Forest Health and Fire Risk



3. Water quality/quantity

Status of Pacific Fishers (*Martes pennanti*) in California

- Poisoning, trapping, habitat loss reduced range by ≈ 50%; now a candidate species under U.S. & California Endangered Species Acts
- Fishers currently absent from Sierras north of Yosemite NP; *populations in southern Sierras spatially & genetically isolated*
- Preferred mature/old growth forests are degraded; management aimed at improving forest health & reducing risk of fire has potential to further imperil remnant subpopulations of fishers in Sierra Nevada

SNAMP Fisher Study: Research Objectives

1. Determine population parameters & limiting factors for Pacific fisher
2. Evaluate effects of fuel reduction treatments (SPLATS) on resource use, survival, & the likelihood of continued persistence of Pacific fishers in the southern Sierra Nevada


Mastication

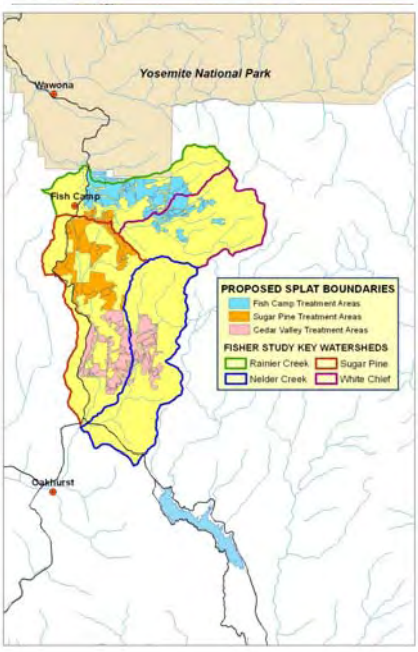

Control burn


Commercial thining

What manner of fuels reduction is optimal for minimizing risk of wildfire while avoiding loss of fishers in southern Sierra Nevada?

SNAMP Fisher Study: Background & Study Area

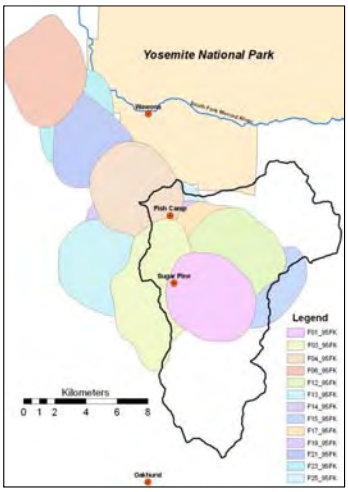
- 8 year study initiated in Sept 2007 - Bass Lake Ranger District, Sierra National Forest
- Focused/high intensity research within four key watersheds where mgt treatments are planned during period of research
- Significant research outside KW: monitoring movements+survival of radiocollared fishers, assessing patterns in distribution related to biotic and abiotic conditions



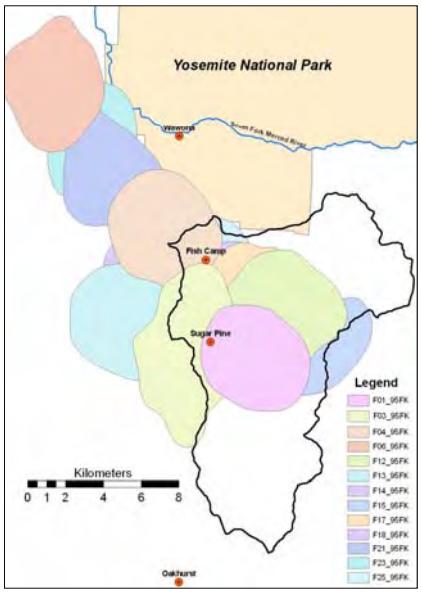
Objectives & Camera-based Occupancy Surveys

Key Project Objective: Assess response and affects of mgt treatments on fisher population in area of Bass Lake RD, Sierra National Forest

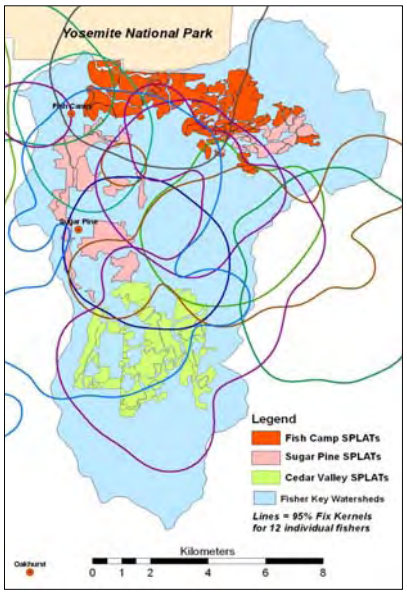
- Fishers in S. Sierras have large home ranges!
- SNAMP Fishers 2008-09 95% Fix Kernels
  Avg 15 adult females: 28.4 ± SE 1.8 km²
  Avg 6 adult males: 64.3 ± SE 10.1 km²
- ***BUT*** the typical fuel treatments occur on a much smaller scale than fisher home range (see next slide)



Multiple female fisher home ranges (95% fixed kernels) in and around Key Watersheds



Multiple female & male home ranges (95% contours) in relation to treatments in Key Watersheds



SNAMP Project Camera-based Occupancy Surveys

How can we detect responses (+ or -) of fishers to changes in habitat associated with fuel treatments?

Several possible approaches:

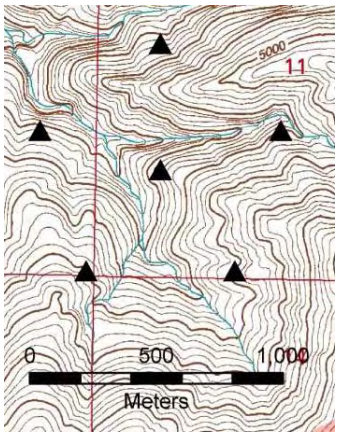
- Closely monitor individuals in order to detect relatively small changes in the boundaries or activity centers of HRs
- Track temporal changes in the occupancy state of treated area(s) *within* fisher occupied habitats
- Other – GPS collars ?

Newfangled GPS radiocollar

Noninvasive Survey Design Considerations/Recommendations*

4 mile² sample unit encompassing either:

- *array of 6 track plate stations, min 12 days of survey effort*
- *2 camera stations min 1 mile (1.6 km) apart, 28 days survey effort*
- *if fishers detected at any station entire sample unit is scored as "occupied"*



*Zielinski and Kucera 1995, Slauson et al. 2009
Images: Carnivore Monitoring Report – Truex 2010

Background on Types of Surveys and Design of Protocols *

Two Primary Types of Surveys with Different Goals/Design Considerations

Occupancy surveys: goal to accurately identify whether 1 or more sample units within defined area are occupied; requires protocol achieving a probability of detection (**P**) of ≥ 0.95

- Example: *determine whether fishers occupy area(s) proposed for land mgt activities altering habitat (one of our strategies)*

Distribution surveys: goal of estimating the proportion of locations occupied by fishers over large geographic areas

- Goal is to optimize **P** (ideally P ≥ 0.80) while surveying many sites across the landscape

*Slauson et al. 2009
Image: Zielinski et al., J. Biogeograhy 2005

Definitions & Parameters in Occupancy Surveys*

Occupancy state – Occupied or not occupied, scored as 1 or 0 respectively

P ("Big P"): probability of detecting a fisher when it is present in the sample unit using the survey protocol

Visits or **checks** (*v*): represent the number of times station(s) are assessed for target animal detection during the "survey duration"

p **("little *p*"):** *per visit* probability of detecting fisher within the sample unit

ψ = Probability that one or more fishers occupies a surveyed research site

*Slauson et al. 2009
Image of fisher tracks: Truex 2010

Analyses and Parameter Estimation for Survey Data*

Typical protocol for track plates: visit/check each station every two days over a 12 day survey duration such that the number of visits (*v*) = 6

Program **PRESENCE****: Detection histories (0 1 0 0 0 1) for sample units are used to estimate values for ***p,*** and ***ψ***

Estimates of ***p*** are then used to Estimate **P** based on number of station visits (***v***)

Equation 1: $P = 1-(1-p)^v$

Example 1: If ***p*** is 0.35 and ***v*** = 6, then **P** = 0.924

Example 2: If number of sample units with detections was 60 out of 100 ("naïve occupancy" = 0.6), then probability of site occupancy (*ψ)* is:

$$0.6 / 0.924 = 0.649 = \psi$$

*Slauson et al. 2009

*** PRESENCE** (MacKenzie et al. 2005) typically used to estimate **p, ψ,** model occupancy in AIC framework using detection histories for multiple sample units*

Considerations & Assumptions for Occupancy Analyses of Detection Data from Surveys*

1. **Probability of occupancy is constant during survey duration (population closure);** *usually true for fishers, but best maintain confined survey period to be sure*
2. **Probability of occupancy is constant across all sites, or can be modeled using covariates representing biotic/abiotic conditions at research site**
3. **Probability of detection constant across sites/surveys, or heterogeneity can be modeled using covariates, and accounted for**
4. **Detection of species and detection histories at sample units are independent**
   - *related to home range - requires sufficient distance between units that one animal will not be detected at multiple units*
   - *General rule: cameras should be separated by diameter of typical male home range*
   - *SNAMP males: mean HR diameter ≈ 8.7 km (5.4 miles)!! ***

***** Possible solution is to identify individual animals…***

**Slauson et al. 2009*

Reflective tape patterns on collar antennas

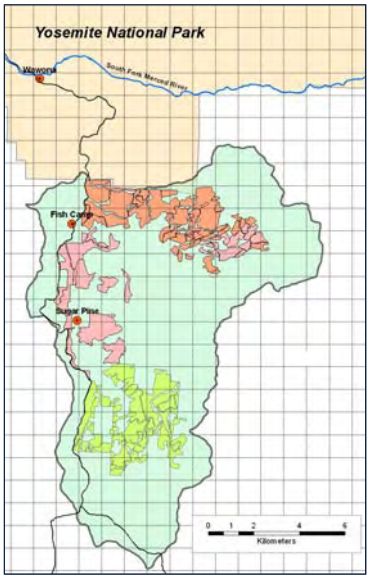
Methods: Occupancy Surveys in Key Watersheds for Assessing Responses to Fuel Treatments

- 1 km^2 grid over KW: Determine occupancy state of each grid before, during, after treatments (BACI design)
- Multi-season analyses to evaluate effects of fuel treatments on occupancy states

H_1: *Grids altered by treatments* will experience more negative transitions than others*

Assumption: ***negative transitions (1 to 0) in areas with treatments represent negative response to habitat change***

* ***Treatment type and % of grids treated will also be important***



Methods: "Types" of Cameras & Their Uses

Survey Cameras: placed near centers of 1 km² grids in "Fishery-looking" habitat, then baited & monitored following standard protocol

- *Baited with venison, pecan nut rings, scent lures, checked every 8 days (4 visits, 32 days)*

Fisher "Den Cams": 2-4 cameras placed around natal and maternal den trees, but not baited or scented. Used to verify den trees & for kit counts

Reproductive Female "Kit Cams": placed within spring-summer home range - goals of (1) verifying kit counts, and (2) tracking kit survival prior to independence

- *Follows same protocol as for survey cameras*

Fisher detections at all cameras & by trapping are used for distribution

Methods: Sources of Landscape and Habitat Variables as Covariates for Occupancy Analyses

Do fishers prefer mid to late-successional mixed conifer forests with relatively high canopy cover?

CWHR Data* - GIS Analyses Calculating Grid Proportions:

- *CWHR Sierra Mixed Conifer Forest Habitat (SMC)*
- *Montane Hardwood-Conifer (MHC)*
- *Montane Hardwood (MHW)*
- *WHR tree size 5 (medium/large tree)*
- *WHR canopy closure M (40-59%) and D (60-100%)*

Conservation Biology Institute Fisher Habitat Model (Spencer et al. 2008):

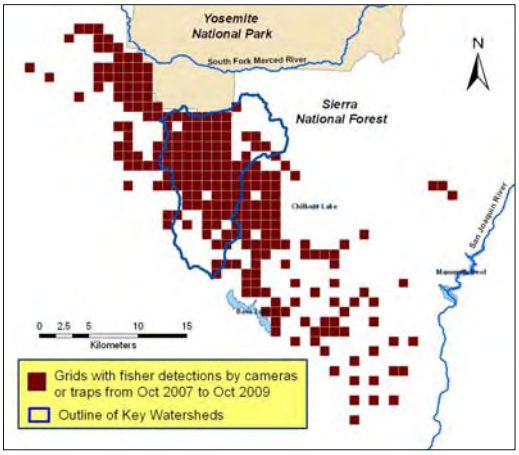
- *Mean CBI score for all surveyed grids*

DEM used to calculate: *Mean elevation for 1 km² grids*

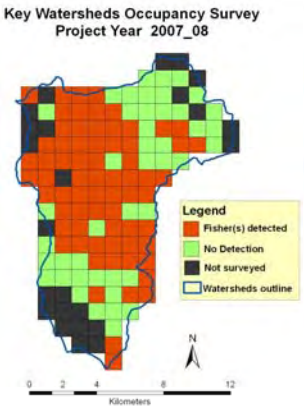
**** New/Updated CWHR Vegetation layer became available last week!!!***

Results: Distribution of Fishers Across Study Area

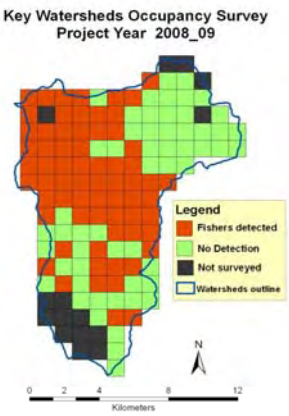
Fishers have been detected in 351 grids across the Study Area since so far…



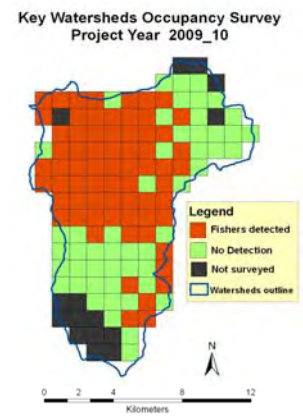
Results: Occupancy Surveys in Key Watersheds



Fisher Active Grids: 69
No fisher detection: 44
Naïve occupancy: 61%



Fisher Active Grids: 67
No fisher detection: 55
Naïve occupancy: 55%



Fisher Active Grids: 68
No fisher detection: 51
Naïve occupancy: 57%

Do have data on negative & positive transitions beween/among years…

Estimates of Probability of Detection, P, for Fall to Spring Surveys

Analyses of Detection Histories for all "FActive" grids during Fall to Spring Surveys (Table 1) produced mean estimate of ***p* = 0.64**

From Equation 1: $1 - (1-p)^v$, *with v = 4,* **P = *0.983***

PROGRAM PRESENCE TABLE 1: Analyses of detection histories for grids surveyed during the Fall to Spring (Oct to May) period to estimate P (Big P). Data for grids with fisher detections only (N = 257).

Model	AIC	Δ AIC	AIC wgt	Model Likelihood	No. Parameters	(-2*LogLike)
2 groups, Constant P	1032.6	0	0.6079	1	4	1024.62
1 group, Survey-specific P	1034.2	1.56	0.2787	0.4584	5	1024.18
1 group, Constant P	1037.1	4.47	0.065	0.107	2	1033.09
2 groups, Survey-specific P	1037.7	5.06	0.0484	0.0797	10	1017.68

Estimates of Probability of Detection for Summer Period Distribution Surveys

Based on Slauson et al. (2009), P declines for fisher distribution surveys during summer (July to Sept), requiring a longer survey duration to achieve P ≥ 0.80

Analyses of detection histories for all FActive grids surveyed during July to Sept (Table 2) produced estimate of ***p* = 0.387**

From Equation 1 $- (1-p)^v$, *with v = 5,* **P = *0.86 for our summer surveys***

PROGRAM PRESENCE TABLE 2: Analyses of detection histories for grids surveyed during the Summer (Jul to Sep) period to estimate P (Big P). Data used for grids with fisher detections only (N = 55).

Model	AIC	Δ AIC	AIC wgt	Model Likelihood	No. Parameters	(-2*LogLike)
1 group, Constant P	262.87	0	0.7962	1	2	258.874357
2 groups, Constant P	266.87	4	0.1077	0.1353	4	258.874357
1 group, Survey-specific P	267.22	4.35	0.0905	0.1136	6	255.219471
2 groups, Survey-specific P	272.77	9.9	0.0056	0.0071	12	248.772399

Occupancy Modeling of Habitat Variables Influencing site occupancy (Ψ) – *Very preliminary*

Are there any study site-specific habitat variables important for understanding Ψ?

Based on AIC weights, the top two models important for predicting Ψ in the SNAMP study area were the mean elevation of the grids, and the mean CBI Habitat value for the grids

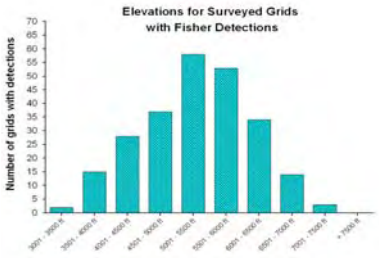
PROGRAM PRESENCE TABLE 3: Models investigating influence of habitat variables as covariates on probability of site occupancy (Ψ) for grids surveyed during October 2008 to May 2009 (N = 259).

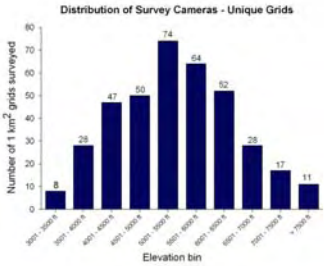
Model	AIC	Δ AIC	AIC wgt	Model Likelihood	No. Parameters	(-2*LogLike)
Ψ(Mean Elev), Constant P	774.36	0	0.6313	1	3	768.36
Ψ(CBI_Habitat), Constant P	776.49	2.13	0.2176	0.3447	3	770.49
1 group, Survey-specific P	777.97	3.61	0.1038	0.1645	6	765.97
Ψ(WHR_SMC), Constant P	780.87	6.51	0.0244	0.0386	3	774.87
Ψ(WHR_Size5), Constant P	782.67	8.31	0.0099	0.0157	3	776.67
1 group, Constant P	784.24	9.88	0.0045	0.0072	2	780.24
2 groups, Survey-specific P	784.72	10.36	0.0036	0.0056	12	760.72
Ψ(DenD), Constant P	785.6	11.24	0.0023	0.0036	3	779.6
2 groups, Constant P	785.79	11.43	0.0021	0.0033	4	777.79
3 groups, Constant P	788.77	14.41	0.0005	0.0007	6	776.77

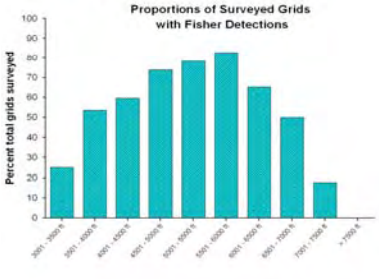
SNAMP Fisher Camera Surveys & Distribution

Period: *21 October 2007 to 15 October 2009*

- 379 unique grids were surveyed
- Fisher were detected in 244 different **survey** cameras *(den cams not included)*
- Most cameras with detections were between 4500 and 6500 feet
- *Correcting for effort reinforces that fishers prefer mid elevation mixed conifer forest habitats in S. Sierras (3500 to 7000 feet)*







SNAMP Fisher Study: Acknowledgments

Funding & Logistics: USDA Forest Service (Mike Chapel, Peter Stine)

MOU Partners & Agencies: US Fish and Wildlife Service, California Dept of Fish & Game, Yosemite National Park

SNAMP Fisher Crew & Volunteers: Joe Bridges, Brady Neiles, Carrie O'Brien, Rebekah Jensen, Taylor Gorman, Jason Massarone, Wendy Mitchell, Wendy Sicard, Thomas Thein, Geoff and Lindsay Cline, Jeff Schneiderman, Jana Ashling, Caroline Jablonicky, Sarah Bassing, Adrianna Beaudette, Shelly Vogel, Mark Ratchford, Rob Wise, Zac Eads, Thomas Day, Kyle Wagner, Jenny Ruthven

USFS Aviation Supervisor John Litton, Pilots Bill Bulfer, Curtis Haney, Jim Irving, Dan English

Kings River Fisher Study: Kathyrn Purcell, Craig Thompson, Rebecca Green, Jim Garner

Sierra NF Bass Lake Ranger District: Dave Martin, Anae Otto, Theresa Lowe, Kevin Williams

UC Davis Collaborators: Mourad Gabriel, Greta Wengert, Local Housing – Bruce Persson