SNAMP Science Team: 
*Wildlife - Fisher*

**Principal Investigators:**
- Reg Barrett, UC Berkeley
- Rick Sweitzer, UC Berkeley

**Staff Research Biologists**
- Carrie O’Brien, Rebekah Jensen, Joseph Bridges, Taylor Gorman, Jason Massarone, Jodi Berg

USFS Flight Support: John Litton, Steve Forkel
Status of Pacific Fisher in California

Historic and Current Distribution

- Trapping + extensive timber harvest late 1800s into 1970s reduced range by 40-50%
- Fisher now absent from Sierras north of Yosemite NP; southern Sierra population genetically isolated

Federal & California Status

- Candidate species U.S. Endangered Species Act
- 2010 Status Review by Cal Dept Fish & Game
  - Limiting factors not known, unclear if populations increasing or decreasing now or in recent past
  - May use managed timberlands more than thought
  - Unpubl genetic data: range reduction & “the gap” may pre-date 1800s...
New Genetic Analysis of Fishers in North America (Knaus et al. 2011)

Figure 1 North American fisher and its geographic distribution. Fisher (Martes pennanti), a mid-sized carnivore, is distributed throughout boreal and montane North America. Subspecific classification has followed geographic subdivision of this range: ssp. pennanti occurs in the east (blue), ssp. columbiana occurs in the Northern Rocky Mountains (light and dark green), and ssp. pacifica is found along the Pacific coast (light and dark red).

INTERPRETATION: Questions about “the gap” remain, but fisher in the Southern Sierra Nevada may be even more genetically distinct from those in northwestern CA than previously thought.
**SNAMP Fisher Study: Research Hypotheses**

**H₁**: Fisher population in California is retracting southward: *historical decline has not significantly reversed*

**H₂**: Fuel treatments may exacerbate this contraction: *prevent return of mature/old growth forest elements to landscape*

- Mastication
- Control burn
- Commercial thinning
What are The Potential Negative Effects of Fuel Treatments on Fisher Biology?

<table>
<thead>
<tr>
<th>Effect: local landscape regional scale</th>
<th>Likely Response</th>
<th>Data Needed/Study Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments cause local areas of habitat to become nonsuitable</td>
<td>Use of treated areas declines/ceases</td>
<td>Before/After data on use of treated areas</td>
</tr>
<tr>
<td>Treated areas no longer provide suitable refuge for fishers</td>
<td>Mortalities are focused around treated areas</td>
<td>Locations, information on causes of mortalities</td>
</tr>
<tr>
<td>Treatments reduce availability of key resources (den/rest sites, forage)</td>
<td>Individual fishers cease using treated areas</td>
<td>Before/After data on home ranges of all animals in area</td>
</tr>
<tr>
<td>Population source areas become sinks areas</td>
<td>Fisher productivity in treated areas declines</td>
<td>Data on reproductive rates, fecundity, survival, dispersal</td>
</tr>
<tr>
<td>Treatments across large areas significantly degrades fisher habitat</td>
<td>Regional decline in viability of fishers</td>
<td>Population parameters &amp; models of popl’n persistence</td>
</tr>
</tbody>
</table>
SNAMP Fisher Study

Research Objectives:

- Assess responses of fishers to fuel treatments
- Identify limiting factors for fishers in Southern Sierras, evaluate likelihood of continued persistence
- 8 year study initiated in September 2007

Research Activities & Methods:

Capture/Collar/Monitor Fishers
- Survival & cause-specific mortality
- Habitat/Resource selection
- Movements & dispersal
- Denning behavior & fecundity

Surveys with Digital Cameras
- Occupancy in areas of fuel treatments
- Habitat use & regional distribution
STUDY AREA: Overview of SNAMP & Kings River Fisher Projects

- Kings River Fisher: *Initiated Spring 2007*
- SNAMP Fisher: *Initiated Fall 2007*

Similar Principal Objectives:
- Determine all key population parameters
- Describe/Evaluate effects of fuel reduction treatments on resource use and survival

*Research methods vary, but goal is to combine similar data & assess likelihood that fisher will persist in southern Sierra Nevada under current land management*
SNAMP Fisher Study Area

Key Watersheds – 131 km²:
- BACI Design: repeat surveys for occupancy, habitat use
- 95% - 100% fishers in area monitored at all times

Overall Research Area – 1150 km²:
- Required for monitoring a minimum 20 fishers
- Encompasses multiple other FS fuel mgt projects
METHODS: Fuel Treatments Outside KWatersheds, & Road Hazard Logging

NOTE: Will not have pre-treatment data on fisher use for all fuel treatment & hazard tree logging activities
**METHODS:** Live-trapping & Monitoring of Individual Fishers

- Traps set in areas with fisher detections
- Animals processed (< 40 min), released back where caught
- Radiocollared fisher then monitored by fixed-wing airplane...

**Table 1. Summary of Trapping Effort and Fisher Captures**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2007-08</th>
<th>2008-09</th>
<th>2009-10</th>
<th>2010-11</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trap nights</td>
<td>280</td>
<td>2,793</td>
<td>2,898</td>
<td>2,343</td>
<td>8,314</td>
</tr>
<tr>
<td>Total captures</td>
<td>19</td>
<td>76</td>
<td>73</td>
<td>43</td>
<td>208</td>
</tr>
<tr>
<td>New fishers</td>
<td>10</td>
<td>35</td>
<td>20</td>
<td>17</td>
<td>82</td>
</tr>
</tbody>
</table>

**Temporal Distribution of Trapping Effort**

- Trap nights
  - April 1-30
  - May 1-31
  - June 1-30
  - July 1-31
  - Aug 1-31
  - Sept 1-30
  - Oct 1-31
  - Nov 1-30
  - Dec 1-31
  - Jan 1-31
  - Feb 1-28
  - March 1-31

Month of year
METHOD/RESULTS: Individual Fishers

- Research animals; 48 females and 34 Males

**Number Actively Monitored Fisher Jan 01, 2008 to July 01, 2011**

*Project Goal:* 20 collared fisher monitored at all times
METHODS/RESULTS: Daily Flights to Monitor Fishers

Table 2. Review of SNAMP Fisher Study Fixed-Wing Telemetry Flights from January 2007 to July 2011.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Flights</td>
<td>207</td>
<td>270</td>
<td>285</td>
<td>132</td>
<td>894</td>
</tr>
<tr>
<td>Flight hours</td>
<td>552</td>
<td>687</td>
<td>734</td>
<td>259</td>
<td>2,232</td>
</tr>
<tr>
<td>AT Locations</td>
<td>3,254</td>
<td>5,886</td>
<td>6,285</td>
<td>3,309</td>
<td>18,734</td>
</tr>
</tbody>
</table>

SNAMP FISHER AERIAL TELEMETRY

John Litton – FS Aviation Supervisor/Pilot
Steve Forkel – FS SNAMP Pilot

Other Pilots:
- Bill Bulfer
- Brad Penner
- Jim Irving
- Dan English
- Curtis Haney
METHODS: Cause-Specific Mortality

Serology & Full Necropsies: blood, fluids; disease exposure to multiple pathogens

Molecular analyses to identify predators killing fishers: Felid- and Canid-specific primers

\(^a\) In association with collaborators M. Gabriel & G. Wengert
METHODS (Revised): Detailed Modeling of Home Range Movements

Main Sources of Location Records: 
ATelem, Cam Locations, GPS collars

Uses for Location Records: 
Home range movements, HR centroids, Dispersal, Habitat/Resource use, etc.

Home Range Analyses: 
- Fixed kernel HR models (min 25 locations) 
- Program: Home Range Tools 
- Ad Hoc bandwidth selection (Kie et al. 2010) 
- All prior HR analyses are superseded

Home Range Model Analyses: 
- Annual (1 Apr – 31 Mar) 
- Summer (16 Jun – 15 Sep) 
- Winter (16 Dec – 28 Feb) 
  - Reprod (≈1 Mar – 15 Jun) 
  - Fall (16 Sep – 15 Dec)
METHODS *(New/Revised)*: Survival By Kaplan-Meier Staggered Entry

- Allows entry of new animals after start of the study
- Missing animals censored when not relocated for ≥ 2 months
- Output: survival rate \( s(t) \), SE, and 95% CIs over periods of interest
- Survival estimates compared using Z-tests (Pollock et al. 1989)

**Sample output: Kaplan-Meier Estimator**

**Table 1. Kaplan-Meier survival estimates for all adult female fishers radiotagged in SNAMP Study Area, Sierra National Forest, California. Data inputs are summed over all months from the start of the study in September 2007 to February 2011.**

<table>
<thead>
<tr>
<th>Time (t)</th>
<th>Month</th>
<th>No at risk ( r_j )</th>
<th>No. deaths ( d_j )</th>
<th>No. censored</th>
<th>No. new added</th>
<th>Survival ( s(t) )</th>
<th>SE for ( s(t) )</th>
<th>95% CI lower</th>
<th>95% CI upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>01 Apr-30 Apr</td>
<td>33</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0.970</td>
<td>0.029</td>
<td>0.912</td>
<td>1.027</td>
</tr>
<tr>
<td>1</td>
<td>01 May-31 May</td>
<td>29</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0.869</td>
<td>0.058</td>
<td>0.755</td>
<td>0.984</td>
</tr>
<tr>
<td>2</td>
<td>01 Jun-30 Jun</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>0.869</td>
<td>0.064</td>
<td>0.744</td>
<td>0.995</td>
</tr>
<tr>
<td>3</td>
<td>01 Jul-31 Jul</td>
<td>27</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0.869</td>
<td>0.060</td>
<td>0.751</td>
<td>0.988</td>
</tr>
<tr>
<td>4</td>
<td>01 Aug-31 Aug</td>
<td>30</td>
<td>3</td>
<td>0</td>
<td>4</td>
<td>0.782</td>
<td>0.067</td>
<td>0.652</td>
<td>0.913</td>
</tr>
<tr>
<td>5</td>
<td>01 Sep-30 Sep</td>
<td>31</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0.782</td>
<td>0.066</td>
<td>0.654</td>
<td>0.911</td>
</tr>
<tr>
<td>6</td>
<td>01 Oct-31 Oct</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.782</td>
<td>0.065</td>
<td>0.656</td>
<td>0.909</td>
</tr>
<tr>
<td>7</td>
<td>01 Nov-30 Nov</td>
<td>33</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0.782</td>
<td>0.064</td>
<td>0.658</td>
<td>0.907</td>
</tr>
<tr>
<td>8</td>
<td>01 Dec-31 Dec</td>
<td>31</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0.782</td>
<td>0.066</td>
<td>0.654</td>
<td>0.911</td>
</tr>
<tr>
<td>9</td>
<td>01 Jan-31 Jan</td>
<td>31</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0.757</td>
<td>0.067</td>
<td>0.626</td>
<td>0.889</td>
</tr>
<tr>
<td>10</td>
<td>01 Feb-28 Feb</td>
<td>31</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.757</td>
<td>0.067</td>
<td>0.626</td>
<td>0.889</td>
</tr>
<tr>
<td>11</td>
<td>01 Mar-31 Mar</td>
<td>21</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0.721</td>
<td>0.083</td>
<td>0.558</td>
<td>0.884</td>
</tr>
</tbody>
</table>

Mountain lions kill fishers
**METHODS:** Standardized Camera Survey Protocol

- RECONYX® digital cameras placed in 1 km² /4 km² grid cells
- Bait: venison+scent lure, pecan nut ring+peanut butter
- Check, rebait every 8 days over min. 32 days
- Prob. detection (P): 0.98 – fall/winter, 0.86 - summer

**Table 3. Brief Summary of Camera Survey Effort from January 2007 to July 2011 by “Cam Year” (mid Oct to early Oct).**

<table>
<thead>
<tr>
<th>Cam Yr</th>
<th>No. surveyed grids</th>
<th>Camera nights</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007_08</td>
<td>219</td>
<td>9,771</td>
</tr>
<tr>
<td>2008_09</td>
<td>339</td>
<td>12,030</td>
</tr>
<tr>
<td>2009_10</td>
<td>403</td>
<td>16,588</td>
</tr>
<tr>
<td>2010_11</td>
<td>307 (to date)</td>
<td>In progress</td>
</tr>
</tbody>
</table>
METHODS: Reproduction/Fecundity

- Ground-telemetry to locate den trees; set 3-4 cams for monitoring; den checks on 3 day intervals
- Den trees verified by persistent use, up/down movements
- Cameras for ≈ 80% of kit counts, tree climbs+den cavity searches (IR Camera) the rest
METHODS (New): Habitat Data for Fisher Den Trees

- 18m radius circular plot centered on den trees
- Aligns with data collected by SNAMP FFEH Team and Kings River Fisher Study
- Den tree attributes, canopy cover, woody debris, tree counts w/DBH, height, etc..

### Summary of Fisher Den Trees Identified by SNAMP Fisher within Bass Lake RD, Sierra National Forest.

<table>
<thead>
<tr>
<th>Spring Season</th>
<th>Natal</th>
<th>Maternal</th>
<th>Repeat Use</th>
<th>Used, Not Confirmed</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>2009</td>
<td>9</td>
<td>22</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>2010</td>
<td>9</td>
<td>20</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>2011</td>
<td>8</td>
<td>7</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>
METHODS (New): Fisher Genetic Analyses for Maternity, Dispersal

- Genetic data can provide valuable insight on reproduction, overall fitness
- Mother-offspring relationships + location-based home ranges provides insight on natal dispersal

Collaboration with USDA FS Wildlife Genetics Lab: microsatellite-based (n=13) DNA analyses

- Program Cervus; genetic analyses to assign maternity
  - Exclusion analysis; identifies “candidate” mothers
  - Field data used to narrow candidate lists
  - Likelihood Maternity Analysis; identifies most likely mother
- Natal Dispersal: distance between centerpoints of natal and subadult/adult home ranges
METHODS (New): Assessing Source/Sink Dynamics

**Definition of Population Source:** Area or region where good quality habitat supports high survival/reproduction compared to areas with poorer habitat where survival/reproduction are lower (Sinks)

Compared to Sink areas a Source region might be expected to:

1. Have higher adult/female/overall survival
2. Produce more surviving juveniles, and/or dispersing animals
3. Have fewer mortalities/unit area, or per fisher home range

*If habitat quality declines, a Source could revert to a Sink*
METHODS *(New)*: Source/Sink – Partitioning the Study Area

Study Area Divided into 4 Regions
*(used landscape features, 3500 ft & 7000 ft elevation contours)*

1. Nelder Grove_Sugar Pine
2. Miami & Chowchilla Mtns
3. Central Camp_Whisky Ridge
4. Grizzly Rd_Jackass_Minarets

- Assigned animals to regions for modeling survival (HR Centroids)
- Enumerated #s of HR for all regions by age/sex class
### Table 4. Parameter estimates on reproduction for adult female fishers from the SNAMP Fisher study.

<table>
<thead>
<tr>
<th>Den season</th>
<th>Adult females producing kits</th>
<th>Estimated fecundity</th>
<th>Identified den trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spring 2008</td>
<td>88% (8 of 9)</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Spring 2009</td>
<td>82% (14 of 17)&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.5 ± SD 0.5</td>
<td>37</td>
</tr>
<tr>
<td>Spring 2010</td>
<td>88% (15 of 17)&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.7 ± SD 0.7</td>
<td>34</td>
</tr>
<tr>
<td>Spring 2011</td>
<td>75% (9 of 12)</td>
<td>1.8 ± SD 0.4</td>
<td>20</td>
</tr>
</tbody>
</table>

<sup>a</sup> One female initiated denning, but ceased using den trees after 30 days

<sup>b</sup> One female initiated denning, but ceased using den trees after 20 days

**RESULTS (Updating): Female Reproduction**

Mating at base of den tree (Spring 2010)
## SUMMARY OVERVIEW: Reproduction/Fecundity/Survival
**SNAMP & Kings River**

Table 1. Summary data on overall mean reproduction, mean fecundity and adult survival for the SNAMP and Kings River Fisher Studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Reprod rate</th>
<th>Fecundity</th>
<th>Ad fem survival</th>
<th>All adult survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>SNAMP</td>
<td>82%</td>
<td>1.6 kits/yr</td>
<td>72%</td>
<td>72%</td>
</tr>
<tr>
<td>Kings River</td>
<td>79%</td>
<td>1.7 kits/yr</td>
<td>75%</td>
<td>73%</td>
</tr>
</tbody>
</table>
METHODS/RESULTS (Continuing): Aiding Creation of Suitable Den Season Buffers
### RESULTS (New): Basic Data on SNAMP Den Trees


<table>
<thead>
<tr>
<th>Tree Species</th>
<th>N</th>
<th>Mean DBH (cm)</th>
<th>Mean Total Height (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black Oak Live</td>
<td>15</td>
<td>78</td>
<td>21.1</td>
</tr>
<tr>
<td>Black Oak Snags</td>
<td>2</td>
<td>104</td>
<td>8.8</td>
</tr>
<tr>
<td>Incense Cedar Live</td>
<td>15</td>
<td>117</td>
<td>33.9</td>
</tr>
<tr>
<td>Incense Cedar Snag</td>
<td>11</td>
<td>105</td>
<td>16.6</td>
</tr>
<tr>
<td>White fir Live</td>
<td>11</td>
<td>103</td>
<td>34.8</td>
</tr>
<tr>
<td>White fir Snags</td>
<td>12</td>
<td>113</td>
<td>34.3</td>
</tr>
<tr>
<td>Sugar Pine Live</td>
<td>3</td>
<td>126</td>
<td>37.1</td>
</tr>
<tr>
<td>Sugar Pine Snags</td>
<td>1</td>
<td>92</td>
<td>34.8</td>
</tr>
<tr>
<td>Ponderosa Live</td>
<td>2</td>
<td>91</td>
<td>34.9</td>
</tr>
</tbody>
</table>
RESULTS (New): Distribution of Den Trees by Species

**Live Den Trees (n = 46)**
- Sugar pine (n=3)
- White fir (n=11)
- Incense cedar (n=15)
- Black oak (n=15)
- Ponderosa (n=2)

**Den Tree Snags (n = 26)**
- Sugar pine (n=1)
- Black oak (n=2)
- Incense cedar (n=11)
- White fir (n=12)
RESULTS (New): Distribution of den trees by aspect

Northerly (Range: 316° - 45°)  
N = 15 trees

Westerly (Range: 226° - 315°)  
N = 12 trees

Easterly (Range: 46° - 135°)  
N = 9 trees

Southerly (Range: 136° - 225°)  
N = 10 trees
DEN TREES: Identifying den trees has been important...
RESULTS: Bobcats are regularly detected at fisher den trees; does concealment cover play a role in survival of denning females?