Competing and Synergistic Threats to Pacific Fishers in the Southern Sierra Nevada

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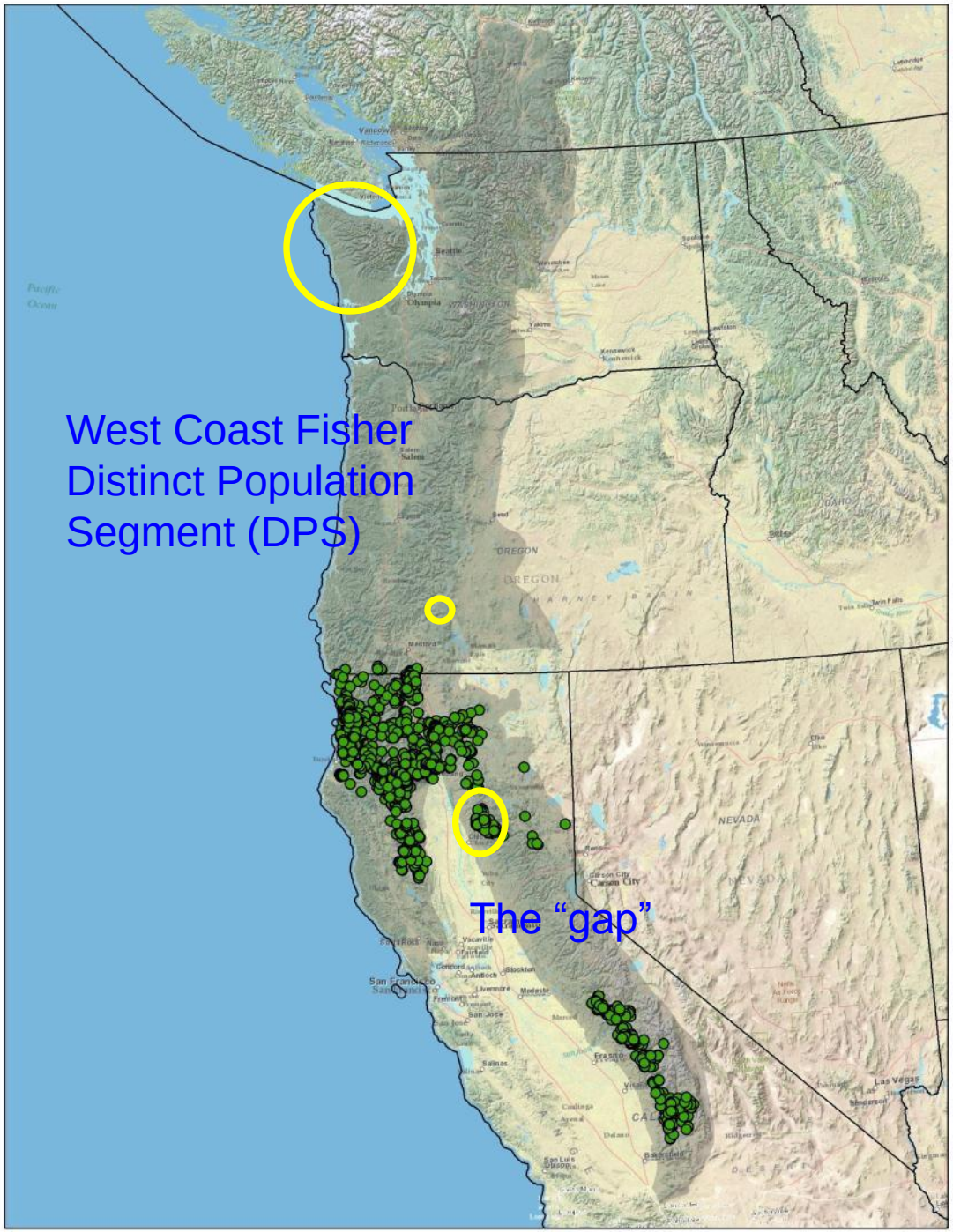
CBI: Providing science for efforts to conserve biological diversity.

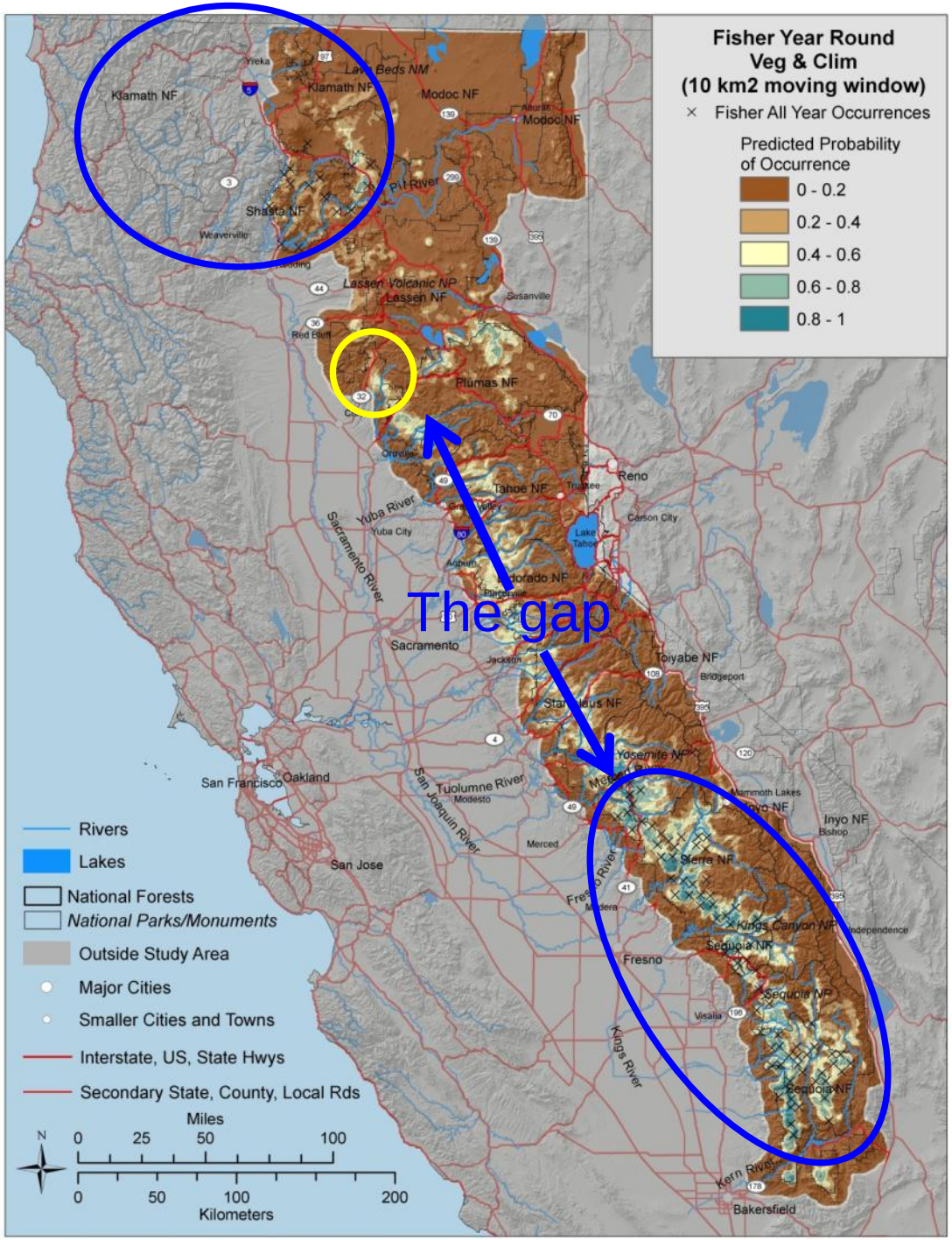
Status of Pacific Fishers

- West Coast DPS = Candidate for listing as Threatened or Endangered.
- Distribution greatly reduced and fragmented.
- Several reintroduced populations ○.
- Numerous threats:
  - Small populations
  - Timber harvest
  - Fires
  - Vegetation management
  - Roadkill
  - "Subsidized" predators
  - Rodenticide poisoning
  - Climate change



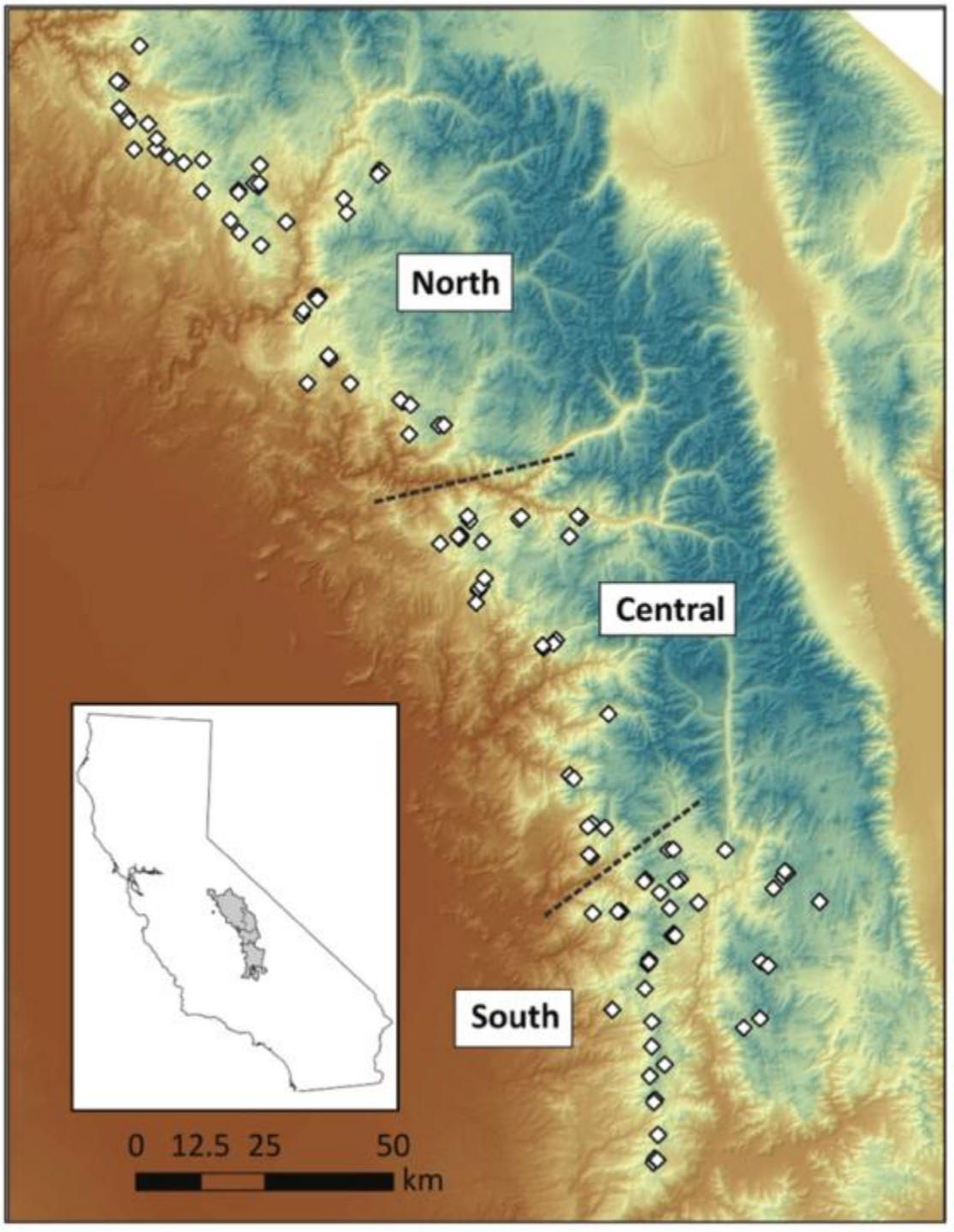
California Fisher Distribution Model

- Predictor variables (averaged over 10 km2):
  - STRUCT2 (an index based on tree size and canopy cover classes)
  - Summer temp amplitude
  - Proportion of mixed conifers
  - Proportion of hardwoods
  - Winter precipitation
  - Summer precipitation
- Some predicted high-value habitat is not occupied.



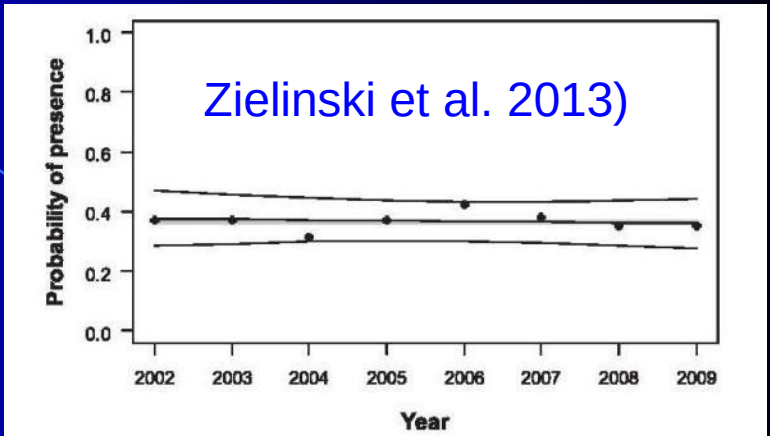
Fisher Population Genetics (Tucker et al. 2012)

- Genetic evidence indicates that:
  - The southern SN population has been isolated since before European colonization.
  - It has experienced ~90% decline in effective population size.
  - It is subdivided into 3 subpopulations with limited dispersal between them.
  - The southernmost subpopulation has been the most stable and was likely a refuge during population declines.



SSN Fisher Population Status and Trends

- Size: Likely <300 adults (Spencer et al. 2011).
- Trends: Stable over last decade (Zielinski et al. 2013).
- Habitat: Recovering from past abuse (?) but complex, multi-scalar issues to address.
- Models suggest that the population SHOULD be expanding, but …
- High "additive" mortality factors appear to be preventing expansion (Spencer et al. 2011).



Overview: **Interacting** Threats to SSN Fisher Population

- Small population size
- Habitat/population fragmentation
- Severe wildfires
- Vegetation management (timber harvest and fuels treatments)
- Increased access by fisher predators
- Rodenticide poisoning
- Reduction of prey base (porcupines, squirrels)
- Roadkill
- Climate change

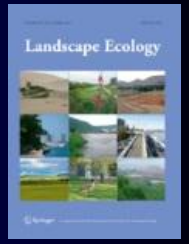
Competing and Synergistic Threats: Managing for Resiliency is Tough!

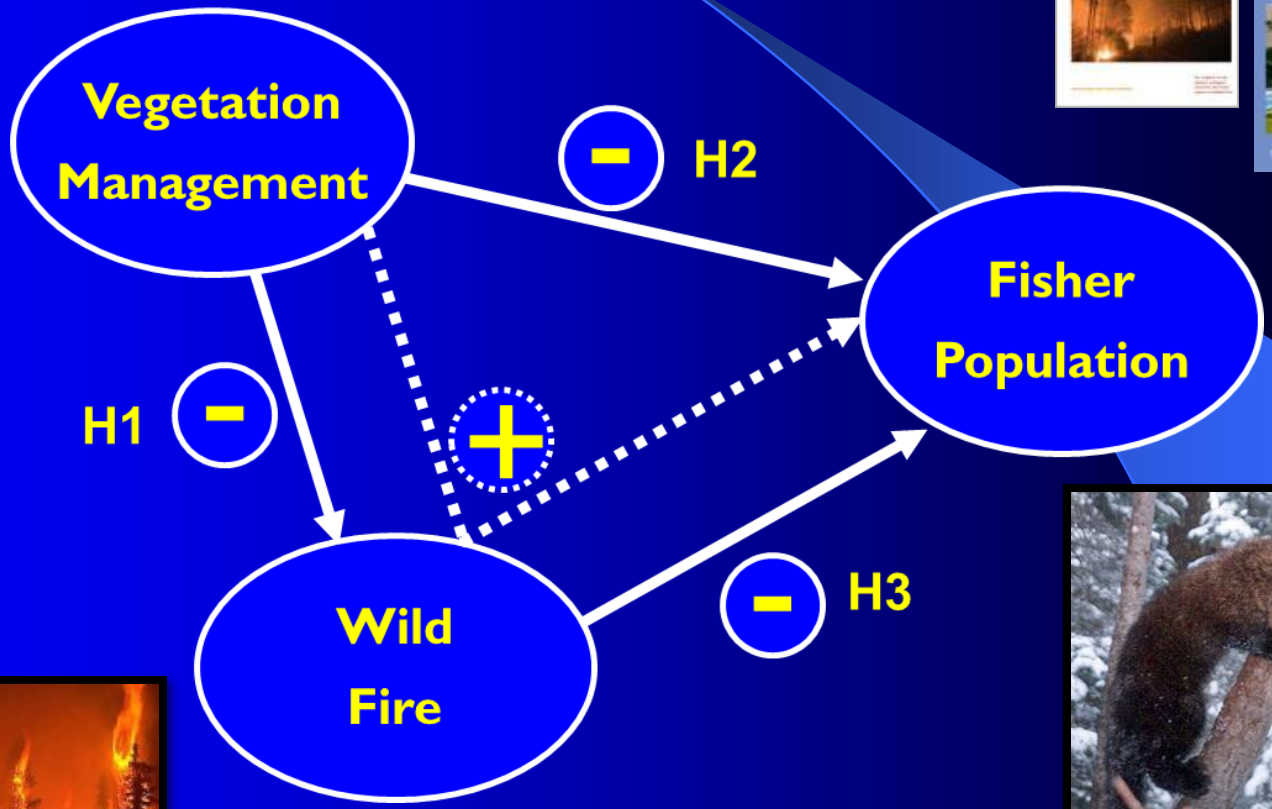
- Complex, probabilistic interactions between:
  - Fires
  - Vegetation treatments
  - Weather
  - Wildlife populations
  - Etc.
- Over multiple scales of interest:
  - Individual/local
  - Stand/community
  - Population/landscape
  - Short-term/longer-term/evolutionary time

Balancing Fishers, Fires, and Fuels Management

- Fisher habitat = fire-prone habitat.
  - Dense mixed-coniferous forests
  - Multi-storied canopies
  - Dead-wood structures
- Reducing fire risks (e.g., thinning) reduces habitat quality.
- But fires can too!

Effects of Fires and Fuels Management on Forests and Fishers (Syphard et al. 2011, Sheller et al. 2011)

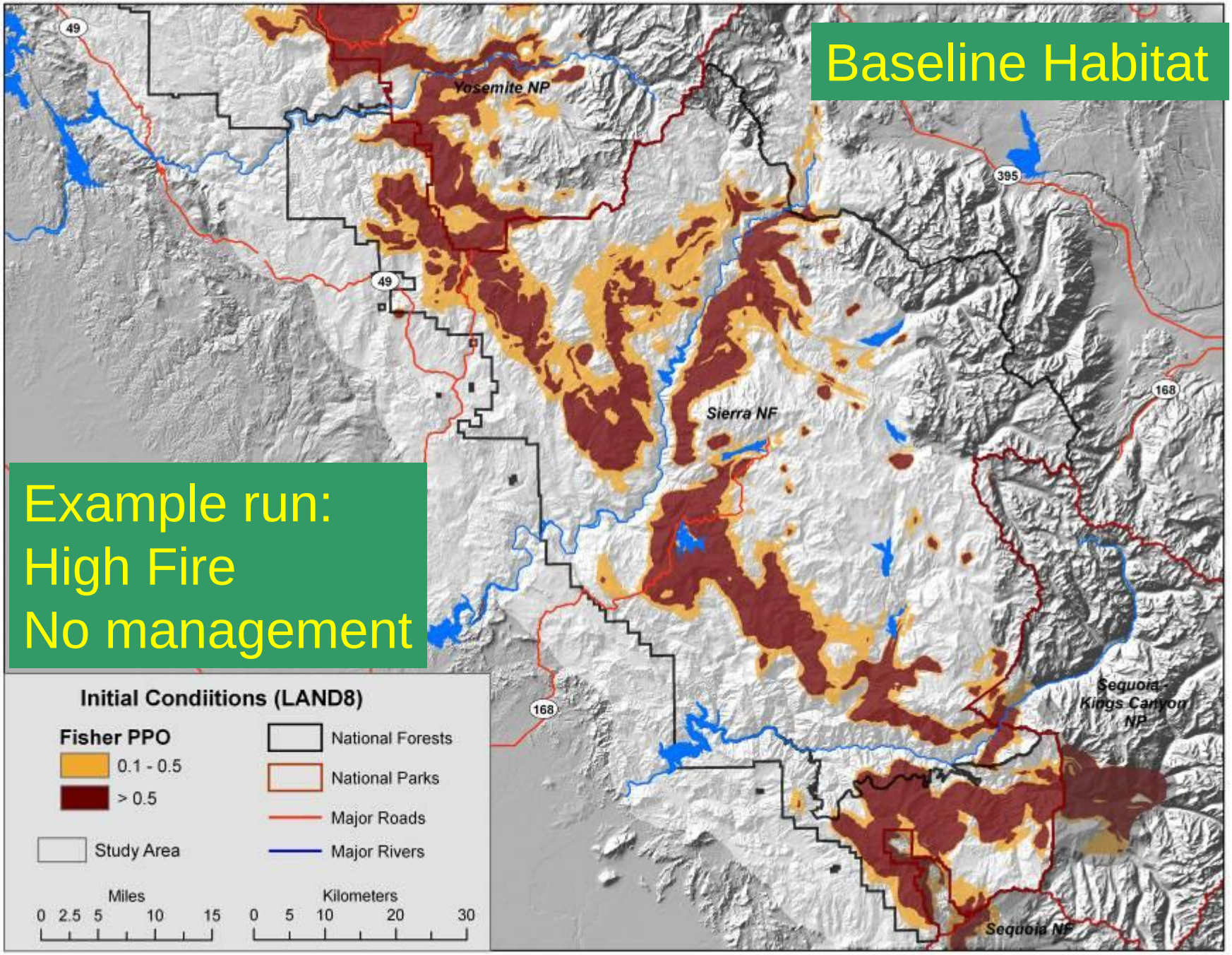




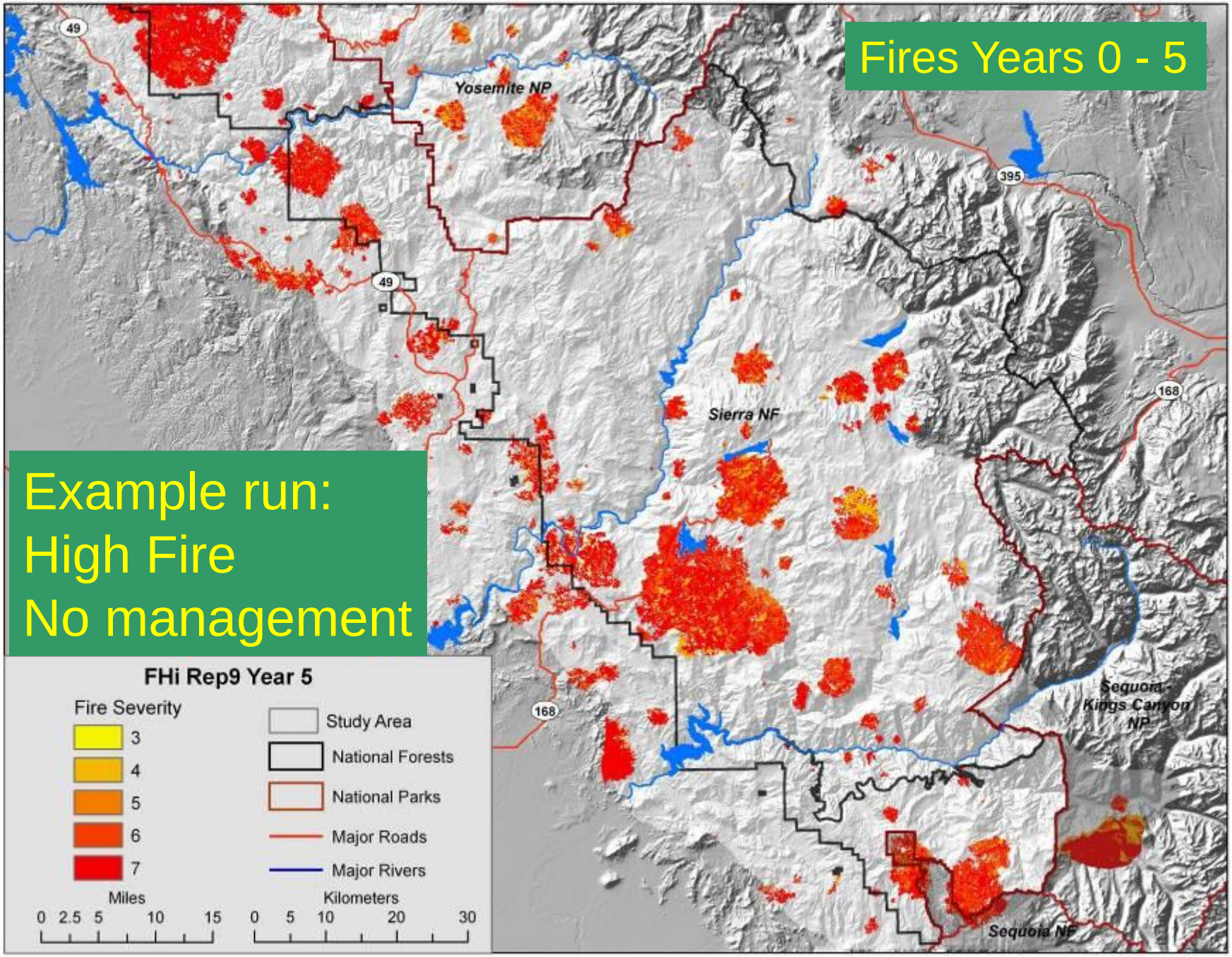
Modeling Approach (1-ha resolution)

- Fisher occupancy (habitat) model (Spencer et al. 2011)
- Fisher population model (Spencer et al. 2011)
  - Stochastic, spatially explicit model (PATCH)
  - Simulates birth, death, and dispersal of territorial females
  - Demographic parameters scale with habitat quality
- Vegetation dynamics model (LANDIS-II; Syphard et al. 2011; Sheller et al. 2011)
  - Simulates forest dynamics (fire, thinning, succession, etc.)
  - Tracks biomass changes by tree species and age cohorts

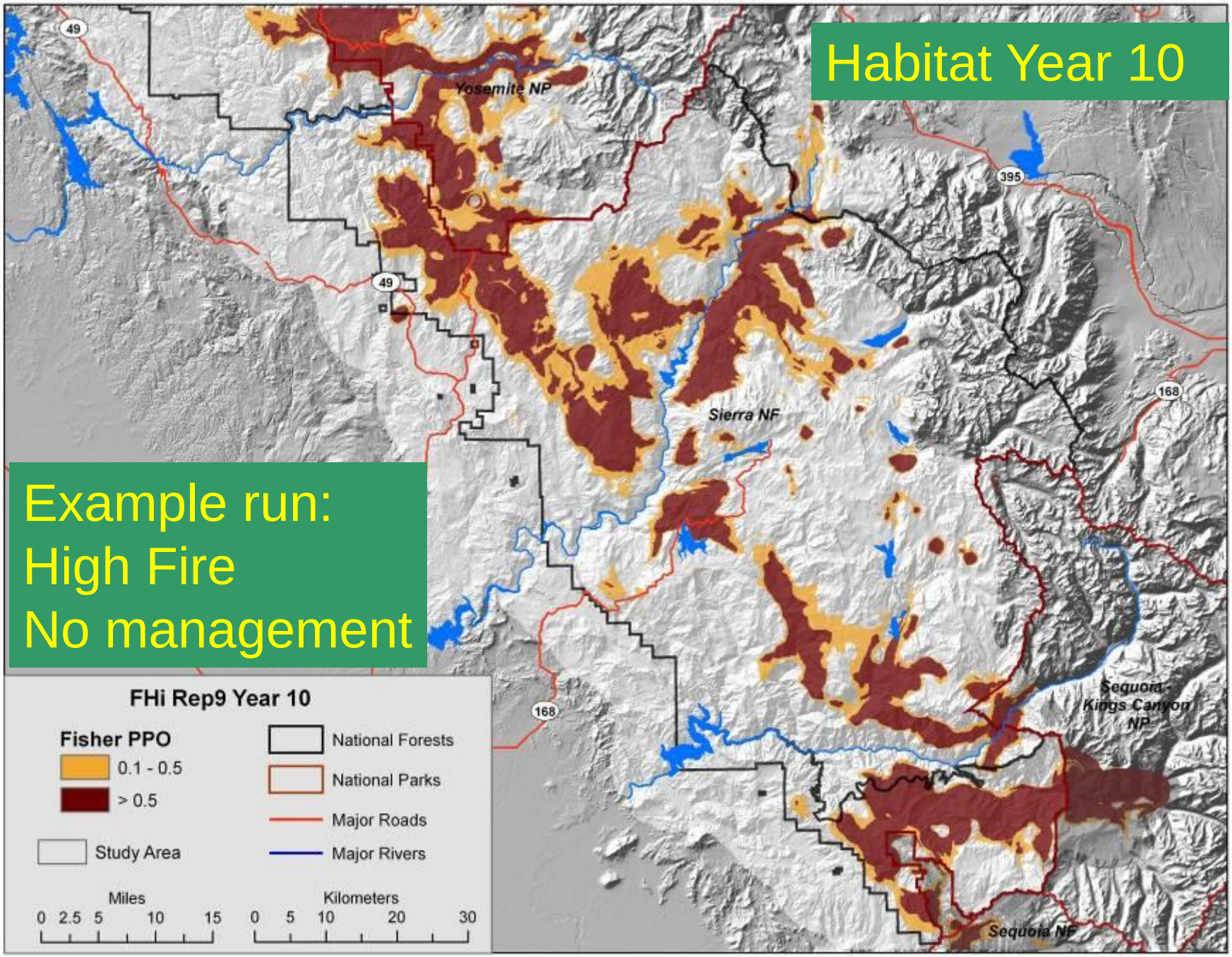
Baseline Habitat



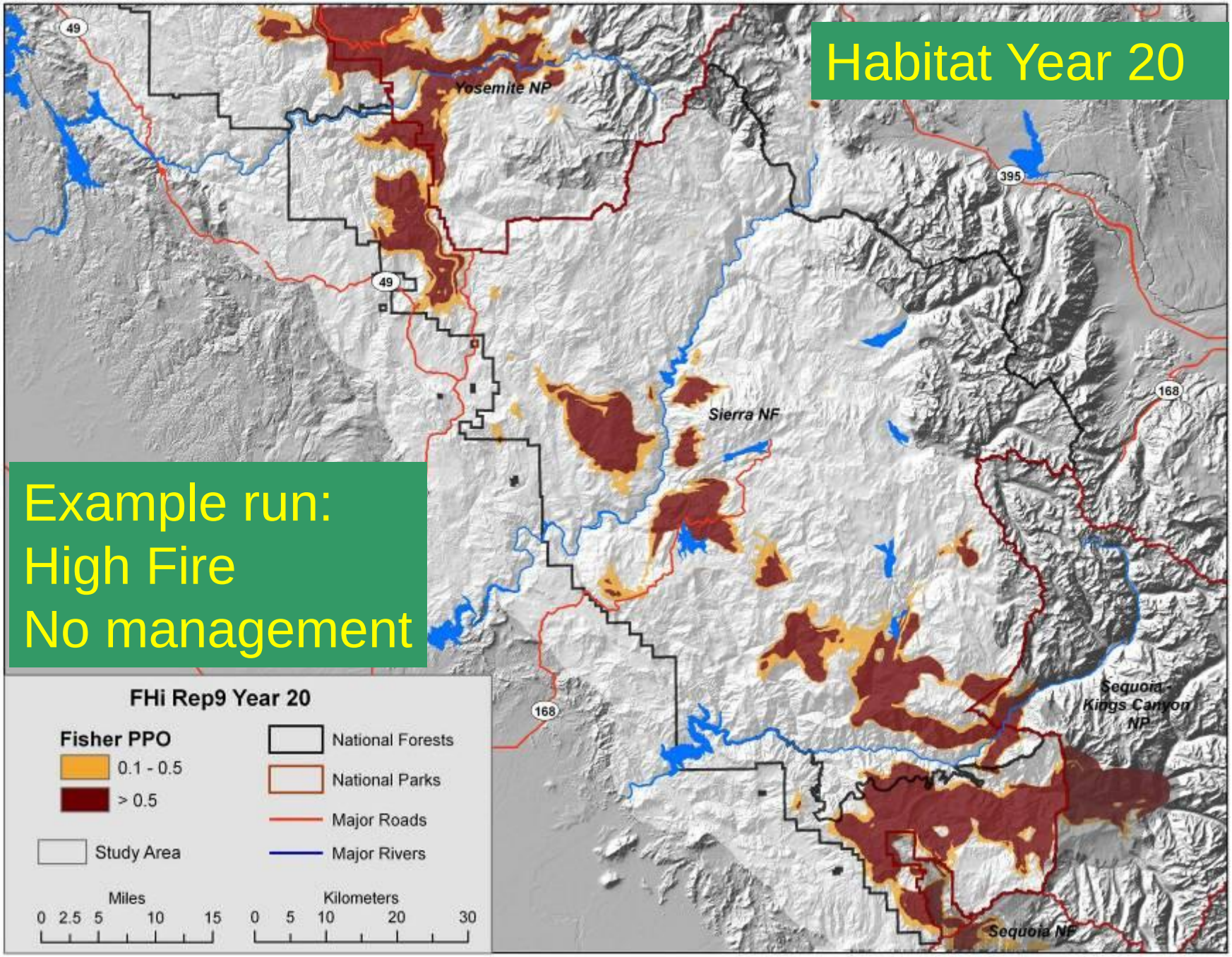
Example run:
High Fire
No management

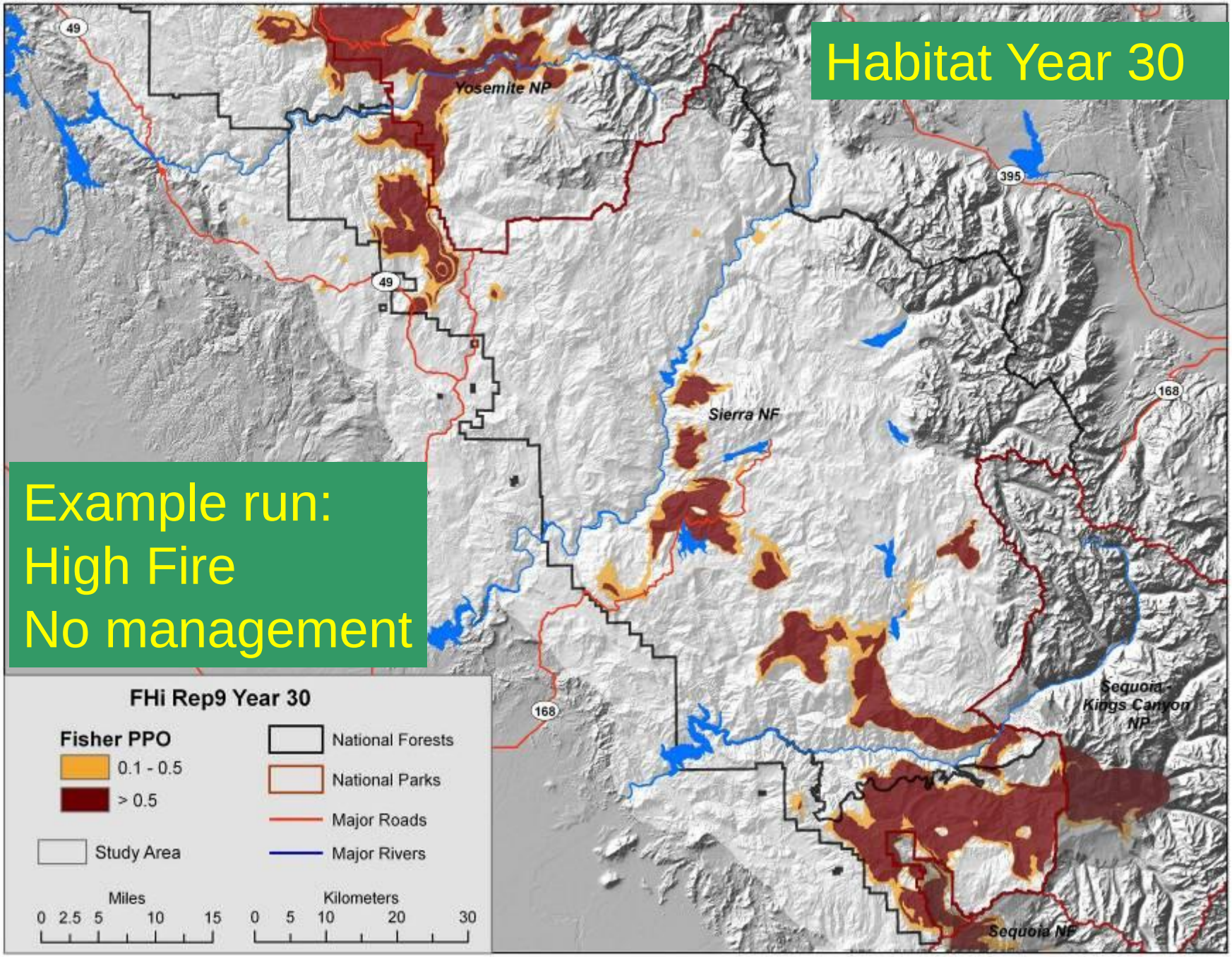

Fires Years 0 - 5
Example run:
High Fire
No management
Yosemite NP
Sierra NF
Sequoia - Kings Canyon NP
Sequoia NF
49
395
168
FHi Rep9 Year 5
Fire Severity
3
4
5
6
7
Study Area
National Forests
National Parks
Major Roads
Major Rivers
Miles
0 2.5 5 10 15
Kilometers
0 5 10 20 30

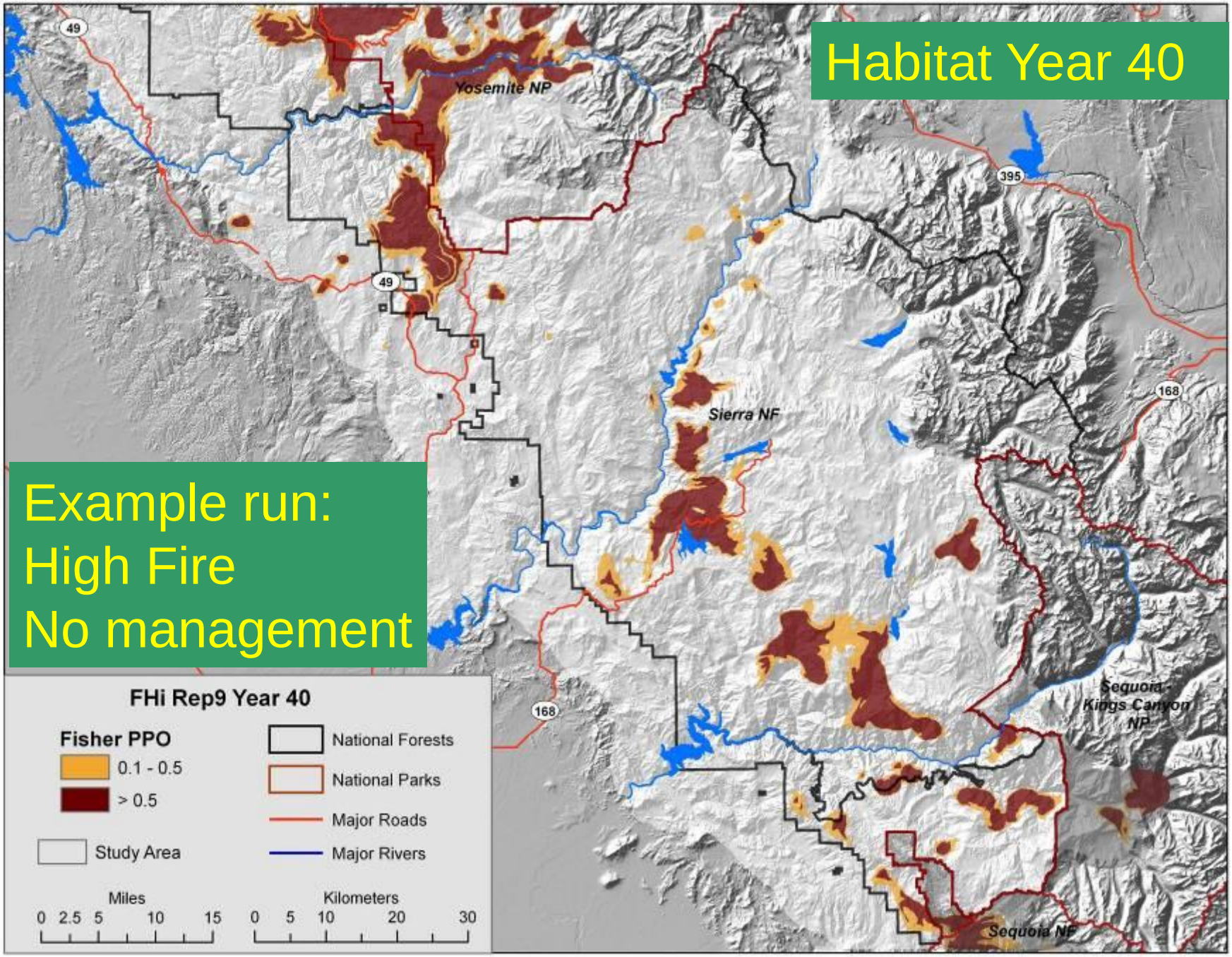
Habitat Year 10

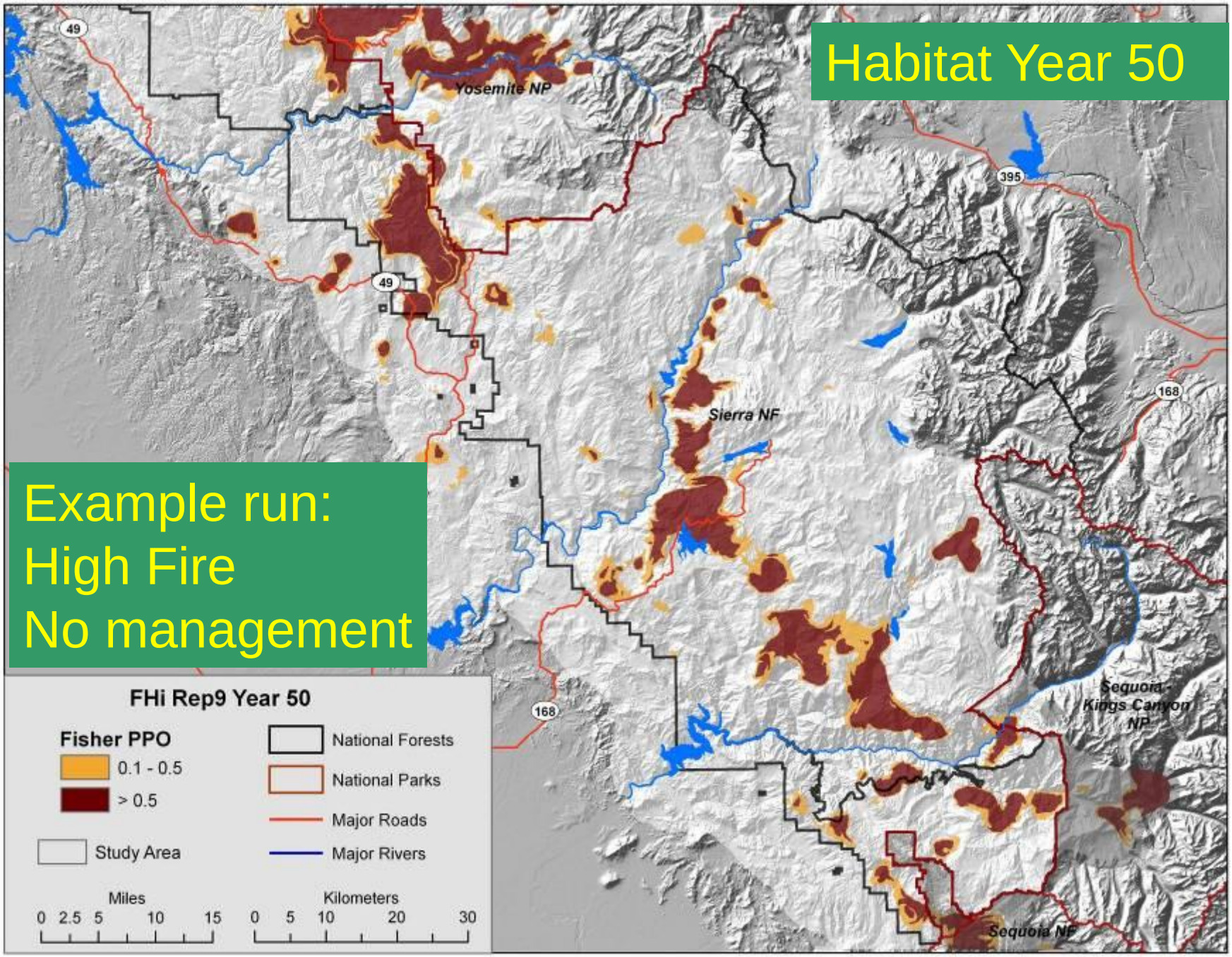


Example run:
High Fire
No management


Habitat Year 20
Example run:
High Fire
No management
Yosemite NP
Sierra NF
Sequoia - Kings Canyon NP
Sequoia NF
49
395
168
FHi Rep9 Year 20
Fisher PPO
0.1 - 0.5
> 0.5
Study Area
National Forests
National Parks
Major Roads
Major Rivers
Miles
0 2.5 5 10 15
Kilometers
0 5 10 20 30


Habitat Year 30
Example run:
High Fire
No management
Yosemite NP
Sierra NF
Sequoia - Kings Canyon NP
Sequoia NF
49
395
168
FHi Rep9 Year 30
Fisher PPO
0.1 - 0.5
> 0.5
Study Area
National Forests
National Parks
Major Roads
Major Rivers
Miles
0 2.5 5 10 15
Kilometers
0 5 10 20 30


Habitat Year 40
Example run:
High Fire
No management
Yosemite NP
Sierra NF
Sequoia - Kings Canyon NP
Sequoia NF
49
395
168
FHi Rep9 Year 40
Fisher PPO
0.1 - 0.5
> 0.5
Study Area
National Forests
National Parks
Major Roads
Major Rivers
Miles
0 2.5 5 10 15
Kilometers
0 5 10 20 30

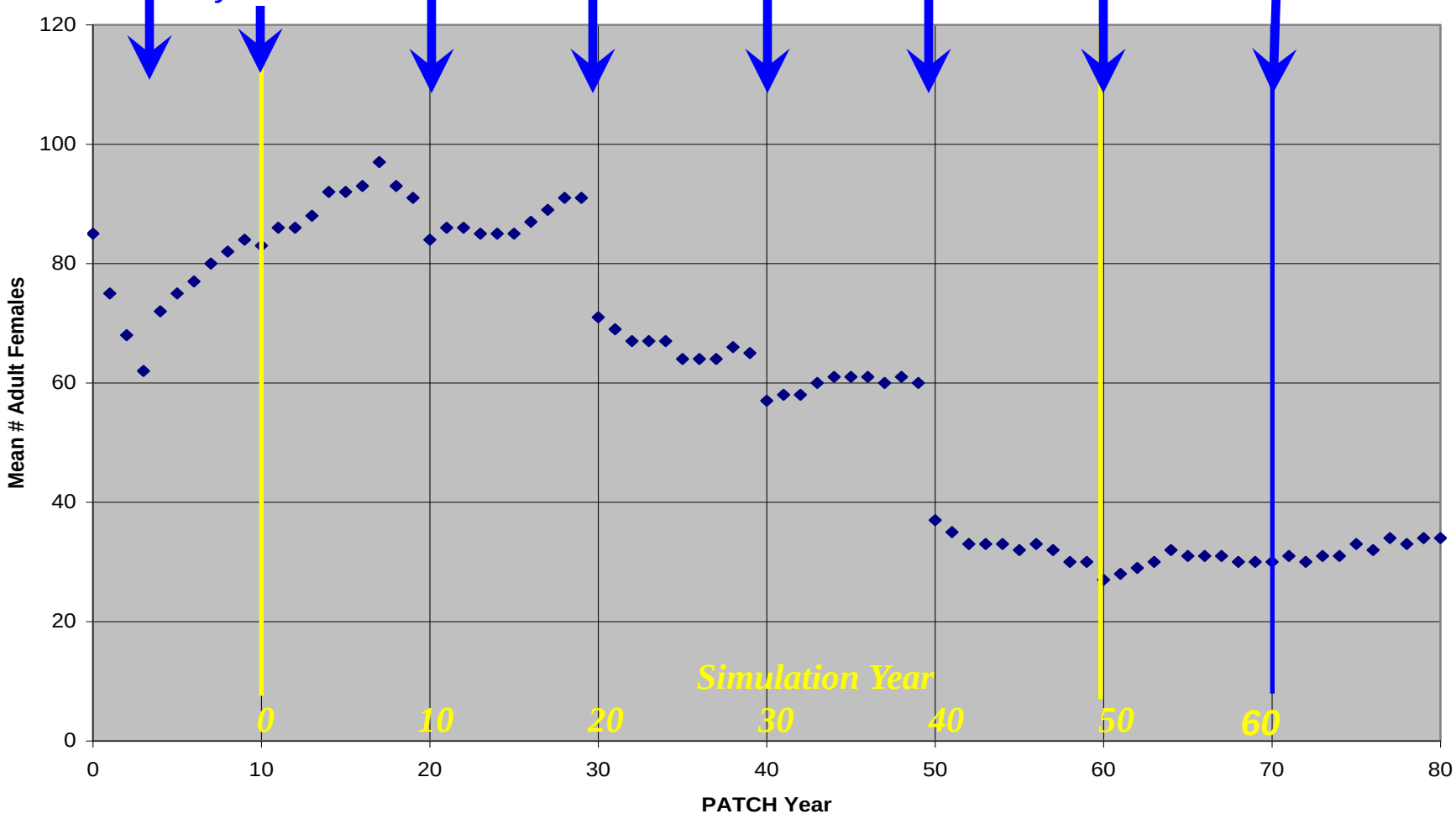

Habitat Year 50
Example run:
High Fire
No management
Yosemite NP
Sierra NF
Sequoia - Kings Canyon NP
Sequoia NF
49
395
168
FHi Rep9 Year 50
Fisher PPO
0.1 - 0.5
> 0.5
Study Area
National Forests
National Parks
Major Roads
Major Rivers
Miles
0 2.5 5 10 15
Kilometers
0 5 10 20 30

Coupling Population Changes with Vegetation Changes

PATCH equilibration period

Each decade:
1. Import LANDIS-II Biomass output into LAND8
2. Import new habitat map into PATCH

Record female fisher population size, year 60

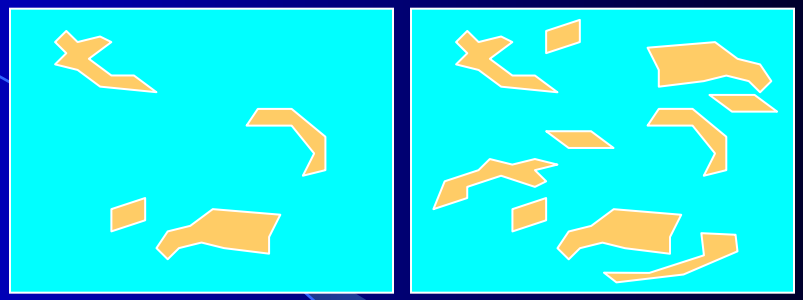


Simulations

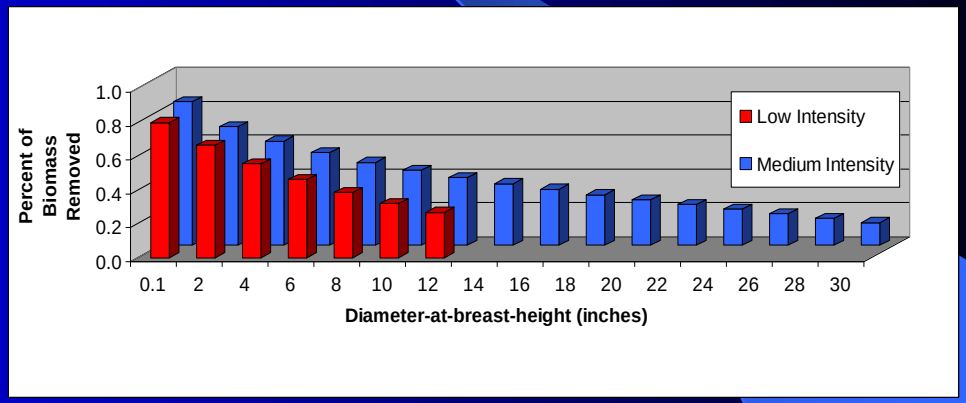
- Factorial design to test effects on ending fisher population of different:
  - Fire regimes
  - Treatment scenarios
- For each scenario:
  - 10 LANDIS-II replicates
  - X 10 PATCH replicates
  - Total of 1400 simulations
- Structural Equation Modeling to test specific hypotheses

Treatment Factors

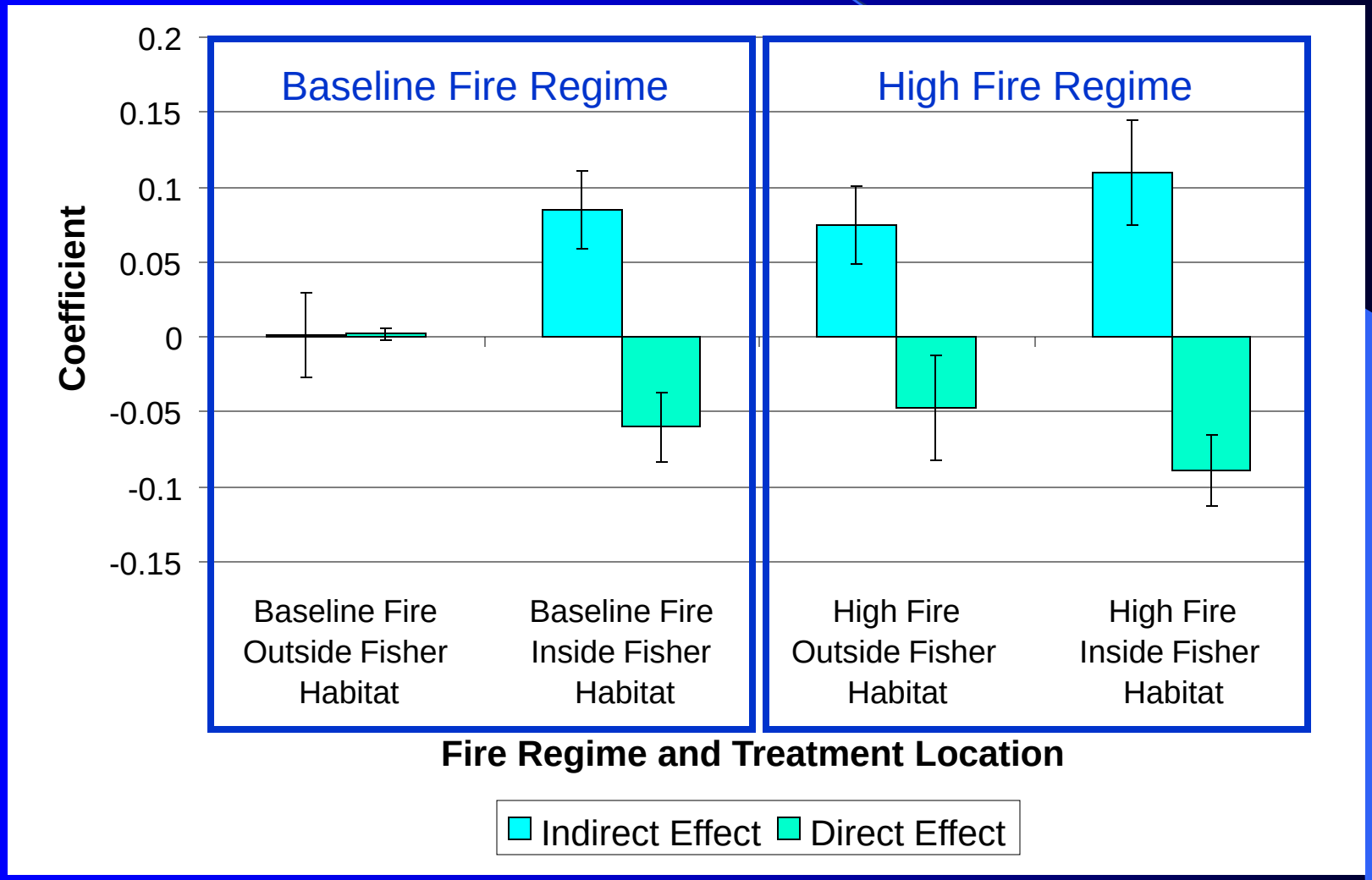
- **Treatment Rate** (proportion treatable landscape treated per 5-year time step)
- **Treatment Intensity** (amount and size distribution of biomass removed)
- **Treatment Location** (inside habitat, outside habitat, or both)



4% per time step 8% per time step



H4: Fuel treatments had positive, indirect effects on fishers, and these exceeded the direct negative effects, especially under High Fire regime.



Summary of Key Findings: Balancing Vegetation Management and Fire Risks

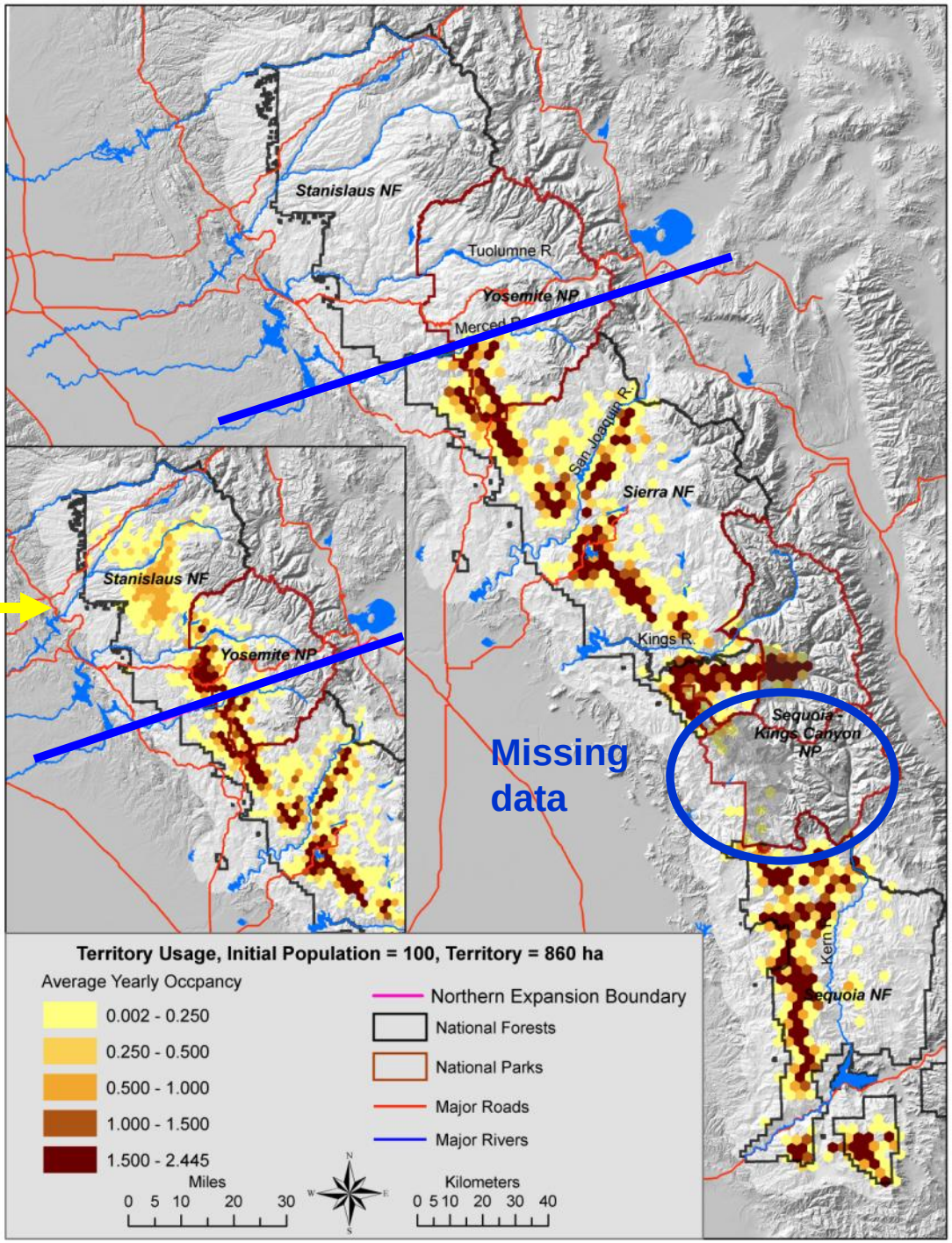
- *At the Landscape/Population Scale:*
  - *Strategic* fuels treatments can increase resiliency of both forests and fisher populations.
  - Treatment effectiveness will likely be greater under a heightened fire regime.
  - Placement of treatments both inside and outside of fisher habitat *may* be best…
  - …but modeling more refined scenarios is necessary to hone in on an optimal solution set.

(Syphard et al. 2011; Sheller et al. 2011)

Fisher Territory Occupancy and Potential for Population Expansion

- Estimated carrying capacity ~50-150 females
- Not counting unfilled habitat potential north of the Merced River.

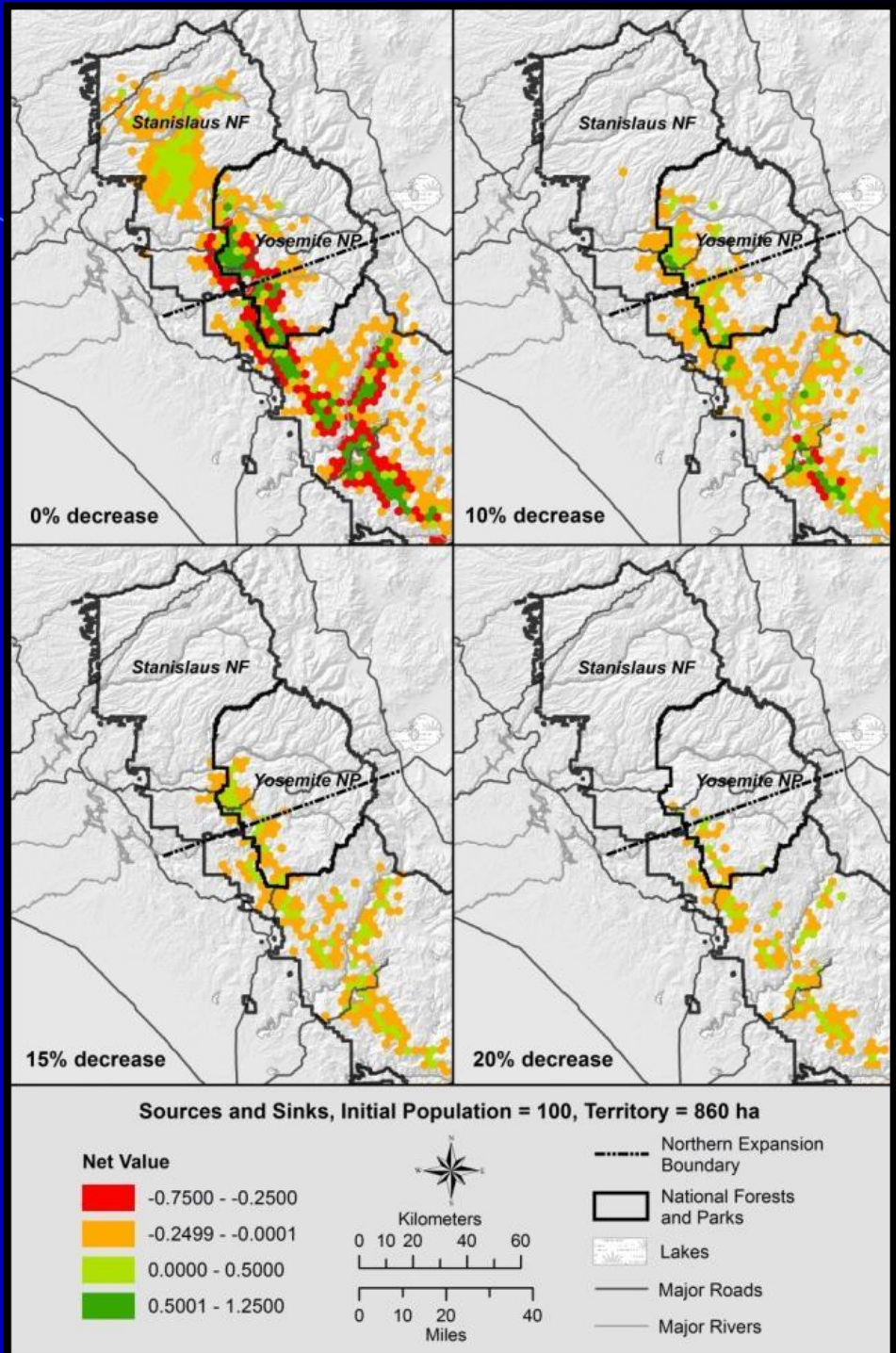
(Spencer et al. 2008, 2011)



Effects of Additive Mortality

- Modest increases in mortality (10-20%) due to human influences can limit fisher expansion into available habitat.

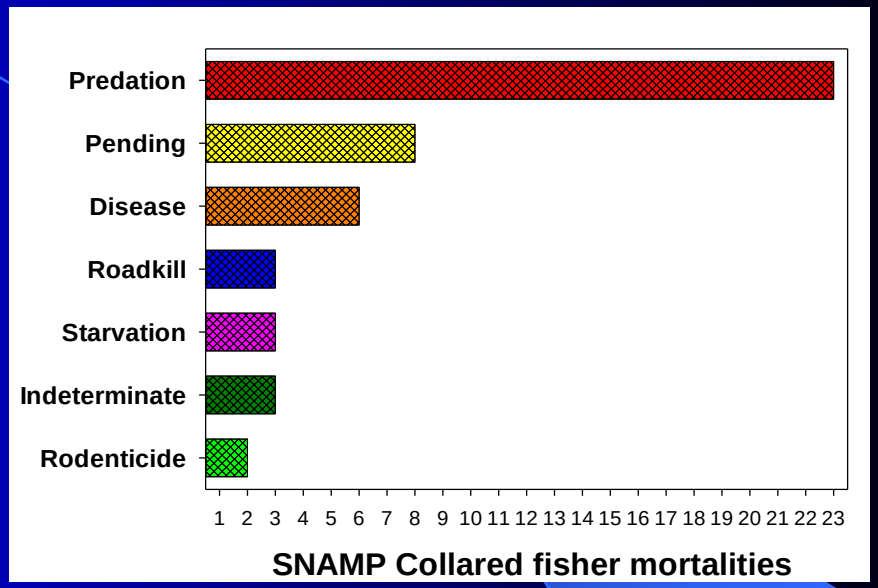
(Spencer et al. 2011 and data from SNAMP and KRP fisher studies)

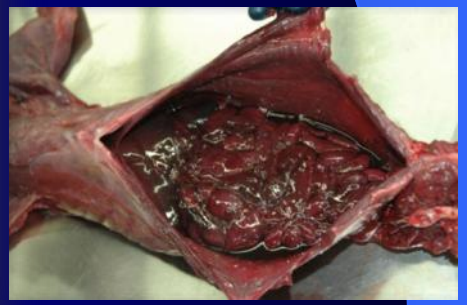


Cause-specific Mortality from SNAMP and KRPF

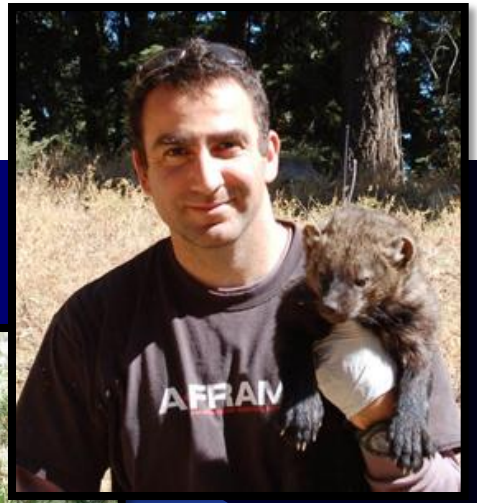
(Sweitzer et al. pers. Comm.)

- 102 fishers: 59 females, 43 males
- Carcasses recovered for 50 collared, 9 noncollared fishers
- Top 3 causes of mortality for collared fishers
  - *Predation: n = 23 (+7 pending)*
  - *Disease: n = 6 (CDV, Bacterial, Parvo)*
  - *Roadkill: n = 3 (+5 noncollared in YNP)*





Rodenticides & California Fishers (M. Gabriel, personal communications)



- Marijuana grow sites contain MASSIVE amounts of chemicals.
- 86% of tested fishers in California exposed to rodenticides.
- 6 confirmed <u>direct</u> mortalities from rodenticides.
- Rodenticide poisoning likely contributes to numerous other mortalities, and…
- It reduces fisher prey availability (where have all the porcupines gone?).

Fisher Denning Probability Model

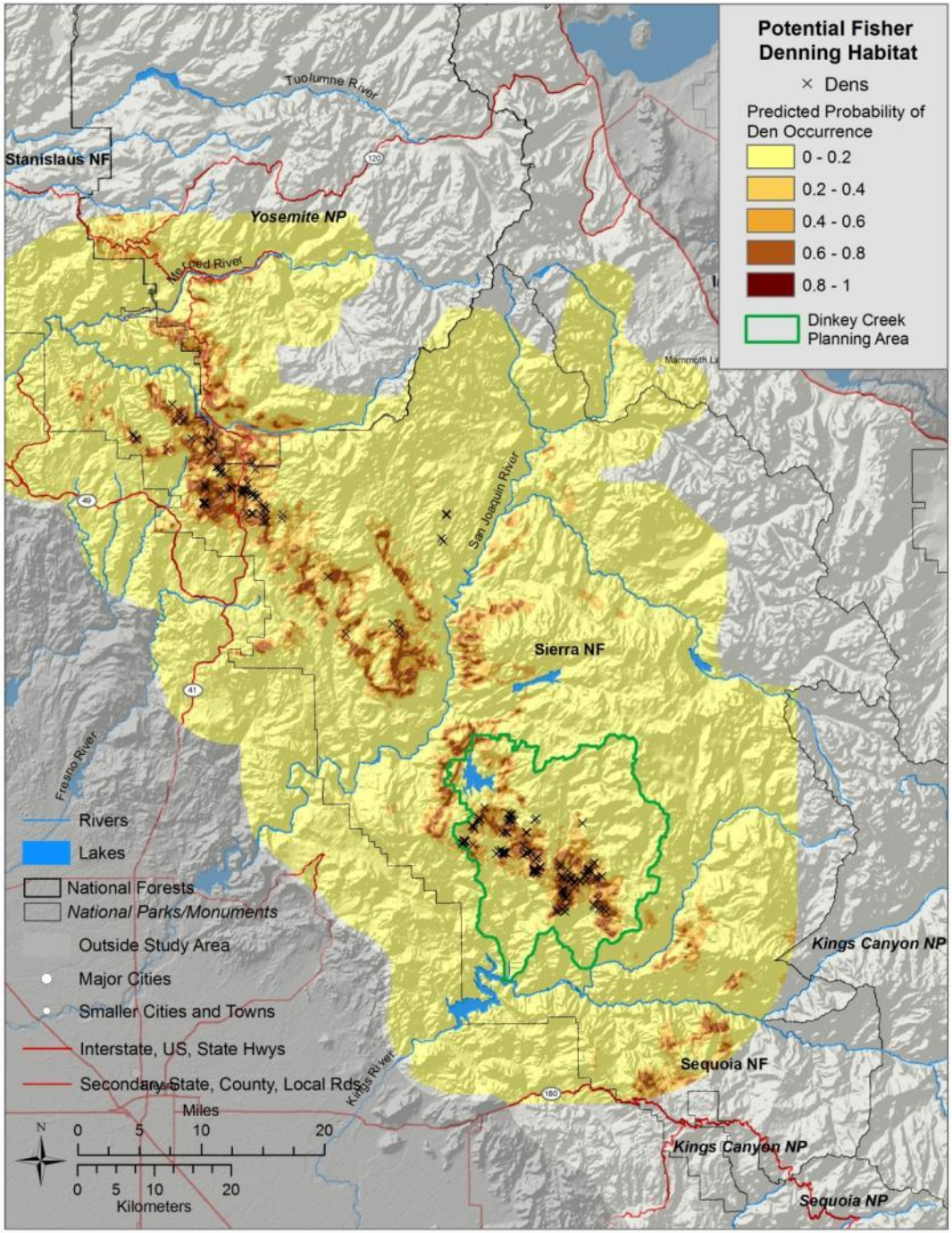
Uses 2 vegetation variables:

- STRUCTURE2 (= dense, big trees)
  - at 2-km^2 resolution (~500 ac)
  - 90% of predictive power.
- Proportion in Hardwoods
  - at 0.5-km^2 (~125 ac)
  - 10% of predictive power.

AUC = 0.938

CWHR Classes:

- 98% dens in density class D (> 60% cover)
- 98% dens in size classes 4 and 5 (> 11-inch DBH).



Composite Map: Fisher Functional Habitat Areas

High Occupancy Areas (Dark Green)

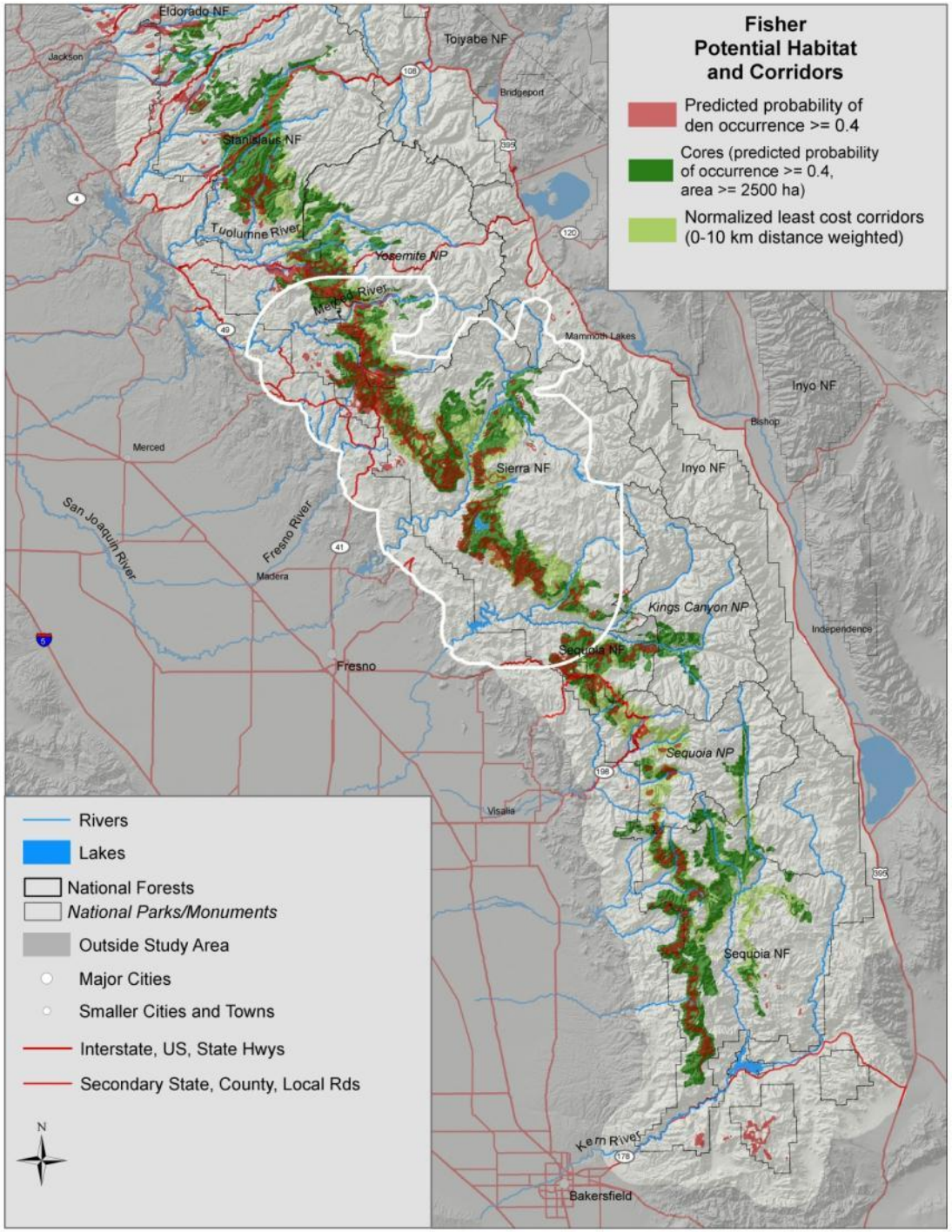
- LAND8 PPO > 0.4
- Home range-scale habitat use:
  - Both sexes
  - Snow-free period
  - Attracted by baits

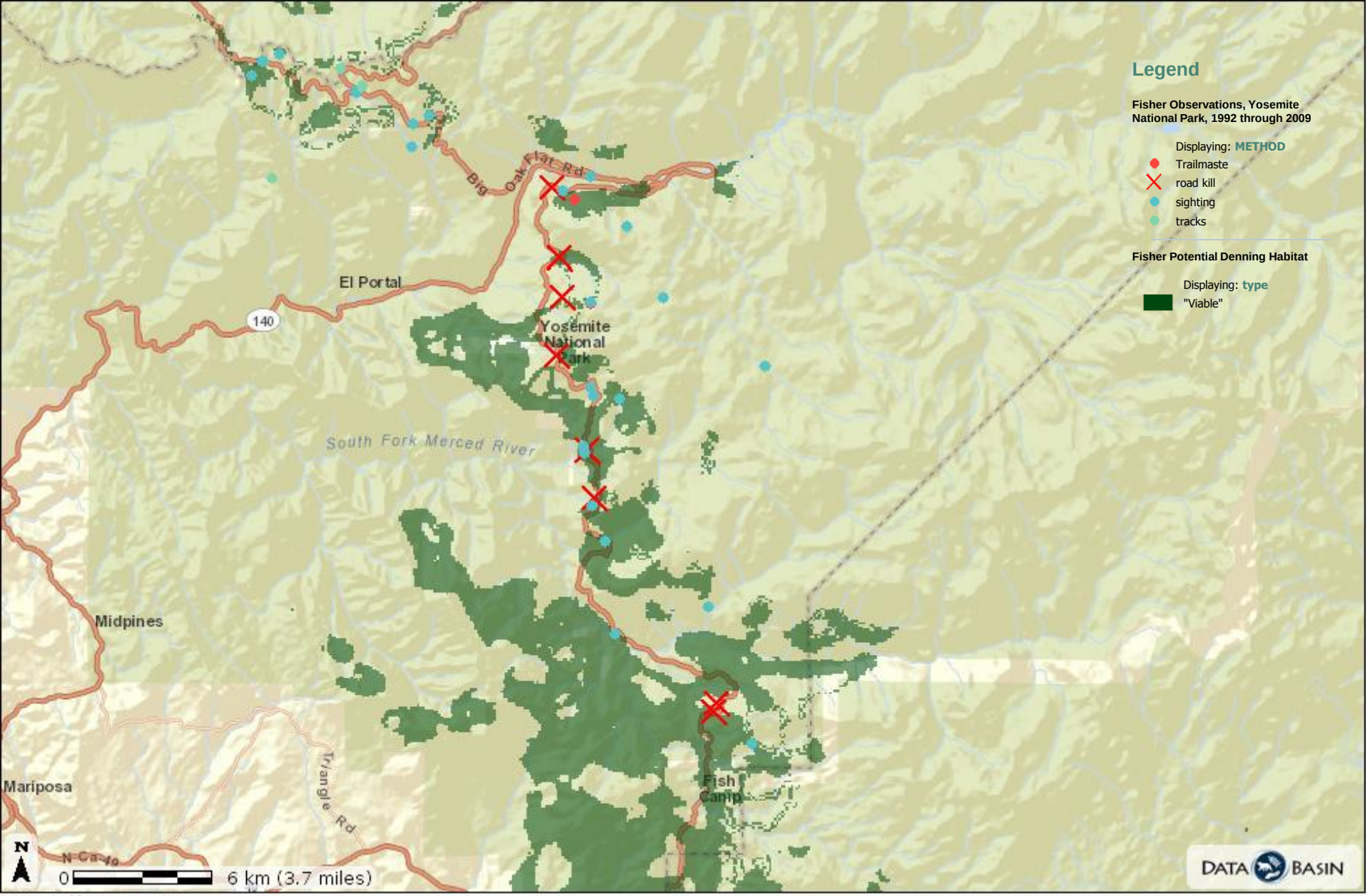
Denning Habitats

- Den PPO > 0.4 (Red)
- Within home range selection:
  - Females only
  - Snow still on ground
  - Freely selected den sites

Movement habitats (Light Green)

- Areas likely to be used during dispersal





Created by: Wayne D. Spencer, 2013

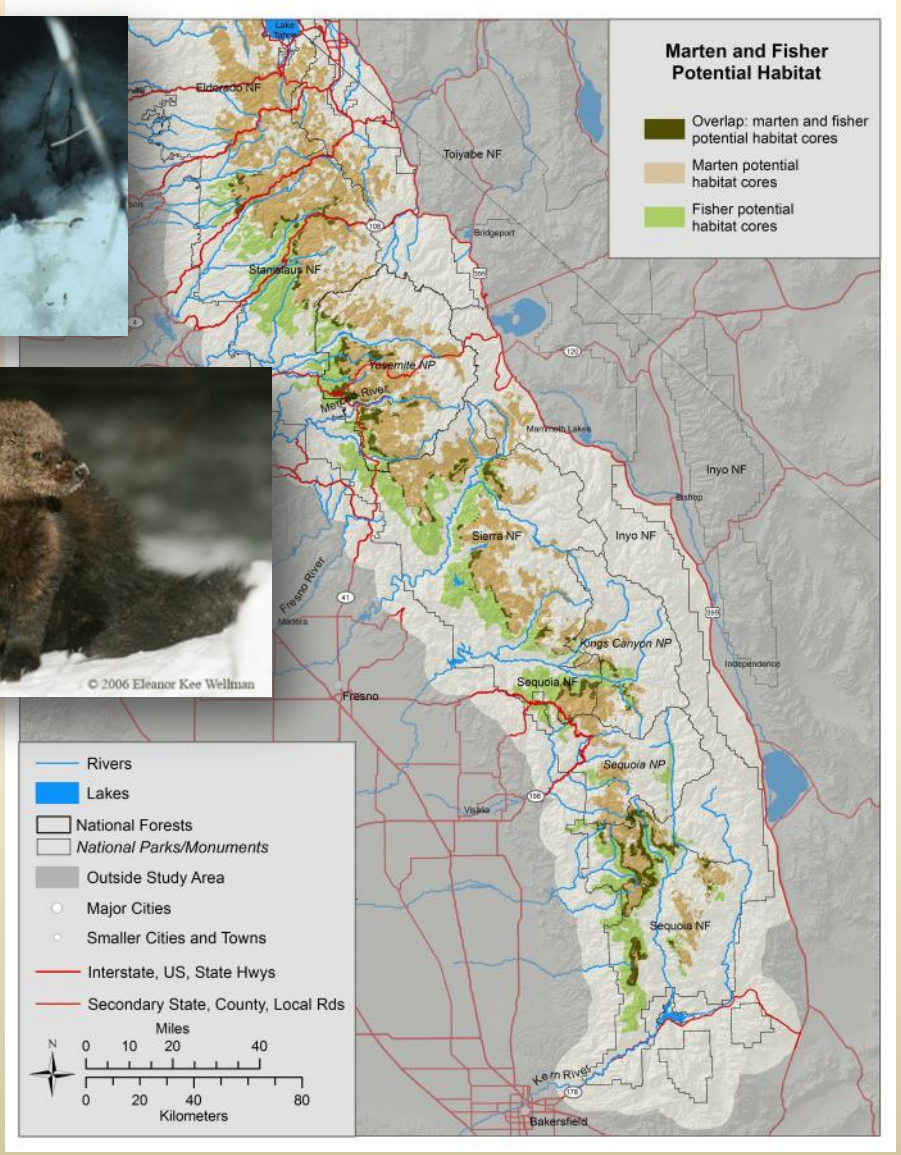
Recap: **Interacting** Threats to SSN Fisher Population

- Small population size
- Habitat/population fragmentation
- Severe wildfires
- Vegetation management (timber harvest and fuels treatments)
- Increased access by fisher predators
- Rodenticide poisoning
- Reduction of prey base (porcupines, squirrels)
- Roadkill
- Climate change

Yale Climate Change Framework:

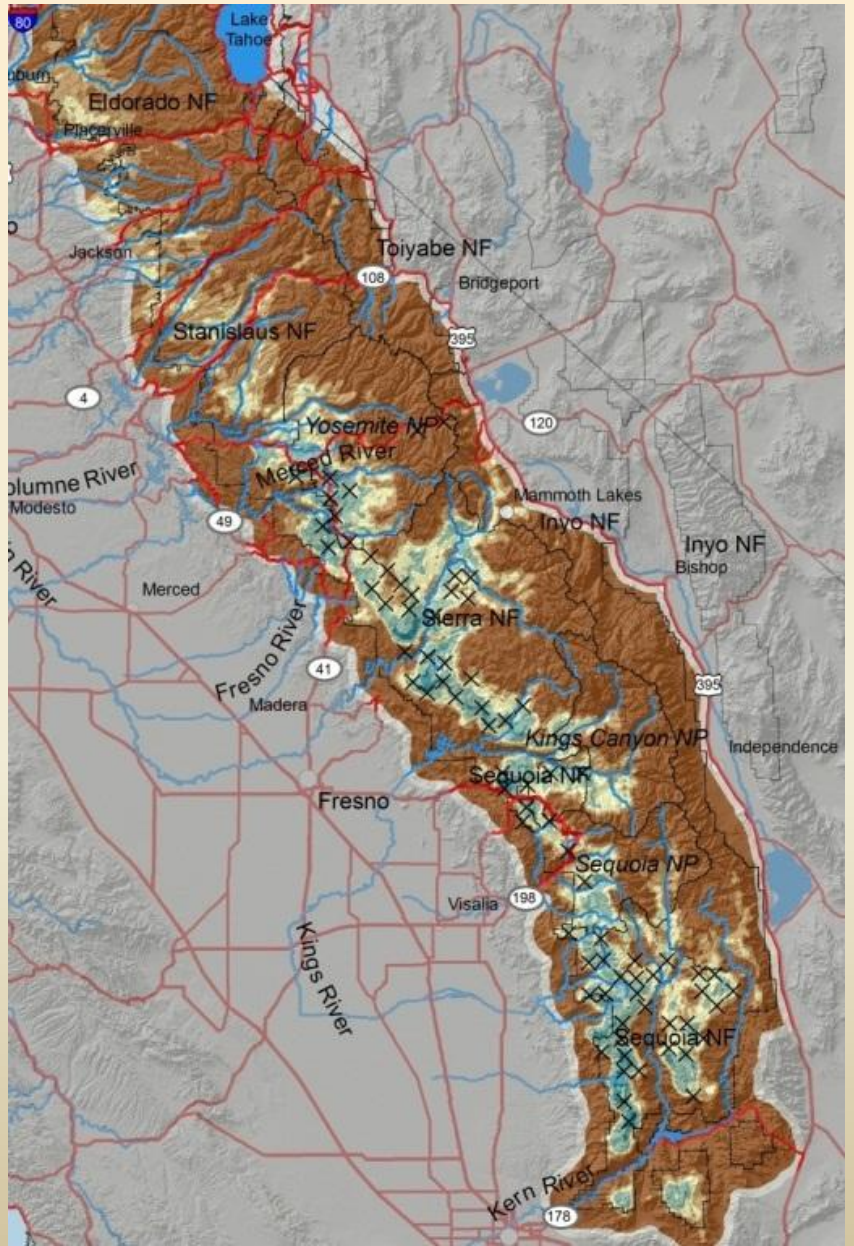
Relationships Between Vegetation, Climate, Martens, and Fishers

- Martens:
  - High elevation
  - Red fir
  - Deep snows
- Fishers:
  - Mid elevation
  - Mixed coniferous-hardwoods
  - Less snow
- Both: Downslope shifts in winter
- Interaction: Fishers kill martens where they co-occur

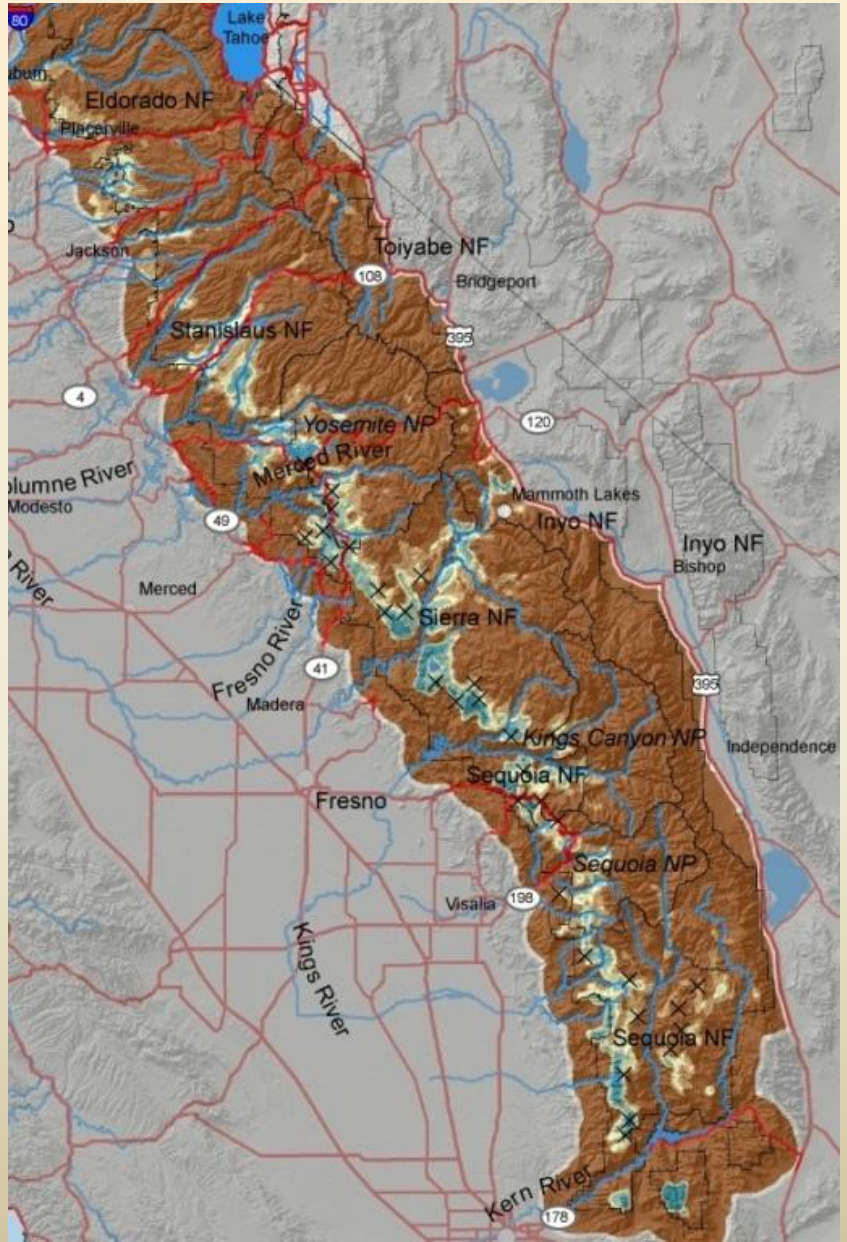


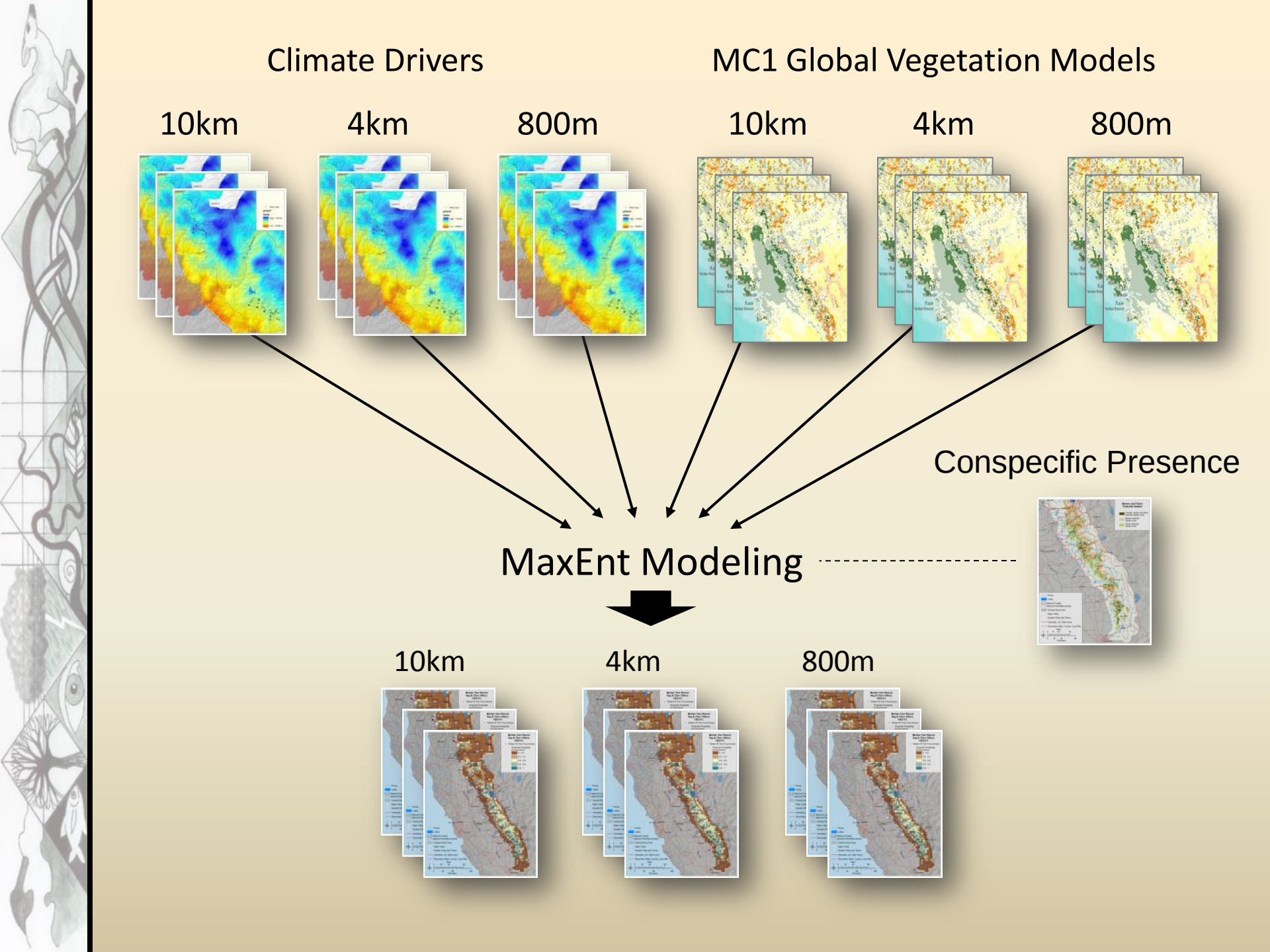
Fisher Seasonal Distribution

Summer



Winter

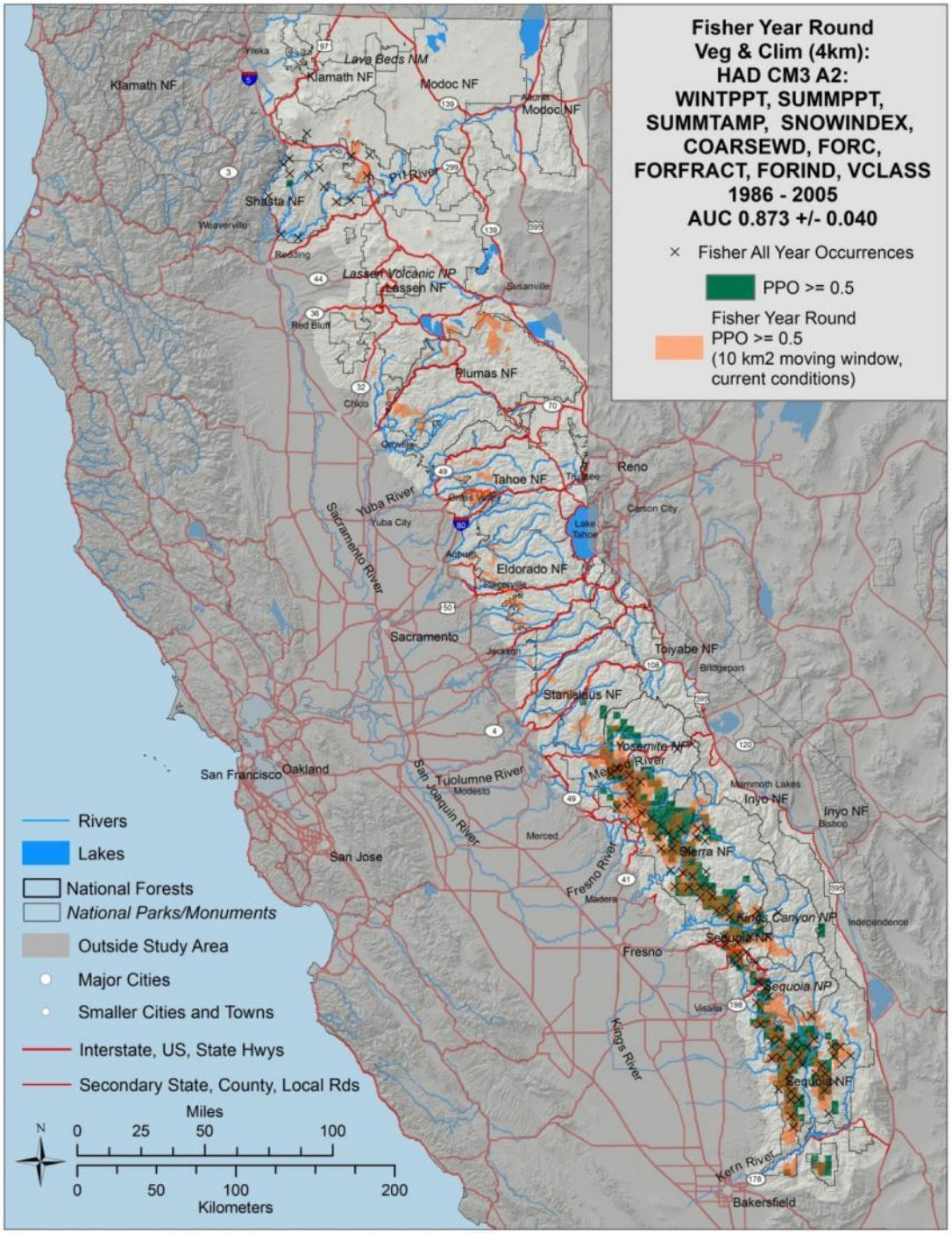



Climate Drivers
MC1 Global Vegetation Models
10km
4km
800m
10km
4km
800m
Conspecific Presence
MaxEnt Modeling
10km
4km
800m

Projected Changes

Fisher year-round model, HAD CM3 A2 scenario (4km)

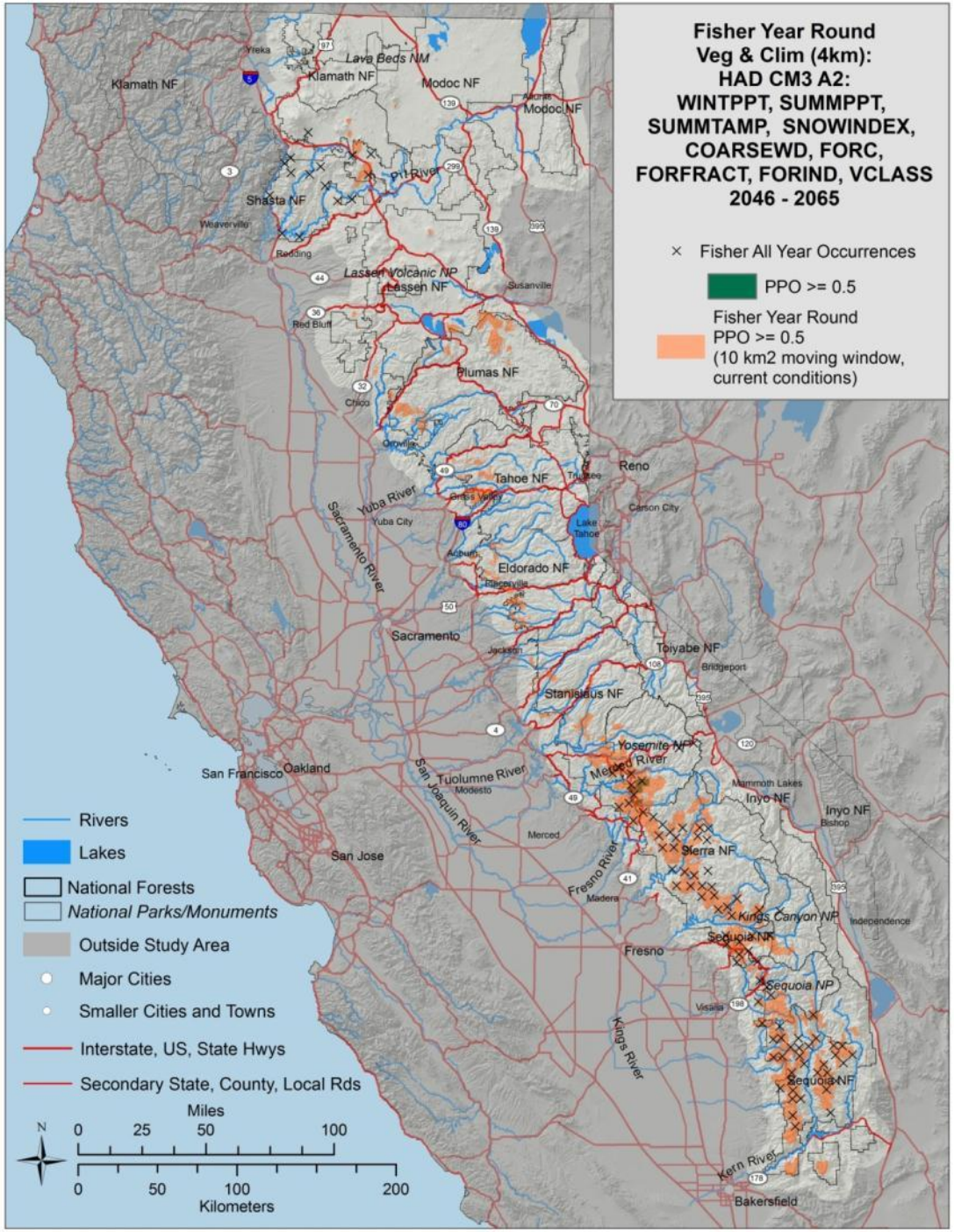
1986-2005



Projected Changes

Fisher year-round model, HAD CM3 A2 scenario (4km)

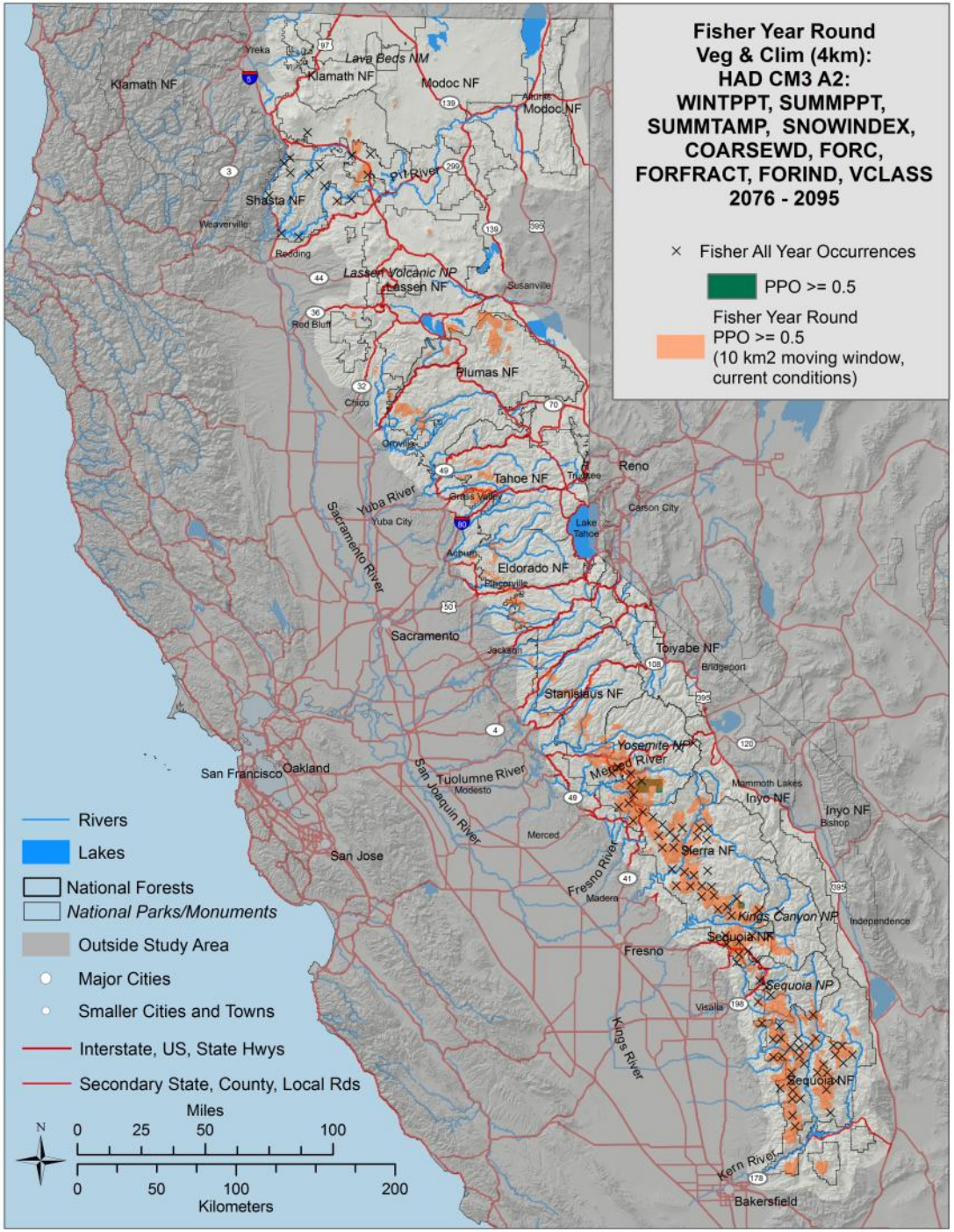
2046-2065



Projected Changes

Fisher year-round model, HAD CM3 A2 scenario (4km)

2076-2095



Conclusions

- Management must:
  - Balance the competing risks of vegetation treatments and fires.
  - Maximize the extent, contiguity, and sustainability of dense, mature forests.
  - Reduce fisher mortality risks:
    - Clean up rodenticides and other pesticides
    - Create/improve road crossing structures
    - Reduce habitat fragmentation and roads to reduce predation
    - Monitor diseases and reduce exposure to pets
  - Protect and enhance potential climate refugia
  - Restore missing prey species (porcupines)?