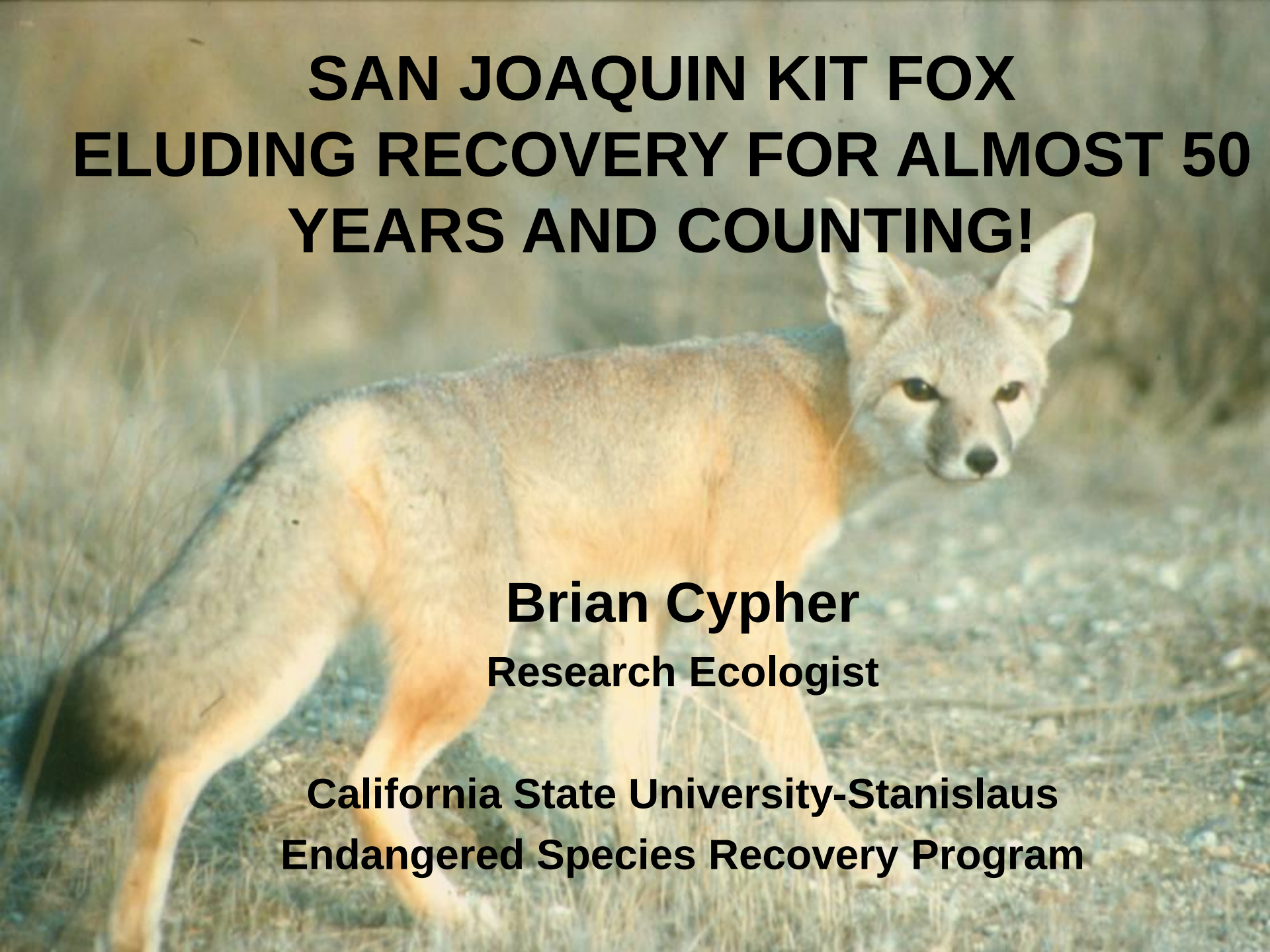
SAN JOAQUIN KIT FOX ELUDING RECOVERY FOR ALMOST 50 YEARS AND COUNTING!



Brian Cypher

Research Ecologist

California State University-Stanislaus

Endangered Species Recovery Program

Presentation Outline

I. Overview of kit fox biology and ecology

II. Endangerment and current status

III. Conservation research

IV. Conservation needs

I. San Joaquin Kit Fox

Overview

- *Vulpes macrotis mutica*
- Arid habitats
- 2-2.5 kg
- Eat rodents, rabbits, and insects
- Don’t need free water
- Coyotes main predator
- Nocturnal
- Diurnal den use
- Dens used all year
- Socially monogamous
- Endangered since 1967

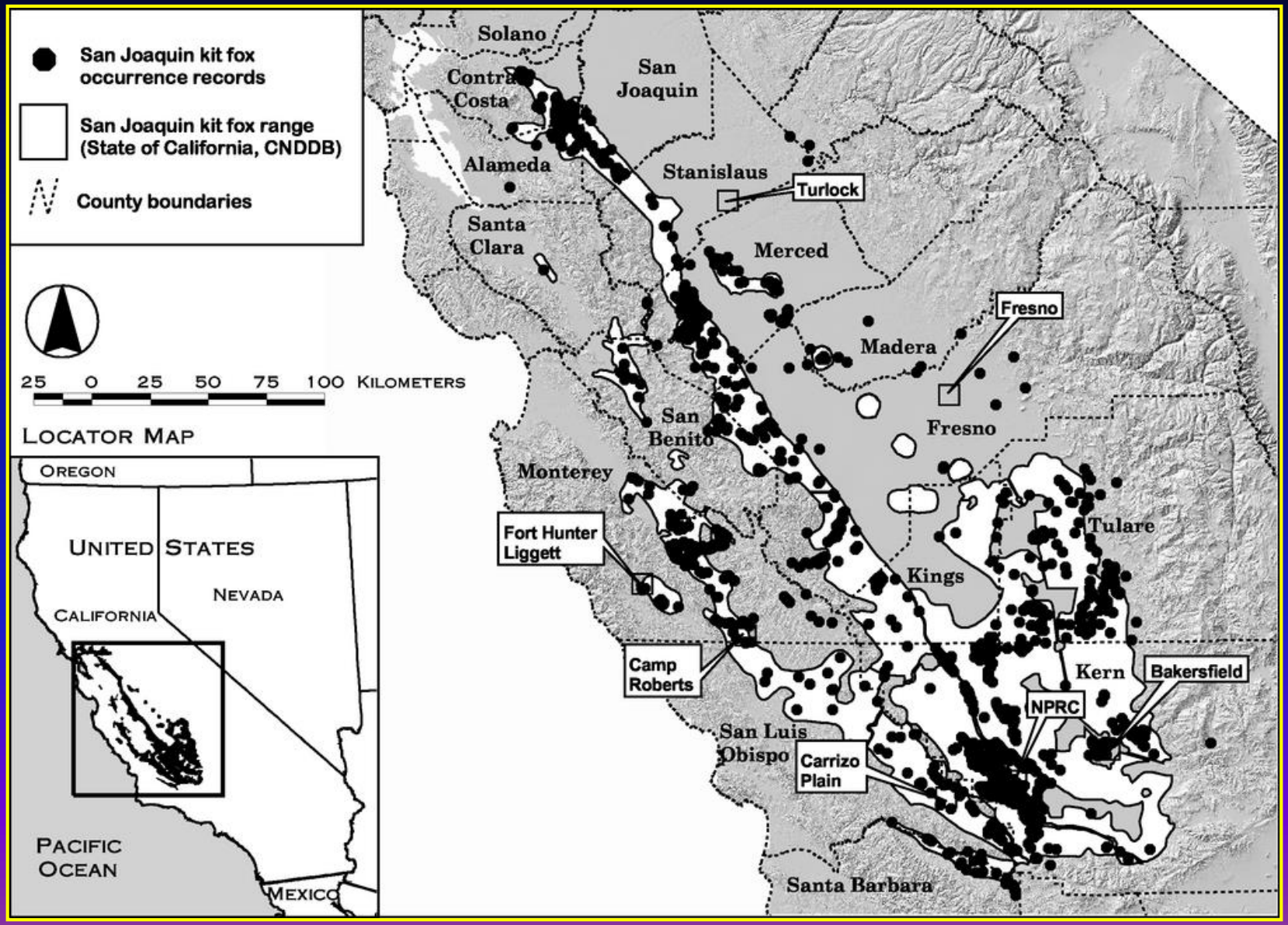

Red fox


Gray fox


Coyote pup

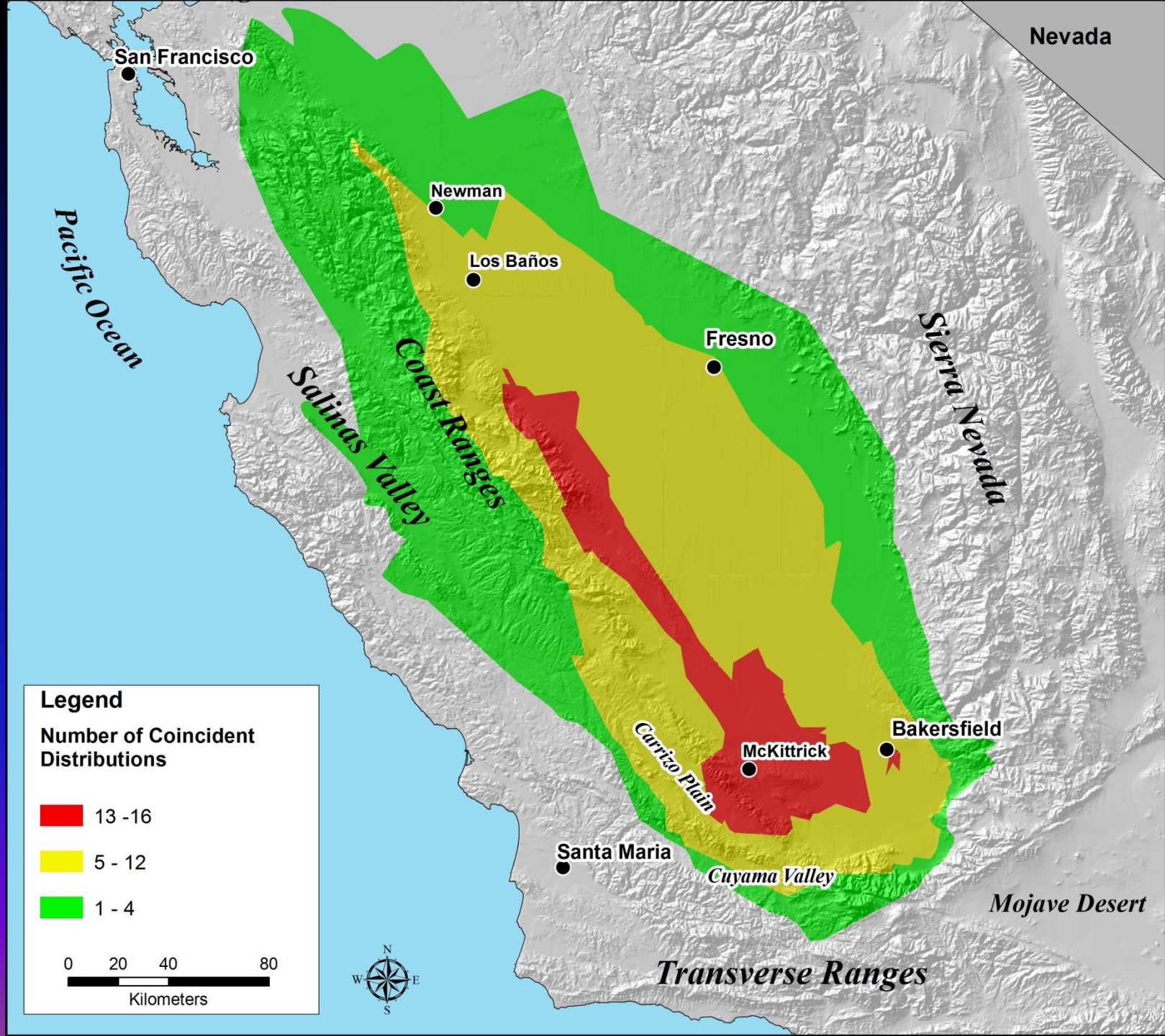

Kit fox

San Joaquin Kit Fox Range - CNDDB



Arid scrublands and grasslands

Kit Foxes in Natural Habitat



Germano et al. 2011

Kit Fox Den Use

- Avoid predators
- Avoid temperature extremes
- Daytime resting
- Moisture conservation
- Rearing young

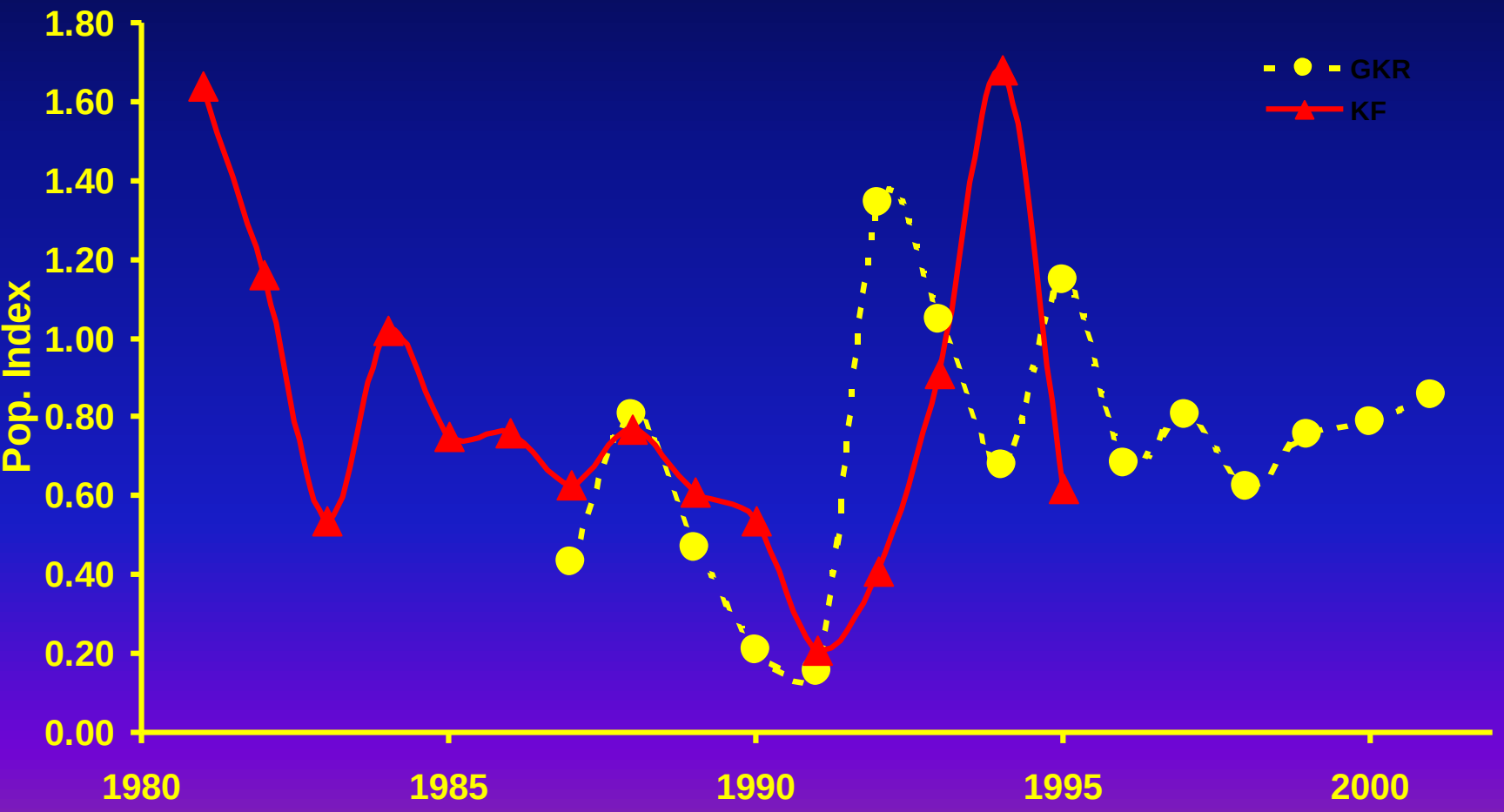
Kit Fox Foods in Natural Habitats


CALIFORNIA QUAIL

We conclude that kangaroo rats constitute the "staff of life" of the kit fox in such localities.

Grinnell, Dixon, & Linsdale, 1937
Fur-bearing Mammals of California, p. 417

Population Dynamics of Kit Foxes (Elk Hills, 1981-1995 no./sq. km.) & Giant Kangaroo Rats (Elkhorn Plain, 1987-2001, av. no. captured/100)

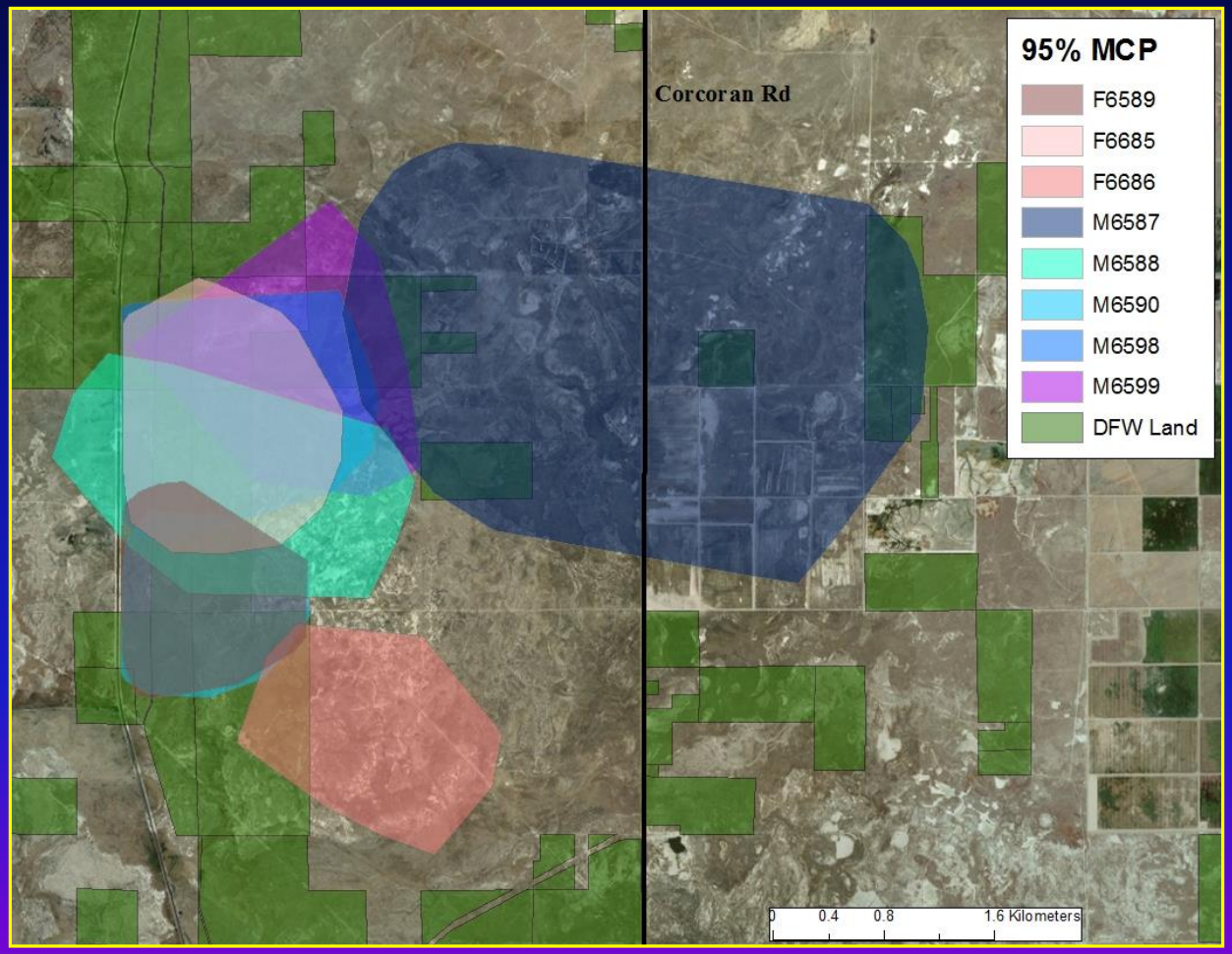


Home Range Size Comparison (sq km)

Study	100% MCP	95% MCP
Elk Hills (Koopman 1995)	4.3	-
Elk Hills (Zoellick et al. 2002)	4.6	-
Carrizo (White and Ralls 1993)	11.6	-
N. Carrizo (w/o 6697)	10.0	6.4
Semitropic (w/o 6587)	3.7	2.4
Lokern (Spiegel and Bradbury 1992)	-	6.1
Lokern (Nelson 2005 – 95% fixed kernel)	-	5.9

Home Ranges
Northern Carrizo

Home Ranges
N. Semitropic Ridge ER



Kit Fox Mortality Sources

- Predators
  - Coyotes
  - Bobcats
  - Domestic dogs
  - Badgers
  - Red foxes
  - Raptors
- Vehicles
- Toxins
  - Rodenticides
  - Contaminants
- Entombment
- Illegal killing

Probability of Surviving for 365 Days (Adults)

Location	*n*	Survival	Range
Lokern: 2001-2004 *(Cypher et al. unpub)*	42	0.64	-
Elk Hills: 1980-1995 *(Cypher et al. 2000)*	341	0.44	0.20-0.81
Carrizo Plain: 1989-1991 *(Ralls and White 1995)*	33	0.61	0.50-0.74

Kit Fox Social Ecology

- Basic social unit is pair (male and female)
- Helper(s) may be present (usually female from previous litter)
- Monogamous and usually mate for life
- Extra-pair copulations are common
- Average litter size is 4
- Young can disperse as early as 4 months of age, but may delay for months or even years
- Can breed in first year but second year is more common

Reproductive Chronology

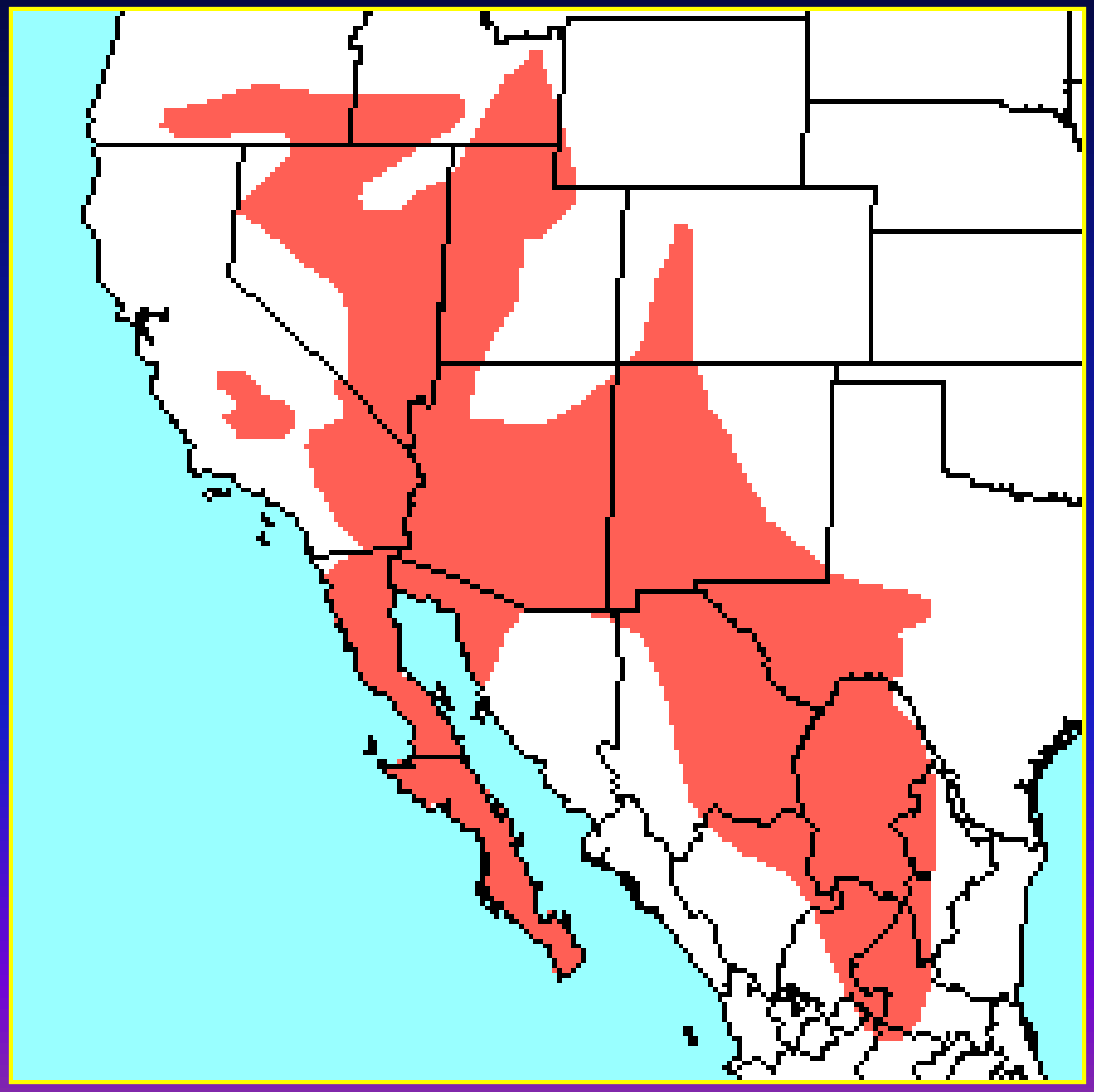
- Pairing: Nov – Dec
- Mating: Dec – Jan
- Parturition: Feb
- Nursing: Feb – Apr
- Weaning: Mar – May
- Independence: May – June
- Dispersal: July and beyond

Reproduction

	Lokern	Elk Hills	Carrizo
No. females:	24	126	19
% Reproductive success:	54.2 (50.0-80.0)	61.1 (20.0-100)	21.1 (0-57.1)
No. litters:	23	97	4
Mean litter size:	3.8 (2-9)	3.8 (1-6)	2.0 (1-3)

II. Why Endangered?

Kit Fox Range



Smithsonian National Museum of Natural History

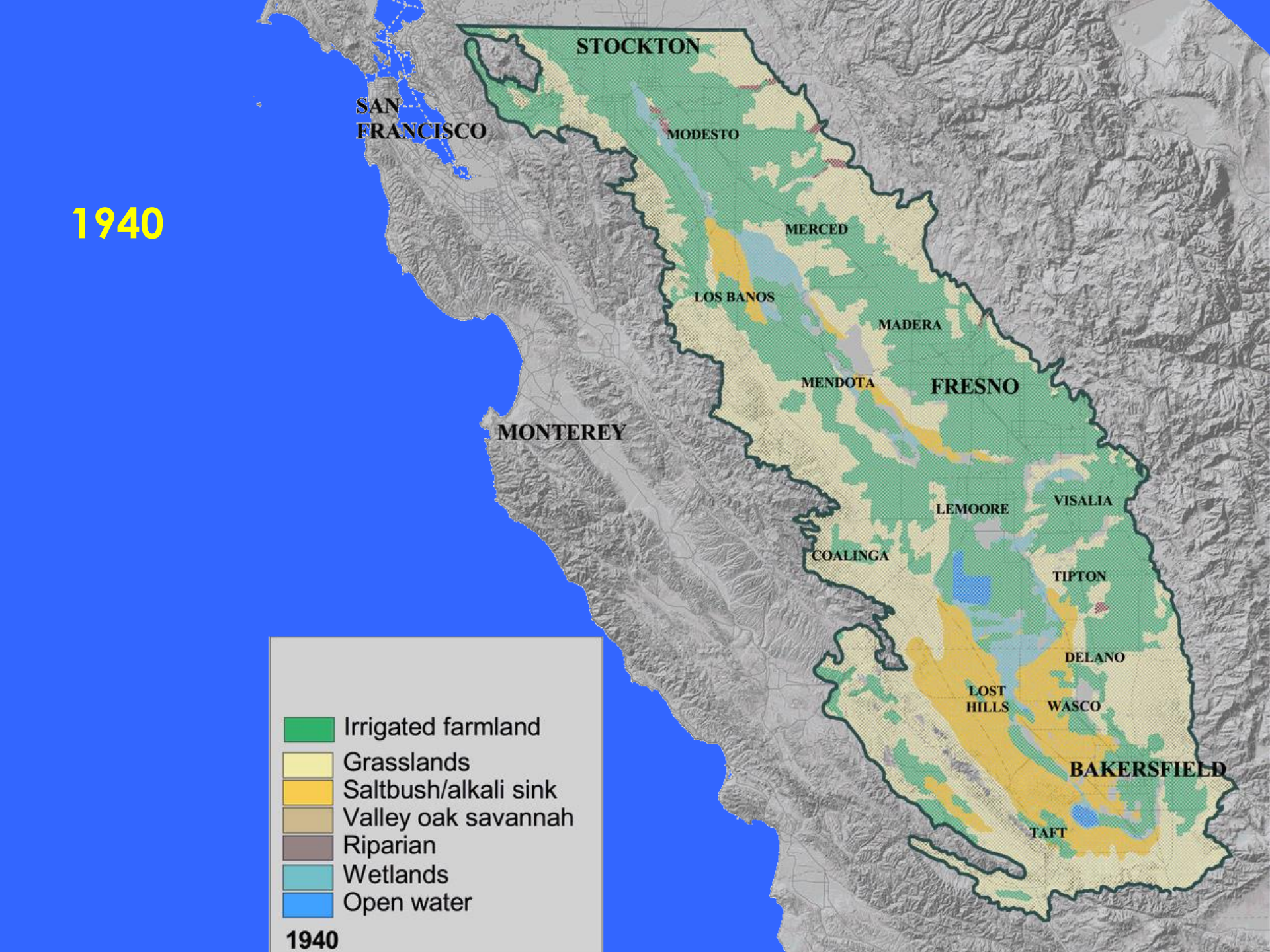
Isolation

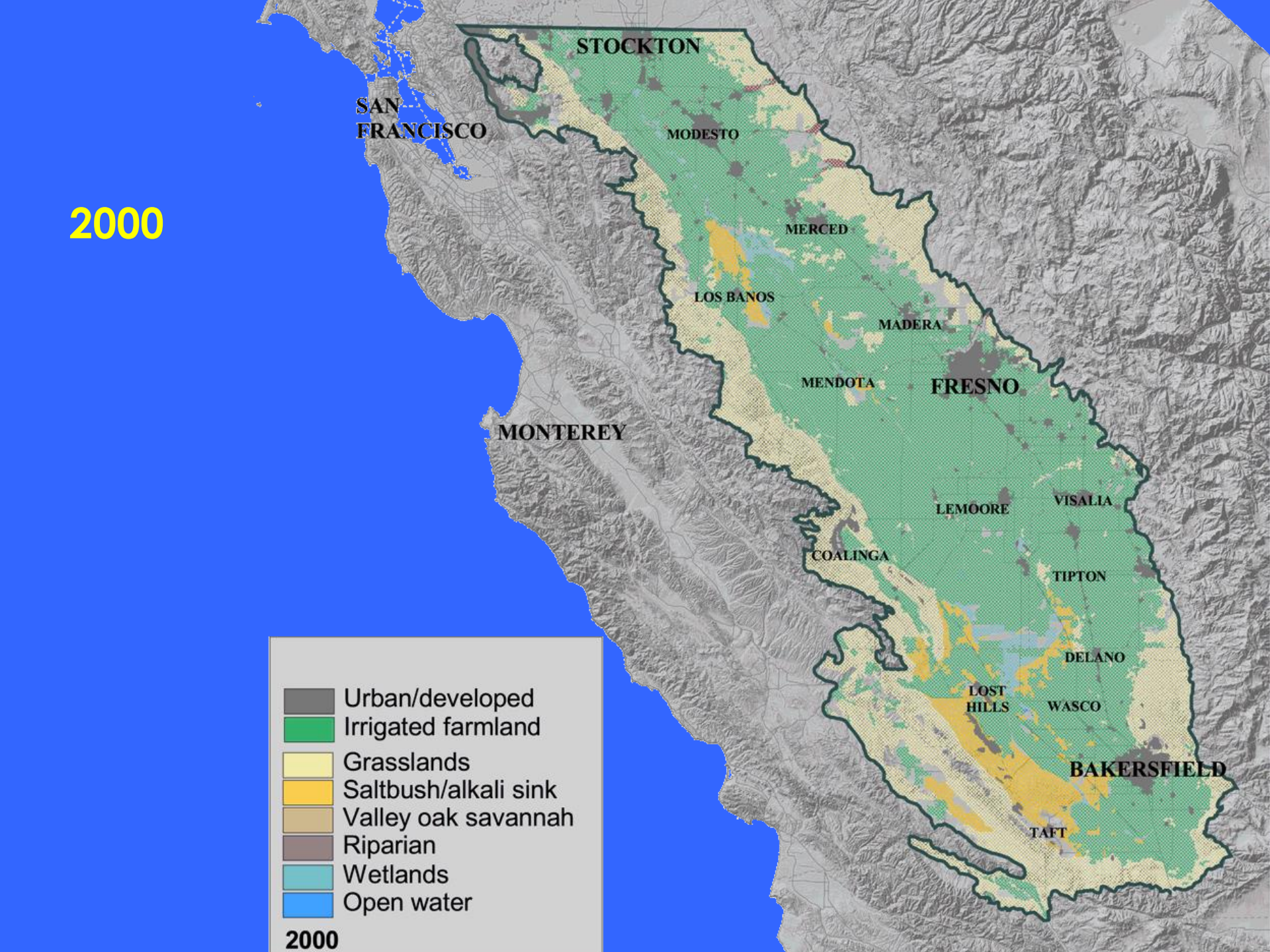

Sacremento Valley
Sierra
Nevada
Mtns.
San Francisco
San Joaquin Valley
Los Angeles

Before European Settlement

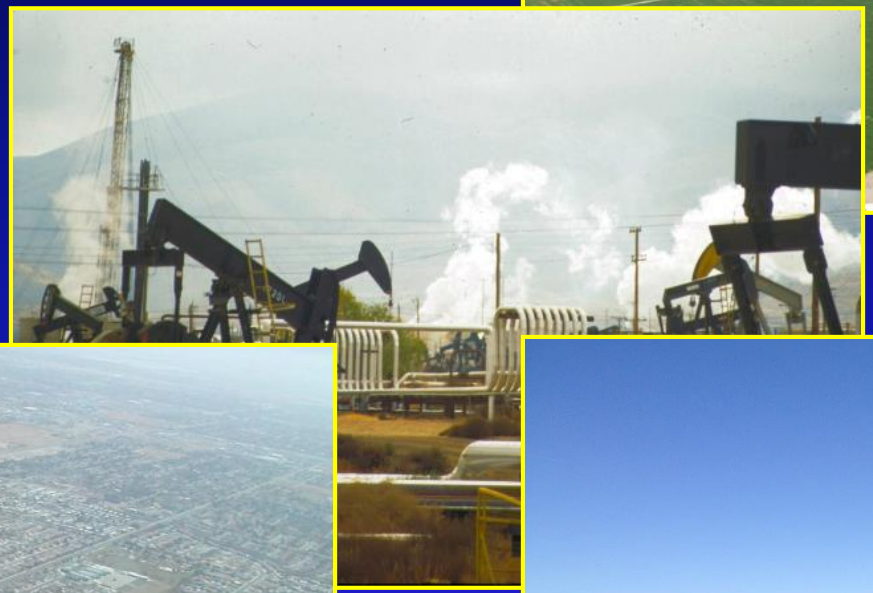

1885
STOCKTON
SAN FRANCISCO
MODESTO
MERCED
LOS BANOS
MADERA
MENDOTA
FRESNO
MONTEREY
LEMOORE
VISALIA
COALINGA
TIPTON
DELANO
LOST HILLS
WASCO
BAKERSFIELD
TAFT
Irrigated farmland
Grasslands
Saltbush/alkali sink
Valley oak savannah
Riparian
Wetlands
Open water
1885


1912
STOCKTON
SAN FRANCISCO
MODESTO
MERCED
LOS BANOS
MADERA
MENDOTA
FRESNO
MONTEREY
LEMOORE
VISALIA
COALINGA
TIPTON
DELANO
LOST HILLS
WASCO
BAKERSFIELD
TAFT
Irrigated farmland
Grasslands
Saltbush/alkali sink
Valley oak savannah
Riparian
Wetlands
Open water
1912

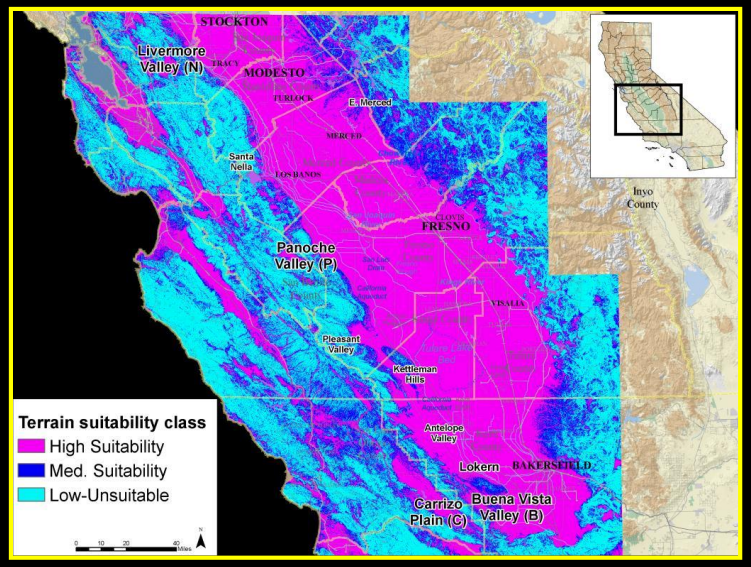

1940
STOCKTON
SAN FRANCISCO
MODESTO
MERCED
LOS BANOS
MADERA
MENDOTA
FRESNO
MONTEREY
LEMOORE
VISALIA
COALINGA
TIPTON
DELANO
LOST HILLS
WASCO
BAKERSFIELD
TAFT
Irrigated farmland
Grasslands
Saltbush/alkali sink
Valley oak savannah
Riparian
Wetlands
Open water
1940


2000
STOCKTON
SAN FRANCISCO
MODESTO
MERCED
LOS BANOS
MADERA
MENDOTA
FRESNO
MONTEREY
LEMOORE
VISALIA
COALINGA
TIPTON
DELANO
LOST HILLS
WASCO
BAKERSFIELD
TAFT
Urban/developed
Irrigated farmland
Grasslands
Saltbush/alkali sink
Valley oak savannah
Riparian
Wetlands
Open water
2000

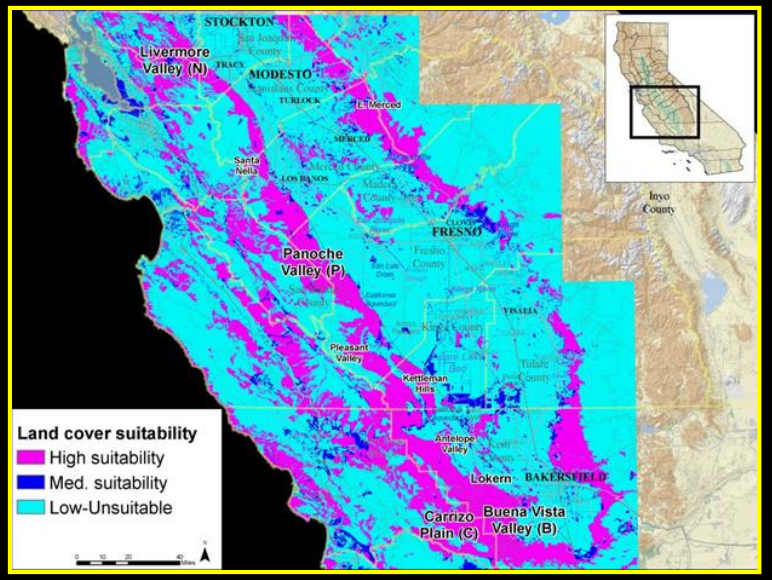
Habitat conversion in the San Joaquin Valley



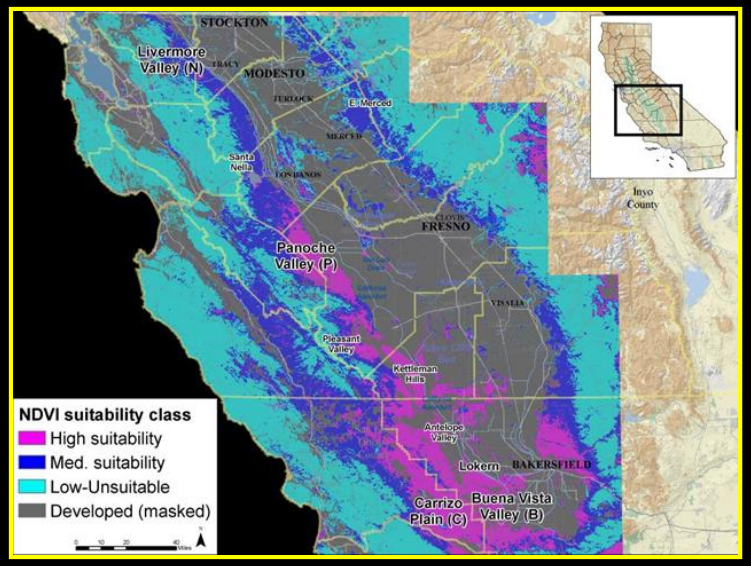
Habitat Suitability Model Input



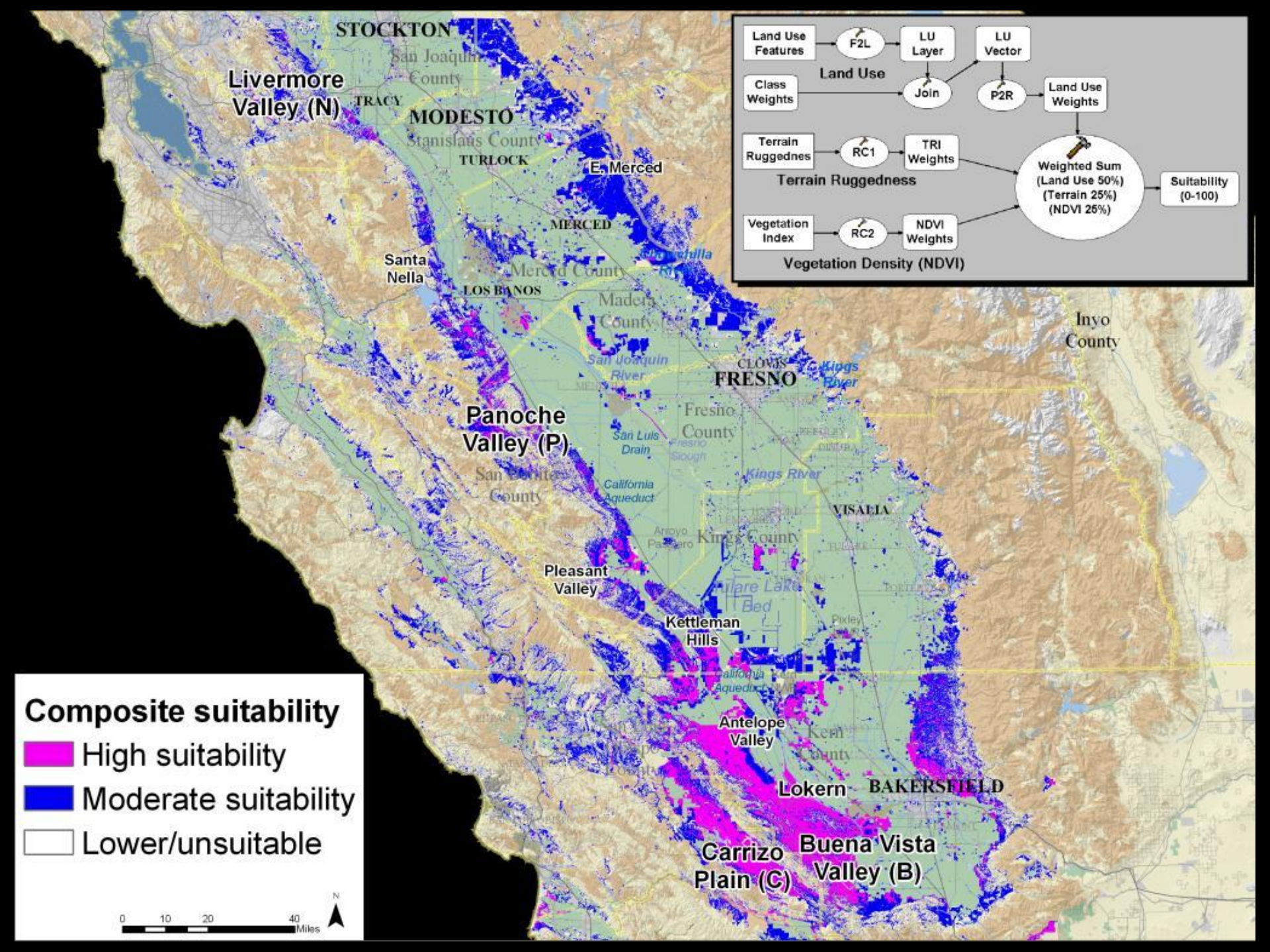
Terrain ruggedness

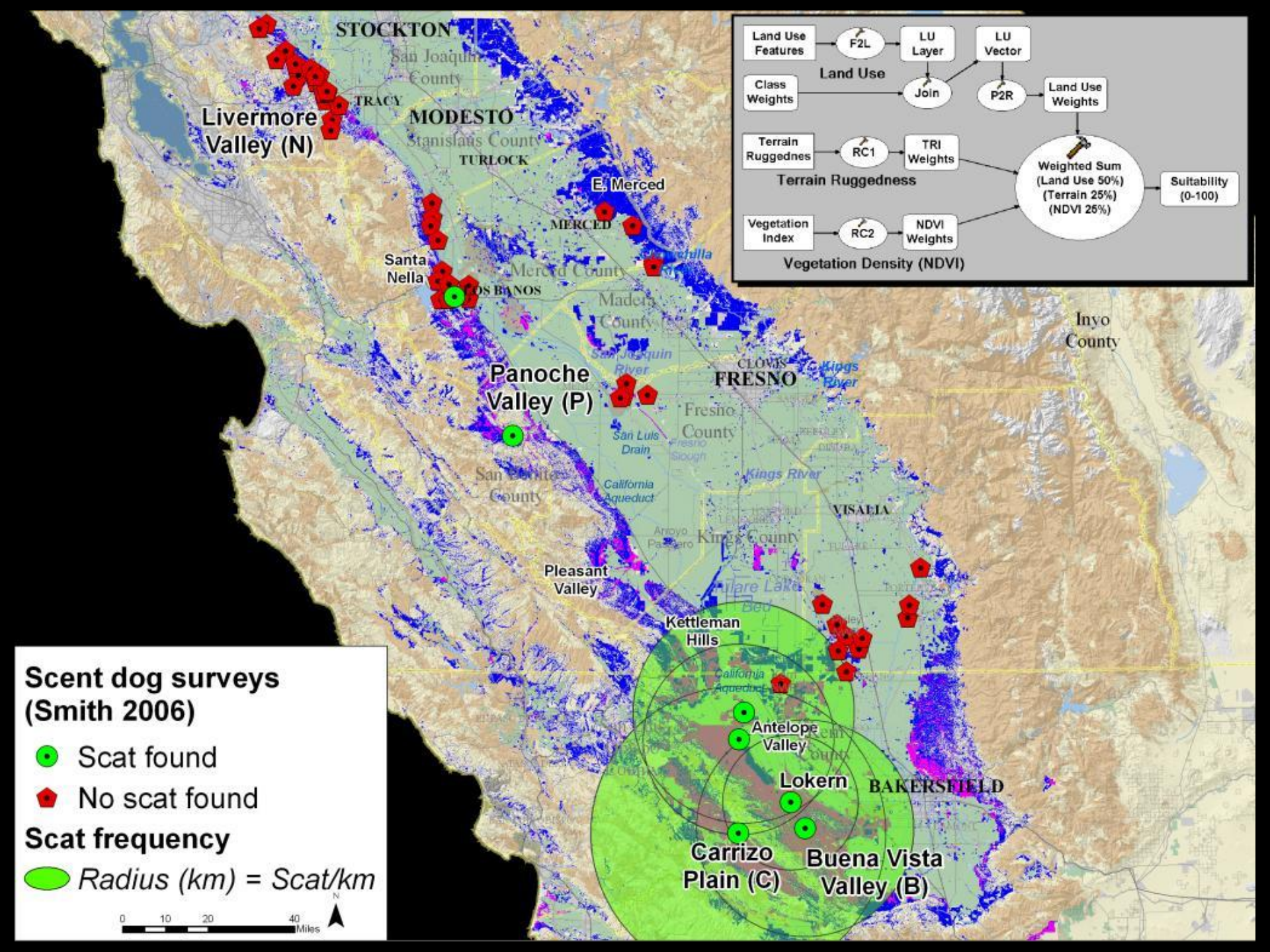


Land cover/use



Vegetation structure


STOCKTON
San Joaquin County
Livermore Valley (N)
TRACY
MODESTO
Stanislaus County
TURLOCK
E. Merced
MERCED
Santa Nella
Merced County
LOS BANOS
Madera County
San Joaquin River
CLOVIS
FRESNO
Kings River
Fresno County
Panoche Valley (P)
San Luis Drain
Fresno Slough
San Benito County
California Aqueduct
Kings River
VISALIA
Kings County
Pleasant Valley
Kettleman Hills
Tulare Lake Bed
Pixley
Antelope Valley
Kern County
Lokern
BAKERSFIELD
Carrizo Plain (C)
Buena Vista Valley (B)
Inyo County
Land Use Features
F2L
LU Layer
LU Vector
Land Use
Class Weights
Join
P2R
Land Use Weights
Terrain Ruggednes
RC1
TRI Weights
Terrain Ruggedness
Weighted Sum (Land Use 50%) (Terrain 25%) (NDVI 25%)
Suitability (0-100)
Vegetation Index
RC2
NDVI Weights
Vegetation Density (NDVI)
Composite suitability
High suitability
Moderate suitability
Lower/unsuitable
0 10 20 40 Miles
N


STOCKTON
San Joaquin County
TRACY
MODESTO
Stanislaus County
TURLOCK
Livermore Valley (N)
E. Merced
MERCED
Merced County
Santa Nella
LOS BANOS
Madera County
San Joaquin River
Panoche Valley (P)
CLOVIS
FRESNO
Fresno County
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Land Use Features
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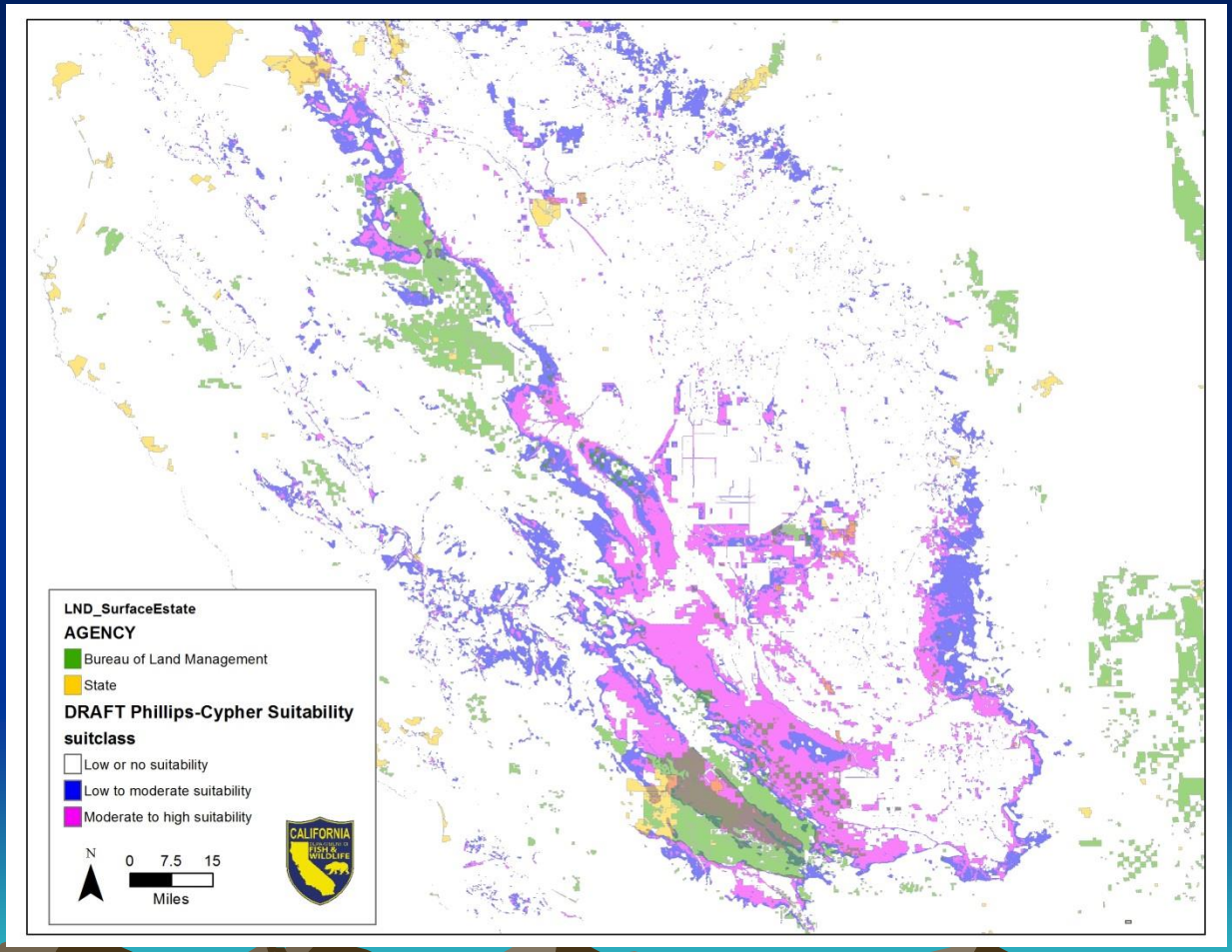
Land Use Weights
Terrain Ruggednes
RC1
TRI Weights
Terrain Ruggedness
Weighted Sum (Land Use 50%) (Terrain 25%) (NDVI 25%)
Suitability (0-100)
Vegetation Index
RC2
NDVI Weights
Vegetation Density (NDVI)
Scent dog surveys (Smith 2006)
Scat found
No scat found
Scat frequency
Radius (km) = Scat/km
0 10 20 40 Miles
N

Conservation Implications

- Approx. 1.4 million ha of high and medium quality habitat
- Kit fox home ranges avg 544 ha (in high quality habitat) = 2,564 home ranges
- 2 breeding adults/HR = 5,128 foxes
- BUT, most of remaining habitat:
  - medium quality (larger HRs, few persistent pops)
  - much fragmentation
  - not all occupied due to high pop turnover

THUS, MUCH FEWER THAN 5,128 FOXES!

How Much is Conserved?

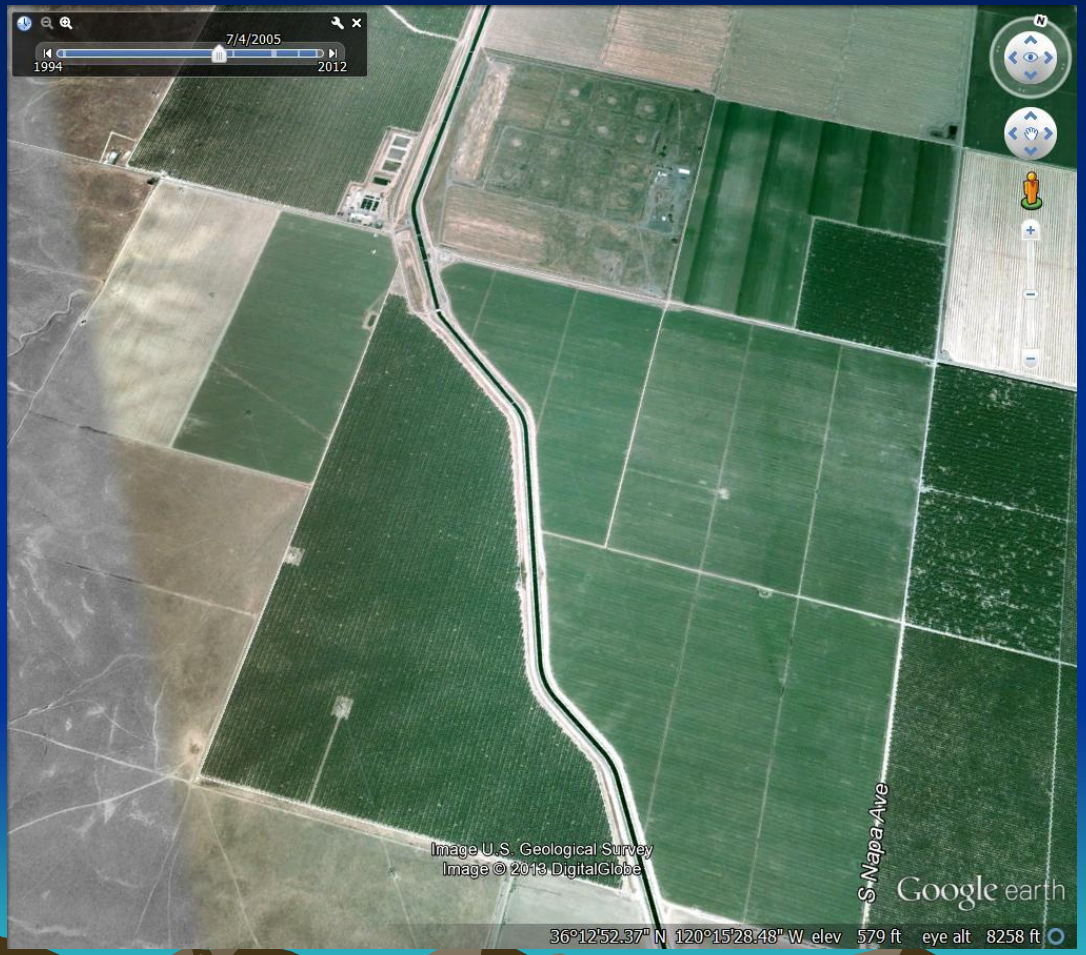


Agricultural Conversions

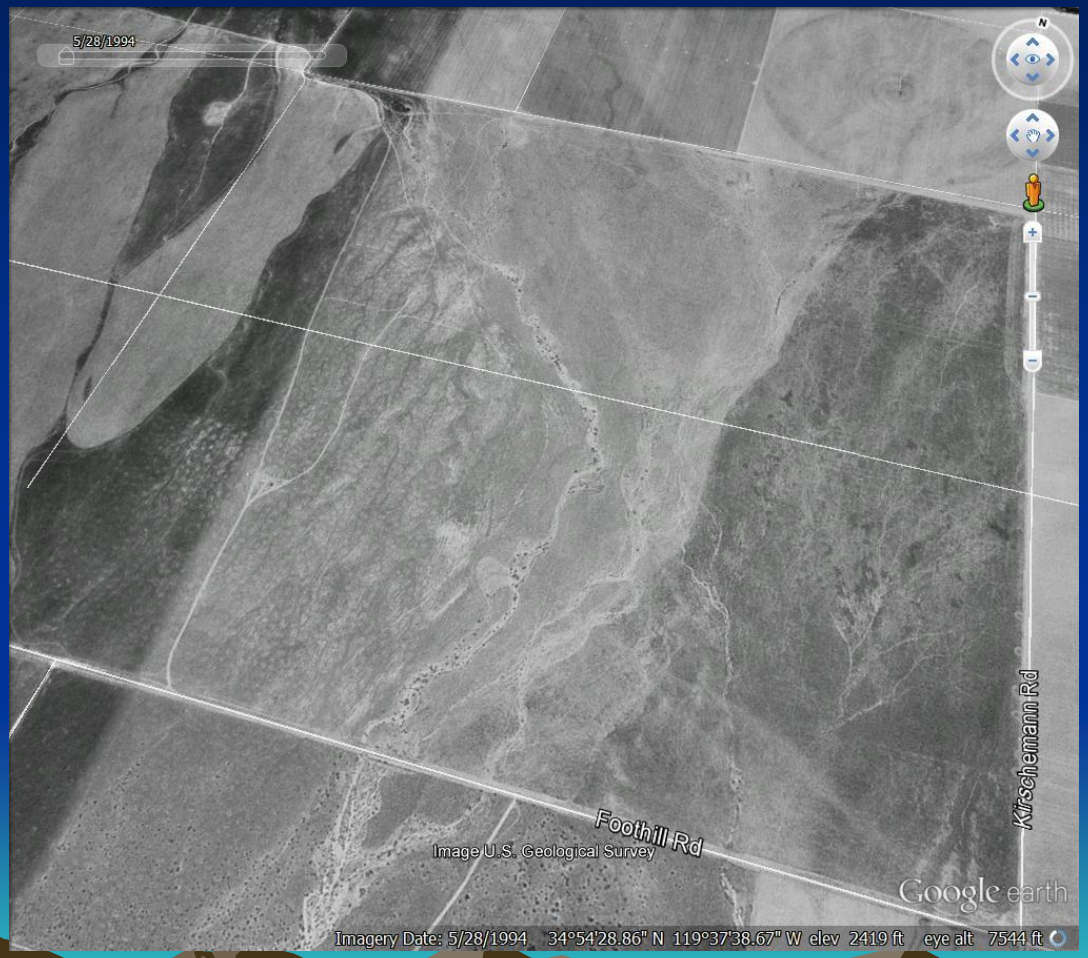
(1994 Coalinga area)

Agricultural Conversions

(2005 Coalinga area)

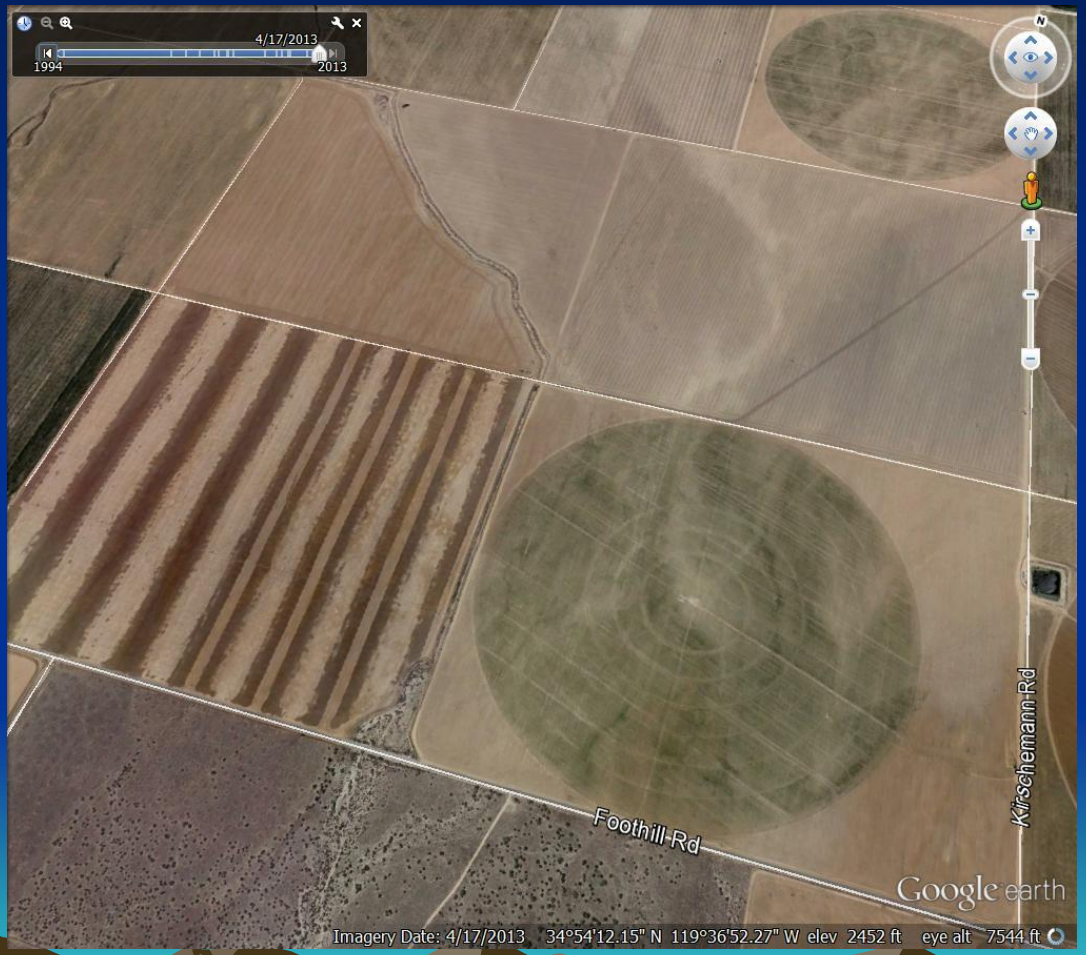


Agricultural Conversions
(1994 Cuyama Valley)

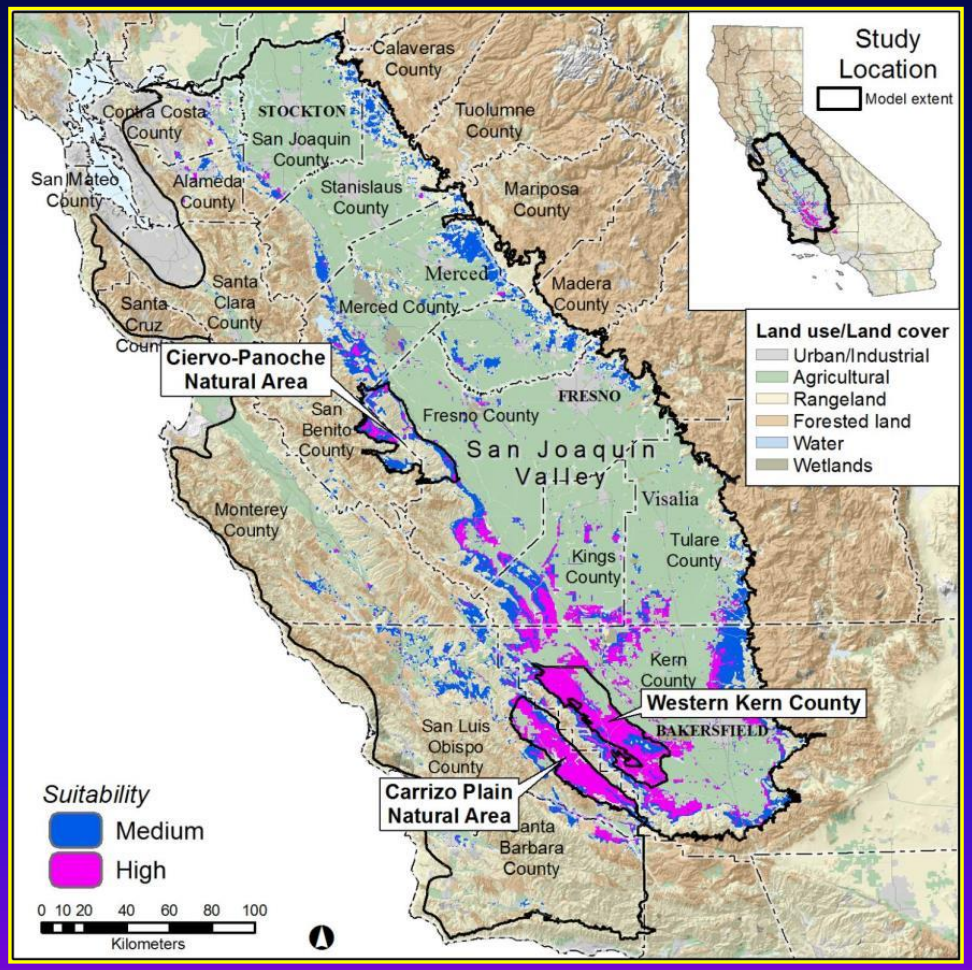


Agricultural Conversions

(2013 Cuyama Valley)



San Joaquin Kit Fox
Habitat Suitability and Core Areas

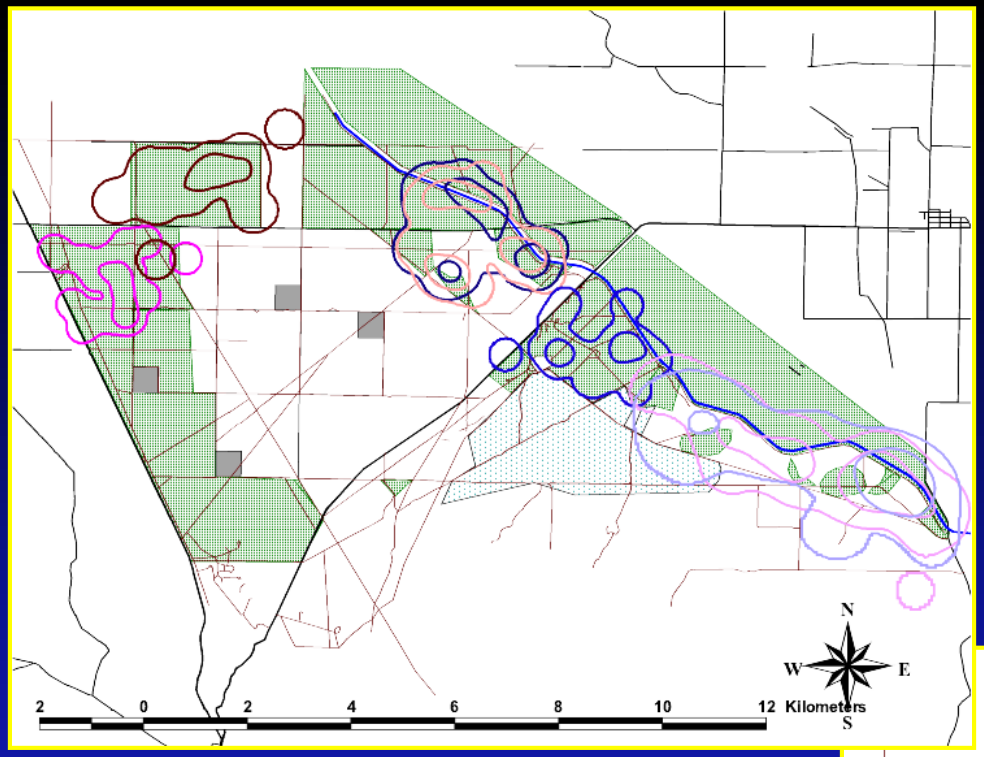



4/16/09 4:02 PM
Cuddeback

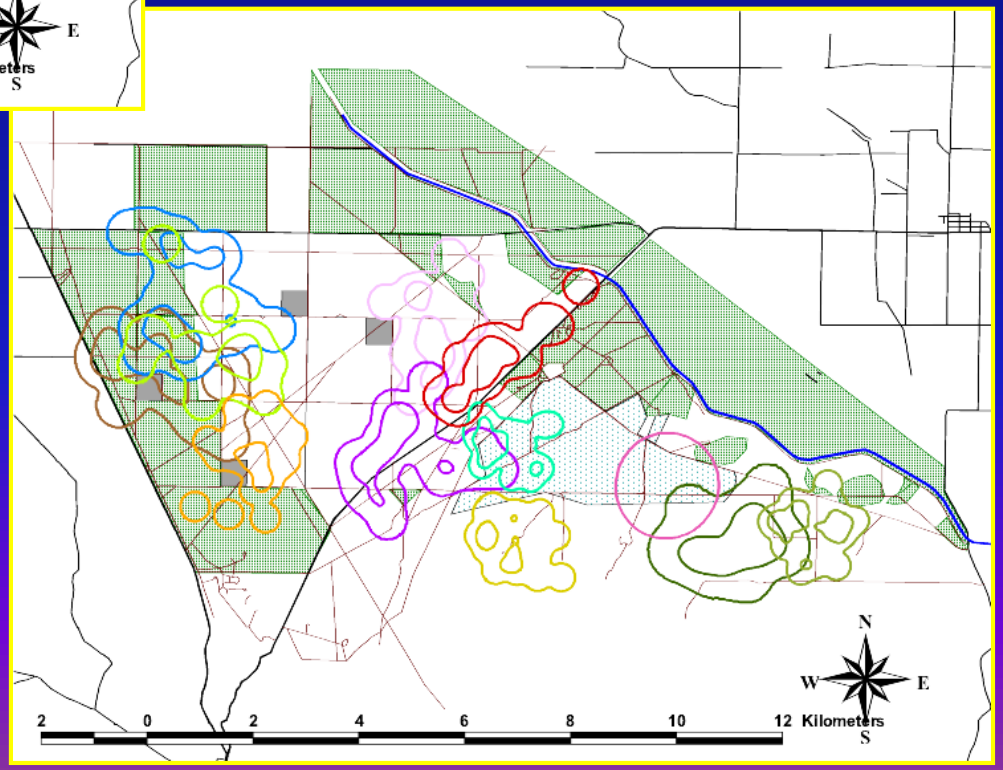
III. Conservation Research

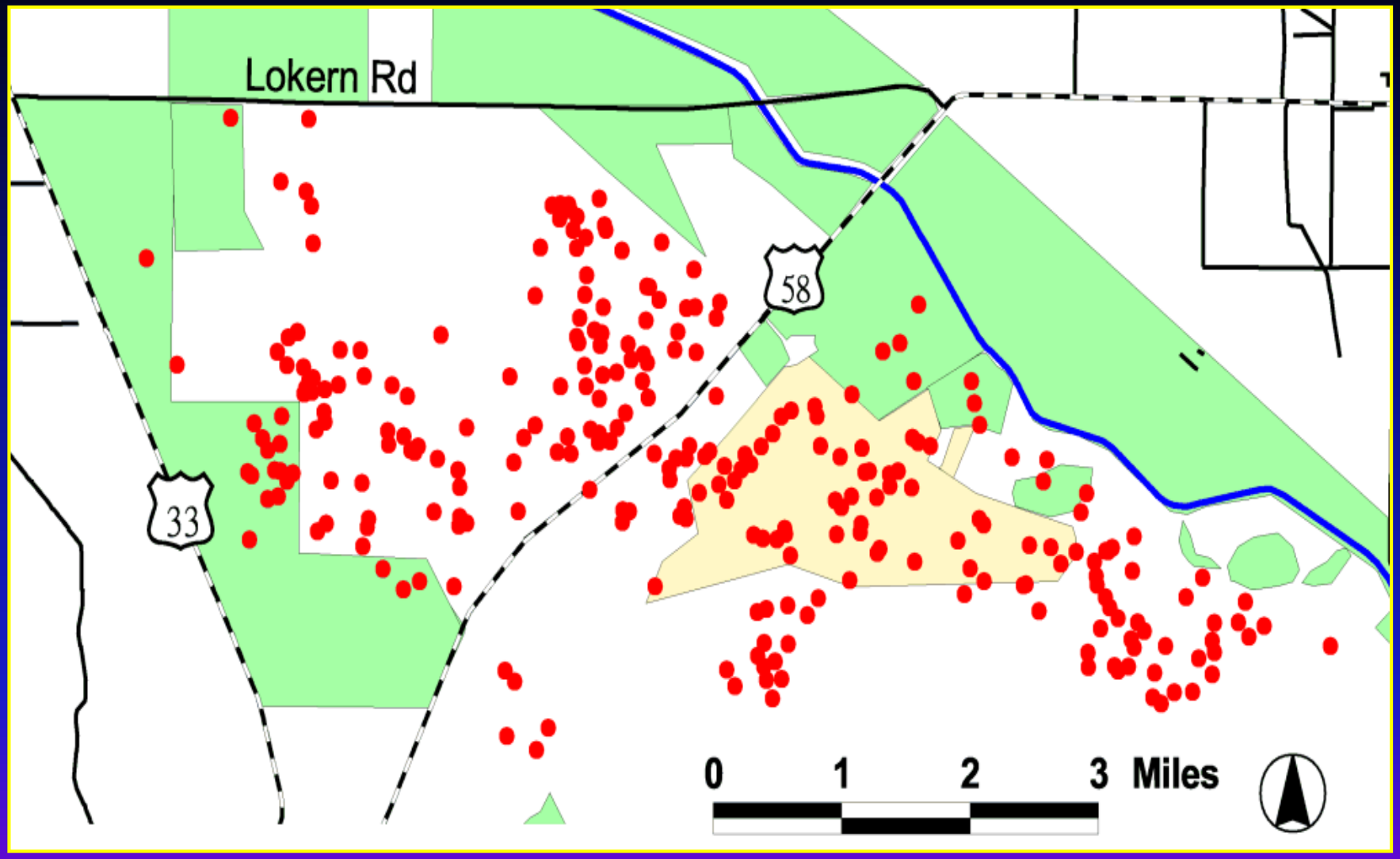
Competitive Interactions Between Kit Foxes and Coyotes

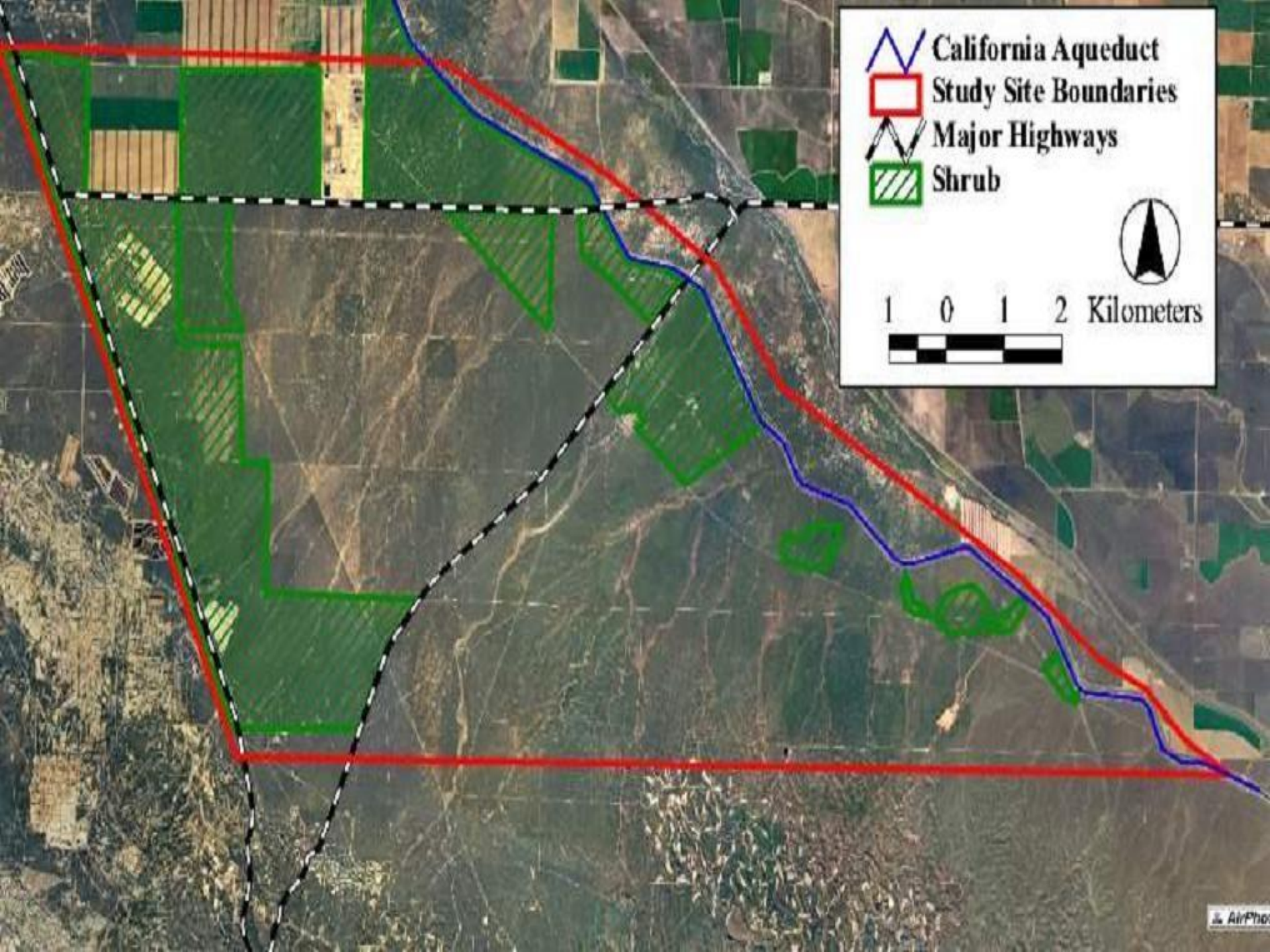
COYOTES



KIT FOXES



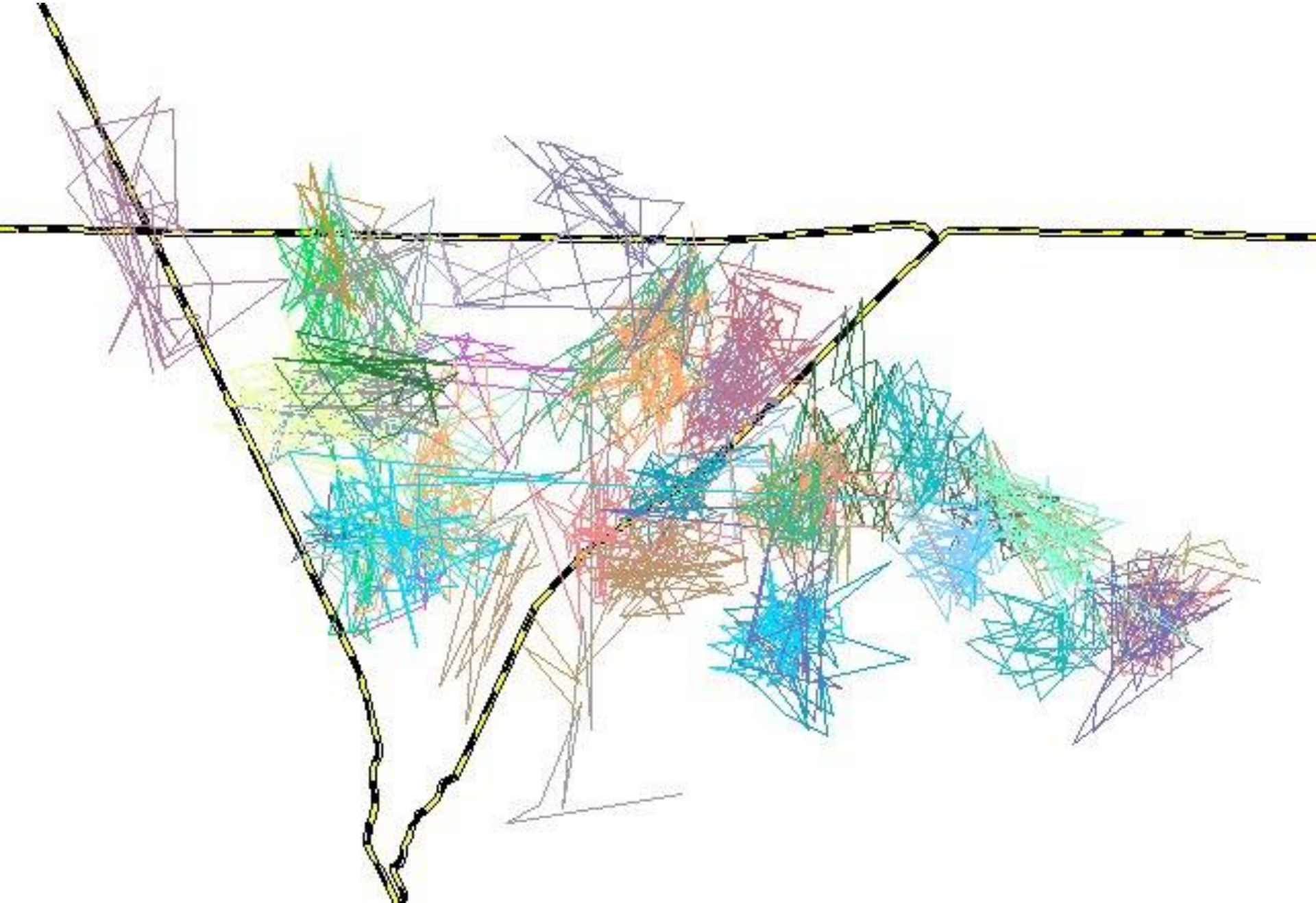

Lokern Rd
58
33
0
1
2
3 Miles


California Aqueduct
Study Site Boundaries
Major Highways
Shrub
1 0 1 2 Kilometers

Kit Fox Mortality

- 25 deaths 2001-2004
- 14 predation
- 5 likely predation
- 5 undetermined
- 1 vehicle collision

Interlocation Movements



Conclusions

- Two-lane highways do not appear to directly impact kit fox survival, reproduction, den placement or use, movements, prey availability, food habits, or competitor abundance

- *These results may not be applicable to larger roads where effects are potentially more significant*

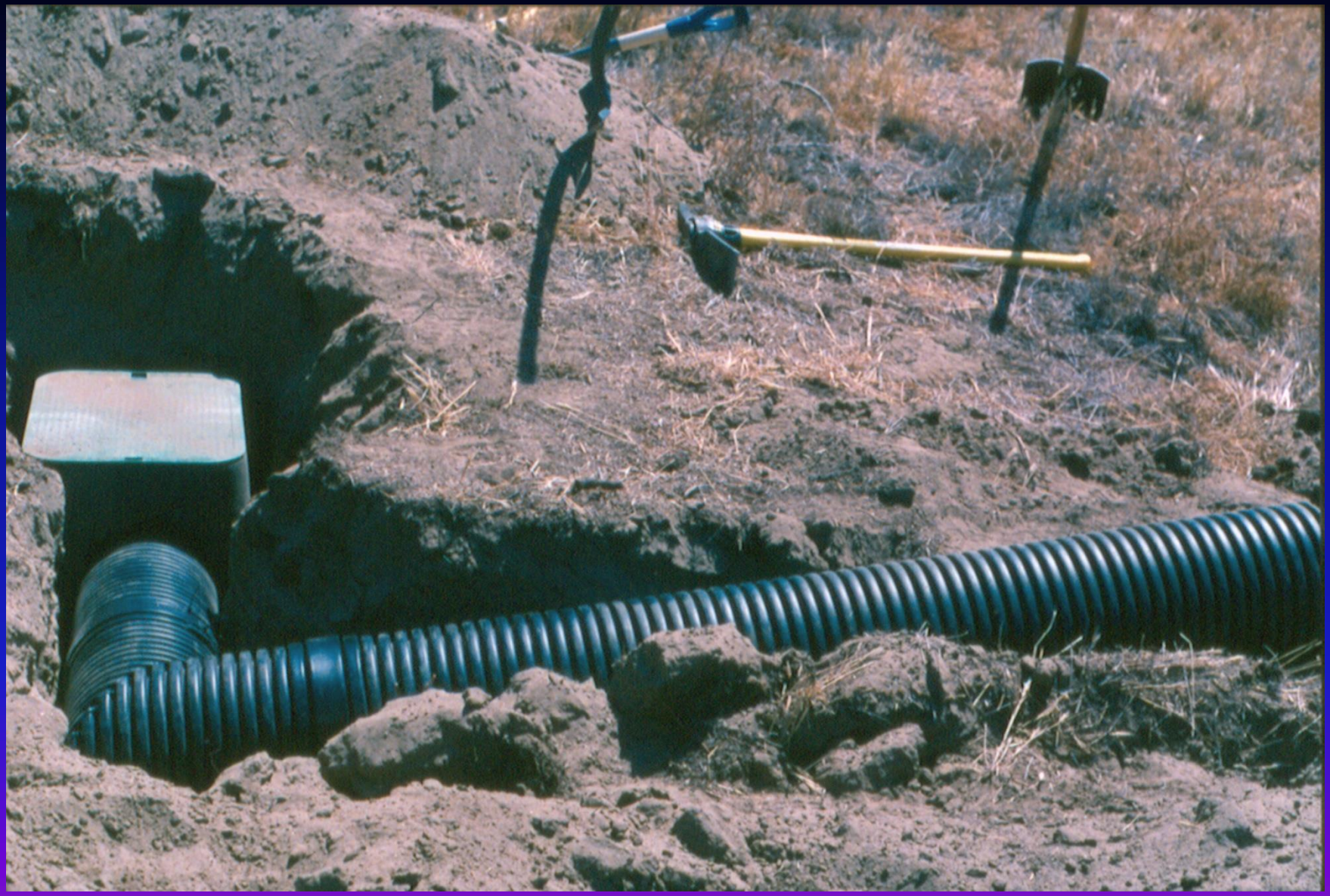

GIVE A BRAKE TO
ENDANGERED SPECIES
SLOW
DOWN
USE CAUTION
OBEY THE SPEED LIMIT

Kit Foxes and Rodenticides

- Collaborating w/ CDFW WIL
- Exposures in 74% of 68 urban foxes
- Exposures rare in non-urban foxes
- Usually 2nd generation
- Multiple substances common
- Unknown whether exposures are primary or secondary
- Studies on-going

ARTIFICIAL DENS DESIGNS AND MATERIALS

- **Designs**
  - 10’ surface
  - 20’ surface
  - 1-entrance subterranean
  - 2-entrance subterranean
  - 1-entrance chamber
  - 2-entrance chamber
- **Materials**
  - Corrugated metal
  - Corrugated plastic
  - PVC
  - Concrete
- **Chambers**
  - Irrigation valve box
  - Igloo dog house



USE OF DENS BY FOXES

	Concrete	Metal	PVC	Plastic
10’ Surf				X
20’Surf				
1-Ent Sub				
2-Ent Sub				
1-Ent Cha				
2-Ent Cha				

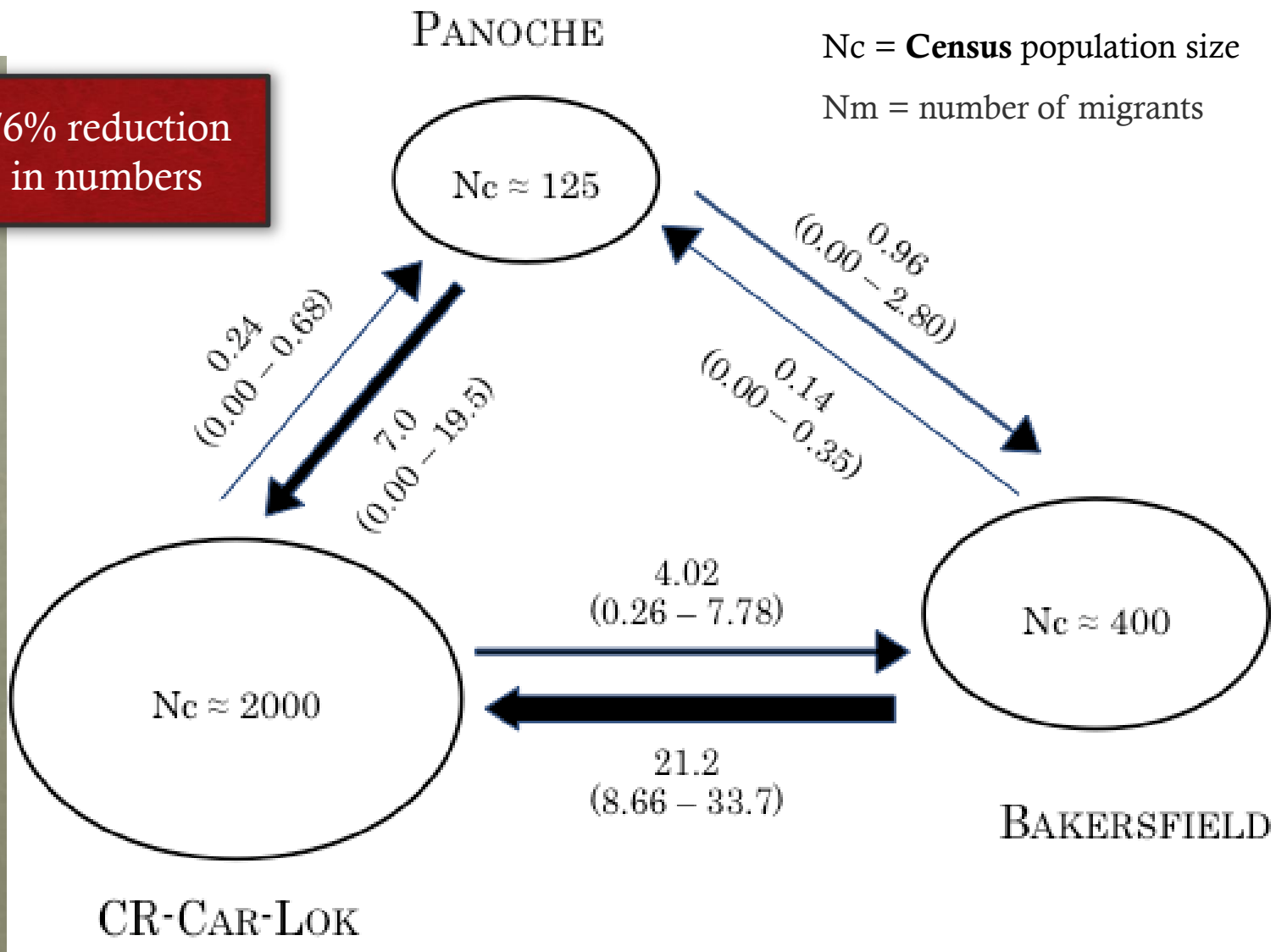
Route 58 Study Site

Kern Water Bank Study Site

Route 14 Study Site

Contemporary Demographics - BAYESASS

76% reduction in numbers



Wilbert 2013

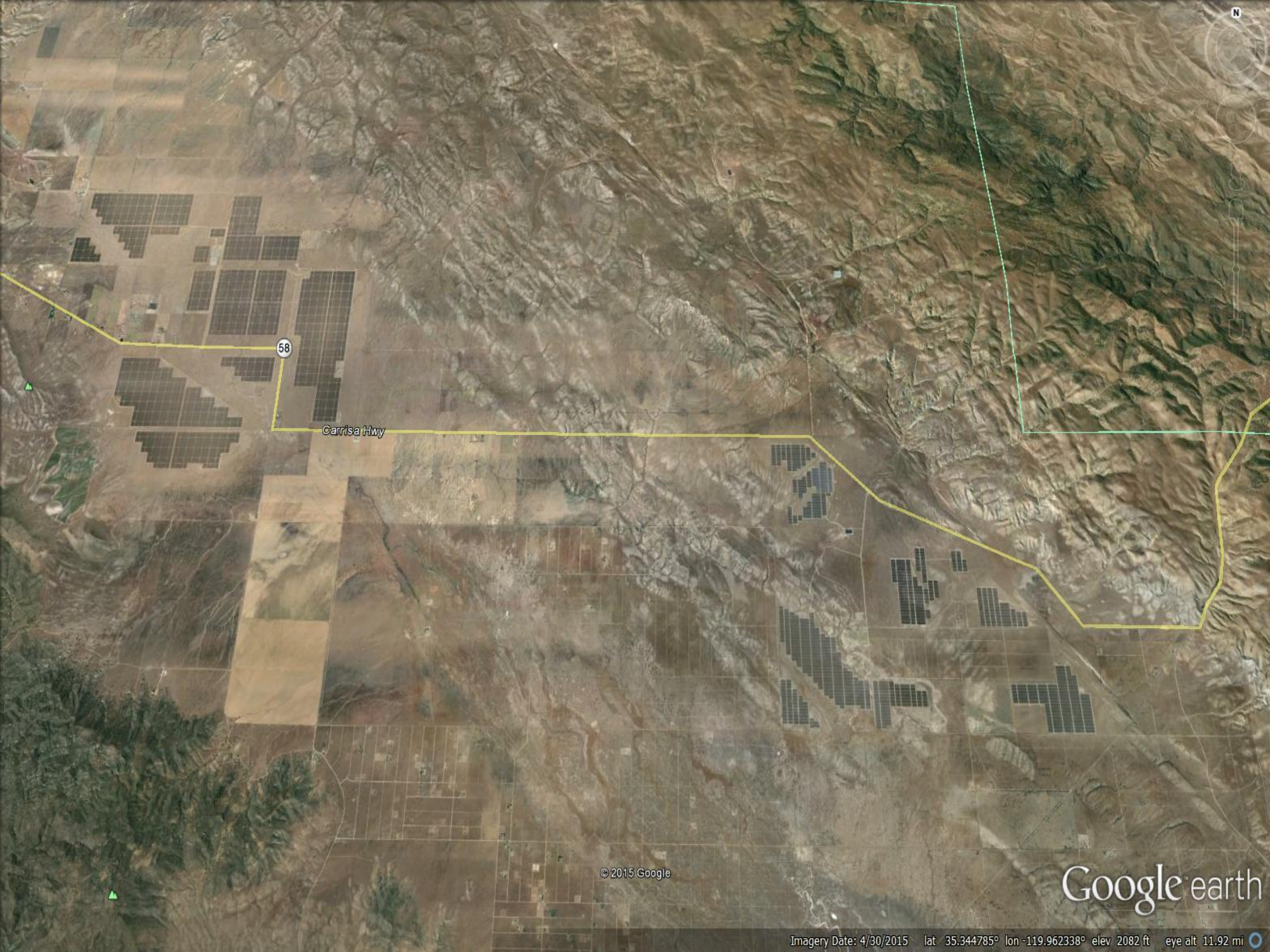
Metapopulation - Conclusions

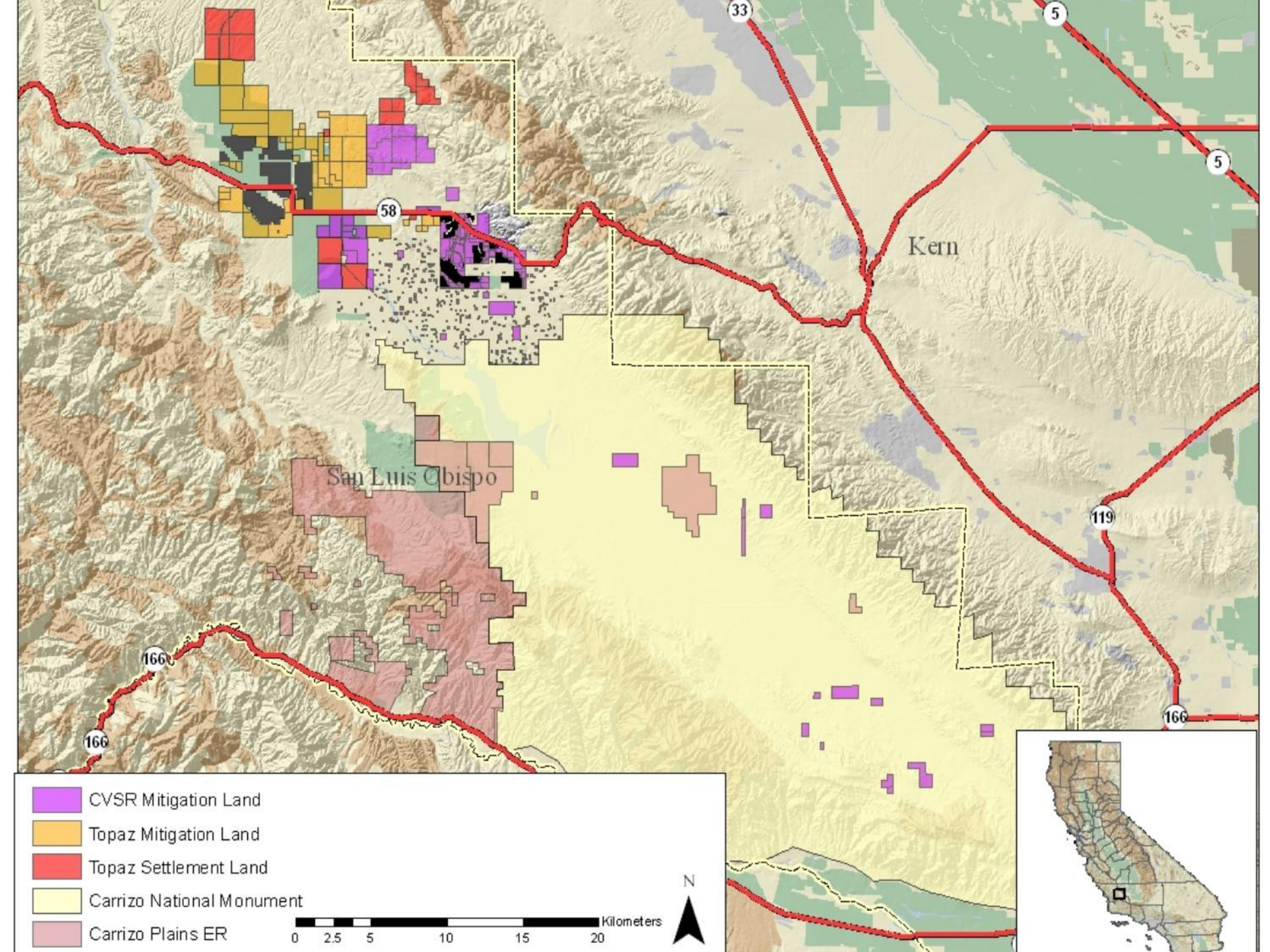
- All of the populations have high levels of genetic diversity,
  & every population carries unique alleles.
- Three major groups with unique genetic signatures & histories:
  1. Ciervo-Panoche in the North
  2. Camp Roberts-Carrizo Plain-Lokern in the West
  3. **Bakersfield** in the East
- Population structure reflects historic barriers and contemporary factors.
- Estimation of 76% reduction in census population size, with a overall reduction in migration rates.

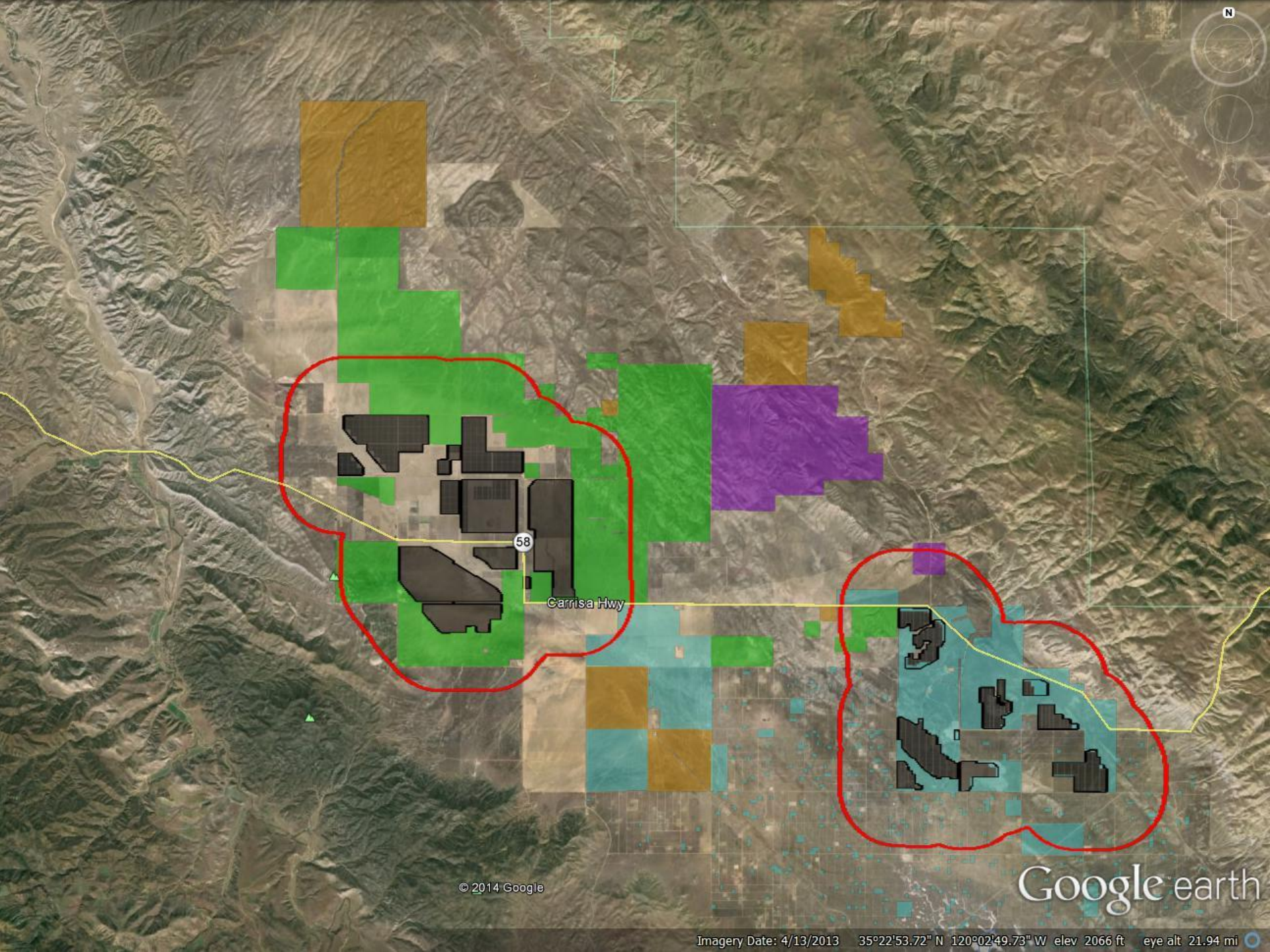
Wilbert 2013

Effects of Oil and Gas Production on San Joaquin Kit Foxes

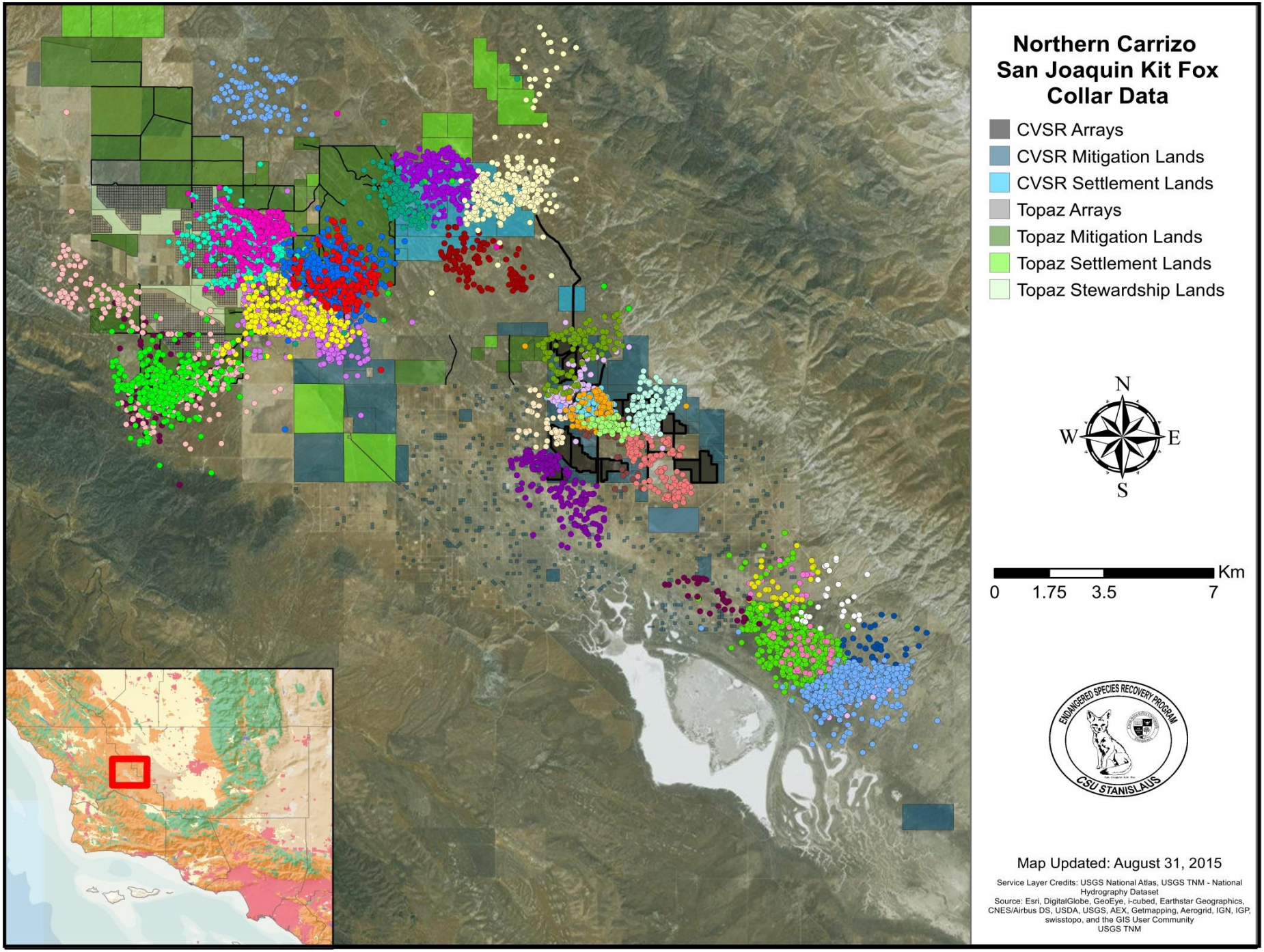
Use of Agricultural Lands by Kit Foxes

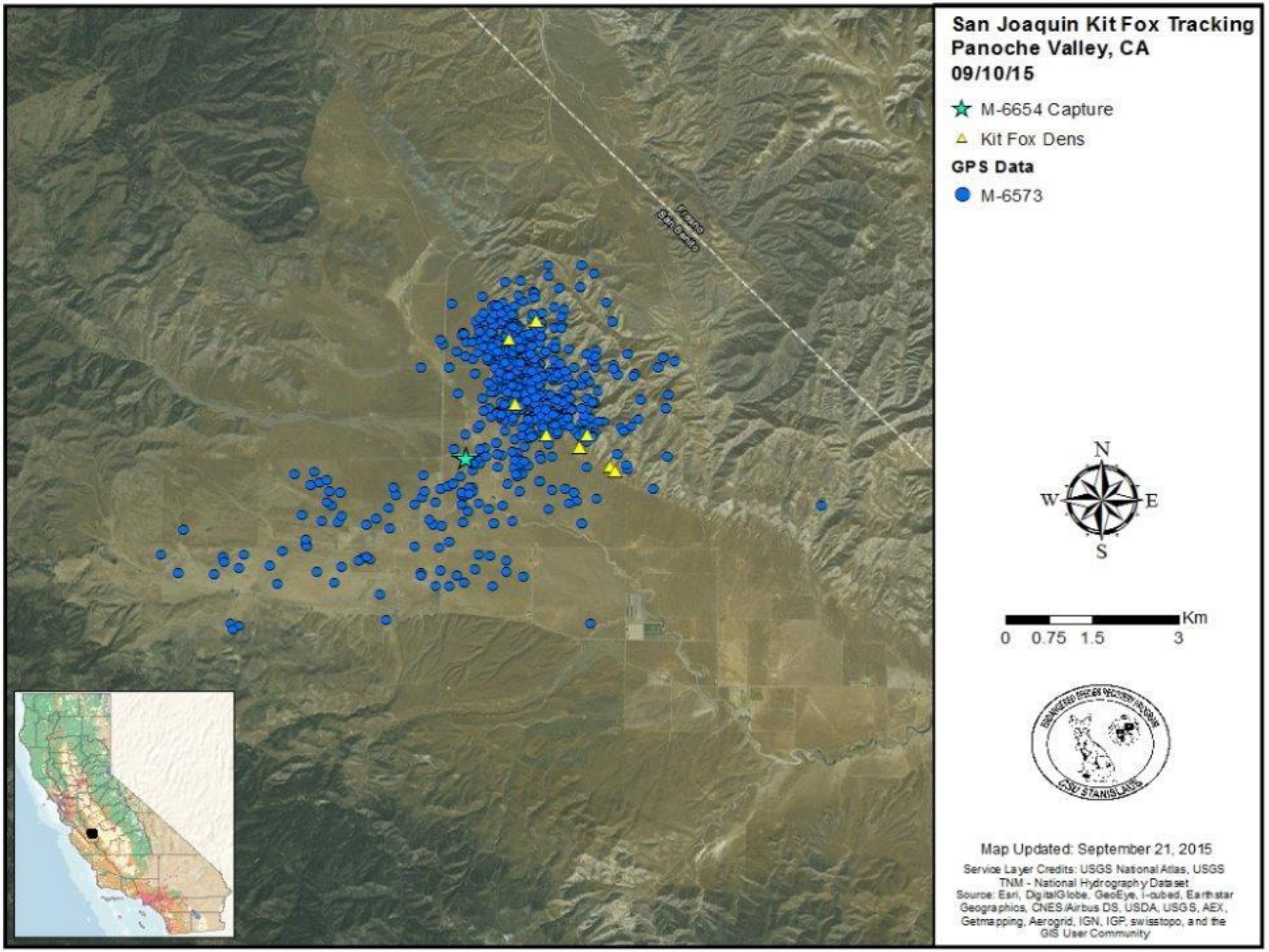

58
Carrisa Hwy
© 2015 Google
Google earth
Imagery Date: 4/30/2015 lat 35.344785° lon -119.962338° elev 2082 ft eye alt 11.92 mi


33
5
5
58
Kern
San Luis Obispo
119
166
166
166
CVSR Mitigation Land
Topaz Mitigation Land
Topaz Settlement Land
Carrizo National Monument
Carrizo Plains ER
N
0 2.5 5 10 15 20
Kilometers


N
58
Carrisa Hwy
© 2014 Google
Google earth
Imagery Date: 4/13/2013 35°22'53.72" N 120°02'49.73" W elev 2066 ft eye alt 21.94 mi


DANGER
HIGH VOLTAGE
No Trespassing.
Entry by Authorized
Personnel Only.
PELIGRO
ALTO VOLTAJE
Prohibido el Paso.
Entrada por Personal
Autorizados Solamente.


Northern Carrizo
San Joaquin Kit Fox
Collar Data
CVSR Arrays
CVSR Mitigation Lands
CVSR Settlement Lands
Topaz Arrays
Topaz Mitigation Lands
Topaz Settlement Lands
Topaz Stewardship Lands
N
W
E
S
Km
0
1.75
3.5
7
ENDANGERED SPECIES RECOVERY PROGRAM
CSU STANISLAUS
Map Updated: August 31, 2015
Service Layer Credits: USGS National Atlas, USGS TNM - National Hydrography Dataset
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
USGS TNM

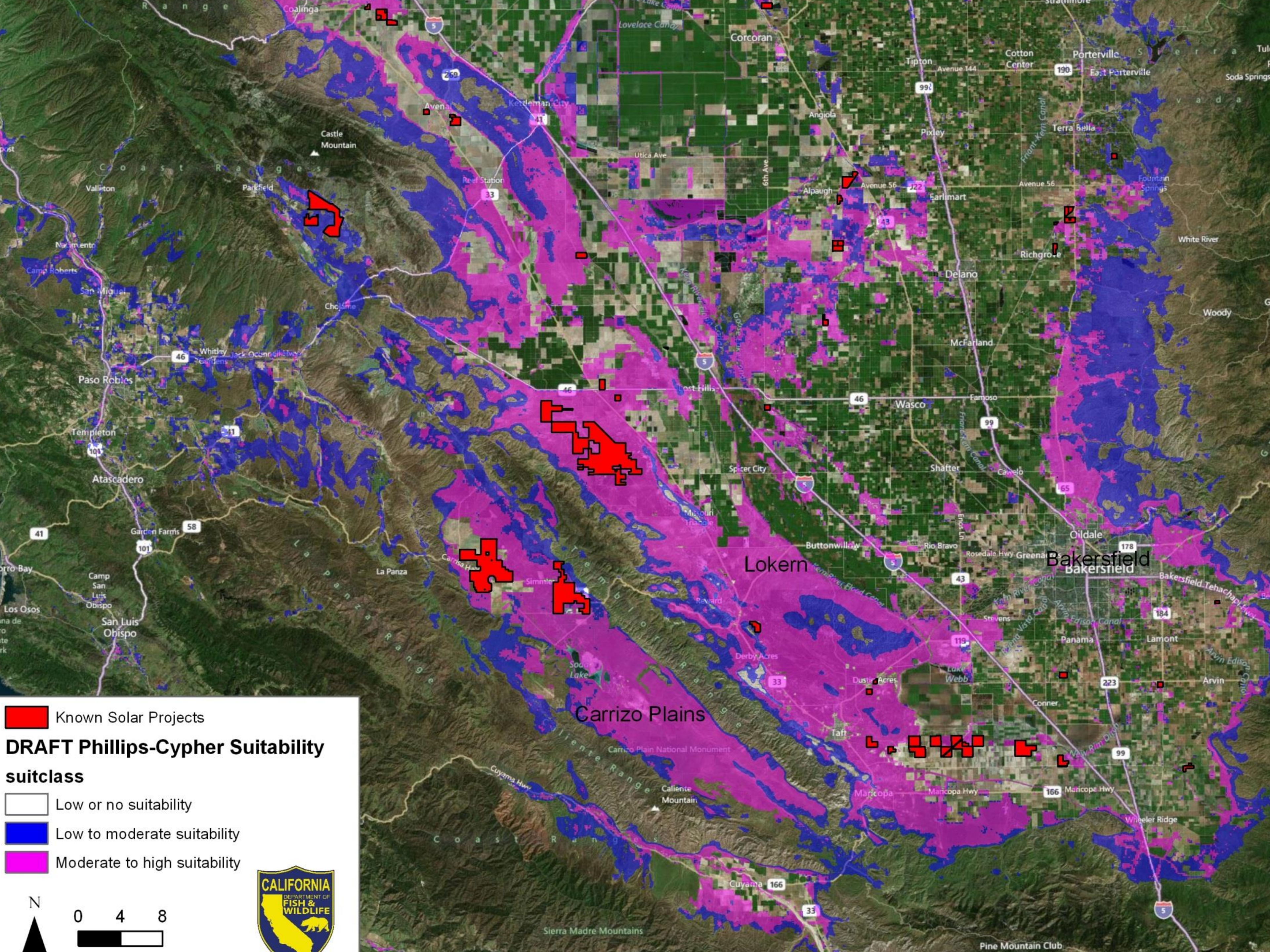

San Joaquin Kit Fox Tracking
Panoche Valley, CA
09/10/15
M-6654 Capture
Kit Fox Dens
GPS Data
M-6573
N
W
E
S
Km
0 0.75 1.5 3
Map Updated: September 21, 2015
Service Layer Credits: USGS National Atlas, USGS TNM - National Hydrography Dataset
Source: Esri, DigitalGlobe, GeoEye, i-cubed, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community


Bushnell
068°F
04-18-2015 06:38:34

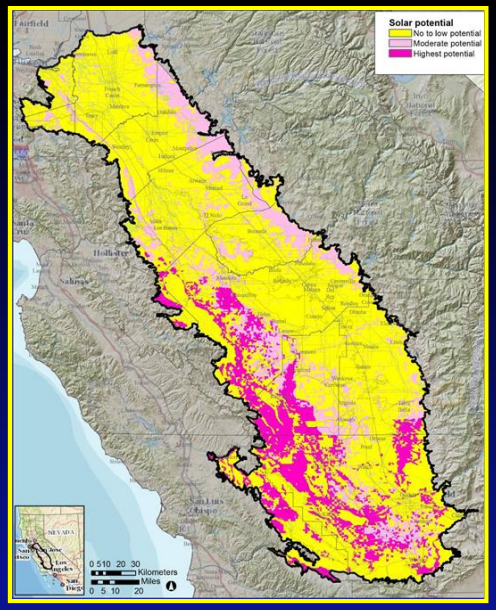

04-18-2015 06:56:53


Bushnell
070°F
04-18-2015 06:40:41

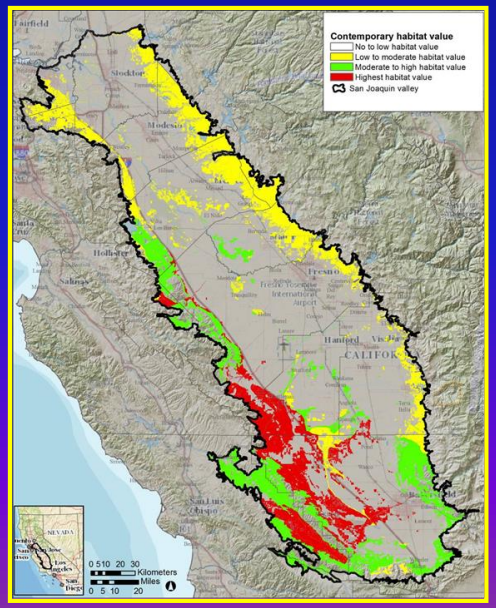

BUCKEYE CAM
BuckEyeCam #2
06/11/2013
20:24:49


Known Solar Projects
DRAFT Phillips-Cypher Suitability
suitclass
Low or no suitability
Low to moderate suitability
Moderate to high suitability
N
0 4 8
CALIFORNIA DEPARTMENT OF FISH & WILDLIFE
Lokern
Carrizo Plains
Bakersfield
Paso Robles
Atascadero
San Luis Obispo
Templeton
Corcoran
Porterville
Delano
McFarland
Wasco
Shafter
Lost Hills
Taft
Maricopa
Coalinga
Avenal
Kettleman City
Castle Mountain
Parkfield
Cholame
Buttonwillow
Oildale
Lamont
Arvin
Earlimart
Richgrove
Tipton
Pixley
Alpaugh
Terra Bella
Spicer City
Derby Acres
Dustin Acres
Cuyama
Caliente Mountain
Sierra Madre Mountains
Wheeler Ridge
La Panza
Los Osos
Garden Farms
San Miguel
Camp Roberts
Nacimiento
Valleton
Woody
White River
Pine Mountain Club

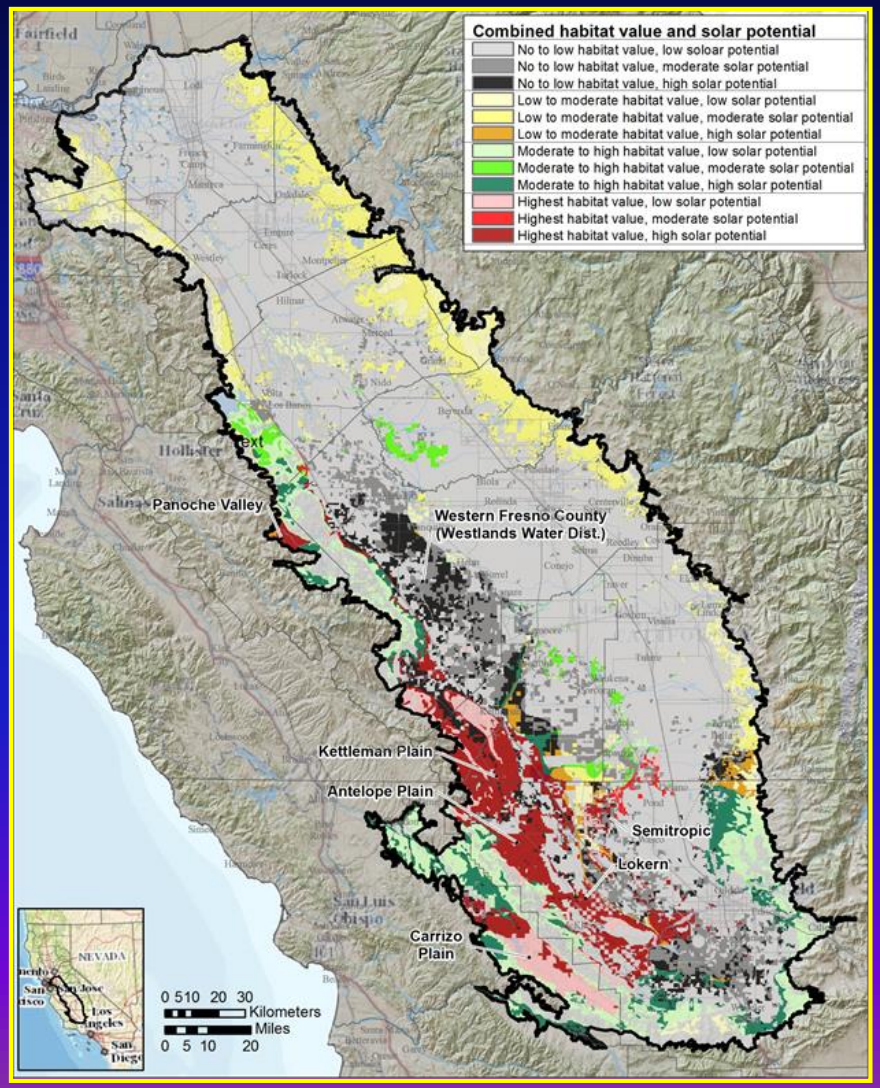
Solar/Listed Species Conflict Zones



Solar energy potential



Composite habitat value




BAKERSFIELD


THREE WAY
BAKERSFIELD

Sports Netting


12/22/2008

Causes of Mortality

Probable Cause	Bakersfield (*n*=229)	Lokern (*n*=63)	Elk Hills (*n*=341)	Carrizo (*n*=41)
Vehicle	27	1	20	1
Predator	17	19	129	17
Entombment	4	-	1	1
Poison	4	-	-	-
Other	4	-	2	-
Undetermined	22	5	73	3
n	78	25	225	22

Probability of Surviving for 365 Days (Adults)

Location	*n*	Survival	Range
Bakersfield: 1997-2004 *(Cypher et al. unpub)*	144	0.70	0.48-0.95
Lokern: 2001-2004 *(Cypher et al. unpub)*	42	0.64	-
Elk Hills: 1980-1995 *(Cypher et al. 2000)*	341	0.44	0.20-0.81
Carrizo Plain: 1989-1991 *(Ralls and White 1995)*	33	0.61	0.50-0.74

Reproduction

	Bakersfield	Lokern	Elk Hills	Carrizo
No. females:	52	24	126	19
% Reproductive success:	78.8 (66.7-100)	54.2 (50.0-80.0)	61.1 (20.0-100)	21.1 (0-57.1)
No. litters:	71	23	97	4
Mean litter size:	3.8 (1-9)	3.8 (2-9)	3.8 (1-6)	2.0 (1-3)


2HR VISITOR

Urban Den Sites

- Drainage basins
- Canals
- Golf courses
- Open lots
- Powerline corridors
- Parks
- Commercial/industrial areas
- Railroad ROWs

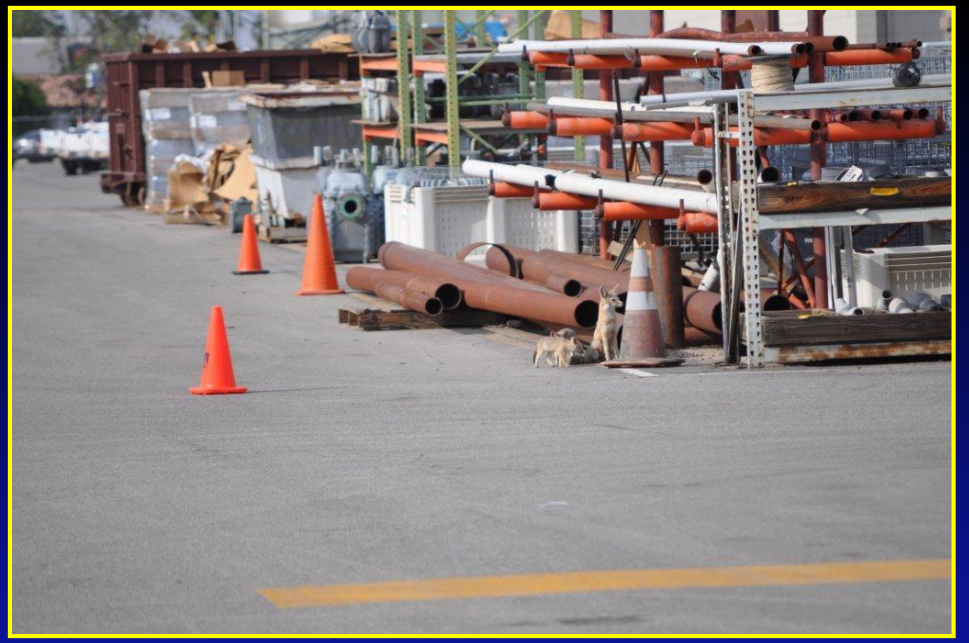
Urban Dens

Open lots

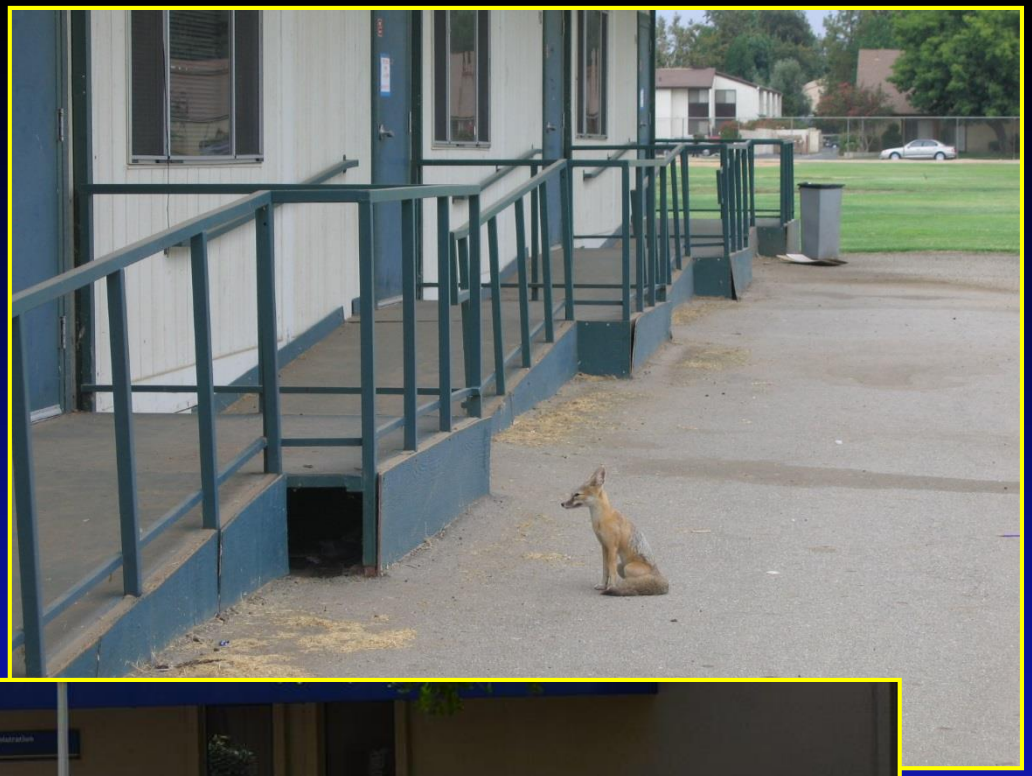
Canals

Golf Courses

Water Drainage Basins



Urban Kit Fox Management Issues



Competitors


Carie Wingert

Sarcoptic mange in urban kit foxes in Bakersfield - 2013

Research Findings

- Utilize diversity of urban habitats
- High survival rates
- High reproductive rates
- Food plentiful
- Den sites plentiful
- Bakersfield population >200
- Conservation potential

FACTORS FAVORING KIT FOXES

Fox Attributes

- Small, quiet, nocturnal
- Not dangerous or destructive
- Use altered habitats
- Tolerate disturbance
- Charismatic

FACTORS FAVORING KIT FOXES

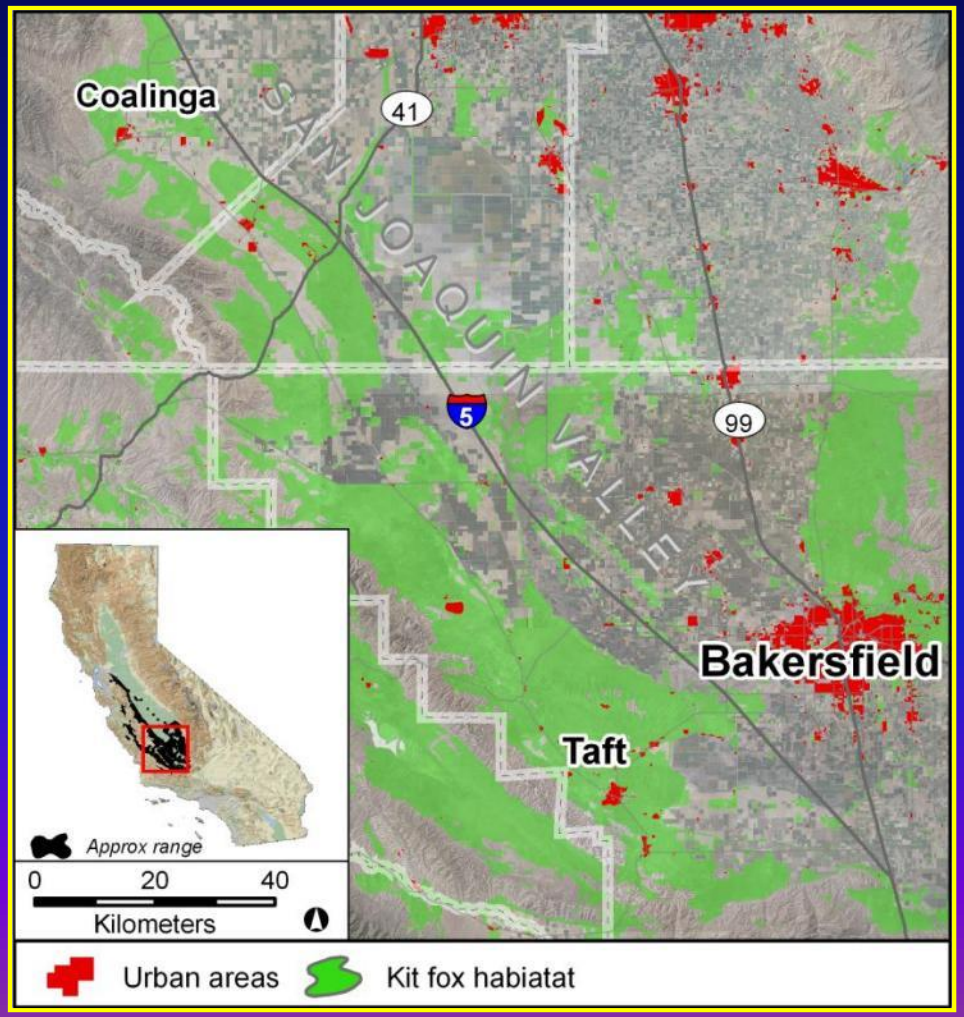
Environment Attributes

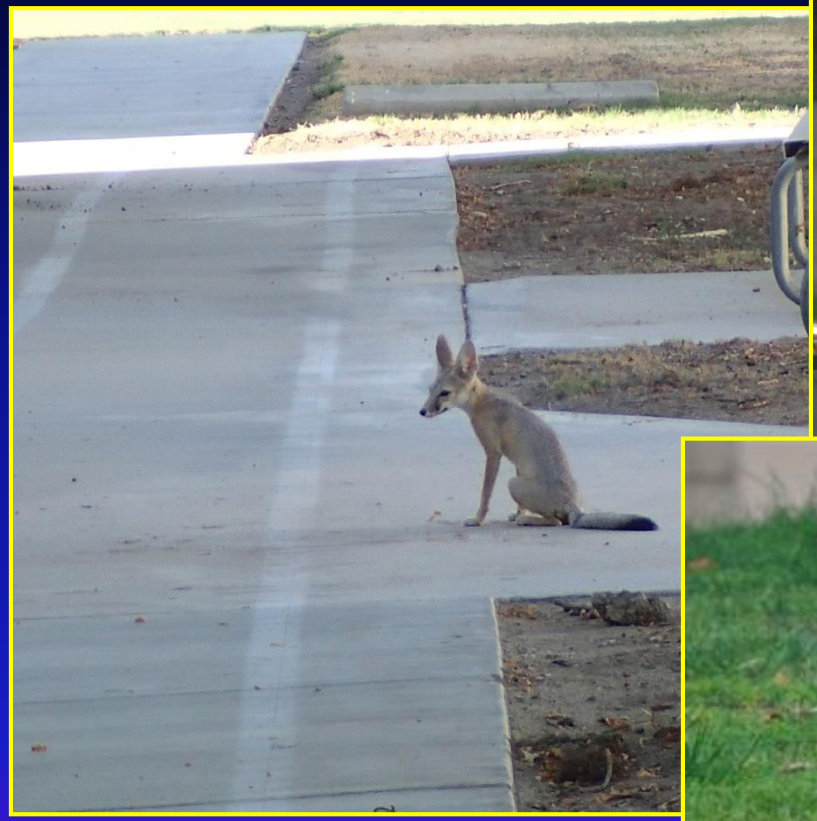
- Food and water consistently abundant
- Denning sites abundant
- Abundant refugia and movement corridors
- Coyotes and bobcats rare
- Protective public

BENEFITS OF URBAN KIT FOX POPULATION

- Increases metapopulation size
- Helps maintain genetic diversity
- Less prone to environmental variation
- Hedge against catastrophes
- Source population for reintroductions
- Public awareness

Urban Areas with San Joaquin Kit Foxes





San Joaquin Kit Fox Demography and Ecology Studies

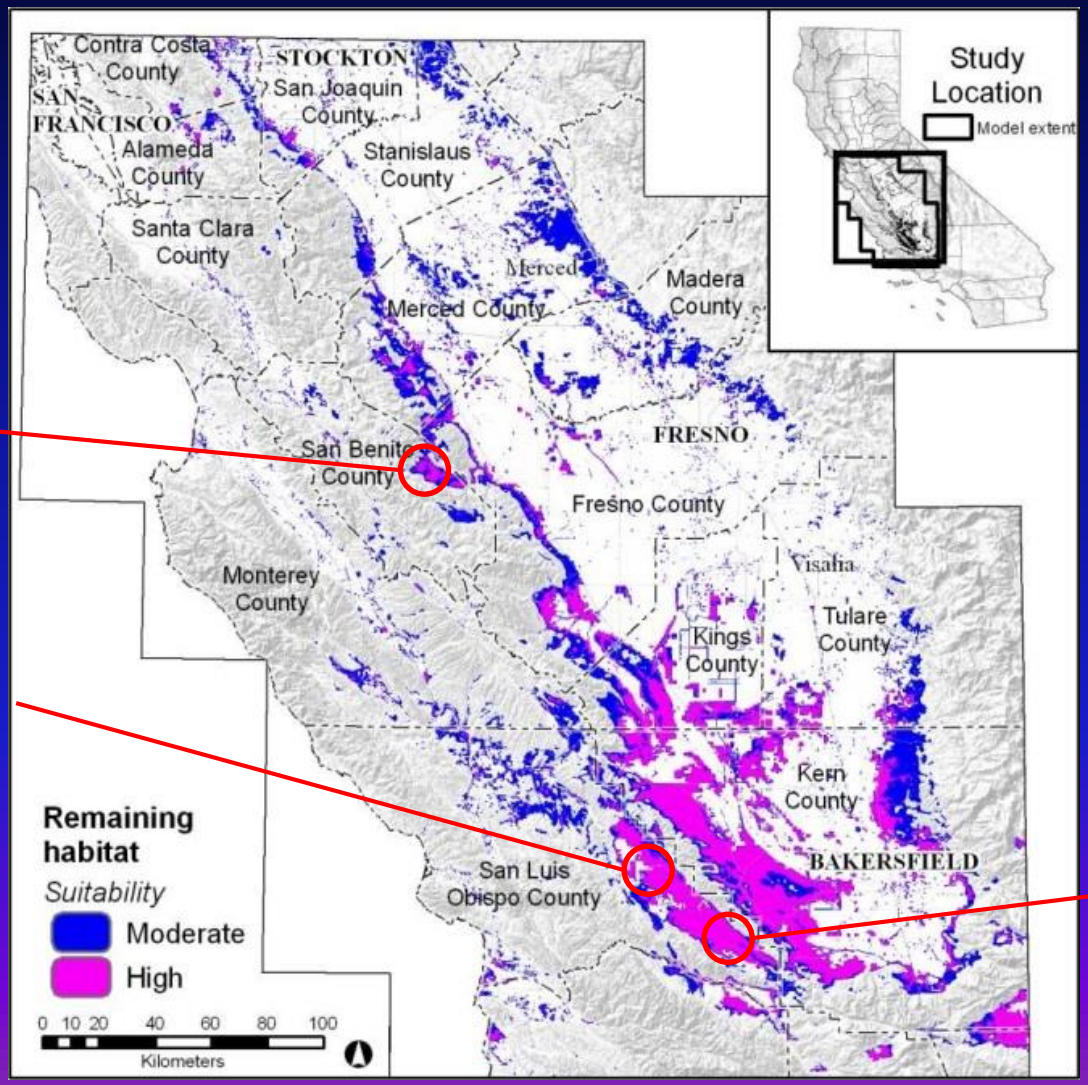
Objectives

- Assess kit fox demographic patterns: survival, causes of mortality, reproduction
- Assess kit fox ecological patterns: space use, den use, food habits
- Compare patterns among locations throughout range, including both core and satellite population areas as well as natural and anthropogenically altered areas
- Develop conservation recommendations based on observed patterns

Current Study Sites

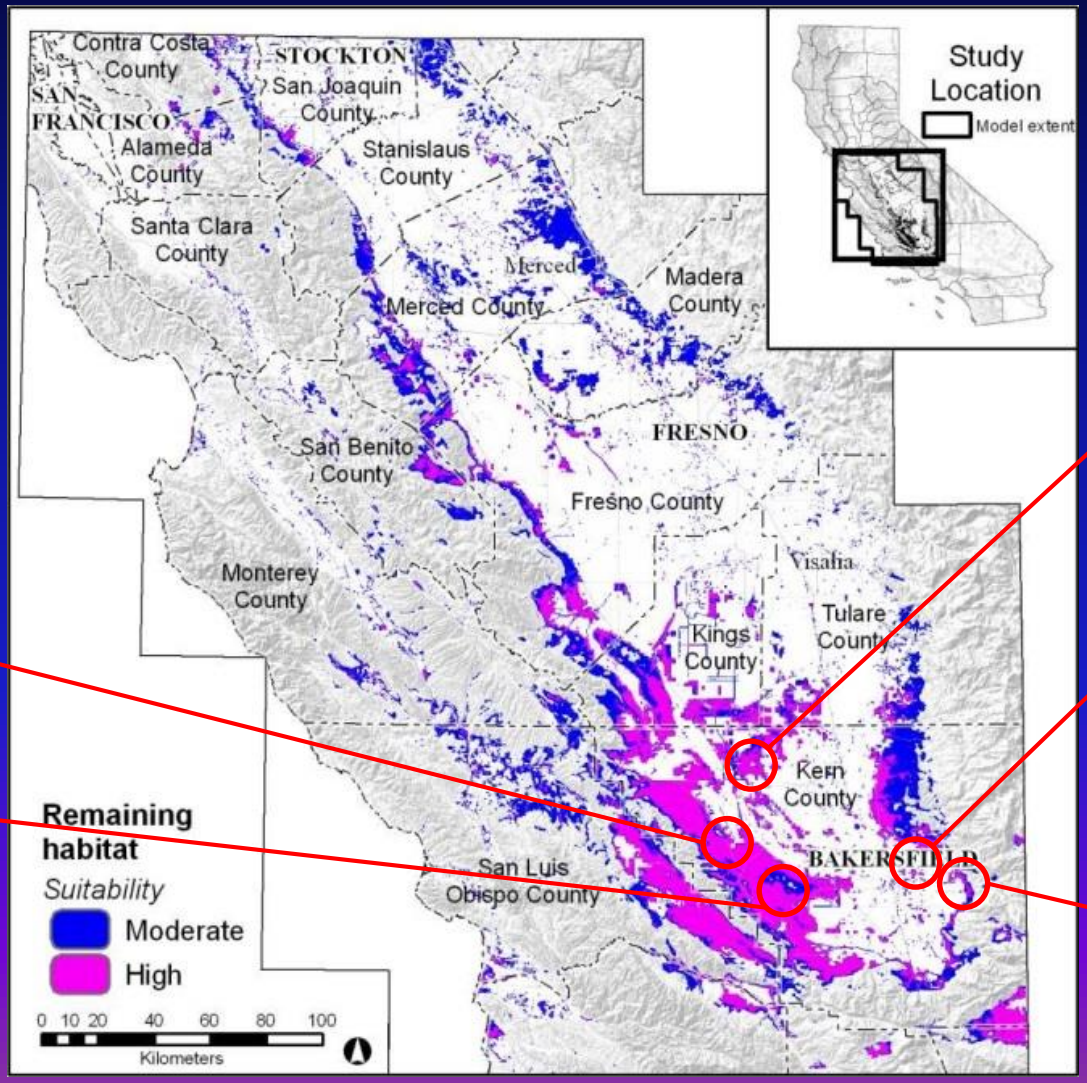
Panoche Valley Solar Site and Mitigation Lands

Northern Carrizo Solar Sites and Mitigation Lands



Southern Carrizo Core Area

Previous Study Sites



Lokern Natural Area – 2001-2004

Naval Petroleum Reserves – 1980-1995

Northern Semitropic Ecological Reserve - 2012

Bakersfield – 2001-2004+

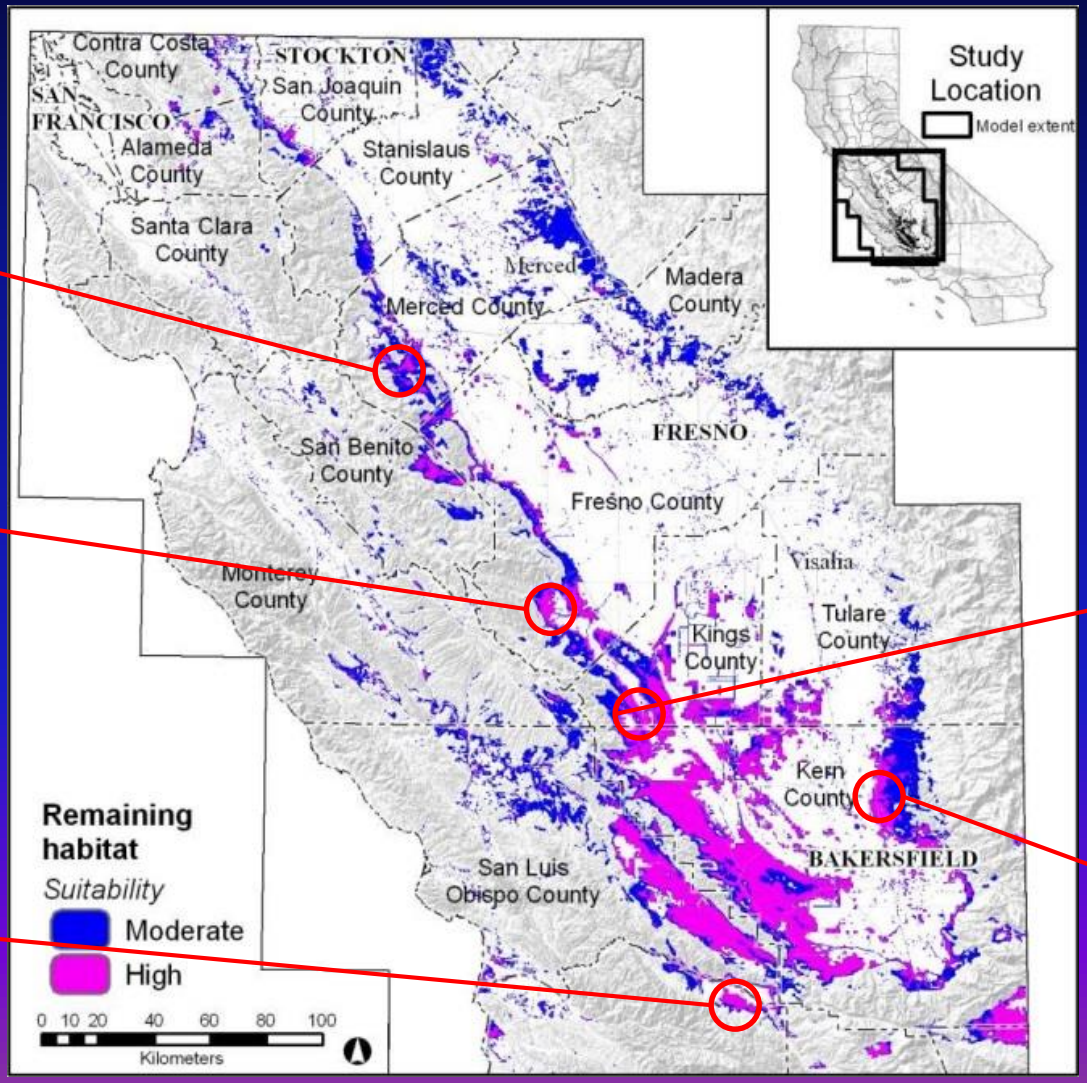
Bena Landfill Conservation Area – 1999-present

“Wish List” Study Sites

Western Merced County

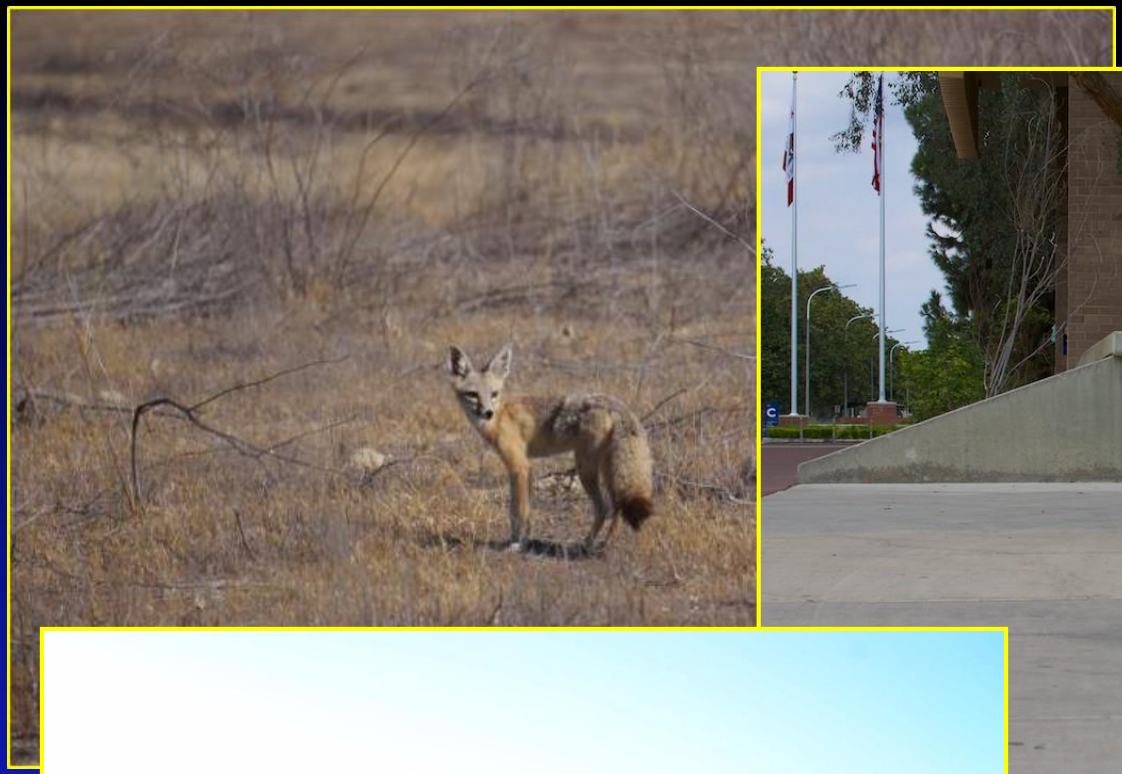
Coalinga – natural and urban

Cuyama Valley



Kettleman Hills Area

Kern Front



Lessons (or "*Reminders*")

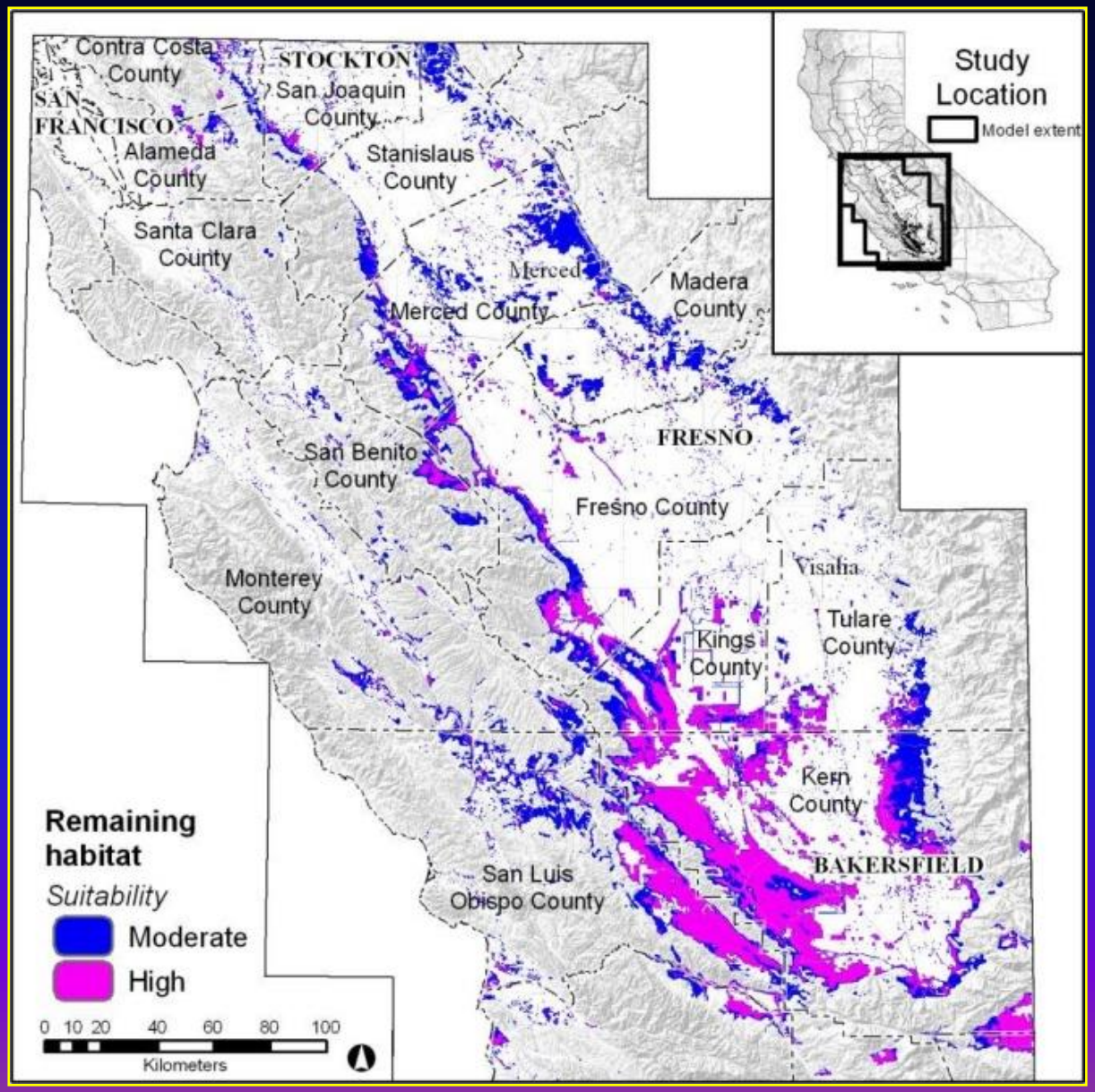
- Populations vary in conditions and stressors
- As a result, populations vary demographically and ecologically
- Consequently, "one size fits all" approach not practical and even potentially dangerous
- Conservation/management strategies should be specifically developed for each site
- Efficacy of strategies will likely be greater as available information for each population/site increases

IV. Conservation Needs

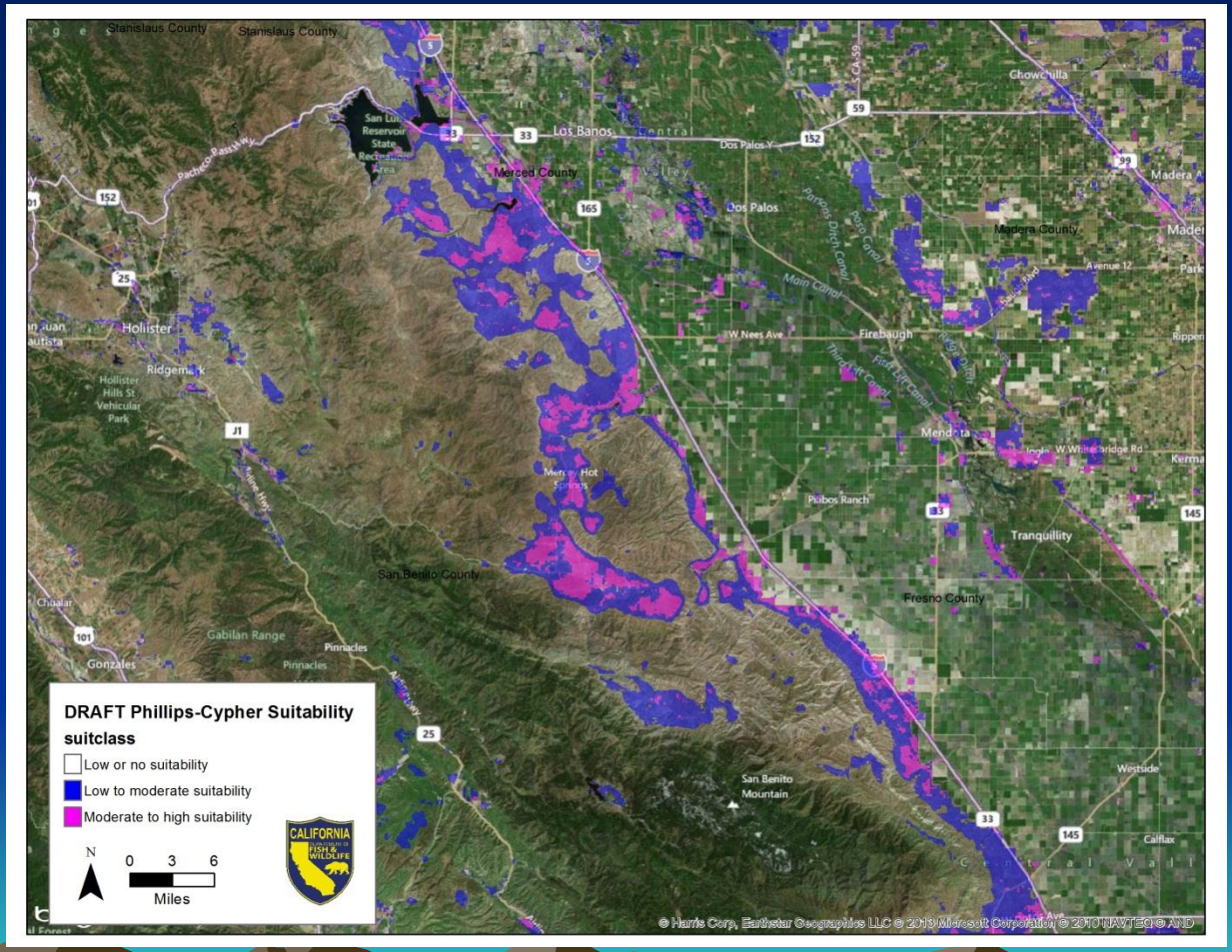
San Joaquin Kit Fox Conservation Needs

- HABITAT! HABITAT! HABITAT!!!
  - Permanently conserved through fee title or CE's
  - The high quality habitat
  - In blocks of at least 10,000 ac
- Maintain/create connectivity between habitat patches
- Appropriate management of habitat
  - Exclusion of incompatible uses
  - Manage vegetation structure
- Continued demographic and ecological studies throughout the range, including anthropogenically altered habitats
- Population viability analyses: range-wide and regional/local
- Climate change impacts
- Outreach: education and awareness

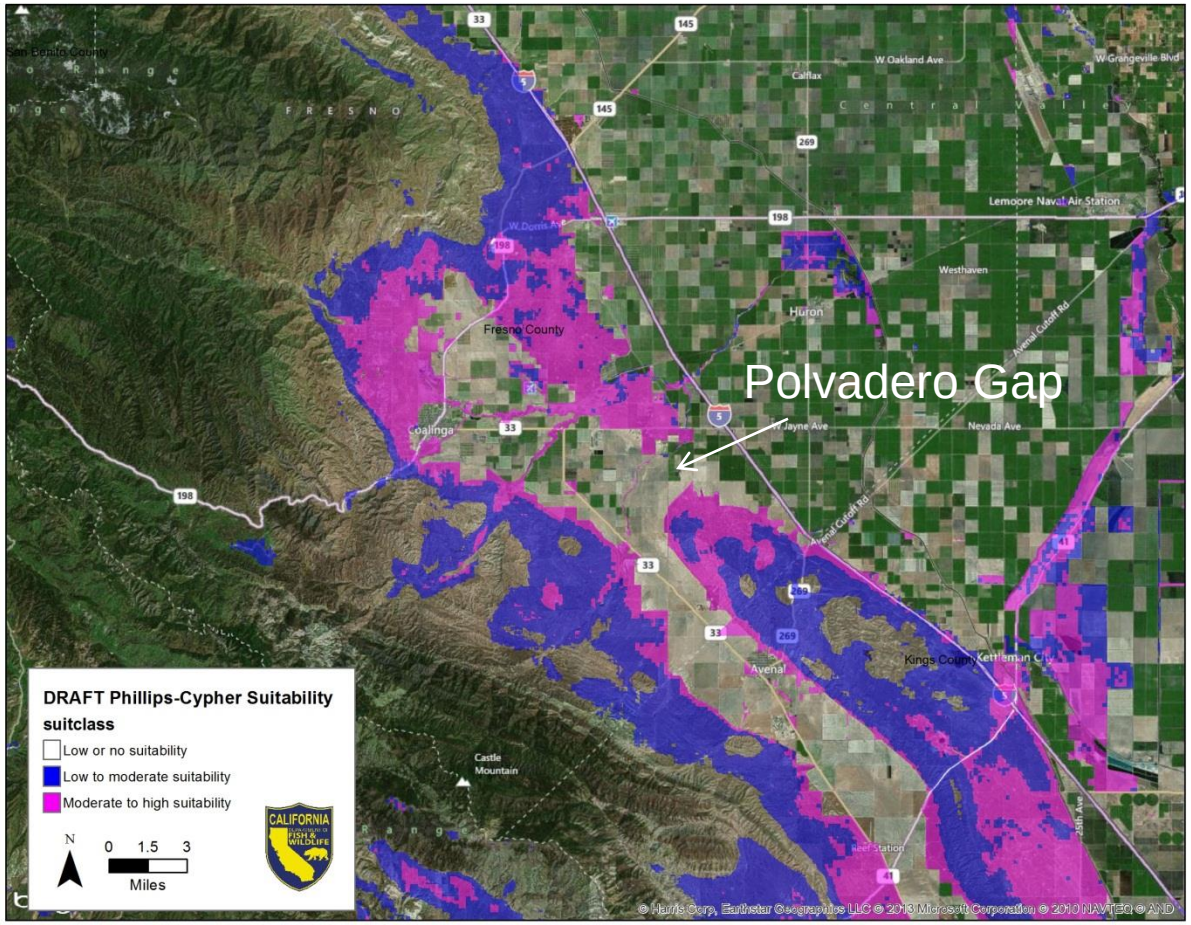
Kit Fox Habitat Suitability



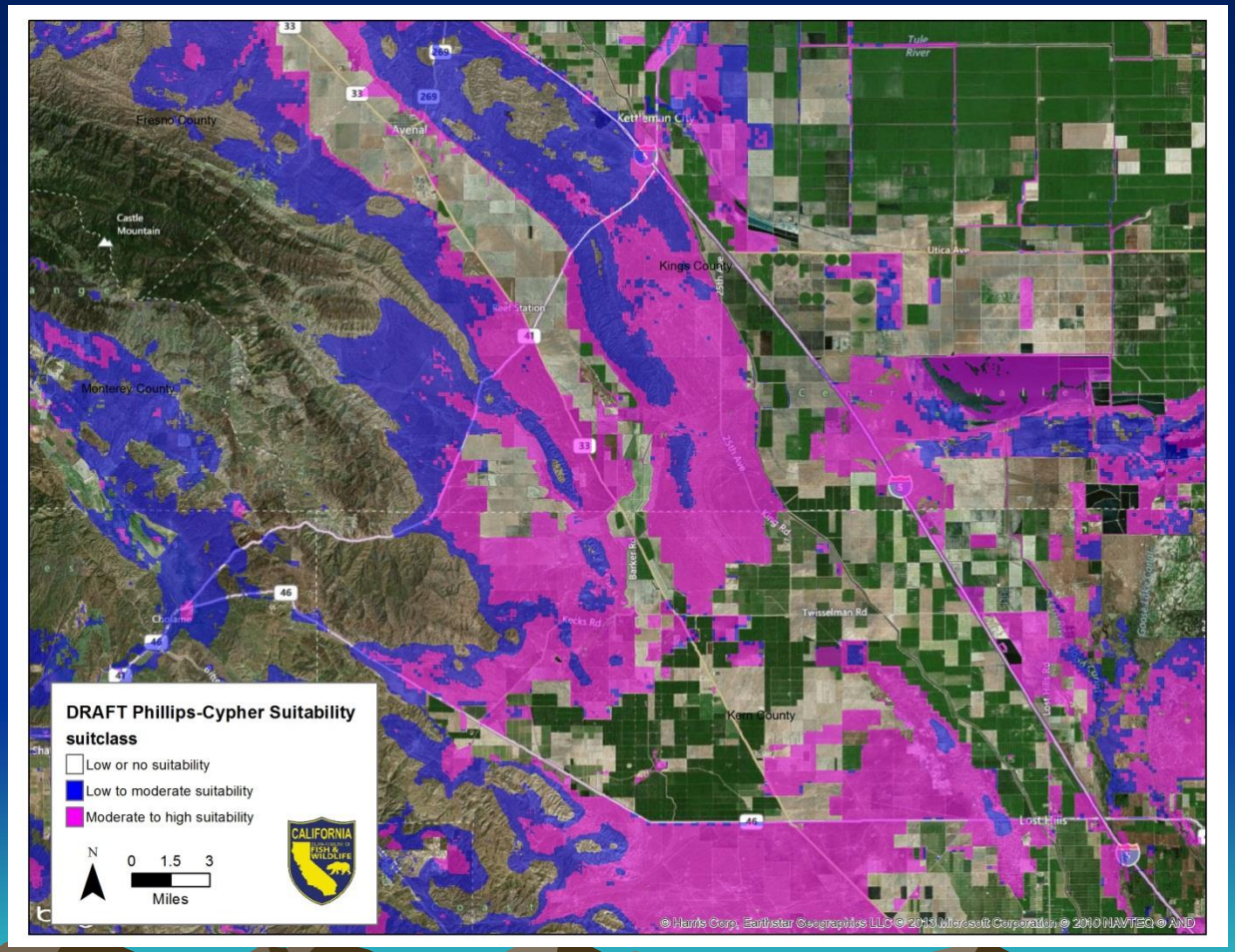
Panoche-Santa Nella



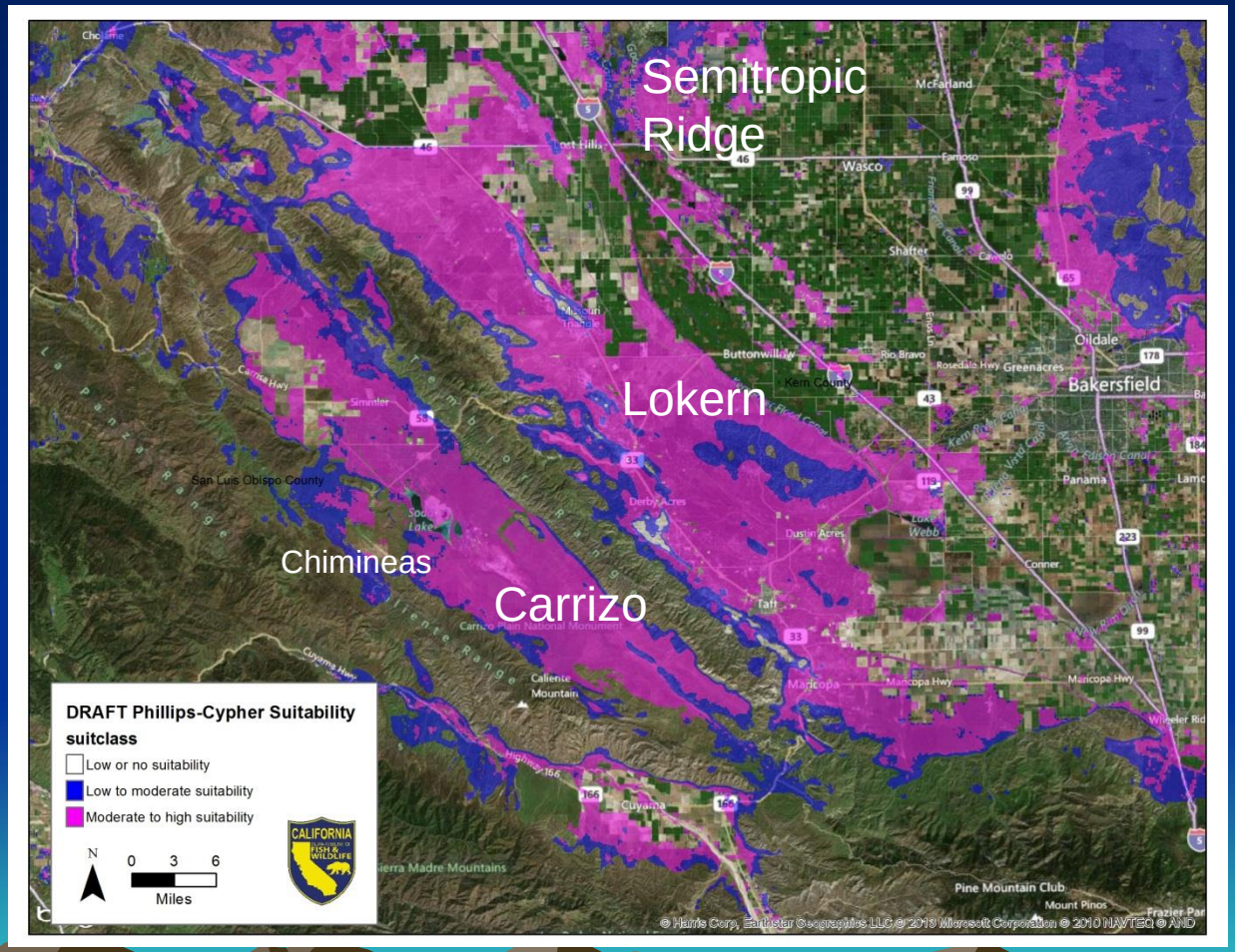
Coalinga


Polvadero Gap
DRAFT Phillips-Cypher Suitability
suitclass
Low or no suitability
Low to moderate suitability
Moderate to high suitability
N
0 1.5 3
Miles
CALIFORNIA
FISH & WILDLIFE
Coalinga
Huron
Westhaven
Lemoore Naval Air Station
Fresno County
Kings County
Avenal
Castle Mountain
Caltax
W Oakland Ave
W Grangeville Blvd
W Jayne Ave
Nevada Ave
Avenal Cutoff Rd
San Benito County
FRESNO
Central Valley

Sunflower Vly, Kettleman Hills



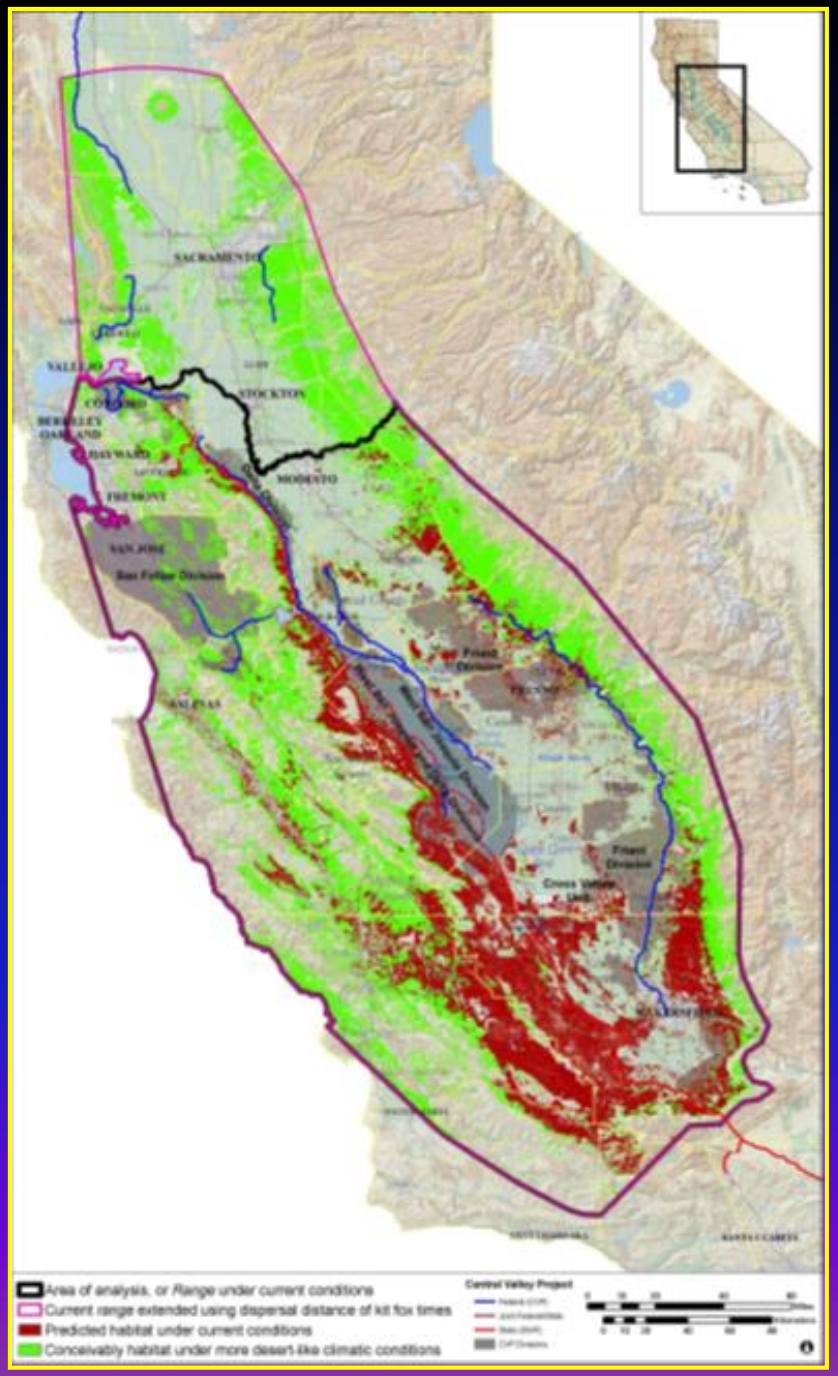
Carrizo, Lokern, Bakersfield



Unsuitable Ground Cover

Vegetation Management by Grazing

Effects of Climate Change on San Joaquin Kit Fox Habitat

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Thanks!